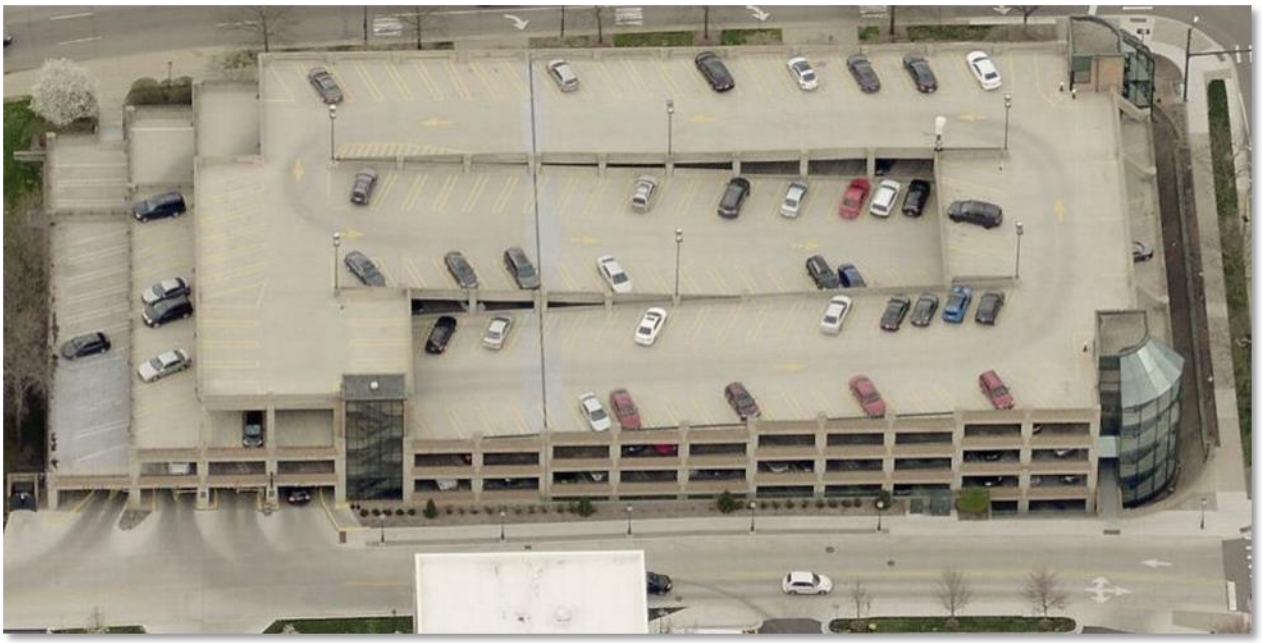
WJE

PROJECT MANUAL

2024 REPAIRS – CHESTER STREET PARKING STRUCTURE

180 Chester Street, Birmingham, MI 48009



ISSUED FOR BID

March 21, 2024

WJE No. 2022.0566.5

PREPARED BY:

Wiss, Janney, Elstner Associates, Inc.

30700 Telegraph Road, Suite 3580

Bingham Farms, MI 48025

248.593.0900 tel

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END OF SECTION 00 01 15

SECTION 00 41 44
BID FORM

PART 1 GENERAL

PROJECT: Chester Street Parking Structure
2024 Repairs
180 Chester Street
Birmingham, Michigan 48009

BID DUE: Refer to City of Birmingham bidding instructions.

SUBMITTED TO: Aaron Ford
City of Birmingham
Email: aford@bhamgov.org

COPY TO: Wiss, Janney, Elstner Associates, Inc.
Attn: Sarah Rush, PE and Matthew Lewis, PE
Email: *srush@wje.com* and *mlewis@wje.com*
Phone: 248-593-0900

SUBMITTED BY: _____
Bidder name

_____
Bidder address

_____

_____
Date

1.1 BIDDER CERTIFIES THE FOLLOWING:

A. Bidder has carefully read and understands Bidding Documents.

B. Bidder has visited site and become familiar with local conditions under which Work is to be performed, including verifying visible conditions, such as dimensions, materials, and attachments to remain, on existing facility.

C. Bidder has correlated Bidder's personal observations with requirements of Bidding Documents. Bidding Documents include Project Drawings and Project Manual dated March 21, 2024, prepared by WJE and addenda.

D. Bidder shall notify Architect/Engineer of discrepancies, omissions, conflicts, or unclear meaning within Bidding Documents; Architect/Engineer will interpret Bidding Documents and, if necessary, issue written addendum. Contracted Work will be based on Architect/Engineer's interpretation of Bidding Documents.

E. Bidder may not withdraw Bid within 60 calendar days after Bid Due date.

F. Bidder agrees that Owner has right to waive informalities and irregularities in Bid received and to accept Bid which, in Owner's judgment, is in Owner's own best interests.

G. Bidder acknowledges receipt of following addenda by checking the corresponding box(es) below.

No. ____ Dated _____ ☐
No. ____ Dated _____ ☐

1.2 LUMP SUM WORK ITEMS

A. Refer to Section 01 11 00.

1.3 ALLOWANCES

A. Refer to section 01 21 00.

B. To address changes in the work not indicated by the Contract Documents and Specifications, and upon written instruction of the Owner, the following prices shall prevail in accordance with the General Conditions.

C. Labor costs: All trades at their prevailing hourly rate plus _____ percent (___%) for profit and overhead.

D. Material costs: At cost plus _____ percent (___%) for profit and overhead.

1.4 UNIT PRICES

A. Refer to Section 01 22 00. See Bid Proposal Form for estimated quantities.

B. Unit Prices as defined in Section 01 22 00 shall be used to determine adjustments to the Contract Amount when changes are made in the quantity of work, regardless of the magnitude of the change. If, however, in the opinion of the Architect/Engineer, a significant increase or decrease in quantity for any unit price work item is justifiable cause for a change in the original unit price, then the Owner reserves its right to re-negotiate the unit price with the contractor.

C. Bidder must state a Unit Price and Total Amount of Bid for each item. In filling out the Bid Form, the Total Amount of Bid in Dollars for each item must be the product of the estimated quantity and the Unit Price. The "GRAND TOTAL" must be the sum of the total amounts bid for the respective individual items.

D. Should the final quantities for each item vary from the estimated quantity, the difference between the final and estimated quantity shall be multiplied by the Unit Price. If the quantity difference is positive, the dollar amount is considered as an additional cost. If the quantity difference is negative, the dollar amount is considered a credit.

E. Prior to beginning any work on a Unit Price basis, the Contractor shall notify the Architect/Engineer sufficiently in advance to permit measurements to be verified. Only quantities which have been verified and approved by the Architect/Engineer shall be used to determine adjustments to the Contract Amount. Performance of any work not required by the Contract Documents, not verified by the Architect/Engineer, or authorized by signed Change Order shall not be considered for payment under the terms of Unit Prices. The Contractor shall be solely responsible for all unauthorized work.

BID PROPOSAL FORM

NOTE: Bidder shall state Unit Price Bid and Total Bid amount for each unit price item. Total Bid amount for each item shall be product of Estimated Quantity by Unit Price. Unit Price Bid and Total Bid amounts shall be written numerically in spaces provided.

GRAND TOTAL shall be sum of Total Bid amounts for various items.

All words and numbers shall be written in non-erasable medium.

1.5 BASE BID

A. For all labor, materials, services and equipment necessary for completion of the work specified, the Bidder bids:

LUMP SUM WORK ITEMS		
Item	**Description**	**Total**
1.	General conditions	$_____
2.	Performance bond, labor, and material payment bond	$_____
3.	Brick masonry coping repair	$_____
4.	Ledge repair at west foundation wall	$_____
5.	Vertical crack repair at Stairs A and B	$_____
6.	Facade and wall cleaning	$_____
7.	Cove seal replacement	$_____
8.	Joint sealant replacement at slab-on-ground	$_____
9.	Roofing replacement at stair towers	$_____
10.	Curtainwall and glazing repairs	$_____
11.	Architectural coating (non-elastomeric) at lower levels	$_____
12.	Steel coating of utilities	$_____
13.	Pavement markings	$_____
14.	Lighting fixture replacement	$_____
15.	Electrical work	$_____
16.	Mechanical work	$_____
17.	Plumbing work	$_____
18.	All other work items defined on Drawings (see Summary of Work)	$_____

LUMP SUM WORK ITEMS		
Item	**Description**	**Total**
	Base Bid Lump Sum Work Items – Subtotal:	$_____

ALLOWANCE WORK ITEMS		
Item	**Description**	**Total**
19.	Contingency allowance	$ 250,000
20.	Localized steel coating	$ 50,000
21.	New mechanical room and concrete pads for mechanical equipment	$ 50,000
22.	Lighting modifications	$ 50,000
	Allowance Work Items – Subtotal:	**$ 400,000**

UNIT PRICE WORK ITEMS					
Item	**Description**	**Est. Qty**	**Unit**	**Unit Price**	**Total**
	CONCRETE REPAIR ITEMS				
23.	Partial-depth top surface concrete repair	500	sq ft	$_____	$_____
24.	Full-depth concrete slab repair	2,500	sq ft	$_____	$_____
25.	Partial-depth overhead concrete repair	250	sq ft	$_____	$_____
26.	Partial-depth concrete beam repair	1,500	sq ft	$_____	$_____
27.	Vertical concrete column or wall repair	1,000	sq ft	$_____	$_____
28.	Bumper wall curb and curb repair	250	lin ft	$_____	$_____
29.	Supplemental epoxy-coated reinforcing steel	1,000	lb	$_____	$_____
30.	Supplemental dowels	500	each	$_____	$_____
31.	Full-depth slab-on-ground repair	50	sq ft	$_____	$_____
	POST-TENSIONING REPAIR ITEMS				
32.	Slab exploratory opening	125	each	$_____	$_____
33.	Grout pocket exploratory opening	250	each	$_____	$_____
34.	Tendon sheathing repair	1,000	lin ft	$_____	$_____
35.	New 7-wire strand	2,500	lin ft	$_____	$_____

UNIT PRICE WORK ITEMS					
Item	**Description**	**Est. Qty**	**Unit**	**Unit Price**	**Total**
36.	Strand coupler	100	each	$_____	$_____
37.	Central stressing coupler, including restressing	50	each	$_____	$_____
38.	New fixed end anchorage	15	each	$_____	$_____
39.	Reseat tendon in existing end anchor	5	each	$_____	$_____
40.	Reseat tendon in existing stressing end anchor, including restressing	10	each	$_____	$_____
	WATERPROOFING AND DURABILITY WORK ITEMS				
41.	Rout and seal cracks in slab	1,500	lin ft	$_____	$_____
42.	Horizontal joint sealant replacement	2,500	lin ft	$_____	$_____
43.	Traffic-bearing membrane installation	80,000	sq ft	$_____	$_____
44.	Leveling course installation	20,000	sq ft	$_____	$_____
45.	Silane sealer installation	140,000	sq ft	$_____	$_____
46.	Winged expansion joint sealant replacement	350	lin ft	$_____	$_____
47.	Premolded expansion joint seal replacement	250	lin ft	$_____	$_____
48.	Silicone-coated precompressed seal replacement	40	lin ft	$_____	$_____
49.	New floor drain	5	each	$_____	$_____
50.	Elastomeric coating on vertical surfaces	500	sq ft	$_____	$_____
	STAIR AND ELEVATOR LANDING REPAIR ITEMS				
51.	Concrete topping replacement at stair treads/landings	1,500	sq ft	$_____	$_____
52.	Concrete topping replacement at elevator landings	250	sq ft	$_____	$_____
53.	Metal stair tread and riser replacement	60	each	$_____	$_____
54.	Metal pan and support framing replacement at stair landings	5	each	$_____	$_____
55.	Metal decking replacement at elevator landings	100	sq ft	$_____	$_____
56.	Structural steel ledger angle replacement at elevator landings	200	lin ft	$_____	$_____

UNIT PRICE WORK ITEMS					
Item	**Description**	**Est. Qty**	**Unit**	**Unit Price**	**Total**
57.	Clean and paint steel framing or decking	2,500	sq ft	$_____	$_____
58.	Perimeter sealant at Stairs A and B	6	level	$_____	$_____
59.	Perimeter sealant at Stair C	3	level	$_____	$_____
60.	Railing post base repair	8	each	$_____	$_____
61.	Glazing replacement	1	each	$_____	$_____
	MASONRY AND FLASHING REPAIR ITEMS				
62.	Rebuild brick veneer	2,500	sq ft	$_____	$_____
63.	Repoint brick veneer	2,000	lin ft	$_____	$_____
64.	Repoint brick veneer	2,000	sq ft	$_____	$_____
65.	Vertical brick crack repair	500	lin ft	$_____	$_____
66.	Helical anchor installation	250	each	$_____	$_____
				Base Bid Unit Price Work Items - Subtotal	**$**

SUMMARY PORTION OF BASE BID

Subtotal Lump Sum Work Items: $_____

Subtotal Allowance Work Items: $ 400,000.00

Subtotal Unit Price Work Items: $_____

BASE BID GRAND TOTAL (Sum of Subtotals): $_____

BASE BID GRAND TOTAL (in words): _____

_____ Dollars

1.6 CONSTRUCTION SCHEDULE

A. It is anticipated that this project will be authorized in Spring 2024 via a written Notice to Proceed.

B. The Contractor agrees to reach substantial completion before Fall 2025 or as otherwise indicated in the City of Birmingham bidding instructions.

C. Time of completion of the proposed Contract is of importance to the Owner and will be considered in the award of the Contract.

D. The Contractor agrees to commence work under the Contract on or before _____ calendar date or a date to be specified in a written "Notice to Proceed."

E. The Contractor proposes to complete all defined Base Bid work within _____ calendar days from the date specified in the Notice to Proceed.

F. The selected Contractor shall submit a detailed construction/work sequence schedule describing the work to be performed in each phase on an event by event basis, together with an estimate of time necessary to complete each phase of the Project.

1.7 ALTERNATES

A. Refer to Section 01 11 00.

B. Alternate bid amounts include labor, materials, services, and equipment necessary for completion of Alternate Work, including costs of related coordination, modification, or adjustment required to fully integrate Alternate Work into Project.

C. Alternate bid amount is net adjustment to Contract Sum to incorporate Alternate into Work. No other adjustments will be made to Contract Sum.

D. For completion of the work specified, the Bidder bids:

ALTERNATE LUMP SUM AND UNIT PRICE WORK ITEMS

Item	Description	Bid Qty	Unit	Unit Cost	Total
1.	Sheet metal coping replacement	-	-	-	$_____
2.	Limestone coping replacement	-	-	-	$_____
3.	Traffic-bearing membrane at Level 3	-	-	-	$_____
4.	Architectural coating (non-elastomeric) at upper levels	-	-	-	$_____
5.	Lighting fixture modifications	-	-	-	$_____

1.8 SUBCONTRACTORS

A. Indicate portion(s) of work to be completed by a subcontractor and name of subcontractor:

Portion of Work	**Subcontractor (if used)**
Post-tensioning	_____
Traffic-bearing membrane	_____
Sealant or expansion seals	_____
Masonry	_____
Roofing	_____
Curtainwall	_____
Mechanical	_____
Electrical	_____
Plumbing	_____
Painting	_____
_____	_____
_____	_____

1.9 BIDDER'S RESUME

A. List a minimum of three projects of similar type and scope performed in the last five years (this form may be copied for providing information on additional projects for each subcontractor):

B. Project 1
Client: _____

Building: _____

Address: _____

Phone: _____

Year when work was performed: _____

Cost of work performed by contractor: _____

Description of scope performed by contractor: _____

_____

_____

C. Project 2
Client: _____

Building: _____

Address: _____

Phone: _____

Year when work was performed: _____

Cost of work performed by contractor: _____

Description of scope performed by contractor: _____

_____

_____

D. Project 3
Client: _____

Building: _____

Address: _____

Phone: _____

Year when work was performed: _____

Cost of work performed by contractor: _____

Description of scope performed by contractor: _____

_____

_____

1.10 BIDDER'S ENDORSEMENT

I hereby certify that all statements herein are made on behalf of _____

_____

_____
(Name and Address of Corporation, Partnership, or Person submitting bid)

of the City of _____State of _____

that I have examined and carefully prepared this Bid from the plans and specifications and have checked the same in detail before submitting this Bid; that I have full authority to make such statements and submit this Proposal in (its, their) behalf; and that the said statements are true and correct.

_____
(Signature)

_____
(Title)

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION – NOT USED

END OF SECTION 00 41 44

SECTION 01 11 00
SUMMARY OF WORK

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Description of existing conditions and Work scope, and Contractor duties and use of premises.

1.2 OWNER/CONTRACTOR AGREEMENT

A. Perform Work under terms of Owner. Sample contract and insurance requirements on City's bid posting provided for reference.

B. Owner: City of Birmingham. 151 Martin Street, Birmingham, MI 48009.

C. Architect/Engineer: Wiss, Janney, Elstner Associates, Inc. 30700 Telegraph Road, Suite 3580, Bingham Farms, MI 48025.

1.3 CONTRACTOR DUTIES

A. Except as specifically noted, provide and pay for:
   1. Labor, materials, and equipment.
   2. Tools, construction equipment, and machinery.
   3. Water, heat, power, and lights required for construction beyond those available at facility.
   4. Other facilities and services necessary for proper execution and completion of Work.
   5. Legally required sales, consumer, and use taxes.
   6. Permits, government fees, and licenses as necessary for proper execution and completion of Work and as applicable at time of receipt of bids.

B. Comply with codes, ordinances, rules, regulations, orders, and other legal requirements of public authorities having jurisdiction, which bear on performance of Work.
   1. Take necessary safety precautions to prevent injury to construction personnel, non-construction personnel, Owner's property, and adjacent facilities.
   2. Perform work in a manner to minimize hazards due to the disturbance of lead containing materials (paint) and comply with MIOSHA requirements for assessing, monitoring, and protecting employees from lead hazard.
   3. Give required notices.
   4. Products shall comply with local regulations, including environmental restrictions.
   5. Promptly submit written notice to Architect/Engineer of observed variance of Contract Documents from legal requirements. It is not the Contractor's responsibility to make certain that Drawings and Specifications comply with codes and regulations.
      a. Propose appropriate modifications to Contract Documents for necessary changes.
      b. Assume responsibility for Work known to be contrary to such requirements, which is performed without notice.

C. Enforce strict discipline and good order among employees. Do not employ unfit persons or persons not skilled in their assigned tasks.

D. Provide 24-hour emergency contact information for Contractor and major subcontractors, including names and telephone numbers.

1.4 PROJECT CONDITIONS

A. Description of Existing Structure:
   1. Constructed in 1988, the Chester parking structure features six levels of parking. Lower Levels 1 and 2 are below grade, with Lower Level 2 consisting of a reinforced concrete slab on ground, while the Level 1 and Level 2 through 4 are supported above grade. The three-bay side-by-side structure is rectangular-shaped, extending 167 feet in the north-south direction and 330 feet in the east-west direction for a total parking area of approximately 282,500 square feet. The central and south bays are sloped to serve as circulation ramps, while the north bay is relatively level with a minor transverse slope for drainage. The floor plans for Level 2, 3, and 4 are incrementally set back at the garage perimeter (terraced).
   2. The structure consists of cast-in-place conventionally reinforced concrete columns supporting cast-in-place post-tensioned (PT) concrete beams and slabs. The PT tendons consist of single 7-wire strands in plastic sheathing with bonded reinforcement. The one-way structural slab consists of tendons extending in the east-west direction spanning between the PT beams, while the temperature and shrinkage tendons run in the north-south direction. One expansion joint is present on the east end of the garage, while multiple construction joints are present in each bay, which corresponds to locations of intermediate PT anchorages.
   3. An existing traffic coating is present at the pedestrian bridges and outside the elevators on Level 1, around perimeter column bases on Level 3, and at some of the expansion joints on Level 3 and all expansion joints on Level 4.
   4. The perimeter walls generally consist of conventionally reinforced concrete supported on the concrete slab, which are clad with brick veneer. Concrete spandrel panels are present at the roof level and recessed areas on the north facade. The vehicle barrier system at interior column lines consists of post-tensioned cables. Steel channels surface-mounted to the exterior concrete columns serve as supplementary vehicle barriers on the south wall of Lower Level 1 to Level 4.
   5. Stair towers with elevator shafts project from the building plan on the east corners of the parking structure and are connected to the adjacent sidewalk with arched reinforced concrete pedestrian bridges at grade. A third stair tower is present to the east of the vehicle entrance. A fourth one-story stair is present at the northwest corner of the structure.
      a. A portion of the floor slab near the elevator shafts of each level consists of a composite reinforced concrete slab with a corrugated steel deck. This slab portion is independent of the adjacent post-tensioned slab and is separated by an expansion joint.
      b. The stair towers are generally clad in brick masonry veneer, metal panels, and curtain wall assemblies.
      c. The stair roofing consists of a ballasted single-ply roofing membrane or adhered singly-ply roofing membrane depending on the location.
   6. Office, utility, and storage rooms are located on the southwest corner of Level 1, Lower Level 1, and Lower Level 2, as well as within the center of Lower Level 2.

B. Original Drawings**:** Original construction drawings developed by Luckenback | Ziegelman and Partners, Inc. dated June 16, 1988, are available and can be provided to bidders for reference. No shop drawings of the post-tensioning system are available. Information provided in WJE's

drawings are based on the original construction drawings and select verified field conditions and as such cannot be guaranteed to be accurate with the as-built construction. All conditions must be verified by the Contractor.

C. Description of Recent Repairs:
   1. Isolated waterproofing and structural repairs were completed at the Chester Street parking structure in 2022, including but not limited to:
      a. Replacement of pre-molded expansion joint seals on Lower Level 1, Level 1, Level 2, and Level 3, including expansion joints near stairs.
      b. Replacement of construction joint sealant within elevated slabs.
      c. Rout and sealing of cracks on the top surfaces of the elevated slabs.
      d. Cleaning and inspecting all floor drains and replacing readily visible damaged components.
      e. Localized partial-depth concrete slab and post-tensioning repairs as needed to perform the above work activities.
      f. Installation of a sump pit and sump in Stair B of Lower Level 2.
      g. Installation of hydrophobic grout injection within the west office and Stair B elevator pit of Lower Level 2.
      h. Installation of a sheet metal flashing cap at the foundation wall outside the west office at Level 1.

D. Descriptions of Anticipated Work by Others:
   1. The Owner has recently solicited bids for the installation of 10 electric vehicle charging stations for the Chester Street Garage.
   2. This project commencement, duration, and schedule are not fully known at this time. Coordinate Work as needed.

E. Description of Deterioration:
   1. Structural post-tensioning tendon corrosion and fractured tendons.
   2. Concrete material degradation and corrosion of embedded mild steel reinforcing.
   3. Worn existing traffic bearing membrane and penetrating silane sealer materials.
   4. Worn and cracked expansion joint seals and debonded joint sealants.
   5. Poor drainage or drain management at slab and roofs.
   6. Structural steel corrosion within stairwell and at elevator landings.
   7. Spalled, cracked, and stained brick masonry veneer.
   8. Broken and displaced glass panels within the curtainwall.
   9. Displaced setting blocks within curtainwall and cracked and debonded glazing.
   10. Cracked and debonded sealant materials.
   11. Deteriorated roofing membranes and leaking roof drainage components.
   12. Peeling and chipped paint on metal stairwell and handrail surfaces.
   13. Aged mechanical, electrical, and plumbing systems or components that are non-compliant or do not support current or future operational uses.

1.5 WORK SCOPE

A. The primary project objectives are to address structural, waterproofing, and facade repairs at the parking structure; repair or improve the mechanical, electrical, and plumbing systems; and paint portions of the garage for improved aesthetics.

B. Work includes, but is not limited to, the following activities:
   1. Concrete repairs
   2. Post-tensioning tendon and anchorage repairs

3. Joint sealant replacement
4. Expansion joint seal replacement
5. Traffic coating (membrane) installation and silane sealer installation
6. Supplemental drain installation and drain bowl replacement
7. Stair tread, riser, and landing repairs
8. Elevator lobby floor slab repairs
9. Perimeter brick coping repairs
10. Masonry and flashing repairs
11. Facade cleaning and cleaning of localized interior staining
12. Restriping all pavement markings
13. Architectural coating (non-elastomeric) installation
14. Steel coating installation
15. Elastomeric coating installation
16. Curtainwall and glazing repairs
17. Roofing replacement at stair towers
18. Mechanical, electrical, and plumbing repairs and improvements

C. Alternate work items include, but are not limited to, the following activities:
1. Sheet metal coping replacement
2. Limestone coping replacement
3. Installation of additional traffic bearing membrane regions at Level 3
4. Architectural coating (non-elastomeric) installation at upper levels

1.6 LUMP SUM WORK ITEMS

A. Lump Sum Item 1 – General conditions: All work defined in the Contract Documents not included in the other work items below. This includes, but is not limited to, supervision; mobilization; coordination and meetings; permits; dust protection and other personal protections; submittals; mock-ups; concrete material testing; sounding all concrete surfaces and mark delaminated areas for Engineering review; review all masonry surfaces and mark areas of deterioration for Engineering review; protection of existing construction from damage; dumpsters; daily job site cleaning; temporary facilities and controls; temporary relocation of lighting fixtures and other electrical items; lifts, scaffolding, and other access needed to conduct work, temporary traffic control and signage; barricades; project close out; and assuming an average of eight (8) hours of Engineer inspection time per week.

B. Lump Sum Item 2 – Performance bond and labor and material payment bond: Each in the amount of 100 percent of the contract sum (Base Bid Grand Total), held for a minimum of 1 year after acceptance of work.

C. Lump Sum Item 3 – Brick masonry coping repair (Keynote N): All work associated with repairing 100% of the brick masonry copings at the perimeter walls, site walls, pedestrian bridge walls, and dumpster screen walls in accordance with the Drawings (Sheets S-103 and S-201, and Detail 2A/S-502) and Section 04 01 21, Section 07 62 00, and Section 07 65 00 including but not limited to the following:
1. Remove brick masonry header units and mortar bed materials
2. Install new flashings and end dams
3. Install new or salvaged brick masonry header units
4. Install sealants at penetrations and intersecting building elements
5. Coordinate removal and replacement of adjacent curtain wall or glazing elements with other trades.

D. Lump Sum Item 4 – Ledge repair at west wall (Keynote O): All work associated with ledge repairs along the west foundation wall in accordance with the Drawings (Details 4/S-201, 5/S-502, 9/S-513) and Section 07 62 00 and Section 07 92 00 including but not limited to the following:
   1. Remove and dispose of existing masonry and flashing materials
   2. Install new backer and sealant at foundation wall
   3. Install new sloped wash or wood blocking
   4. Install new self-adhered membrane system
   5. Install new sheet metal flashings and cleats
   6. Install preformed silicone sealant
   7. Install backer rod and sealant at reglet.

E. Lump Sum Item 5 – Vertical crack repair at Stairs A and B: All work associated with repair of the vertical load-bearing masonry walls at the stairs in accordance with the Drawings (Sheets S-401 through S-404, Detail 4/S-502) and Section 03 01 31 and Section 03 01 34 including but not limited to the following:
   1. Shore elevator landings, stair stringers, and curtainwall system and/or phase work as needed
   2. Sawcut edges of removal area
   3. Remove and dispose of cracked and sound brick masonry and grout fill
   4. Clean and prepare exposed grout and steel reinforcing bar surfaces
   5. Coating exposed steel with corrosion-inhibiting coating
   6. Recasting wall section using concrete materials
   7. Curing
   8. Embed thin bricks at Level 1 pedestrian bridge surfaces to restore aesthetic
   9. Installing compressible filler, backer, and sealant at sides of repair area as specified.
   10. Representative locations are identified on Detail 5&6/S-515.

F. Lump Sum Item 6 – Facade and wall cleaning: All work associated with cleaning facade, site walls, pedestrian bridges, interior walls below elevator landings at Lower Level 2 and Lower Level 1, and dumpster screen wall surfaces in accordance Section 04 01 20 and Section 08 80 00, including the concrete, masonry, curtainwall, and other substrates. Work includes cleaning of localized efflorescence, biological, and corrosion staining (Keynotes P & Q) including but not limited to locations identified in the Drawings (Sheets S-201, S-202, S-401, S-403, S-405, S-515, S-516).

G. Lump Sum Item 7 – Cove sealant replacement (Keynote K): All work associated with replacement of cove sealant joint materials on Lower Level 1 to Level 4 in accordance with the Drawings (Sheet S102 to S106) and Section 07 92 00. Work includes but is not limited to the following:
   1. Remove and dispose of existing sealant materials
   2. Prepare concrete substrate
   3. Install new backer rod and sealant materials
   4. Work to include all horizontal-to-vertical transitions at the site including but not limited to the following: between slab and wall elements, slab and column elements, slab and curb elements, slab and bollard elements, wall and curb elements, sidewalk and curb elements, and sidewalk and site wall elements.
      a. Work **excludes** cove sealant at elevated stair landings and treads (see Unit Price Items), and Lower Level 2 slab-on-ground (see Lump Sum Item 8).
      b. Representative locations are indicated on Sheets S-513 to S-515.

H. Lump Sum Item 8 – Joint sealant replacement at slab-on-ground (Keynote K): All work associated with replacement of joint sealant materials within the Lower Level 2 slab-on-ground in accordance with the Drawings (Sheet S101) and Section 07 92 00. Work includes but is not limited to the following:
   1. Remove and dispose of existing sealant materials
   2. Prepare concrete substrate
   3. Install new backer rod and sealant materials
   4. Coordinate access within chain link fence area with Owner
   5. Work to include all control joint, construction joint, and horizontal-to-vertical transitions at the site including but not limited to the following: between slab and wall elements, slab and column elements, slab and curb elements, slab and bollard elements, and wall and curb elements.
      a. Work **excludes** cove sealant at elevated stair landings and treads (see Unit Price Items)
      b. Representative locations are identified on Details 5/S-515 and 5&6/S-516.

I. Lump Sum Item 9 – Roofing replacement at stair towers: All work associated with removal and replacement of the roofing assemblies and associated components at the three stair towers in accordance with the Drawings (Sheets S-106, S-407 and S-511) and Section 07 53 23 and 07 62 00. Work includes but is not limited to the following:
   1. Remove and dispose of existing ballast, roofing membrane, insulation, wood nailers, metal copings, flashing, gutters, and downspouts
   2. Permit Architect/Engineer inspection of exposed steel decking
   3. Install of new roofing assemblies as specified.
   4. Coordinate roofing-related work with other trades (e.g., glazing, masonry).

J. Lump Sum Item 10 – Curtainwall and glazing repairs. All work associated with the curtain wall and glazing repairs in accordance with the Drawings (Sheet S-202, Elevation 4/S-201, and Sheet S-512) and Section 08 80 00, including but not limited to the following:
   1. Removing and resetting localized glass panels
   2. Replacing localized glass panels
   3. Curtain wall glazing setting block repairs
   4. Curtain wall glazing horizontal butt joint sealant replacement
   5. Curtain wall sill flashing repairs
   6. Perimeter glazing sealant replacement at curtain wall, window, door, louver, and other wall-penetrating elements within the facade, stair towers, storage and utility rooms, offices, and other enclosures.
   7. Temporarily stabilizing curtainwall during pedestrian bridge work as needed.
   8. Coordinating removal of adjacent curtain wall or glazing elements with other trades (e.g., concrete, masonry, roofing).

K. Lump Sum Item 11 - Architectural coating (non-elastomeric) at lower levels: All work associated with the application of an architectural coating in accordance with Section 09 97 24, including but not limited to: masking surfaces and utilities that are not to receive coating; protections of persons and property; preparing substrate surfaces; application of coating. Work includes coating application for the following elements within the lower levels (Lower Level 1 and Lower Level 2):
   1. Cast-in-place concrete wall surfaces
   2. Concrete masonry (block) wall surfaces
   3. Cast-in-place concrete columns
   4. Cast-in-place concrete ceilings (underside of elevated slabs and all beam surfaces)

5. Scope includes surfaces facing the parking area interior, including those surfaces perpendicular to the parking area interior (top, bottom, or sides of wall, beam, and column surfaces)
6. Where visible from the exterior of the parking structure in select regions of Lower Level 1, the top, bottom, and exterior surfaces of exterior columns and exterior walls are **excluded** from the work scope. Representative work extent is shown in Detail 1/S-514. The underside of the pedestrian bridges and the vertical beam surfaces directly below expansion joints are **excluded** from the work scope.

L. Lump Sum Item 12 - Steel coating of utilities: All work associated with the application of a steel coating in accordance with Section 09 97 13, including but not limited to: masking surfaces that are not to receive coating; protections of persons and property; preparing substrate surfaces; application of coating. Work includes the following elements:
1. New internal storm drain lines

M. Lump Sum Item 13 – Pavement markings: All work associated with preparation and application of parking stall markings in accordance with Drawings (Sheet S-101 to Sheet S-106) and Section 32 17 23.13, including but not limited to the following:
1. Prior to the start of work, measure and document the existing pavement markings, including parking stall striping and numerals, traffic lines and arrows, accessible markings, and crosshatching.
2. Submit shop drawings for review and approval before proceeding with work. Incorporate ADA and EV related documents provided by others.
3. Prepare concrete surfaces.
4. Apply new markings per the approved shop drawings.

N. Lump Sum Item 14 – Lighting fixture replacement: All work associated with the installation of new base bid LED lighting fixtures in accordance with the Drawings and Specifications, including but not limited to the following:
1. Removal and disposal of the existing lighting fixtures.
2. Installation of the new base bid lighting fixtures, including luminaires with no up-light and mounted directly to the J-box.

O. Lump Sum Item 15 – Electrical work: All work associated with the electrical modifications, repairs, and installations in accordance with the Drawings and Specifications, including but not limited to the following:
1. Coordinate with the EV charger installation scope (separate RFP and contract award).
2. Work **excludes** the lighting fixture work scope identified in Lump Sum Item 15.

P. Lump Sum Item 16 – Mechanical work: All work associated with the mechanical work in accordance with the Drawings and Specifications, **excluding** the construction of new mechanical room and concrete pads identified in the Allowances Section 01 21 00.

Q. Lump Sum Item 17 – Plumbing work. All work associated with the plumbing work in accordance with the Drawings and Specifications, **excluding** the steel painting scope identified in Lump Sum Item 12.

R. Lump Sum Item 18 – All other work items defined on the Drawings, including but not limited to the corresponding work items:
1. Install new diamond plate cover between pedestrian bridges and elevator landings per Detail 4/S-501, 2 locations.

2. Install sheet metal drip flashing in masonry reglet at pedestrian bridges per Detail 2/S-503.
3. Repair Level 4 stair tower door thresholds and metal storefront frames per Detail 8&9/S-516, 3 locations.
4. Repair Level 4 enclosure corner per Detail 10/S-516.
5. Repair Stair C ceiling drywall and paint per Detail 7/S-516.
6. Remove existing sealant at Stair B between brick and metal roof coping (15 LF), fill open brick core holes where exposed, and install sheet metal reglet flashing with sealant as noted on Detail 5&10/S-202.

1.7 ALLOWANCE WORK ITEMS

A. Refer to Section 01 21 00.

1.8 UNIT PRICE WORK ITEMS

A. Refer to Section 01 22 00.

1.9 ALTERNATE LUMP SUM WORK ITEMS

A. The following Alternate Work Items are solicited for consideration by Owner

B. Alternate Work Item 1 – Sheet metal coping replacement (Keynote N): In lieu of the base bid brick masonry coping repairs (Lump Sum Item 3), perform all work associated with replacement of the brick masonry copings with new sheet metal copings in accordance with the Drawings (Detail 2B/S-502) and Section 07 62 00 and Section 07 65 00 including but not limited to the following:
   1. Remove and dispose of existing brick header units and mortar bed materials
   2. Install new wood blocking
   3. Install new flashings and end dams
   4. Install new sheet metal copings
   5. Install sealants at penetrations and intersecting building elements
   6. Coordinate removal of adjacent curtain wall or glazing elements with other trades.

C. Alternate Work Item 2 – Limestone coping replacement (Keynote N): In lieu of the base bid brick masonry coping repairs (Lump Sum Item 3), perform all work associated with replacement of the brick masonry copings with new limestone copings in accordance with the Drawings (Detail 2C/S-502) and Section 04 01 40, Section 07 62 00, and Section 07 65 00 including but not limited to the following:
   1. Remove and dispose of existing brick header units and mortar bed materials
   2. Install new flashings and end dams
   3. Install new limestone coping units
   4. Install sealants at penetrations and intersecting building elements
   5. Coordinate removal of adjacent curtain wall or glazing elements with other trades.

D. Alternate Work Item 3 – Traffic-bearing membrane at Level 3 (Keynote L): All work associated with extending the base bid installation of the traffic bearing membrane at Level 3 to include the entirety of Level 3 in lieu of the specified silane sealer installation and localized traffic bearing membrane areas shown on the Drawings (Sheet S-105).

E. Alternate Work Item 4 - Architectural coating (non-elastomeric) at upper levels: All work associated with the application of an architectural coating in accordance with Section 09 97

24, including but not limited to: masking surfaces and utilities that are not to receive coating; protections of persons and property; preparing substrate surfaces; application of coating. Work includes coating application for the following elements within the upper levels (Level 1, Level 2, Level 3, and Level 4):

1. Cast-in-place concrete wall surfaces, excluding the exterior and roof level walls
2. Cast-in-place concrete columns
3. Cast-in-place concrete slab ceilings (underside of elevated slabs and all beam surfaces)
4. Scope includes surfaces facing the parking area interior, including those surfaces perpendicular to the parking area interior (top, bottom, or sides of wall beam, and column surfaces).
5. The top, bottom, and exterior surfaces of the exterior columns, exterior beams, and exterior walls are **excluded** from the work scope. Representative work extent is shown in Detail 1/S-514. At the Level 4 roof, the interior surfaces of the exterior walls and exterior columns are **excluded** from the work scope. Vertical beam surfaces directly below expansion joints are **excluded** from the work.

F. Alternate Work Item 5 – Lighting fixture modifications: All work associated with including an 18 inch stem mount to suspend the fixtures lower than the Base Bid, and including an up-light, in accordance with the Drawings and Specifications.

G. Alternate Work activities will be selected at the discretion of Owner.

1.10 SCHEDULE

A. It is anticipated that work will **begin in Spring 2024** with substantial completion **before Fall 2025,** or as otherwise indicated in the City of Birmingham bidding instructions.

B. Contactor shall provide adequate manpower and experience as required to meet the project schedule.

1.11 AWARD CRITERIA

A. Contractor award will be based on the following weighted criteria, as judged by Owner, or as otherwise identified in City of Birmingham bidding instructions:
   1. Cost: 80%
   2. Qualifications and Bidder's Resume: 10%
   3. Schedule: 10%

1.12 CONTRACTOR USE OF PREMISES

A. Confine operations at Site to areas permitted by law, ordinance, permits, and Contract Documents.

B. Owner will occupy premises outside of Work area during construction period.
   1. Cooperate with Owner to minimize conflicts and facilitate Owner usage.
   2. Perform Work to avoid interference with Owner's day-to-day operations. Notify Owner's Representative at least 72 hours in advance of activities that will affect Owner's operations.
      a. Maintain utilities serving areas occupied by Owner or others. Do not interrupt utilities unless approved in writing in advance by Owner's Representative. Notify Owner's Representative at least 72 hours in advance of interruption. Provide temporary utility services if required.

3. Maintain vehicular, pedestrian, and emergency access to portions of facility that are in use. Keep entrances and exits clear of stored materials and construction equipment.
   a. Short interruptions in access may be permitted if approved in advance in writing by the Owner's Representative.
   b. Schedule deliveries to minimize interruptions.
4. Do not disturb Site outside of Work area.
5. Provide temporary protection around existing equipment and stored materials as required.
6. Minimize damage to building weatherproofing system during construction period, and promptly repair damage caused by construction operations. Protect building and occupants in Work area.
7. Notify the Owner's Representative at least one week in advance of when portions of Work area will be removed from use or returned to use.

C. Minimize interference with adjacent walkways and facilities.

D. Additional storage or operational area outside of Work area, either inside or outside of building, shall be coordinated in advance with the Owner's Representative.
1. Construction equipment, tools, etc., shall not be stored in areas of Owner's continued use.
2. Do not unreasonably encumber Site with materials or equipment.
3. Do not load Project structure with weight that will endanger Project structure.
4. Assume full responsibility for Site security and protection and safekeeping of products stored at Site.
5. Obtain and pay for additional storage areas needed for operations.

E. Construction activities shall be limited to the following times:
1. Mondays thru Fridays between 7:00 AM to 7:00 PM
2. Saturdays between 7:00 AM to 7:00 PM when mutually agreed upon with Owner.
3. Only as permitted by ordinance, if more restrictive than above.

1.13 TRAFFIC MAINTENANCE

A. The Contractor's work area will consist of not more than **300 spaces** at any one time except as approved in advance by the Owner's Representative.

B. The Owner will continue to use the parking structure during the renovation. The Contractor must schedule and arrange their work so as to maintain access at all times to all parking areas that are not under construction, for both vehicles and pedestrians. Short interruptions in traffic flow may be permitted but all interruptions must be scheduled and approved in advance in writing by the Owner.

C. Contractor shall submit updated copies of Contractor's construction schedule showing the sequence, commencement, and completion dates for all phases of the Work.

D. Conduct demolition operations and the removal of debris to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities.

E. The Contractor shall provide barricades and directional signs to safely direct traffic around the Work area. Signs shall be stenciled with black symbols on orange background with lettering three (3) inches high.

1.14 OWNER OCCUPANCY

A. Owner will occupy areas outside of Work area where construction has been completed, before Substantial Completion. On occupancy, Owner will assume responsibility for maintenance and custodial service for occupied portions of building. Occupancy shall not constitute acceptance of total Work; assume responsibility for Work in re-occupied areas not in conformance with Contract Documents.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION

3.1 SITE WORK

A. Prior to beginning any repair work, submit plan for containing, collecting, and recycling construction debris, and disposing of any hazardous waste in safe manner.

B. Restore all site items to their condition prior to start of construction after repairs have been completed.

C. Pressure wash and clean all surfaces within work area.

END OF SECTION 01 11 00

SECTION 01 21 00
ALLOWANCES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Administrative and procedural requirements for allowances.

1.2 DESCRIPTION OF ALLOWANCES

A. Contingency allowance: For Work not specifically included in the Bid Form.

B. Localized steel coating allowance: For cleaning and coating localized steel substrates not specifically included in Bid Form. Costs for incidental labor required to issue submittals and to address hazardous materials are included in the Contract Sum, not Allowance.

C. New mechanical room and concrete pad allowance: For constructing new elements to support new mechanical equipment not specifically included in Bid Form.

D. Light fixture revision allowance: For providing a light fixture different from that specifically included in the Bid Form. Costs for incidental labor required to issue submittals and install the modified light fixture are included in the Contract Sum, not Allowance.

1.3 ALLOWANCE ADJUSTMENT

A. As Work covered by allowance becomes known, submit cost proposal to Architect/Engineer for Work. See Section 01 26 00.
   1. Provide cost proposals from more than one source upon request.
   2. Provide breakdown of cost proposal upon request.
   3. If applicable, include reasonable allowances for cutting losses, tolerances, mixing wastes, normal product imperfections, and similar margins. Prepare explanation and documentation to substantiate distribution of overhead costs and other margins claimed, upon request.
   4. Include costs for unloading and handling at the site, labor, installation costs, overhead, profit, and other associated expenses as part of allowance.
   5. Include recommendations that are relevant to performing Work.

B. Owner will execute Change Order to authorize Allowance Work.
   1. Advise Architect/Engineer of date when Allowance Work must be authorized to avoid delaying Work.

C. Submit invoices and delivery slips to show actual quantities of materials delivered to site for Allowance Work.

D. Coordinate materials and their installation for Allowance Work with related materials and installations to ensure that Allowance Work is integrated and interfaced with related work. Furnish templates as required to coordinate installation.

E. At Project closeout, credit unused Allowance amounts to Owner.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION

3.1 SCHEDULE OF ALLOWANCES

A. Allowance No. 1 (Bid Form Lump Sum Item 19) – Contingency allowance: Include the sum identified in the Bid Form as a project contingency to be used as directed by the Architect/ Engineer and as approved by the Owner if required to address any hidden, unanticipated, or unforeseen conditions.
   1. This allowance includes material cost, receiving, handling, and installation, and Contractor overhead and profit.

B. Allowance No. 2 (Bid Form Lump Sum Item 20) – Localized steel coating: Include the sum identified in the Bid Form to clean and paint localized steel elements not included elsewhere in the scope of work in accordance with Section 09 97 13.
   1. Localized areas anticipated to be included in this scope of work include isolated stair stringers and framing; stair railings; curtainwall framing, metal guardrails and steel channels; existing internal storm drain lines, potable water lines, and fire sprinkler lines.
   2. Actual work performed will depend on the inspection of the exposed conditions following concrete topping removal and as reviewed and approved by Owner in localized regions of chipped or peeling paint. Some substrates are galvanized steel and were previously painted with an incompatible coating system.
   3. This allowance includes material cost, receiving, handling, and installation, and Contractor overhead and profit.

C. Allowance No. 3 (Bid Form Lump Sum Item 21) – New mechanical room and concrete pads for mechanical equipment: Include the sum identified in the Bid Form to construct the new structural and architectural elements not defined elsewhere in the scope of work to support the new mechanical equipment.
   1. Architect/Engineer will issue a design Bulletin with final design drawings, details, and technical specifications for the work.
   2. Contractor to submit an itemized proposal with backup for disbursement of allowance amount.
   3. This allowance includes material cost, receiving, handling, and installation, and Contractor overhead and profit.
   4. Contractor to coordinate with mechanical subcontractor and other trades during the work.

D. Allowance No. 4 (Bid Form Lump Sum Item 22) – Lighting modifications: Include the sum identified in the Bid Form to provide a modified light fixture or layout from that defined in the elsewhere in the scope of work, if elected and as approved by Owner.
   1. This allowance includes adjustments to the material cost and Contractor overhead and profit.

END OF SECTION 01 21 00

SECTION 01 22 00
UNIT PRICES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Administrative and procedural requirements for unit price Work.

1.2 DEFINITIONS

A. Unit price is defined as a fixed price, including all overhead, profit and providing other necessary costs for providing a specified unit of work. Contract Sum may be increased or decreased by Unit Price adjustments as provided in the Bid Form Section 00 41 44, based on difference between estimated bid quantity and actual Work quantity.

1.3 MEASUREMENT PROCEDURES

A. Measure Work performed on unit price basis and maintain record of location and unit price quantity of each repair installed. Unless stated otherwise by Architect/Engineer, document unit price quantities with plan view or elevation drawings, or both, and tables with required data, cross-referenced to drawings. Submit recorded information to Architect/Engineer on weekly basis.

B. Architect/Engineer will verify accuracy of measurements and approve final quantities. Notify Architect/Engineer at least 72 hours before Work will be performed that might make this verification difficult or impossible.

C. Notify Owner's Representative and Architect/Engineer at once in writing of unit price work that deviates materially from Unit Price basis for payment and for which adjustment in Unit Price is desired.
   1. Measure and quantify all such deviations and allow Architect/Engineer to verify accuracy of measurements, prior to performing Work that might make verification difficult or impossible.
   2. Adjustments will be considered only if all repairs of given type have been measured and all deviations, both plus and minus, have been included in determination of average deviation from Unit Price basis for payment.

1.4 PAYMENT PROCEDURES

A. As part of project closeout, Contract Sum will be modified by the Add and Deduct unit prices times variation in actual Work quantity from estimated quantity included in Bid Form, based on quantities measured by Contractor and approved by Architect/Engineer.

B. Unit Prices shall be used to determine adjustments to the Contract Amount when changes are made in the quantity of work, regardless of the magnitude of the change.

C. Should the final quantities for each item vary from the estimated quantity in the bid form, the difference between the actual and estimated quantity shall be multiplied by the Unit Price. If the quantity difference is positive, the dollar amount will be considered as an additional cost for which the contractor is entitled full of compensation via an approved change order. If the

quantity difference is negative, the dollar amount will be considered a credit to the Owner via an approved change order.

D. Prior to beginning any work on a Unit Price basis, the Contractor shall notify the Architect/Engineer sufficiently in advance to permit measurements to be verified. Only quantities which have been verified and approved by the Architect/Engineer shall be used to determine adjustments to the Contract Amount. Performance of any work not required by the Contract Documents, not verified by the Architect/Engineer, or authorized by signed Change Order shall not be considered for payment under the terms of Unit Prices. The Contractor shall be solely Responsible for all unauthorized work.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION

3.1 SCHEDULE OF VALUES

Bid Item	Type of Work	Unit
	CONCRETE REPAIR ITEMS	
23.	Partial depth top surface concrete repair (Keynote A) The cost for this work includes providing and installing: a) Locating tendons b) Shoring c) Partial-depth removal and disposal of sound and unsound concrete to a minimum depth of 3/4 in. around existing conventional steel reinforcement (minimum 2 inch thickness, average 3-1/2 inch) d) Protection of existing reinforcing and post-tensioning sheathing from damage e) Repairing the exposed tendon sheathing damaged by concrete removal or surface preparation activities f) Temporary measures to prevent water intrusion into tendon sheathing g) Sawcutting edges of removal area h) Cleaning and preparing exposed concrete and steel reinforcing bar or PT anchorage surfaces i) Coating exposed steel with corrosion-inhibiting coating j) Recasting slab with ready-mix concrete or proprietary repair concrete k) Tooling perimeter of repair area l) Curing m) Installation of sealant around perimeter of repair on the top surface Refer to the Drawings (Sheets S-101 through S-106 and Details 1/S-503 and 2/S-504) and Section 03 01 31 and Section 03 01 34 for related information. Post-tensioning tendon repairs, supplemental epoxy-coated steel reinforcement and dowels shall be paid separately per their respective unit price bid items. Payment based on surface area (square foot) of concrete repair area.	$/SF

Bid Item	Type of Work	Unit
24.	Full-depth concrete slab repair (Keynote B) The cost for this work includes providing and installing: a) Locating tendons b) Shoring c) Removal and disposal of sound and unsound concrete (5.5 inch to 7 inch nominal thickness, see Drawings) d) Protection of existing reinforcing and post-tensioning sheathing from damage e) Sawcutting edges of removal area f) Repairing the exposed tendon sheathing damaged by concrete removal or surface preparation activities g) Temporary measures to prevent water intrusion into tendon sheathing h) Cleaning and preparing exposed concrete and steel reinforcing bar or PT anchorage surfaces i) Coating exposed steel with corrosion-inhibiting coating j) Formwork k) Recasting slab with ready-mix concrete or proprietary repair concrete l) Tooling perimeter of repair area m) Curing n) Installation of sealant around perimeter of repair on the top surface Refer to the Drawings (Sheets S-101 through S-106 and Detail 2/S-503) and Section 03 01 31 and Section 03 01 34 for related information. Post-tensioning tendon repairs, supplemental epoxy-coated steel reinforcement and dowels shall be paid separately per their respective unit price bid items. Payment based on surface area (square foot) of concrete repair area.	$/SF

Bid Item	Type of Work	Unit
25.	Partial-depth overhead concrete repair (Keynote C) The cost for this work includes providing and installing: a) Locating tendons b) Shoring c) Partial-depth removal and disposal of sound and unsound concrete to a minimum depth of 3/4 in. around existing conventional steel reinforcement (average 3-1/2 inch thickness) d) Protection of existing reinforcing and post-tensioning sheathing from damage e) Sawcutting edges of removal area or chipping edges square to an approximate depth of ½ inch f) Repairing the exposed tendon sheathing damaged by concrete removal or surface preparation activities g) Cleaning and preparing exposed concrete and steel reinforcing bar or PT anchorage surfaces h) Coating exposed steel with corrosion-inhibiting coating i) Formwork, if necessary j) Recasting slab with ready-mix concrete or proprietary repair concrete k) Curing Refer to the Drawings (Sheets S-112 through S-116 and Detail 3/S-503) and Section 03 01 31 and Section 03 01 34 for related information. Post-tensioning tendon repairs, supplemental epoxy-coated steel reinforcement and dowels shall be paid separately per their respective unit price bid items. Payment based on surface area (square foot) of concrete repair area.	$/SF
26.	Partial-depth concrete beam repair (Keynote E) The cost for this work includes providing and installing: a) Locating tendons where present b) Shoring c) Partial-depth removal and disposal of sound and unsound concrete to a minimum depth of 3/4 in. around existing conventional steel reinforcement (average 4 inch thickness) d) Protection of existing reinforcing and post-tensioning sheathing from damage e) Sawcutting edges of removal area f) Repairing the exposed tendon sheathing damaged by concrete removal or surface preparation activities g) Cleaning and preparing exposed concrete and steel reinforcing bar surfaces h) Coating exposed steel with corrosion-inhibiting coating i) Formwork j) Recasting beam with ready-mix concrete or proprietary repair concrete k) Curing Refer to the Drawings (Sheets S-112 through S-116 and Details 6/S-504 and 3/S-501) and Section 03 01 31 and Section 03 01 34 for related information. Post-tensioning tendon repairs, supplemental epoxy-coated steel reinforcement and dowels shall be paid separately per their respective unit price bid items. Payment based on surface area (square foot) of concrete repair area.	$/SF

Bid Item	Type of Work	Unit
27.	Vertical concrete column or wall repair (Keynote D) The cost for this work includes providing and installing: a) Shoring b) Partial-depth removal and disposal of sound and unsound concrete to a minimum depth of 3/4 in. around existing conventional steel reinforcement (average 3-1/2 inch thickness) c) Sawcutting edges of removal area d) Cleaning and preparing exposed concrete and steel reinforcing bar surfaces e) Coating exposed steel with corrosion-inhibiting coating f) Formwork g) Recasting column/wall with ready-mix concrete or proprietary repair concrete h) Curing Refer to the Drawings (Sheets S-101 through S-106 and Detail 4/S-503) and Section 03 01 31 and Section 03 01 34 for related information. Supplemental epoxy-coated steel reinforcement and dowels shall be paid separately per their respective unit price bid items. Payment based on surface area (square foot) of concrete repair area.	$/SF
28.	Bumper wall curb and curb repair (Keynote F) a) Removal and disposal of sound and unsound concrete (average 5 inch thickness and 4 inch width) b) Sawcutting edges of removal area c) Cleaning and preparing exposed concrete and steel reinforcing bar surfaces d) Coating exposed steel with corrosion-inhibiting coating e) Formwork, match existing profile f) Recasting curb with ready-mix concrete or proprietary flowable repair concrete g) Curing Refer to the Drawings (Sheets S-101 through S-106 and Detail 5/S-504) and Section 03 01 31 and Section 03 01 34 for related information. Supplemental epoxy-coated steel reinforcement and dowels shall be paid separately per their respective unit price bid items. Payment based on length (linear feet) of concrete repair area.	$/LF
29.	Supplemental epoxy-coated reinforcing steel The cost for this work includes providing and installing: a) Epoxy-coated (shop applied) conventional steel reinforcement (bars or welded wire reinforcement) in concrete repair areas b) New bar supports to properly support and position reinforcement Payment based on weight (ton) of steel installed, measured to the nearest pound (lb).	$/LB

Bid Item	Type of Work	Unit
30.	Supplemental dowels The cost for this work includes providing and installing: a) Drilling holes for dowels b) Cleaning holes by alternately brushing and blowing out with clean air, per specification and in accordance with ESR and manufacturer's instructions c) Removing epoxy coating (if present) on portion of dowel embedded in concrete d) Filling holes with structural adhesive e) Installing dowels in accordance with ESR and manufacturer's instructions f) Coating exposed portions of dowel with corrosion-inhibiting coating after installation (if epoxy coating is not present) Refer to Drawings (Details 5&5A/S-503) for related information. Payment based on each dowel installed.	$/EA
31.	Full-depth slab-on-ground repair (Keynote B) The cost for this work includes providing and installing: a) Removing and disposing of sound and unsound concrete (4-1/2 inch average thickness) b) Sawcutting edges of removal area c) Cleaning and preparing exposed concrete and steel reinforcing bar surfaces d) Coating exposed steel with corrosion-inhibiting coating. e) Compacting existing subgrade materials f) Restoring vapor barrier g) Recasting slab with ready-mix concrete or proprietary repair concrete h) Curing Refer to the Drawings (Sheet S-101 and Detail 3/S-504) and Section 03 01 31 and Section 03 01 34 for related information. Supplemental epoxy-coated steel reinforcement and dowels shall be paid separately per their respective unit price bid items. Payment based on surface area (square foot) of concrete repair area.	$/SF
POST-TENSIONING REPAIR ITEMS		
32.	Slab exploratory opening (Keynote G) The cost for this work includes providing and installing: a) Locating tendons b) Partial-depth removal and disposal of sound and unsound concrete to expose post-tensioning tendons (average 3 inch thickness, 18 inches long, 6 inches wide, primarily located overhead on slab underside) c) Temporary measures to prevent water intrusion into tendon sheathing d) Permitting Engineer access to inspect tendons e) Preparation and restoration of exploratory opening per requirements for a partial-depth top surface or overhead concrete repair. Refer to the Drawings (Sheets S-112 through S-116 and Detail 3/S-507) and Section 03 01 24, Section 03 01 31, and Section 03 01 34 for related information. Supplemental dowels shall be paid separately per the respective unit price bid item. Payment based on each exploratory opening created.	$/EA

Bid Item	Type of Work	Unit
33.	Grout pocket exploratory opening (Keynote H) The cost for this work includes providing and installing: a) Removing existing grout from stressing pocket b) Permitting Engineer access to inspect tendon anchorage and encapsulation components c) Assisting Engineer as needed to remove encapsulation cap, clean steel, and cut tendon tail d) Cleaning and preparing exposed concrete and steel surfaces e) New encapsulation cap f) Coating exposed steel with corrosion-inhibiting coating (where not protected by new encapsulation cap) g) New repair material h) Curing Refer to the Drawings (Sheets S-101 through S-106 and Detail 1/S-507) and Section 03 01 24 for related information. Elastomeric coating on surface of structural concrete shall be paid separately per the respective unit price bid item. Payment based on each exploratory opening created. Assume average of 3 grout pocket exploratory openings are created per access location.	$/EA
34.	Tendon Sheathing Repair The cost for this work includes providing and installing: a) Preparing prestressing steel surfaces b) Post-tensioning coating on prestressing steel c) Longitudinally split tubing d) Sheathing repair tape, two layers Refer to the Drawings (Detail 1/S-506) and Section 03 01 24 for related information. Concrete removal and replacement shall be paid separately per their respective unit price bid items. Payment based on length (linear foot) of sheathing repaired.	$/LF

Bid Item	Type of Work	Unit
35.	New 7-wire strand The cost for this work includes providing and installing: a) Removing existing strand b) New 1/2 in. diameter, 7-wire strand in extruded sheathing c) At locations where existing strand is removed and existing sheathing remains embedded in concrete, provide and install: a. Post-tensioning coating b. Cleaning existing intact sheathing embedded in concrete prior to threading new strand to remove debris and moisture c. Threading new strand through existing sheathing where intact in existing concrete d) At concrete repair openings with sufficient access to install new tendon: a. Installing new tendon including extruded sheathing and integral post-tensioned coating e) Tendon sheathing repair to seal new sections of sheathing to existing sheathing, in accordance with Bid Item 34. Refer to the Section 03 01 24 for related information. Payment based on length (linear foot) of strand installed.	$/LF
36.	Strand coupler The cost for this work includes providing and installing: a) Protection of existing tendon sheathing to remain b) Installing one new strand coupler and heat-reactive shrink tubing c) Encapsulating the strand coupler with new heat-reactive shrink tubing d) Repairing the exposed tendon sheathing similar to Bid Item 34. Refer to the Drawings (Detail 4/S-505) and Section 03 01 24 for related information. Concrete removal and replacement, new strand, and restressing the tendon elsewhere along its length shall be paid separately per their respective unit price bid items. Payment based on each strand coupler installed.	$/EA

Bid Item	Type of Work	Unit
37.	Central stressing coupler, including restressing The cost for this work includes providing and installing: a) Shoring b) Detensioning tendons if holding force c) Protection of existing tendon sheathing to remain d) Installing one new central stressing coupler and heat-reactive shrink tubing e) Restressing tendon a. Restressing the repaired tendon to specified force b. Recording post-tensioning force and elongation c. Submitting stressing record to Engineer for review and waiting for approval to cut tendon tails. d. Lift-off test, if necessary e. Finishing tails of tendons f) Phasing of repairs, if necessary g) Installing new post-tensioning coating in coupler h) Encapsulating the central stressing coupler with new heat reactive shrink tubing i) New tendon sheathing and lap to existing sheathing similar to Bid Item 34. Refer to the Drawings (Detail 3/S-505) and Section 03 01 24 for related information. Concrete removal and replacement and new strand shall be paid separately per their respective unit price bid items. Payment based on each central stressing coupler installed and restressed.	$/EA
38.	New fixed end anchorage The cost for this work includes providing and installing: a) Shoring b) Detensioning tendons if holding force c) Removing existing anchorage hardware d) Protection of existing tendon sheathing to remain e) New epoxy-coated reinforcing bars at end anchorages, including two hairpins and four supplemental reinforcing bars and dowels, as well as supplemental dowels and bars as required to position required reinforcement and support anchorage f) Installing of new fixed end anchorage, including backseating new wedges onto new or existing strand g) New tendon sheathing and lap to existing sheathing, similar Bid Item 34. Refer to the Drawings (Detail 2/S-503) and Section 03 01 24 for related information. Concrete removal and replacement, new strand, and coupler shall be paid separately per their respective unit price bid items. Restressing the tendon elsewhere along its length shall be paid under the appropriate unit price item. Payment based on each fixed end anchorage installed.	$/EA

Bid Item	Type of Work	Unit
39.	Reseat tendon in existing end anchor The cost for this work includes providing and installing: a) Removing existing wedges b) Cleaning exposed steel of corrosion and other contaminants c) Installing and seating new wedges d) Installing new encapsulation caps and repairing grout pocket in accordance with Bid Item 33. Refer to Section 03 01 24 for related information. Concrete removal and replacement, new strand and coupler shall be paid separately per their respective unit price bid items. Restressing the tendon elsewhere along its length shall be paid under the appropriate unit price item. Payment based on each tendon reseated.	$/EA
40.	Reseat tendon in existing stressing end anchor, including restressing The cost for this work includes providing and installing: a) Removing existing tendon and wedges b) Cleaning exposed steel of corrosion and other contaminants c) Installing and seating new wedges d) Restressing tendon a. Restressing the repaired tendon to specified force b. Recording post-tensioning force and elongation c. Submitting stressing record to Engineer for review and waiting approval to cut tendon tails. d. Lift-off test, if necessary e. Finishing tail of tendon e) Installing new caps and repairing grout pocket similar to Bid Item 33. Refer to Section 03 01 24 for related information. New strand and coupler shall be paid separately per their respective unit price bid items. Payment based on each tendon reseated and restressed.	$/EA
WATERPROOFING AND DURABILITY WORK ITEMS		
41.	Rout and seal cracks in slab (Keynote J) The cost for this work includes providing and installing: a) Existing sealant removal, if present b) Routing crack c) Preparing concrete surface for new sealant d) Bond breaker e) Primer f) Sealant g) Curing Refer to the Drawings (Detail 2/S-509) and Section 07 92 00 for related information. Payment based on length (linear feet) of sealing cracks.	$/LF

Bid Item	Type of Work	Unit
42.	Horizontal joint sealant replacement (Keynote J) The cost for this work includes providing and installing: a) Existing sealant removal, if present b) Preparing concrete surface for new sealant c) Bond breaker d) Primer e) Sealant f) Curing Refer to the Drawings (Detail 1/S-509) and Section 07 92 00 for related information. Payment based on length (linear feet) of sealant replaced.	$/LF
43.	Traffic-bearing membrane installation (Keynote L) The cost of this work includes providing and installing: a) Preparation of existing waterproofing membrane to remain, as applicable b) Cleaning and preparing horizontal concrete surfaces to be coated c) Cleaning and preparing vertical surfaces to be coated (upturns) d) Protection of prepared surfaces from contamination until membrane installation e) Detail coat of membrane over all joints, cracks, changes in direction, and tie-ins f) Heavy-duty membrane system g) Upturning membrane at vertical surfaces h) Reapplication of membrane at areas disturbed by testing Refer to the Drawings (Sheet S-509) and Section 07 18 00 for related information. Payment based on surface area (square foot) of membrane installed.	$/SF
44.	Leveling course installation The cost of this work includes providing and installing: a) Applying leveling course on concrete surface following surface preparation and at direction of Engineer prior to installing traffic bearing membrane system. b) Curing Refer to Section 07 18 00 for related information. Payment based on surface area (square foot) of leveling installed.	$/SF
45.	Silane sealer installation The cost of this work includes providing and installing: a) Cleaning and preparing concrete surfaces to be sealed b) Silane water repellant sealer, two applications Refer to the Drawings (Detail 1/S-510) and Section 07 19 17 for related information. Payment based on surface area (square foot) of sealer installed.	$/SF

Bid Item	Type of Work	Unit
46.	Winged expansion joint sealant replacement (Keynote Y) The cost of this work includes providing and installing: a) Removal of existing joint seal b) Joint opening cleaning and preparation c) New expansion joint seal d) Accessories, including wall-mounted elements and upturned legs e) Bond breaker f) Sealant Refer to the Drawings (Sheet S-510) and Section 03 15 11 for related information. Payment based on length (linear feet) of expansion joint seal replaced.	$/LF
47.	Premolded expansion joint seal replacement (Keynote Y) The cost of this work includes providing and installing: a) Removal of existing joint seal b) Joint opening cleaning and preparation c) New expansion joint seal d) Accessories, including plates and wall-mounted elements e) Bond breaker f) Sealant Refer to the Drawings (Sheet S-510) and Section 03 15 11 for related information. Payment based on length (linear feet) of expansion joint seal replaced.	$/LF
48.	Silicone-coated precompression seal replacement The cost of this work includes providing and installing: a) Removal of existing joint sealant where present b) Joint opening cleaning and preparation c) New silicone-coated precompression seal Refer to the Drawings (Detail 8/S-510) and Section 07 92 00 for related information. Payment based on length (linear feet) of seal installed.	$/LF
49.	New floor drain The cost of this work includes providing and installing: a) Removing existing floor drain where present b) Four supplemental dowels c) New drain d) Connecting drain to existing piping (average 4 linear feet) Refer to the Drawings (Detail 1/S-504) for related information. Payment based on each drain installed. Concrete removal and replacement paid for under separate unit price item.	$/EA

Bid Item	Type of Work	Unit
50.	Elastomeric coating on vertical surfaces The cost of this work includes providing and installing: a) Cleaning and preparing vertical concrete surfaces b) Protecting prepared surface from contamination until coating installation c) Elastomeric coating system Refer to the Drawings (Detail 1C/S-507) and Section 09 96 53 for related information. Payment based on surface area (square foot) of coating installed.	$/SF
STAIRWELL AND ELEVATOR LANDING REPAIR ITEMS		
51.	Concrete topping replacement at stair treads/landings (Keynote V) The cost of this work includes providing and installing: a) Removal and disposal of concrete topping (average 2 inches) b) Cleaning and preparing metal stair pan substrate c) Coating exposed steel with corrosion-inhibiting coating d) Recasting topping with ready-mix or proprietary repair concrete e) Curing Refer to Drawings (Sheets S-401, S-403, and S-405 and Detail 5/S-501) and Section 03 01 31 and Section 03 01 34 for related information. Payment based on surface area (square foot) of topping repair.	$/SF
52.	Concrete topping replacement at elevator landings (Keynote U) The cost of this work includes providing and installing: a) Removal and disposal of concrete topping (average 5 inches) b) Cleaning and preparing corrugated metal deck substrate c) Coating exposed steel with corrosion-inhibiting coating d) Welded wire reinforcing within concrete removal area e) Recasting topping with ready-mix or proprietary repair concrete f) Curing Refer to Drawings (Sheets S-401, S-403, and S-405) and Section 03 01 31, Section 03 01 34, and Section 05 02 00 for related information. Payment based on surface area (square foot) of topping repair.	$/SF
53.	Metal stair tread and riser replacement (Keynote V) The cost of this work includes providing and installing: a) Removal and disposal of existing tread and riser bent plate assembly, including the bent plate supports (minimum 4 supports) b) New tread and riser bent plate assembly, including bent plate supports c) Welded connections to match as-built conditions d) Painted finish at exposed surfaces Refer to Drawings (Sheets S-401, S-403, and S-405 and Detail 5/S-501) and Section 05 02 00 and Section 09 97 13 for related information. Payment based on each tread and riser assembly (each step) replaced. Concrete removal and replacement paid for under separate unit price item.	$/EA

Bid Item	Type of Work	Unit
54.	Metal pan and support framing replacement at stair landings (Keynote V) The cost of this work includes providing and installing: a) Removal and disposal of existing landing pan, interior stiffener angles, and perimeter support angles (stair landing tube framing anticipated to remain) b) New landing assembly c) Welded connections to match existing d) Painted finish at exposed surfaces Refer to Drawings (Sheets S-401, S-403, and S-405 and Details 5/S-501 and 1&2/S-516) and Section 05 02 00 and Section 09 97 13 for related information. Payment based on each landing assembly (each) replaced. Concrete removal and replacement paid for under separate unit price item.	$/EA
55.	Metal decking replacement at elevator landings (Keynote U) The cost of this work includes providing and installing: a) Removal and disposal of existing corrugated metal decking b) New metal decking to match existing c) Welded connections to match existing d) Painted finish at exposed surfaces Refer to Drawings (Sheets S-401, S-403, and S-405 and Detail 4/S-515) and Section 05 02 00 and Section 09 97 13 for related information. Payment based on surface area (square foot) of decking replaced. Concrete removal and replacement paid for under separate unit price item.	$/SF
56.	Structural steel replacement at elevator landings (Keynote X) The cost of this work includes providing and installing: a) Removal and disposal of existing structural steel b) New structural steel to match existing (average L3.5x3.5x3/8, minimum 3 foot length replaced per location) c) Bolted connections to match existing d) Painted finish at exposed surfaces Refer to Drawings (Sheets S-112 through S-116 and Detail 4&5/S-515) and Section 05 02 00 and Section 09 97 13 for related information. Payment based on length (linear feet) of ledger angles replaced/installed.	$/LF
57.	Clean and paint steel framing or decking (Keynote W) The cost of this work includes providing and installing: a) Cleaning and preparing metal substrate b) Coating system Refer to Drawings (Sheets S-112 through S-116, Sheet S-515 and S-516) and Section 09 97 13 for related information. Payment based on surface area (square feet) of metal painted.	$/SF

Bid Item	Type of Work	Unit
58.	Perimeter cove sealant at Stairs A and B The cost of this work includes providing and installing: a) Existing sealant removal, if present, around the perimeter of the concrete topping b) Preparing surfaces for new sealant c) Bond breaker d) Primer e) Sealant f) Curing Refer to Drawings (Sheet S-516 and Detail 1/S-509) and Section 07 92 00. Payment based on each stair level where perimeter sealant is replaced. Assume each stair level includes an average of 2 flights (8 stair treads and risers per flight), 1 large curved landing, and 1 small landing.	$/LEVEL
59.	Perimeter cove sealant at Stair C The cost of this work includes providing and installing: a) Existing sealant removal, if present b) Preparing surfaces for new sealant c) Bond breaker d) Primer e) Sealant f) Curing Refer to Drawings (Sheet S-516 and Detail 1/S-509) and Section 07 92 00. Payment based on each stair level where perimeter sealant is replaced. Assume each stair level includes an average of 2 flights (8 stair treads and risers per flight), 1 large landing, and 1 small landing.	$/LEVEL
60.	Railing post base repair The cost of this work includes providing and installing: a) Temporary removal and/or shoring of existing railing components b) Removal and disposal of sound and unsound concrete to remove existing steel grout pocket casing c) Removing corroded steel rail base d) Steel bar e) Recasting slab similar to Bid Item 23 f) Cleaning and preparing exposed steel g) Coating Refer to Drawings (Detail 6/S-516) and Section 05 02 00 and Section 09 97 13. Payment based on each post base repaired.	$/EA

Bid Item	Type of Work	Unit
61.	Glazing replacement The cost of this work includes providing and installing: a) Removal and disposal of an existing glazing unit (average 6 feet by 4 feet) b) Glazing unit, accessories, and sealants Refer to Drawings (Sheet S-512) and Section 08 80 00. Payment based on each glazing unit replaced. This work is beyond lump sum scope of work.	$/EA
MASONRY AND FLASHING REPAIR ITEMS		
62.	Rebuild brick veneer (Keynote R) The cost for this work includes providing and installing: a) Removing and disposing of unsound brick masonry b) Stainless steel masonry wall ties c) New brick masonry, toothing masonry into surrounding brick to remain Refer to Drawings (Sheet S-201 and Detail 2/S-508) and Section 04 01 21. Payment based on surface area (square feet) of brick masonry replacement. Assume minimum of 2 square feet per location.	$/SF
63.	Repoint brick (Keynote S) The cost for this work includes providing and installing: a) Removal and disposal of existing mortar b) Cleaning and preparing surfaces for new mortar c) New mortar in lifts Refer to Drawings (Sheets S-201, S-401, S-403, S-405 and Detail 1/S-508) and Section 04 01 27 and Section 04 05 01. Payment based on length (linear feet) of mortar replaced. Assume minimum of 4 linear feet per location.	$/LF
64.	Repoint brick (Keynote S) The cost for this work includes providing and installing: a) Removal and disposal of existing mortar b) Cleaning and preparing surfaces for new mortar c) New mortar in lifts Refer to Drawings (Sheets S-201, S-401, S-403, S-405 and Detail 1/S-508) and Section 04 01 27 and Section 04 05 01. Payment based on surface area (square feet) of mortar replaced. Assume minimum of 2 square feet per location.	$/SF

Bid Item	Type of Work	Unit
65.	Vertical brick crack repair (Keynote T) The cost for this work includes providing and installing: a) Removal and disposal of cracked brick units and cracked mortar b) Cleaning and preparing surfaces c) New brick units d) New mortar in lifts Refer to Drawings (Sheets S-201, S-401, S-403, S-405 and Detail 3/S-508) and Section 04 01 21, Section 04 01 27, and Section 04 05 01. Payment based on length (linear feet) of vertical brick crack repaired. Assume minimum of 4 linear feet per location.	$/LF
66.	Helical anchor installation The cost for this work includes providing and installing: a) Anchors at existing brick to remain b) Mortar over anchor hole Refer to Drawings (Details 5/S-508). Payment based on each helical anchor installed. Assume minimum of 4 helical anchors (each) per access location.	$/EA

3.2 MEASUREMENT OF QUANTITIES

A. Measure work to be performed on a unit price basis according to the methods described in 1, 2, 3 and 4 below. Payment will be made for work actually performed, based on quantities jointly recorded by the Contractor and Architect/Engineer and approved by the Architect/Engineer. Unless stated otherwise, records described below shall consist of both plan view drawings and tables cross-referenced to the drawings with the required data. Unless otherwise stated, the Architect/Engineer will verify the accuracy of the record by visual examination of the work performed and measurement of the quantities. The Contractor shall submit this record to the Architect/Engineer on a weekly basis.
   1. Items to be paid based on surface area of repair. The Contractor shall maintain a record of the location and surface area in square feet for each repair installed. The Contractor shall submit this record prior to the placement of concrete material and allow adequate time for Architect/Engineer review.
   2. Items to be paid based on each repair: The Contractor shall maintain a record of the locations where the repair has been installed.
   3. Items to be paid based on length of repair: The Contractor shall maintain a record of the location and length in linear feet for each repair installed.
   4. Items to be paid based on weight of repair: The Contractor shall maintain a record of the location and weight of supplemental steel installed for each repair.

B. The Contractor shall notify the Owner's Representative and the Architect/Engineer at once in writing of any unit price work that deviates materially from the prescribed basis for bidding and for which an adjustment in Unit Price is desired. The Contractor shall measure and quantify all such deviations, subject to verification by the Architect/Engineer, prior to any repair work which might make verification impossible. No adjustments in Unit Prices will be considered unless supporting field measurements are provided, and subject to the Owner's Representative's prior approval. Adjustments will only be considered if all repairs of a given type have been measured and all deviations, both plus and minus, have been included in the determination of the average deviation from the Unit Price basis.

END OF SECTION 01 22 00

SECTION 01 26 00
CONTRACT MODIFICATION AND PAYMENT PROCEDURES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Administrative and procedural requirements for preparing, handling, and processing Contract modifications and Applications for Payment, including alternates and product substitutions.

1.2 ALLOWANCES

A. See Section 01 21 00 – Allowances for related procedure information.

1.3 UNIT PRICE WORK

A. See Section 01 22 00 – Unit Prices for related procedure information.

1.4 ALTERNATES

A. Description of Alternates:
   1. See Section 01 11 00 - Summary of Work for description of Alternate Bid Items.

B. Procedures:
   1. Upon notification of alternates selected by the Owner, inform subcontractors of selected alternates and of changes in the Work due to selection or rejection of alternates.
   2. Execute accepted alternates under the same conditions as other work of the Contract.
   3. Modify or adjust affected adjacent Work as necessary to completely integrate the Work of an alternate into Project.

1.5 SUBSTITUTION PROCEDURES

A. Definitions:
   1. Substitutions: Changes proposed by Contractor in products, materials, equipment, or methods of construction from those required by Contract Documents.
      a. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
      b. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

B. Submittals:
   1. Substitution Requests: Submit three copies of request for consideration. Use CSI Form 13.1A or similar form. Identify product or fabrication or installation method to be replaced. Include Specification section and Drawing numbers and titles.
      a. Provide the following information. If the following information is not provided, Architect/Engineer may return requests without action, except to record noncompliance with these requirements.

1) Statement indicating why specified product, fabrication, or installation cannot be provided, if applicable.
2) Product Data, including drawings and descriptions of products, and fabrication and installation procedures. Where applicable or requested, include:
    a) Samples.
    b) Certificates and qualification data.
3) Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
    a) Research reports evidencing compliance with the building code in effect for Project.
    b) Necessary approvals of public authorities having jurisdiction.
4) A detailed comparison of significant qualities of proposed substitution with those of specified Work. Include an annotated copy of applicable Specification section. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from specified Work.
5) List of similar installations for completed projects with project names and addresses and names and addresses of architect/engineers and owners.
6) Coordination information, including a list of changes or modifications needed to other portions of Work that will be necessary to accommodate proposed substitution.
7) Cost information and a detailed comparison of Contractor's construction schedule using proposed substitution compared to specified product, including the effect on overall Contract Time. Include proposal of change, if any, in Contract Sum or Contract Time.
8) Contractor's certification that proposed substitution complies with requirements in Contract Documents, including specified warranty, except as indicated in substitution request; is compatible with other portions of Work and other products; and is appropriate for applications indicated and will produce indicated results.
    a) Investigate and document compatibility of proposed substitution with related products and materials. Engage qualified testing agency to perform compatibility tests recommended by manufacturer.
9) Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of the proposed substitution to produce the indicated results.

b. In addition, for substitutions of convenience, requested substitution must:
    1) Offer Owner substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Architect/Engineer for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
    2) Not require extensive revisions to Contract Documents.
c. Substitutions for Cause: Submit requests for substitution immediately upon discovery of need for change, but not less than 14 days prior to time required for preparation and review of related submittals.
d. Substitutions for Convenience: Not allowed, unless otherwise indicated.

2. Architect/Engineer's Action: If necessary, Architect/Engineer will request additional information or documentation for evaluation within seven days of receipt of substitution request. Architect/Engineer will notify Contractor of acceptance or rejection of proposed

substitution within 14 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.

a. Acceptance or rejection of proposed substitutions shall be at the sole discretion of Architect/Engineer, whose decision is final.
b. Accepted substitution will be incorporated into the Contract by Change Order, Construction Change Directive, or Architect/Engineer's Supplemental Instructions for minor changes in Work.
c. Use product specified if Architect/Engineer does not issue decision on use of proposed substitution within time allocated.

C. Modify or adjust Work as necessary to integrate work of approved substitutions.

1.6 CONTRACT MODIFICATION PROCEDURES

A. Minor Changes in Work: Architect/Engineer will issue supplemental instructions authorizing minor changes in Work, not involving adjustment to Contract Sum or Contract Time, on AIA Document G710, Architect's Supplemental Instructions or periodic site reports**.**

B. Proposal Requests:
1. Owner-Initiated Proposal Requests: Architect/Engineer will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or Contract Time. The description may include supplemental or revised Drawings and Specifications.
a. Proposal Requests issued by the Architect/Engineer are for information only, and are not instructions to either stop Work or execute the proposed change.
b. Within the time specified in the Proposal Request after receipt of the Proposal Request, submit adjustments to the Contract Sum and Contract Time necessary to execute change.
2. Contractor-Initiated Proposals: If latent or unforeseen conditions require modifications to the Contract, propose changes by submitting a request for change to the Architect/Engineer.
a. Include a statement outlining reasons for the change and provide a complete description of the proposed change.
b. Submit adjustments to the Contract Sum and Contract Time necessary to execute the change within 14 days of becoming aware of latent or unforeseen condition. Owner will reject claims submitted later than 14 days after latent or unforeseen condition becomes known.
3. Indicate the effect of the proposed change on the Work, and adjustments to the Contract Sum and Contract Time necessary to execute the change.
a. Include quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
c. Include costs of labor and supervision directly attributable to the change.
d. Do not include Contractor's or subcontractor's indirect expense unless it is clearly shown that the nature or extent of Work has changed from that which could have been foreseen from information in the Contract Documents. No change to Contractor's indirect expense is permitted for the selection of higher- or lower-priced materials, or systems of the same scope and nature as originally indicated.

e. Include an updated Construction Schedule that indicates the effect of the change, including changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of Contract Time.
f. Comply with requirements in Section 01 60 00 if proposed change requires substitution of one product or system for product or system specified.

4. Use AIA Document G709, Work Changes Proposal Request, for Proposal Requests.

C. Construction Change Directives:
1. Architect/Engineer may issue a Construction Change Directive on AIA Document G714, Construction Change Directive, instructing Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.
a. A Construction Change Directive contains a complete description of the change in Work, including a method to determine changes in the Contract Sum and Contract Time.
2. Maintain detailed records on time and material basis of Work required by Construction Change Directive.
a. After completion of the change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

D. Change Order Procedures:
1. Owner will authorize a change in the Contract by executing AIA Document G701, Change Order.

1.7 PAYMENT PROCEDURES

A. Schedule of Values:
1. Format and Content:
a. Include the following Project identification.
1) Project name and location.
2) Name of Architect/Engineer.
3) Contractor’s name and address.
4) Date of submittal.
b. Provide a breakdown of the Contract Sum in sufficient detail to facilitate an evaluation of the Applications for Payment.
1) Coordinate with Project Manual Table of Contents.
2) Provide separate line items for initial cost of materials, for each subsequent stage of completion, and for total installed value of that part of Work.
3) Provide separate line item for each part of Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
4) Where Work is phased, include effects of phasing in Schedule of Values.
5) Each item in the Schedule of Values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.
6) Show temporary facilities and other major cost items that are not a direct cost of actual Work-in-place, as either separate line items in the Schedule of Values or distributed as general overhead expense, at Contractor’s option.
7) Round amounts to nearest whole dollar; total shall equal Contract Sum.

2. Coordinate the Schedule of Values with other administrative forms and schedules, including the Construction Schedule, submittal schedule, and application for payment forms.
3. Submit the Schedule of Values to Architect/Engineer at least two weeks before submittal of the initial Application for Payment.
4. Update and resubmit the Schedule of Values before the next Application for Payment when a Change Order results in a change in the Contract Sum.

B. Applications for Payment:
1. Payment Application Form: Use AIA Document G702 and AIA Document G703 Continuation Sheets as the form for Applications for Payment.
2. Each Application for Payment shall be consistent with previous applications and payments as certified by the Architect/Engineer and paid by Owner.
3. Application Preparation: Complete every entry on form. Notarize and execute by person authorized to sign legal documents on behalf of Contractor. Architect/Engineer will return incomplete applications without action.
    a. Entries shall match data on the Schedule of Values and Contractor's Construction Schedule. Use updated schedule if revisions were made.
    b. Include amounts of Change Orders and Construction Change Directives issued before the last day of the construction period covered by the application.
4. Submittal: Submit three signed and notarized original copies of each Application for Payment to Architect/Engineer by method ensuring receipt. One copy shall include waivers of lien and similar attachments. Send the submittal with a transmittal form listing attachments and recording appropriate information about the application.
5. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's lien from every entity who is lawfully entitled to file mechanic's lien arising out of the Contract and related to the Work covered by payment.
    a. Submit partial waivers on each item for the amount requested in the application, after deduction for retainage on each item.
    b. When the application shows completion of an item, submit final or full waiver.
    c. Execute waiver forms in a manner acceptable to Owner.
    d. Owner reserves the right to designate which entities involved in Work must submit waivers.
6. Application for Payment at Substantial Completion: After issuing a Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of Work claimed as substantially complete.
    a. Include documentation supporting claim that Work is substantially complete and statement showing accounting of changes to Contract Sum.
    b. This application shall reflect Certificates of Partial Substantial Completion issued previously for Owner occupancy of designated portions of Work.
7. Final Payment Application: Submit a final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:
    a. Evidence of completion of Project closeout requirements.
    b. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
    c. Updated final statement, accounting for final changes to the Contract Sum.
    d. AIA Document G706, Contractor's Affidavit of Payment of Debts and Claims.
    e. AIA Document G706A, Contractor's Affidavit of Release of Liens.
    f. AIA Document G707, Consent of Surety to Final Payment.
    g. Evidence that claims have been settled.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION – NOT USED

END OF SECTION 01 26 00

SECTION 01 30 00
ADMINISTRATIVE REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Project coordination and supervision, meetings, schedules, and photographic documentation.

1.2 COORDINATION

A. Project has special requirements for coordinating Work because of the following conditions.
   1. Complex nature and phasing of Work activities.
   2. Partial occupancy of facility by Owner during construction period.
   3. Residential nature of building and neighborhood.
   4. Hazardous nature of Work.

B. Provide supervision, planning, scheduling, and control to perform Work and meet requirements of Contract Documents.
   1. Schedule and coordinate construction operations in sequence required to obtain best results where installation of one part of Work depends on installation of other components, before or after its own installation.
   2. Notify affected parties in writing, as necessary, of special procedures required for coordination.
   3. Coordinate scheduling and timing of required administrative procedures to ensure orderly progress of Work. Such administrative activities include the following:
      a. Preparation of a construction schedule and Schedule of Values.
      b. Installation and removal of temporary facilities and controls.
      c. Delivery and processing of submittals.
      d. Progress and pre-installation meetings.
      e. Project closeout activities.

C. Notify the Owner's Representative in writing 48 hours in advance of time when construction areas will be returned to the Owner for use or when new Work areas are required.

D. Submit a building access plan to Owner's Representative for review and written approval at least ten working days prior to its implementation. Include locations of temporary enclosures and storage.

1.3 SUPERVISION

A. Provide a project superintendent at the Site a minimum of 8 hours per day during the progress of the Work. The superintendent shall be literate and fluent in English and equipped to receive and send digital photographs via mobile phone.

1.4 MEETINGS

A. General:
   1. Schedule and conduct meetings at the Site, unless otherwise indicated.

2. Notify participants, others involved, and individuals whose presence is required, of the date and time of the meeting. Notify the Owner and Architect/Engineer of scheduled meeting dates and times.
3. Agenda: Prepare a meeting agenda and distribute agenda to invited attendees.
4. Minutes: Architect/Engineer will record significant discussions, agreements, and disagreements, and distribute the meeting minutes in the form of a site visit report to concerned parties, including the Owner and Architect/Engineer, within 7 days of the meeting.

B. Pre-Construction Meeting:
1. Conduct a pre-construction meeting before Work begins. The Owner's Representative, Architect/Engineer, and responsible representatives from major subcontractors and other concerned parties shall be present. Participants shall be familiar with the Project and authorized to conclude matters relating to the Work.
2. Describe in detail when each portion of the Work is to be performed, based on the construction schedule. Discuss phasing and critical work sequencing. Subcontractors shall participate in discussion.
3. Discuss the following:
    a. Subcontractors, including responsibilities and personnel assignments.
    b. Key personnel, including contact information, and their duties.
    c. Procedures for requests for interpretations, field decisions, and change orders.
    d. Submittal procedures.
    e. Procedures for processing Applications for Payment.
    f. Use of premises, including office and storage areas, parking availability, and Owner's requirements.
    g. Work hours and restrictions.
    h. Deliveries and priorities.
    i. Temporary facilities and controls.
    j. Testing and inspecting requirements.
    k. Safety, first aid, and security procedures.
    l. Housekeeping procedures, including progress cleaning and construction waste management and recycling.
    m. Preparation of record documents.
4. Discuss questions that Contractor or subcontractors may have about Work or construction schedule.
5. The Architect/Engineer will interpret the Contract Documents.
6. The Owner's Representative will discuss partial occupancy and use of the facility during the construction and other Owner concerns.

C. Pre-Installation Meetings: Conduct pre-installation meetings before each construction activity that requires coordination with other construction.
1. Responsible representatives from the Installer and manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall be present.
2. Review the progress of the construction and preparations for the particular activity under consideration, including the following:
    a. Contract Documents, including warranty requirements, requests for interpretations, and Change Orders.
    b. Regulations of public authorities having jurisdiction.
    c. Construction Schedule, including deliveries.
    d. Submittals, manufacturer's written recommendations, and mockups.

e. Temporary facilities and controls; space and access limitations; and protection of construction and personnel.
f. Installation procedures, including weather limitations, coordination with other work, protection of adjacent work, compatibility concerns and possible conflicts, acceptability of substrates, testing and inspecting requirements, and required performance results.

3. Include required corrective measures and actions in meeting minutes.
4. Do not proceed with the installation if the meeting was not successfully concluded. Initiate necessary actions to resolve impediments to the performance of the Work and reconvene the meeting at the earliest feasible date.

D. Progress Meetings: Conduct biweekly progress meetings.
1. The Owner's Representative, Architect/Engineer, and representatives of each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be present. Participants shall be familiar with the Project and authorized to conclude matters relating to the Work.
2. Review and correct or approve the minutes of the previous progress meeting. Review items of significance that could affect the progress of the Work. Include topics for discussion as appropriate to the status of the Project.
3. Construction Schedule: Review the progress of the Work since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to the construction schedule. Determine how construction behind schedule will be expedited, and secure commitments from the parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
a. Review the schedule for the next period.
4. Review present and future needs of each entity present, including the following:
a. Sequence of operations, interface requirements, and coordination of the Work.
b. Status of submittals, deliveries, and off-site fabrication.
c. Site utilization, temporary facilities and controls, access, hazards and risks, and progress cleaning.
d. Field observations, problems, and decisions.
e. Quality and work standards, and status of corrective measures for deficient items.
f. Status of payment requests, requests for interpretations, proposal requests, pending changes, Change Orders, and pending claims and disputes.
5. If Work is proceeding according to the construction schedule, the Engineer may cancel the next meeting.

1.5 SCHEDULES

A. Prepare a construction schedule for all the Work, including a complete sequence of construction by activity. The schedule shall be in the form of a horizontal bar chart, with a separate horizontal bar for each construction activity and the first workday of each week identified.
1. Provide beginning and completion dates for each construction activity and phase.
a. Indicate the completion percentage for each activity on the first day of each month.
b. Indicate time periods when portions of the Site will not be available for Owner use and when stairs and elevators will be used for construction activities.
c. Indicate periods of interruption of utility services.
2. Provide submittal dates and dates when reviewed submittals will be required.
3. Provide product procurement and delivery dates.

4. Provide dates for the selection of finishes.
5. Provide separate sub-schedules as necessary to provide more detail for critical portions of the schedule.

B. Submit the construction schedule to the Owner's Representative and Architect/Engineer within one week after the date of the Notice to Proceed.

C. Update the schedule on a monthly basis or when actual construction progress deviates significantly from that shown on the current schedule.
1. Show all changes that have occurred since the previous schedule was prepared, including the progress of each activity, current completion dates, and major changes in scope.
2. Provide a narrative report that discusses the following items and their effects on the schedule.
   a. Progress of each activity and current completion date, compared to the previous schedule.
   b. Description of changes.
   c. Problem areas, including current and anticipated delay factors.
   d. Corrective actions taken or proposed.
3. Resubmit to the Owner's Representative and Architect/Engineer.

D. Distribute the current schedule to the job-site file, subcontractors, and other affected parties. Instruct parties to report any inability to comply and to provide a detailed explanation with suggested remedies.

1.6 PHOTOGRAPHIC DOCUMENTATION

A. Photograph existing conditions that are important to the construction or that deviate substantially from the Contract Documents; significant conditions that will be concealed by the Work; finish surfaces that might be misconstrued as damage caused by removal or other Work operations; and immediate follow-up when on-site events result in construction damage or loss.
1. Photographs shall be in focus and shall clearly show the condition.
2. Provide images in JPG format, produced by a digital camera with a minimum sensor size of 6.0 megapixels, and at an image resolution of at least 3000 by 2000 pixels. Each image shall include a date and time stamp, and a unique sequential identifier.
3. Maintain a complete set of photographs at the Site, with an image log including:
   a. Name of Project.
   b. Unique sequential identifier.
   c. Date and time photograph was taken.
   d. Description of vantage point, indicating location, direction by compass point, and elevation or story of construction or key plan with photograph locations, or both.

B. Within two days of taking photographs, submit the complete digital-image electronic file with image log to the Architect/Engineer and Owner's Representative. Submit digital images exactly as originally recorded in the camera, without alteration, manipulation, editing, or modification.
1. Submit photographs of pre-existing damage prior to beginning Work in area.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 01 30 00

SECTION 01 33 00
SUBMITTAL PROCEDURES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Administrative and procedural requirements for submitting shop drawings, product data, samples, and other submittals.

1.2 SUBMITTALS

A. General:
   1. Format:
      a. PDF Submittals: Prepare submittals as a PDF package, incorporating complete information into one PDF file for each product or material. Name each PDF file with submittal number
      b. Paper submittals: Include a permanent label or mark-up on the submittal or cover sheet, with the following information.
   2. Submittal Identification: Include the following information in each submittal.
      a. Project name.
      b. Date.
      c. Names of Architect/Engineer, Contractor, subcontractor, manufacturer, supplier, and firm or entity that prepared submittal, as appropriate.
      d. Identification information, such as the number and title of the appropriate Specification section, Drawing number and detail references, location(s) where product is to be installed, or other necessary information.
      e. Label each submittal with the six digit Specification section number followed by a decimal point and then sequential number (e.g., 042000.01). On resubmittals, include alphabetic suffix after another decimal point (e.g., 042000.01.A).
      f. Provide space approximately 6 by 8 inches on or beside the label or title block for the Contractor's approval stamp and the action stamp of the Architect/Engineer.
   3. Deviations: Highlight, encircle, or otherwise specifically identify deviations from the Contract Documents on submittals.

B. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not use reproductions of the Contract Documents or standard printed data.
   1. Preparation: Fully illustrate requirements outlined in the Contract Documents. Include the following information, as applicable:
      a. Dimensions, including notation of those established by field measurement.
      b. Identification of products.
      c. Fabrication and installation drawings.
      d. Roughing-in and setting diagrams.
      e. Shopwork manufacturing instructions.
      f. Templates and patterns.
      g. Schedules.
      h. Notation of coordination requirements.
      i. Relationship to adjoining construction clearly indicated.
      j. Seal and signature of professional Engineer if specified.

2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches but no larger than 30 by 40 inches.

C. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
   1. Clearly mark each copy of the submittal to show which products and options are applicable. Delete information which is not applicable. Supplement standard information with project-specific information.
   2. Include the following information, as applicable:
      a. Manufacturer's catalog cuts, product specifications, schematic drawings, installation instructions, and written recommendations.
      b. Compliance with referenced standards.
      c. Testing by recognized testing agency.
   3. Submit the number of copies required by the Contractor plus two that will be retained by the Architect/Engineer, or digital file. Mark up and retain one returned copy as a Project Record Document.

D. Samples: Submit physical samples to illustrate functional and aesthetic characteristics of the product, for review of materials and workmanship, for compatibility with other elements, and for comparison with the actual installed elements.
   1. Samples shall be of sufficient size to show the general visual effect.
   2. Include sets of at least three samples that show the full range of color, pattern, texture, graining, and finish.
   3. Transmit samples that contain multiple, related components, such as accessories, together in one submittal package.
   4. Identification: Attach a label on an unexposed side of each sample that includes the following:
      a. Generic description of sample.
      b. Product name, name of manufacturer, and sample source.
      c. Number and title of appropriate Specification section.
   5. Samples for Initial Selection: Submit two full sets of units or sections of units from the supplier's product line, showing the full range of colors, textures, and patterns available. Architect/Engineer will retain one set and return one set with the options selected.
   6. Samples for Verification: Submit full-size units or samples of the size indicated, prepared from the same material to be used for the Work, cured and finished in the manner specified, and physically identical with material or product proposed for use, and that show the full range of color and texture variations expected.
      a. Submit the number of samples required by the Contractor plus one that will be retained by the Architect/Engineer. Mark up and retain one returned sample as a Project Record Document.
   7. Maintain approved samples at the Site, available for quality-control comparisons during construction. Samples may be used to determine final acceptance of construction associated with the sample.

E. Delegated Design:
   1. Where required by the Contract Documents, in addition to shop drawings, product data, and other required submittals, submit a statement, signed and sealed by responsible design professional, for each product and system specifically assigned to the Contractor to be designed or certified by a design professional.
      a. Indicate that products and systems comply with performance and design criteria in the Contract Documents.

b. Include a list of codes, loads, and other factors used in performing these services, and signed and sealed design calculations where required.

1.3 SUBMITTAL PROCEDURE

A. Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.

B. Coordinate the preparation and processing of submittals with performance of construction activities.
   1. Coordinate each submittal with fabrication, purchasing, testing, delivery, submittals requiring concurrent review, and related activities that require sequential activity.
   2. Allow sufficient time for submittal and resubmittal review. Failure to provide sufficient time for submittal and resubmittal reviews will not be a basis for extension of the Contract Time.

C. Review Time:
   1. Allow 14 days for the review of each submittal and resubmittal.
   2. Allow additional time if coordination with subsequent submittals is required. The Architect/Engineer will advise the Contractor when the submittal being processed must be delayed for coordination.
   3. Time for review shall commence when the Architect/Engineer receives the submittal.

D. Contractor Review:
   1. Review each submittal, coordinate with other Work, and check for compliance with the Contract Documents. Verify field dimensions and conditions. Identify variations from the Contract Documents and product or system limitations that may be detrimental to the successful performance of completed Work. Note corrections.
   2. Before submitting to the Architect/Engineer, stamp or electronically mark-up, with a uniform approval stamp, including the reviewer's name; the date of Contractor's approval; and a statement certifying that the submittal has been reviewed, checked, and approved for compliance with the Contract Documents.
   3. Submittal Log: Maintain submittal log that lists submitted items per specification section. Record dates submitted, dates returned, and disposition of each item based on Architect/Engineer's review. Submit final log showing approved materials at Substantial Completion.

E. Transmittal: Package each submittal individually and appropriately for transmittal and handling. Transmit each submittal using AIA Document G810.
   1. Email Transmittal: Provide PDF transmittal. Include digital image file illustrating Sample characteristics, and identification information for record.
   2. Web-Based Project Software: Prepare submittals in PDF form, and upload to web-based Project software website. Enter required data in web-based software site to fully identify submittal.
   3. Paper Transmittal: Include paper transmittal including complete submittal information indicated.

F. Architect/Engineer Action:
   1. Architect/Engineer will not review submittals that are received from sources other than the Contractor or that do not bear the Contractor's approval stamp, and will return them without action to the Contractor.

2. Architect/Engineer will review each submittal for conformance with the design concept of the Project and compliance with the Contract Documents. Architect/Engineer will make marks to indicate corrections or modifications required, and stamp or electronically mark-up with an action stamp. The action stamp will include the reviewer's name, date of review, and required Contractor action. Contractor actions may include making corrections or modifications to the submittal or resubmitting the submittal, or both.

G. Resubmittals: Make resubmittals in the same form and number of copies as the initial submittal.
   1. Note the date and content of previous submittal.
   2. Note the date and content of the revision in the label or title block and clearly indicate the extent of the revision and changes made.
   3. Resubmit until the Architect/Engineer indicates that no resubmittal is required.

H. Distribution: Furnish final copies (paper or digital) to the Site file, record documents file, manufacturers, subcontractors, suppliers, fabricators, installers, public authorities having jurisdiction, and others as necessary for performance of construction activities. Show the distribution on the transmittal forms.

I. For construction, use only the final submittals with the Architect/Engineer's action stamp.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 01 33 00

SECTION 01 40 00
QUALITY REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Administrative and procedural requirements for quality assurance and quality control.

B. Testing and inspecting services are required to verify compliance with requirements specified or indicated, and do not relieve the Contractor of responsibility for compliance with requirements of the Contract Documents.
   1. Specified tests, inspections, and related actions do not limit the Contractor's other quality assurance and quality control procedures that facilitate compliance with requirements of the Contract Documents.
   2. Requirements for the Contractor to provide quality assurance and quality control services required by the Architect/Engineer, Owner, or public authorities having jurisdiction are not limited by provisions of this Section.

C. Related Sections:
   1. See sections in Divisions 2 through 32 for specific test and inspection requirements.

1.2 REFERENCES

A. Reference Standards: Latest edition as of Specification date.
   1. ASTM International:
      a. E329: Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.

1.3 DEFINITIONS

A. Quality Assurance Services: Activities, actions, and procedures performed before and during the execution of the Work to guard against defects and deficiencies and substantiate that the proposed construction will comply with requirements.

B. Quality Control Services: Tests, inspections, procedures, and related actions during and after the execution of the Work to evaluate that the actual products incorporated into the Work and the completed construction comply with requirements. Services do not include contract enforcement activities performed by the Architect/Engineer.

1.4 COMPLIANCE CRITERIA

A. General: If compliance with two or more standards is specified and standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement.

B. Minimum Quantity or Quality Level: Quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable

limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements.

C. Refer uncertainties to the Architect/Engineer for a decision before proceeding.

1.5 SUBMITTALS

A. Testing Agency Qualification Data: Provide documentation demonstrating compliance with ASTM E329 of laboratory and personnel.

B. Reports: Prepare and submit certified written reports. Submit copies of reports to the Owner's Representative, Architect/Engineer, and Contractor. Reports shall include the following:
   1. Date of issue.
   2. Project title and number.
   3. Name, address, and telephone number of testing agency.
   4. Dates and locations of samples and tests or inspections.
   5. Names of individuals making tests and inspections.
   6. Description of the Work and test and inspection method.
   7. Identification of product and Specification section.
   8. Complete test or inspection data.
   9. Test and inspection results and interpretation of test results.
   10. Record of temperature and weather conditions at the time of sample taking and testing and inspecting.
   11. Comments or professional opinion on whether tested or inspected Work complies with requirements of the Contract Documents.
   12. Name and signature of laboratory inspector.
   13. Recommendations on retesting and re-inspecting.

C. Permits, Licenses, and Certificates: For the Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on the performance of the Work.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Comply with the requirements of ASTM E329, with experience and capability to conduct testing and inspecting indicated and with additional qualifications specified in individual sections.

B. Mockups: Full-size, physical assemblies that are constructed on-site.
   1. Mockups are used to verify selections made under sample submittals; to demonstrate proposed range of aesthetic effects and workmanship and, where indicated, qualities of materials and execution; and to review construction, coordination, testing, or operation.
   2. Do not construct mockups until corresponding product data, shop drawings, samples, and other submittals have been approved.
   3. Construct mockups for each form of construction and finish required, in accordance with applicable Specification section or as shown on Drawings, using materials indicated for completed Work.
      a. Construct mockups at location and of size indicated or as directed by Architect/Engineer, under same environmental conditions expected during Work.
      b. Use equipment, materials, and procedures proposed for use on Project.
   4. Provide access to mockups.

5. Architect/Engineer will observe mockup construction. Notify Architect/Engineer 7 days in advance of dates and times when mockups will be constructed.
6. Portions of mockup that will be concealed shall be inspected by Architect/Engineer prior to concealment and, when approved, photographed for future reference.
7. If Architect/Engineer or Owner's Representative determines mockup does not comply with requirements, modify mockup or construct new mockup until mockup is approved. Remove and replace mockups that are not approved.
8. Do not order materials; or proceed with fabrication or construction on portions of Work requiring mockups or affected by construction represented by mockups, until mockup has been approved by Architect/Engineer and Owner's Representative.
9. Maintain approved mockups during construction in undisturbed condition as standard for judging completed Work.
10. Demolish and remove mockups when directed, unless otherwise indicated.

PART 2 PRODUCTS NOT USED

PART 3 EXECUTION

3.1 QUALITY CONTROL

A. Owner Responsibilities: Where quality control services are indicated as the Owner's responsibility, the Owner will engage a qualified testing agency to perform these services.
   1. Owner will furnish Contractor with names and contact information of testing agencies engaged and descriptions of types of testing and inspecting they are engaged to perform.
   2. Costs for retesting and re-inspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to the Contractor, and the Contract Sum will be adjusted by Change Order.

B. Contractor Responsibilities: Tests and inspections not explicitly assigned to the Owner, and testing and inspecting requested by the Contractor and not required by the Contract Documents, are the Contractor's responsibility. Unless otherwise indicated, provide quality control services specified and those required by public authorities having jurisdiction, whether specified or not.
   1. Where services are indicated as the Contractor's responsibility, engage a qualified testing agency to perform these services.
      a. Contractor shall not employ the same entity engaged by Owner, unless agreed to in writing by Owner.
   2. Notify the testing agency at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
   3. Where quality control services are indicated as the Contractor's responsibility, submit a certified written report, in duplicate, of each quality control service.
   4. Submit additional copies of each written report directly to public authorities having jurisdiction, when they so direct.
   5. Retesting/Re-inspecting: Regardless of whether the original tests or inspections were the Contractor's responsibility, provide quality control services, including retesting and re-inspecting, for construction that replaced Work that failed to comply with the Contract Documents.

C. Testing Agency Responsibilities: Cooperate with the Architect/Engineer and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.

1. Determine location from which test samples will be taken and in which in-situ tests are conducted.
2. Notify the Architect/Engineer and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
3. Conduct and interpret tests and inspections and state in each report whether tested and inspected Work complies with or deviates from requirements.
4. Submit a certified written report of each test, inspection, and similar quality control service.
5. Do not release, revoke, alter, or increase requirements of the Contract Documents or approve or accept any portion of the Work.
6. Do not perform any duties of the Contractor.

D. Coordination: Coordinate the sequence of activities to accommodate the required quality assurance and quality control services with a minimum of delay and to avoid the necessity of removing and replacing construction to accommodate testing and inspecting.
   1. Schedule times for tests, inspections, obtaining samples, and similar activities.
   2. Notify the testing agency sufficiently in advance of operations to permit assignment of personnel.

E. Associated Services: Cooperate with the Architect/Engineer and testing agencies performing required tests, inspections, and similar quality control services, and provide reasonable auxiliary services as requested. Provide the following:
   1. Submittals of concrete mix designs and other materials and products necessary for the testing agency to test and evaluate field work.
   2. Access to the Work.
   3. Incidental labor and facilities necessary to facilitate tests and inspections.
   4. Adequate quantities of representative samples of materials that require testing and inspecting. Assist the testing agency in obtaining samples.
   5. Facilities for storage and field curing of test samples.
   6. Security and protection for samples and for testing and inspecting equipment at Site.

F. Repair and Protection:
   1. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
      a. Provide materials and comply with installation requirements specified in other sections. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible.
   2. Protect construction exposed by or for quality control services.
   3. Repair and protection are the Contractor's responsibility, regardless of assignment of responsibility for quality control services.

END OF SECTION 01 40 00

SECTION 01 50 00
TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for temporary utilities, support facilities, and protection and controls.

B. Pay for temporary utilities, support facilities, and protection and control measures unless otherwise indicated. Allow other entities to use temporary utilities and facilities without cost, including Owner's Representative, Architect/Engineer, subcontractors, testing agencies, and public authorities having jurisdiction.

1.2 REFERENCES

A. Reference Standards: Latest edition as of Specification date.
   1. Associated General Contractors of America (AGC).
      a. Manual of Accident Prevention for Construction.
   2. National Electrical Contractors Association (NECA).
      a. 200 - Recommended Practice for Installing and Maintaining Temporary Electric Power at Construction Sites.
   3. National Fire Protection Association (NFPA).
      a. 70 - National Electric Code.
      b. 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations.

1.3 SUBMITTALS

A. Site Plan: Show temporary facilities, utility hookups, staging and storage areas, and parking areas for construction personnel.

B. Dust Control Plan: Submit coordination drawing and narrative that describes dust control measures proposed for use, proposed locations, and proposed time frame for their operation. Identify further options if proposed measures are later determined to be inadequate. Include the following:
   1. Locations of dust control partitions at each phase of Work.
   2. Location of proposed air filtration system discharge.
   3. Other dust control measures.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 GENERAL

A. Comply with AGC Manual of Accident Prevention for Construction; applicable laws and governmental rules and regulations; and public authorities having jurisdiction.

B. Conditions of Use:
   1. Locate temporary services and facilities where they will serve Project adequately and result in minimum interference with performance of Work. Coordinate locations with Owner's Representative.
   2. Provide temporary services and facilities ready for use when needed to avoid delay.
   3. Maintain temporary and existing services and facilities clean and neat, in good operating condition, and in condition acceptable to Owner's Representative.
   4. Relocate and modify temporary services and facilities as required by progress of Work.
   5. Enforce strict discipline in use of temporary services and facilities. To minimize waste and abuse, limit availability of temporary services and facilities to essential and intended uses.
   6. Remove temporary services and facilities when no longer needed, but no later than Substantial Completion.
      a. Personnel remaining after Substantial Completion will be permitted to use permanent facilities under conditions acceptable to Owner's Representative.
      b. Restore Site to condition existing before Project commencement.
      c. Materials and facilities that constitute temporary facilities are property of Contractor.

C. Provide temporary ladders, ramps, runways, stairs, scaffolding, staging, enclosures, hoists, rubbish chutes, and other construction aids as may be required for Work.

3.2 TEMPORARY UTILITIES

A. General: Install temporary service or connect to existing service.
   1. Coordinate with utility company.
   2. Arrange with utility company, Owner's Representative, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
   3. Arrange for public authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

B. Water Service: Use of Owner's existing water service will be permitted.
   1. Provide connections and extensions of service as required for construction operations.
   2. Provide additional water as necessary.

C. Electric Power Service: Use of Owner's existing electric power service will be permitted.
   1. Provide connections, extensions of service, and receptacle outlets as required for construction operations.
   2. As necessary, provide additional electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations. Do not overload Owner's service.
   3. Comply with NECA 200 and NFPA 70.
   4. Maintain temporary service in safe condition and utilize in safe manner.

D. Lighting: Owner will provide existing lighting at existing locations.
   1. Provide additional lighting, as necessary, with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
   2. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.

3.3 TEMPORARY FACILITIES

A. General: Provide incombustible construction for offices, shops, and sheds located within construction area or within 30 feet of building lines. Comply with NFPA 241.

B. Parking: Construction personnel shall park in Work area or off-site unless other arrangements are made in advance in writing with Owner's Representative.

C. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel at location designated by Owner's Representative.
   1. Provide disposable supplies, including toilet tissue, paper towels, and paper cups. Maintain adequate supply. Provide covered waste containers for disposal of used material.
   2. Service toilets at least twice weekly.
   3. Provide wash facilities supplied with potable water at convenient locations for personnel who handle materials that require clean up. Supply cleaning compounds appropriate for each type of material handled. Dispose of drainage properly.
      a. Provide safety showers, eyewash fountains, and similar facilities for convenience, safety, and sanitation of personnel.
   4. Comply with public authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.

D. Storage Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.

E. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of public authorities having jurisdiction.

F. Use of Existing Stairs and Elevators: Use of Owner's existing stairs and elevators will be permitted, as long as stairs and elevators are cleaned and maintained in condition acceptable to Owner's Representative.
   1. Coordinate daily usage with Owner's Representative and with requirements for facility operations.
   2. Provide protective coverings, barriers, devices, signs, or other procedures to protect stairs, elevator cars, and entrance doors and frame, and to maintain means of egress.
   3. At Substantial Completion, restore stairs and elevators to condition existing before initial use, including replacing worn cables, guide shoes, and similar items of limited life.

G. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.
   1. Construction maintenance and operation shall be in accordance with public authorities having jurisdiction.
   2. Locate sufficient distance from exterior walls and protect walls to prevent damage.

3.4 TEMPORARY PROTECTION AND CONTROLS

A. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction in ways and by methods that comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
   1. Comply with applicable laws, governmental rules and regulations, and public authorities having jurisdiction with regard to noise, dust, pest, and pollution control.

2. Perform work in a manner to minimize hazards due to the disturbance of lead containing materials (paint) and comply with MiOSHA requirements for assessing, monitoring, and protecting employees from lead hazard.

B. Temporary Fencing:
   1. Tree and Plant Protection: Install temporary fencing located as indicated or outside drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.
   2. Site Enclosure Fence: Before construction operations begin, provide Site enclosure fence in manner that will prevent people and animals from easily entering Site except by entrance gates.
      a. Provide lockable entrances to prevent unauthorized entrances. Lock entrances during non-working hours. Maintain security by limiting number of keys and restricting distribution to authorized personnel. Provide Owner's Representative with one set of keys.

C. Barricades, Warning Signs and Lights, and Traffic Controls: Provide and maintain barricades, warning signs and lights, and traffic controls. Provide traffic control as necessary for construction vehicles entering and leaving Site, and for non-construction vehicles on or near Site. Comply with requirements of public authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.

D. Project Identification and Temporary Signs: Provide Project identification and other signs at locations indicated to inform public and individuals seeking entrance to Project. Unauthorized signs are not permitted.
   1. Provide temporary directional signs for construction personnel and visitors.
   2. Maintain signs so they are legible at all times.

E. Covered Walkway: Erect protective covered walkways for passage of individuals through or adjacent to Site. Coordinate with entrance gates, other facilities, and obstructions. Comply with regulations of public authorities having jurisdiction.
   1. Construct covered walkways using scaffold or shoring framing.
   2. Provide overhead decking, protective enclosure walls, handrails, barricades, warning signs, exist signs, vandal-resistant lights, safe and well-drained walkways, and similar provisions for protection and safe passage.
   3. Maintain appearance of walkway for duration of Work.

F. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241.
   1. Provide portable, UL-rated fire extinguishers with class and extinguishing agent as required by locations and classes of fire exposures.
   2. Prohibit smoking on Site.
   3. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of public authorities having jurisdiction.
   4. Store combustible materials in approved safety containers and enclosures, away from building if possible.
   5. Develop and supervise overall fire-prevention and -protection program for personnel at Site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.

G. Dust and Fume Control: Prevent dust, dirt, fumes, and odors from entering occupied areas.
   1. Provide and maintain floor-to-ceiling dustproof partitions to limit dust, dirt, fumes, and migration to occupied areas.
   2. Filter supply air or disconnect HVAC systems in or near Work area that service occupied areas.
   3. Ensure adequate measures are in place to building occupants from airborne lead dust or particles exceeding the MiOSHA Action Level.

H. Noise Control: Perform Work in manner to minimize noise, during hours authorized by Owner's Representative.

I. Existing Drains:
   1. Verify that drains in or near Work area are open and free flowing prior to start of Work.
   2. Lawfully remove construction effluent from Site. Do not allow construction debris to flow into existing drains or sewer systems.
   3. Rout or replace clogged drain lines at completion of Work.

J. Temporary Construction Protection:
   1. Provide and secure temporary weathertight protection for in-progress exterior construction, as needed, including unfinished Work on walls and roofs.
   2. Provide insulation or temporary heating as necessary for curing, drying, and protection of installed construction.
      a. Select equipment that will not have harmful effect on completed installations or elements being installed.
      b. Maintain temporary heating on 24-hour basis until no longer needed.
      c. Unless noted otherwise, insulation is considered incidental to construction and will not be paid for separately.
      d. Unless otherwise specified, temporary heating will not be considered part of Work and will be paid as additional Work item. Notify Owner's Representative in advance of need for temporary heating and estimated added cost. Do not proceed with temporary heating until authorized in writing by Owner's Representative.
   3. Protect finished surfaces against damage. Minimize traffic on finished roof surfaces and do not use for material storage.

END OF SECTION 01 50 00

SECTION 01 60 00
PRODUCT REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Administrative and procedural requirements for selection of products for use in Project, including requests for comparable products and general product delivery, storage, and handling requirements.

B. Related Sections:
   1. Section 01 26 00 - Contract Modification and Payment Procedures: Product substitution procedures.

1.2 DEFINITIONS

A. Products: Items obtained for incorporating into Work, whether purchased for Project or taken from previously purchased stock. Includes "material," "equipment," "system," and terms of similar intent.
   1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature, which is current as of date of Contract Documents.
   2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
   3. Comparable Product: Product that is demonstrated and approved through submittal process to have indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

1.3 PRODUCT SELECTION PROCEDURES

A. General Product Requirements: Provide products that comply with Contract Documents, are undamaged, and, unless otherwise indicated, are new at time of installation.
   1. Select products compatible with other products specified or previously selected.
   2. Provide products complete with accessories, trim, finish, fasteners, and other items needed for complete installation and indicated use and effect.
   3. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
   4. Owner reserves right to limit selection to products with warranties in conformance with requirements of Contract Documents.
   5. Where products are accompanied by term "as selected," Architect/Engineer will make selection.
   6. Descriptive, performance, and reference standard requirements in Specifications establish salient characteristics of products.
   7. Or Equal: For products specified by name and accompanied by term "or equal," or "or approved equal," or "or approved," comply with requirements for comparable product

requests in Submittals Article or substitutions for convenience requests in Section 01 26 00 to obtain approval for use of unnamed product.

B. Product Selection Procedures:
   1. Products:
      a. Where Specifications name single manufacturer and product, select named product. Comparable products or substitutions for Contractor's convenience will not be considered.
      b. Where Specifications include list of names of both manufacturers and products, select one of products listed that complies with requirements. If “or equal” products are permitted, comply with requirements for comparable product requests in Submittals Article or substitutions for convenience requests in Section 01 26 00 for consideration of unnamed products that comply with requirements.
      c. Where Specifications name product, or refer to product indicated on Drawings, and include list of manufacturers, select specified or indicated product or comparable product by one of other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on product named. Comply with requirements for comparable product requests in Submittals Article or substitutions for convenience requests in Section 01 26 00 for consideration of unnamed product by one of other named manufacturers.
      d. Where Specifications specify product or method by reference or performance standards only, select product that meets or exceeds standards.
   2. Manufacturer/Source:
      a. Where Specifications name single manufacturer or source, select product by named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
      b. Where Specifications include list of manufacturers' or source’s names, select product by one of manufacturers or sources listed that complies with requirements. If “or equal” products are permitted, comply with requirements for comparable product requests in Submittals Article or substitutions for convenience requests in Section 01 26 00 for consideration of unnamed manufacturer's or source’s product.

C. Visual Selection Specification: Where Specifications include phrase "as selected by Owner from manufacturer's standard or full range of colors, patterns, and textures" or similar phrase, select product that complies with other specified requirements.
   1. Standard Range: Manufacturer's product line, excluding premium items.
   2. Full Range: Manufacturer's product line, including standard and premium items.
   3. Owner will select color, gloss, pattern, density, and texture from manufacturer's indicated product line.

1.4 SUBMITTALS

A. Products List: Within 14 days after date of Notice to Proceed, submit to Architect/Engineer list of products proposed for use, organized by Specification section. Include name and address of manufacturer, trade name of product, model or catalog designation, and intended use.
   1. Products List does not replace requirement to submit product data, comparable product requests, or substitution requests.

B. Comparable Product Requests: Submit three copies of request for consideration. Identify product, fabrication, or installation method to be replaced. Include relevant Specification section and Drawing numbers and titles.
   1. Provide the following information. If the following information is not provided, Architect/Engineer may return requests without action, except to record noncompliance with these requirements.
      a. Detailed comparison of significant qualities of proposed product with those named in Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
      b. Evidence that proposed product provides specified warranty.
      c. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
      d. Samples, if requested.
      e. Statement that proposed product does not require revisions to Contract Documents, that it is consistent with Contract Documents and will produce indicated results, and that it is compatible with other portions of Work.
   2. If there is cost difference between specified product and proposed product, submit as substitution rather than comparable product.

C. Architect/Engineer's Action: If necessary, Architect/Engineer will request additional information or documentation for evaluation within seven days of receipt of comparable product request. Architect/Engineer will notify Contractor of acceptance or rejection of proposed comparable product within 14 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
   1. Acceptance or rejection of proposed comparable products shall be at sole discretion of Architect/Engineer, whose decision is final.
   2. Use product specified if Architect/Engineer does not issue decision on use of proposed comparable product within time allocated.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.

B. Delivery:
   1. Schedule delivery to minimize long-term storage at Site and to prevent overcrowding of construction spaces.
   2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
   3. Deliver products to Site in undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
   4. Inspect products on delivery to determine compliance with Contract Documents and to determine that products are undamaged and properly protected.

C. Storage:
   1. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.

2. Store products that are subject to weather damage under cover in weathertight enclosure above ground, with ventilation adequate to prevent condensation.
3. Protect stored products from damage and stored liquids from freezing.
4. Store products to allow for inspection and measurement of quantity or counting of units.
5. Store materials in manner that will not endanger Project structure, away from edge of Project structure.
6. Provide secure location and enclosure at Site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner's Representative.
7. Move stored products that interfere with operations of Owner or other Contractors.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 01 60 00

SECTION 01 70 10
EXECUTION OF WORK

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: General administrative and procedural requirements governing execution of Work, including the following:
   1. Examination of existing conditions.
   2. Preparation.
   3. Removal of existing construction, including salvage and reuse of materials.
   4. Cutting and patching.
   5. Installation of Work.
   6. Protection of installed construction.
   7. Correction of Work.
   8. Progress cleaning.

B. Cutting and patching includes the following:
   1. Removal and replacement of existing construction necessary to install Work or make several parts fit properly.
   2. Removal and replacement of Work
      a. That is defective;
      b. That does not conform to requirements of Contract Documents;
      c. To provide for installation of ill-timed Work;
      d. To alter Work; or
      e. To allow observation of concealed Work.
   3. Removal of samples of installed Work for testing.

1.2 PAYMENT

A. Pay for cutting and patching unless requested by Architect/Engineer for Work that is not defective or nonconforming.

1.3 REFERENCES

A. Definitions:
   1. Cutting: Removal of in-place construction necessary to permit installation or performance of other work.
   2. Existing to remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.
   3. Patching: Fitting and repair work required to restore construction to original condition after installation of other work.
   4. Remove: Detach items from existing construction and legally dispose of off-site, unless indicated to be removed and salvaged or removed and reinstalled.
   5. Remove and reinstall: Detach items from existing construction, prepare for reuse, and reinstall where indicated.
   6. Remove and salvage: Detach items from existing construction and deliver to Owner ready for reuse.

B. Reference Standards: Latest edition as of Specification date.
   1. ASTM International:
      a. C1036: Standard Specification for Flat Glass.
   2. National Fire Protection Association (NFPA).
      a. 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations.

1.4 SUBMITTALS

A. Submit plan/procedures for protecting stored materials, installed work, building, and Site.

B. Submit plan/procedures for assessing, monitoring, and mitigating potential material hazards.

C. Submit, prior to beginning Work, documentation of existing conditions, including finish surfaces, which might be misconstrued as damage caused by Work.

D. Submit identification codes and inventory of materials to be salvaged or reinstalled.

E. Cutting and Patching Proposal: Submit proposal describing cutting and patching procedures at least ten days before time cutting and patching will be performed. Include the following information:
   1. Describe extent of cutting and patching, how cutting and patching will be performed, and why cutting and patching cannot be avoided. List products to be used and firms or entities that will perform Work.
   2. Indicate when cutting and patching will be performed.
   3. Describe anticipated results, including changes to structural elements and changes in building's appearance and other significant visual elements. Where cutting and patching involve temporarily or permanently modifying structural elements, submit details and engineering calculations showing that temporary measures and permanent construction will not adversely affect structure.
   4. Obtain Architect/Engineer's review comments for cutting and patching proposal and respond to comments before cutting and patching. Review does not waive right to later require removal and replacement of unsatisfactory work.

F. Manufacturers' recommendations for cleaning spillage and over-application of products.
   1. Proposed products and methods for cleaning where no manufacturers' recommendations.

1.5 QUALITY ASSURANCE

A. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.
   1. Structural Elements: When cutting and patching structural elements, notify Architect/Engineer of locations and details of cutting and await directions from Architect/Engineer before proceeding. Shore, brace, and support structural element, as necessary, during cutting and patching. Do not cut and patch structural elements in manner that could change their load-carrying capacity or load-deflection ratio.
   2. Other Construction Elements: Do not cut and patch other construction elements or components in manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety. Other construction elements might include the following:
      a. Water, moisture, or vapor barriers.
      b. Membranes and flashings.

c. Exterior curtain wall or facade construction.
d. Equipment supports.

3. Visible Elements: Do not cut and patch exposed construction in a manner that results in visible evidence of cutting and patching or in a manner that would, in Architect/Engineer's opinion, reduce building's aesthetic qualities. Remove and replace construction that has been cut and patched in visually unsatisfactory manner.

B. Cutting and Patching Conference: Before proceeding, meet at Site with parties involved in cutting and patching. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

C. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of products and equipment.

1.6 PROJECT CONDITIONS

A. Notify Architect/Engineer of discrepancies between Drawings and existing conditions before proceeding with Work.

B. Assume responsibility for actual condition of existing construction.

1.7 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during Contractor operations, by methods and with materials so as not to void existing warranties.

PART 2 PRODUCTS

2.1 MATERIALS

A. General: Comply with requirements specified in other Sections.
1. Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match adjacent surfaces to fullest extent possible.
a. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide match acceptable to Architect/Engineer for visual and functional performance of in-place materials.

B. Cleaning: Select cleaning materials, equipment, and methods to avoid scratching, marring, defacing, staining, or discoloring surfaces.
1. Use cleaning materials and methods recommended by manufacturer of surface to be cleaned.
2. Use cleaning materials on surfaces recommended by cleaning-material manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION OF EXISTING CONDITIONS

A. Survey existing conditions and correlate with requirements indicated to determine extent of removal Work required.
1. Inventory and record condition of items to be removed and salvaged or reinstalled.

B. Document with photographs or videotape, or both, existing conditions of adjoining construction, including finish surfaces, which might be misconstrued as damage caused by demolition or other Work activities; existing conditions that are important to construction or that deviate substantially from Contract Documents; and significant conditions that will be concealed by Work.
   1. Prior to commencing Work, perform and submit benchmark glass condition assessment including photographs or videotape that documents existing scratches or other surface damage to glass, as well as tenacious debris adhered to glass. Existing conditions not specifically identified and documented are assumed to meet requirements of ASTM C1036.
   2. At end of Project, for damage not specifically identified and documented prior to start of Work, restore damage to condition prior to start of Work or replace at no cost to Owner. Allowable scratches and surface damage to glass shall be limited to documented preconstruction scratches and damage plus allowable blemishes per ASTM C1036.

C. Examination and Acceptance of Conditions: Before proceeding with each component of Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
   1. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
   2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
   3. Provide a written description of conditions detrimental to performance of the Work, including substrates and unacceptable installation tolerances, and recommend corrections.
   4. Proceed with installation only after unsafe or unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

D. When unanticipated structural, electrical, or mechanical elements that conflict with intended function or design are encountered, investigate and measure nature and extent of conflict. Promptly submit written report to Architect/Engineer.

E. Survey existing conditions as Work progresses to detect hazards resulting from construction.

F. Provide access to Work areas and perform localized demolition as necessary for inspection of concealed underlying conditions by Architect/Engineer and Owner’s Representative.

3.2 UTILITIES AND MECHANICAL AND ELECTRICAL SYSTEMS

A. Disconnect and seal or cap off indicated utility services and mechanical and electrical systems in Work areas.

B. Where existing utility services or mechanical or electrical systems are required to be removed, relocated, or abandoned, bypass such services/systems before beginning Work to prevent interruption to occupied areas.

C. Temporarily support and protect existing utilities, mechanical, fire protection, and electrical systems that interfere with repair locations and are indicated to remain.

D. Remove abandoned conduit or piping that interferes with repair locations.

3.3 PREPARATION

A. Field Measurements: Take field measurements as required to fit Work properly. Recheck measurements before installing each product. Where portions of Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

B. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of Contract Documents caused by differing field conditions outside of the control of the Contractor, submit a request for information to Architect/Engineer. Include a detailed description of the problem encountered, with recommendations for changing the Contract Documents. Submit requests on CSI Form 13.2A, "Request for Interpretation."

3.4 PARTIAL REMOVAL

A. Demolish and remove existing construction and installations only as necessary and required for proper installation of Work indicated on the Drawings and Specifications.
   1. Conduct removals carefully to avoid damaging existing construction and installations that will remain. Protect construction that will remain against damage and soiling. When permitted by Architect/Engineer, items may be removed to a suitable, protected storage location during removal Work and cleaned and reinstalled in original locations after removal operations are complete.
      a. Neatly cut openings and holes plumb, square, and true to dimensions required.
      b. Cut or drill from exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
      c. Use cutting methods least likely to damage construction to remain.
      d. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces.
      e. Temporarily cover openings to remain.
   2. Provide and maintain shoring, bracing, and structural supports, as required to preserve stability and prevent movement, settlement, or collapse of construction or finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
   3. Remedy damage to existing construction and installations caused by Contractor operations.

B. Items to be Salvaged or Reinstalled.
   1. Carefully remove from building, clean, and mark with identifying code.
   2. Store in secure area and protect from damage.
   3. Replace damaged items to be reinstalled with new items to match undamaged originals.
   4. Items to be salvaged.
      a. Pack or crate, and label contents of containers.
      b. Store in secure area until delivery to Owner.
      c. Transport to Owner's on-site storage area.
      d. Protect from damage during transport and storage.

3.5 CUTTING AND PATCHING

A. General: Cut in-place construction to provide for installation of other components or performance of other construction and proceed with patching after construction operations requiring cutting are complete, as required to restore surfaces to their original condition.

1. Employ skilled workers to perform cutting and patching.
2. Proceed with cutting and patching at earliest feasible time and complete without delay.
3. Provide temporary support of work to be cut.
4. Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
5. Coordinate cutting and patching with use of and free passage to adjoining occupied areas.

B. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
   1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
   2. Finished Surfaces: Cut or drill from exposed or finished side into concealed surfaces.
   3. Concrete and Masonry: Cut using cutting machine, such as abrasive saw or diamond-core drill.
   4. Provide substrate suitable for installation of Work and patching.
   5. Notify Architect/Engineer and Owner’s Representative immediately of damage to concealed elements, such as electrical conduits.

C. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. Provide materials and comply with installation requirements specified in other Sections.
   1. Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
   2. Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in manner that will minimize evidence of patching and refinishing. Provide even surface of uniform finish, color, texture, and appearance.
   3. Where patching occurs in painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over patch, and apply final paint coat over entire unbroken surface containing patch. Provide additional coats until patch blends with adjacent surfaces.
   4. Patch exterior building enclosure components in manner that restores enclosure to weathertight condition.

D. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.6 INSTALLATION OF WORK

A. General: Locate Work and components of Work accurately, in correct alignment and elevation. Make vertical work plumb and make horizontal work level.

B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.

C. Install products at time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.

D. Conduct construction operations so no part of Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.

E. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.

F. Templates: Obtain and distribute to parties involved templates for work specified to be factory prepared and field installed. Check shop drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.

G. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where the size and type of attachments are not indicated, verify size and type required for load conditions.
   1. Allow for building movement, including thermal expansion and contraction.
   2. Coordinate the installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Site in time for installation.

H. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for best visual effect. Fit exposed connections together to form hairline joints.

I. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous. Provide adequate ventilation during use of volatile or noxious materials.

3.7 PROTECTION OF INSTALLED CONSTRUCTION

A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at the time of Substantial Completion.

B. Comply with the manufacturer's written instructions for temperature and relative humidity.

3.8 CORRECTION OF WORK

A. Repair or remove and replace defective construction. Restore damaged substrates and finishes.
   1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.

B. Restore permanent facilities used during construction to their condition prior to construction.

C. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.

D. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.

E. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

3.9 PROGRESS CLEANING

A. General: Clean Site and Work areas daily, including common areas. Enforce requirements strictly. Separate materials per disposal requirements and dispose of legally.

1. Provide containers for waste materials, debris, and rubbish.
2. Do not hold waste materials, debris, or rubbish more than seven days during normal weather or three days if temperature is expected to rise above 80 degrees F.
3. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
4. Collect hazardous and unsanitary waste materials and debris in separate containers from other waste. Use containers intended for holding waste materials of type to be stored and mark containers appropriately. Remove from Site daily and dispose of legally.
5. Do not bury or burn waste materials, debris, or rubbish on-site. Do not discharge or wash waste materials, debris, or rubbish down sewers or into waterways.

B. Site: Maintain Site and surrounding areas free of waste materials, debris, and rubbish from construction operations and personnel.

C. Work Areas: Clean areas where Work is in progress to level of cleanliness necessary for proper execution of Work.
   1. Remove liquid spills promptly.
   2. Where dust would impair proper execution of Work, broom-clean or vacuum entire work area or dampen area, as appropriate.

D. Installed Work: Keep installed Work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

E. Concealed Spaces: Remove debris from concealed spaces before enclosing space.

F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at the time of Substantial Completion.

G. Handle waste materials, debris, and rubbish in a controlled manner with as few handlings as possible. Do not throw from heights.

H. Limiting Exposures: Supervise construction operations to assure that no part of construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during construction period.

END OF SECTION 01 70 10

SECTION 01 70 20
PROJECT CLOSEOUT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Administrative and procedural requirements for contract closeout, including final cleaning; Substantial Completion and final completion procedures; and project record documents.

B. Related Sections:
   1. Divisions 02 through 32 sections for special cleaning and specific closeout requirements for Work in those sections.

1.2 SUBMITTALS

A. Punch List: List of items to be completed or corrected.
   1. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside limits of construction. Use CSI Form 14.1A or similar form.
      a. Organize list of spaces in sequential order.
      b. Organize items applying to each space by major element.
      c. Include the following information at top of each page:
         1) Project name.
         2) Date.
         3) Name of Architect/Engineer.
         4) Name of Contractor.
         5) Page number.
      d. Submit one 8-1/2-by-11-inch copy.

B. Warranties:
   1. Organize warranty documents into orderly sequence based on table of contents of Project Manual.
      a. Bind warranties in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.
      b. Provide heavy, paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify product or installation. Provide a typed description of product or installation, including product name and names, addresses, and telephone numbers of manufacturer and Installer.
      c. Identify each binder on the front and spine with typed or printed title "WARRANTIES," Project name, and name of Contractor.
      d. Scan warranties and assemble the complete warranty submittal package into a single indexed electronic PDF file with links enabling navigation to each item. Provide a table of contents at the beginning of the document.
   2. Submit one set of binders and one scanned copy of warranty package.
   3. Provide additional copies of each warranty to include in maintenance manual.

C. Project Record Documents:
   1. Submit two sets of marked-up prints, print each Drawing, whether or not changes and additional information were recorded. Organize Record Drawings into sets and bind sets of prints. Revise and resubmit if Architect/Engineer determines information recorded or quality of drafting is unacceptable.
   2. Submit two copies of marked-up Specifications, including addenda and contract modifications.
   3. Submit two copies of each marked-up Product Data submittal. Include one copy in Product Maintenance Manual.
   4. Assemble and submit two copies of test and inspection reports, surveys, mix records, inspection reports by public authorities having jurisdiction, and other miscellaneous records. Bind or file miscellaneous records and identify each, ready for continued use and reference.

D. Product Maintenance Manual:
   1. Assemble complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated in the Work. Include maintenance data required in individual Specification sections, for each product and system and the following:
      a. Manufacturer's address and product information, cross-referenced to Specification section number and title.
         1) Include project-specific product details, such as color, pattern, texture, and material and chemical composition.
         2) Include re-ordering information for specially manufactured products.
         3) For manufacturers' standard printed data, include only sheets pertinent to product installed. Mark each sheet to identify each product incorporated into the Work. If data include more than one item, identify each item using appropriate references from Specification sections. Identify data applicable to the Work and delete references to information not applicable.
      b. Name, address, and telephone number of Installer or supplier.
      c. Maintenance and service schedules for preventive and routine maintenance.
      d. Maintenance procedures, and maintenance materials and sources.
      e. Maintenance record forms.
      f. Copies of maintenance service agreements and warranties.
   2. Organize into suitable sets of manageable size, with a separate section for each product, material, and finish.
      a. Bind and index data in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, sized to receive 8-1/2-by-11-inch paper and in thickness necessary to accommodate contents, with pockets inside covers to receive folded oversized sheets.
      b. Provide heavy, paper dividers with plastic-covered tabs for each separate product. Mark tab to identify product or installation.
      c. Identify each binder on front and spine with typed or printed title "PRODUCT MAINTENANCE MANUAL," Project name, and subject matter of contents.
      d. Scan the maintenance manual and assemble the complete maintenance submittal package into a single indexed electronic PDF file with links enabling navigation to each item. Provide a table of contents at the beginning of the document.
   3. Submit one set of binders and one scanned copy of maintenance manual package.

PART 2 PRODUCTS

2.1 MATERIALS

A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 EXECUTION

3.1 FINAL CLEANING

A. General: Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations. Return adjacent surfaces and areas to condition existing before Work began.

B. In areas disturbed by construction activities, complete the following cleaning operations before requesting inspection for certification of Substantial Completion for the entire Project or for a portion of the Project. Clean each surface or unit to the condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions. Employ experienced workers or professional cleaners.
   1. Remove tools, construction equipment, machinery, and surplus material from Site.
   2. Clean Site, yard, and grounds, including landscaped areas, of rubbish, waste materials, litter, and other foreign substances.
      a. Broom clean paved areas. Remove petrochemical spills, stains, and other foreign deposits.
      b. Rake grounds that are neither planted nor paved to smooth, even-textured surface.
   3. Clean exposed exterior and interior hard-surfaced finishes to dirt-free condition, free of stains, films, and similar foreign substances. Polish surfaces to achieve specified finish. Avoid disturbing natural weathering of exterior surfaces.
      a. Touchup and otherwise repair and restore marred exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that show evidence of repair or restoration.
         1) Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates.
   4. Clean and restore transparent and reflective surfaces, such as mirrors and glass in doors and windows, to their original condition. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
   5. Remove labels that are not permanent.
   6. Clean plumbing fixtures to sanitary condition, free of stains, including stains resulting from water exposure.
   7. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency.
   8. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
   9. Sweep floors broom clean. Vacuum carpet and similar soft surfaces, removing debris and excess nap; shampoo if visible soil or stains remain.
   10. Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove paint and mortar droppings and other foreign substances.

11. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
12. Leave Project clean and ready for occupancy.

3.2 SUBSTANTIAL COMPLETION

A. Before requesting inspection for determining date of Substantial Completion, complete the following. List items below that are incomplete with request.
   1. Prepare punch list, value of items on list, and reasons why Work is not complete.
   2. Deliver tools, spare parts, extra materials, and similar items to location designated by the Owner's Representative. Label with manufacturer's name and model number where applicable.
   3. Terminate and remove temporary facilities from Site, along with mockups, construction tools, and similar elements.
   4. Complete final cleaning requirements, including touchup painting.
   5. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.

B. Request inspection for Substantial Completion. On receipt of request, Architect/Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect/Engineer will prepare Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect/Engineer, that must be completed or corrected before certificate will be issued.
   1. Request re-inspection when Work identified in previous inspections as incomplete is completed or corrected.
   2. Results of completed inspection will form the basis of requirements for final completion.

3.3 FINAL COMPLETION

A. Before requesting final inspection for determining final completion, complete the following:
   1. Submit final Application for Payment.
   2. Submit copy of Architect/Engineer's Substantial Completion inspection punch list, endorsed and dated by Architect/Engineer, with statement that items on punch list have been completed or otherwise acceptably resolved.
   3. Submit executed warranties, maintenance service agreements, certifications of inspection and occupancy, paid utility bills, and similar documents.
   4. Prepare and submit Project Record Documents, operation and maintenance manuals, and similar final record information.
   5. Instruct Owner's personnel in maintenance of products installed.

B. Request final inspection. On receipt of request, Architect/Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect/Engineer will prepare final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.
   1. Request re-inspection when Work identified in previous inspections as incomplete is completed or corrected.

3.4 PROJECT RECORD DOCUMENTS

A. During Work, maintain one set of prints of full size Drawings and reviewed shop drawings, Specifications, site visit reports, approved submittals, and product data for recording

deviations of as-built construction from design information. Include addenda and Contract modifications.

1. Accurately document and record changes and modifications as soon as possible after they occur, in understandable manner.
2. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later. Record and check markup before enclosing concealed installations.
3. Include:
    a. Dimensional changes.
    b. Revisions to Drawing details and details not on Drawings.
    c. Changes made by Change Order or Architect/Engineer's written orders. Note Change Order numbers or similar identification.
    d. Field records for variable and concealed conditions.
    e. Record information on Work that is shown only schematically or omitted from Drawings.
    f. Actual products and materials used.
        1) Include product data, specifically marked for Project, and cross-referenced to Specifications, Drawings, and Change Orders.
        2) Include names of manufacturer and Installer, and other information necessary to provide record of selections made.
        3) Include significant changes in product delivered to Site and changes in manufacturer’s written instructions for installation.
4. Mark record document most capable of showing actual physical conditions completely and accurately. Cross-reference on other record documents.
5. Mark record documents with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of Work at the same location.

B. Store Record Documents and samples in field office apart from Contract Documents used for construction. Maintain Record Documents in good order and in clean, dry, legible condition, protected from deterioration and loss. Provide access to Record Documents for Architect/Engineer's reference during normal working hours.

END OF SECTION 01 70 20

SECTION 02 01 11
SHORING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Supply, installation, and removal of temporary shoring to support structural elements vertically.

B. Related Sections:
1. Section 01 11 00 – Summary of Work
2. Section 01 22 00 – Unit Prices
3. Section 03 01 24 – Unbonded Post-Tensioning Repair
4. Section 03 01 31 – Concrete Removal and Surface Preparation
5. Section 03 01 34 – Concrete Repair
6. Section 04 01 21 – Brick ~~m~~Masonry Repair and Replacement
7. Section 05 02 00 – Structural Steel
8. Section 08 80 00 – Glazing

1.2 PAYMENT

A. Include the following on a lump sum or unit price basis as described in Sections 01 11 00 and 01 22 00:
1. Design of shoring, developing shoring procedures, preparing shoring submittals, and providing and installing shoring.

1.3 COORDINATION

A. Coordinate with Owner's Representative and with other trades to ensure that shoring does not interfere with Owner use of Site or work of other trades.

B. Comply with pertinent requirements of Authorities Having Jurisdiction (AHJ)

C. The Contractor shall be responsible for means and methods of shoring and temporary support and for the sequences and procedure being used.

1.4 SUBMITTALS

A. Product Data: Manufacturer's literature and technical data indicating type of shoring proposed for use and safe load-carrying capacity of shoring for heights and lengths of shoring components to be used.

B. Shop Drawings: Shop drawings showing locations, distribution, and quantity of shoring. Include connection and bearing details. Shop drawings shall be prepared by or under supervision of qualified, licensed Structural Engineer and shall be sealed by engineer.

C. Design Calculations: Calculations prepared by or under supervision of qualified, licensed professional engineer, and sealed by engineer, indicating that shoring meets design criteria.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store shoring materials in approved storage area at Site, such that materials do not interfere with Owner's continued use of facility.

B. Limit stored materials on structure to safe loading capacity of structure at time materials are stored, and to avoid permanent deck deflection.

1.6 PROJECT CONDITIONS

A. Comply with Owner's limitations and restrictions for Site use and accessibility.

PART 2 PRODUCTS

2.1 MANUFACTURED ASSEMBLIES

A. Design Criteria:
   1. Design for self-weight of structure, superimposed dead loads, and 20 psf live load in area accessible only to construction traffic or 40 psf live load in areas open to vehicular traffic over tributary area of member being repaired.
   2. Design shall include a minimum factor of safety of 2.0.
   3. Design spreaders to distribute load over an effective area to result in a 2,500 psf or less bearing pressure on the concrete slab.
   4. Consider removal of loads from member and transfer of loads into structure below, without overloading structural members.
   5. Detail shoring to avoid interference with Owner operations.
   6. Consider shoring stiffness relative to stiffness of members being shored.

B. Shoring: Steel posts, steel frames, or other steel assemblies with sufficient capacity to support calculated shoring loads at spacing and positioning shown on shop drawings.
   1. Adjustable through positive means, such as screw jacks, to achieve tight fit to structure above and below and to compensate for elastic shortening of shores during loading and service.
   2. Use undamaged components, including bracing, supplied by shoring manufacturer.

2.2 ACCESSORIES

A. Spreaders:
   1. At bottom of shores: steel, aluminum, or timber cribbing with a minimum cross section of 3-1/2 inches by 3-1/2 inches, or other material; with sufficient bearing area and length to distribute shoring reactions into supporting structural element below.
   2. At top of shores: Timber, steel, or aluminum spreader beams or wood bearing pads; to fully support member being shored without damage to member surface.

B. Shims: Wood or steel; at bearing points above shores to ensure tight contact with shored member.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements and other conditions affecting installation or performance of shoring Work.
   1. Ensure that work done by other trades is complete and ready for shoring Work.
   2. Notify Engineer in writing of conditions which may adversely affect installation or performance of shoring Work and recommend corrections.
   3. Do not proceed with shoring Work until adverse conditions have been corrected and reviewed by Engineer.
   4. Commencing shoring Work constitutes acceptance of Work surfaces and conditions.

3.2 INSTALLATION

A. Install shoring in accordance with manufacturer's recommendations and approved shop drawings. Installed assembly shall be of such quality that assembly will support imposed loads without excessive settlement or deflection.
   1. Position to avoid interference with Owner operations.
   2. Install snug, plumb, and square. Install cross-bracing recommended by shoring manufacturer and shoring designer to prevent buckling failure of individual members and overall shoring stability failure. Extend shoring above and below level of repair work as required by shoring design.
   3. Install spreader beams or bearing pads and shims as necessary, and adjust shores to ensure tight, uniform fit against structural element to be supported. Minimize differential loading of vertical shoring members.
   4. Install timber cribbing wood or wood bearing pads as necessary to distribute loads into supporting elements. If more than 1 layer of cribbing is required, install each successive layer perpendicular to preceding layer.
   5. If shoring is to be placed on coated or finished surface, protect surface from damage with plywood, plastic sheets, or other means.

B. Preload shores with screw jacks to bring shoring into a uniform, snug-tight condition.

C. Protect shores from damage from construction activities, Owner use of facility, and other causes.

D. Check shores daily and adjust as necessary to maintain snug condition, plumbness, and full effectiveness.

E. Modify and adjust shoring as required to meet conditions of work and to ensure Project safety.

3.3 FIELD QUALITY CONTROL

A. Shoring Design Engineer shall inspect and approve shoring materials and installation prior to start of any demolition work.

3.4 REMOVAL OF SHORES

A. Remove shores when compressive strength of repair concrete exceeds 75 percent of its specified 28-day strength and after the post tensioning stressing records have been approved by the Engineer or when repair of steel section or glazing is completed. Contractor may elect

to have additional concrete strength tests performed at his own expense, to confirm when repair concrete meets removal requirements.

B. Store shoring materials in approved storage area at Site, such that materials do not interfere with Owner's continued use of facility. Promptly remove shoring materials from Site when no longer needed for work.

END OF SECTION 02 01 11

SECTION 03 01 24
UNBONDED POST-TENSIONING REPAIRS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Repair of damaged sheathing, splicing of damaged or fractured unbonded prestressing tendons, stressing prestressing tendons, rebuilding damaged or deteriorated end anchorages, extraction and threading of prestressing strand.

B. Related Sections:
   1. Section 01 11 00 – Summary of Work
   2. Section 01 22 00 – Unit Prices
   3. Section 01 50 00 – Temporary Facilities and Controls
   4. Section 02 01 11 – Shoring
   5. Section 03 01 31 – Concrete Removal and Surface Preparation
   6. Section 03 01 34 – Concrete Repair
   7. Section 07 18 00 – Traffic Coating
   8. Section 07 92 00 – Joint Sealants

1.2 UNIT PRICES

A. Perform the Work on a unit price basis as described in Section 01 22 00.
   1. There may be different types of tendon repairs along the length of a given tendon. Each repair type will be designated by the Engineer and recorded individually for payment.

1.3 REFERENCES

A. Definitions:
   1. Prestressing steel: Seven-wire strand in wedge anchorage system.
   2. Tendon: Entire post-tensioning assembly, including prestressing steel, corrosion-inhibiting post-tensioning coating, sheathing, and anchorages.

B. Reference Standards: Standards latest edition of date of Specification or as referenced in applicable building code.
   1. American Concrete Institute (ACI):
      a. 301 - Specification for Structural Concrete.
      b. 423.4R - Report on Corrosion and Repair of Unbonded Single-Strand Tendons.
      c. 423.7 - Specification for Unbonded Single-Strand Tendon Materials and Commentary.
   2. ASTM International:
      a. A416 - Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete.
   3. Concrete Reinforcing Steel Institute (CRSI):
      a. MSP-2 - Manual of Standard Practice.
   4. Post-Tensioning Institute (PTI):
      a. DC80.3 - Guide for Evaluation and Repair of Unbonded PT Concrete Structures.
      b. M10.3 - Field Procedures Manual for Unbonded Single Strand Tendons.
   5. The Society for Protective Coatings (SSPC):

a. Joint Surface Preparation Standard SSPC-SP 6/NACE No. 3 Commercial Blast Cleaning.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordinate with Owner's Representative and with other trades to ensure that adjacent areas are not adversely affected.

B. Sequencing: To be determined based on conditions of tendons exposed with each Work Area.

1.5 SUBMITTALS

A. Product Data: Manufacturer's literature and technical data for post-tensioning coating, sheathing repair materials, couplers, center stressing couplers, and new anchorage systems for prestressing steel.

B. Samples: New prestressing steel, heat-shrinkable tubing, and sheathing tape.

C. Certificates: From prestressing steel supplier that repair subcontractor is experienced in post-tensioning repair Work and acceptable for Project.

D. Test Reports: Certified mill test reports for each coil or pack of prestressing steel, containing the following information:
1. Type of material
2. Diameter and net area of steel
3. Heat number and identification
4. Standard chemical analysis for heat of steel
5. Ultimate tensile strength
6. Yield strength at 1 percent extension
7. Elongation at failure
8. Modulus of elasticity
9. Relaxation properties
10. Conformance with requirements of ASTM A416, Grade 270

E. Field Quality Control: Stressing records

F. Construction Procedures:
1. For temporary closures and egress plan
2. For temporary shoring
3. For splicing and stressing prestressing steel
4. For safety precautions during detensioning and stressing of prestressing steel

G. PT installation drawings and stressing calculations, including tensioning forces, wobble and curvature friction coefficients and anchor set, and calculated elongations. Calculations shall be signed and sealed by a Professional Engineer licensed in the project jurisdiction.

H. Post-Tensioning Repair Subcontractor Qualifications:
1. Evidence that Subcontractor's *existing company* has minimum five years of continuous experience in application of specified materials; list of at least five representative, successfully completed projects of similar scope and size, including similar structural systems. Include:
a. Project name

b. Owner's name
c. Owner's Representative name, address, and telephone number
d. Description of work
e. Project supervisor
f. Total cost of post-tensioning repair work and total cost of project
g. Completion date

2. List of five projects of similar scope and size supervised by proposed foreman. Include:
   a. Project name
   b. Owner's name
   c. Owner's Representative name, address, and telephone number
   d. Description of work
   e. Project supervisor
   f. Total cost of post-tensioning repair work and total cost of project
   g. Completion date

1.6 QUALITY ASSURANCE

A. Post-Tensioning Repair Subcontractor Qualifications: Experienced firm that is approved, authorized, or licensed by prestressing steel supplier to install post-tensioning repairs. Trained by supplier in proper uncoiling, installation, protection, and stressing of prestressing steel. Must have successful installations of specified materials in local area in use for a minimum of 5 years.
   1. If Subcontractor cannot meet requirements, a representative of the prestressing steel supplier shall be at Site at all times during Work to supervise and control Work and to train Subcontractor's personnel in proper use of materials and equipment.
   2. Employ superintendent with minimum 5 years of experience as superintendent on similar projects, who is fluent in English, to be at Site at all times during the Work. Do not change the superintendent during the course of the Project except for reasons beyond the control of the Subcontractor; inform Engineer in advance of any changes.
      a. Superintendent shall be present during post-tensioning Work, shall exercise immediate control over operations, and shall closely check Work for full conformance with requirements. Failure of Work to comply with requirements will result in removal of superintendent from Project.
   3. Use PTI-certified workers in compliance with ACI 301.
      a. PTI certification for Unbonded PT Repair, Rehabilitation and Strengthening may be substituted for the same Level of Unbonded PT Installation, Unbonded PT Installer, or Unbonded PT Inspector certification.
      b. The installation crew foreman must have PTI Level 2 Unbonded PT Inspector or Installer certification.
      c. At least fifty percent of installation personnel must have PTI Level 1 Unbonded PT Field Installation certification.
      d. The tensioning crew foreman and at least fifty percent of tensioning crew personnel must have PTI Level 2 Unbonded PT Inspector or Installer certification; the remainder of the tensioning crew must have PTI Level 1 Unbonded PT Field Installation certification.

B. Mockups: Install coupler and center stressing coupler hardware at one repair location to demonstrate installation procedure. Minimize damage to adjacent concrete.
   1. Owner's Representative and Engineer will observe mockup.
   2. If Engineer determines mockup does not comply with requirements, modify mockup or construct new mockup until mockup is approved by Engineer. Reposition hardware as necessary, at no cost to Owner.

3. Approved mockup will be standard for judging completed Work.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.

B. Delivery:
   1. Schedule delivery to minimize long-term storage at Site and to prevent overcrowding of construction spaces.
   2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
   3. Deliver products to Site in undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
   4. Assign heat number to prestressing steel within group or in same member, and tag accordingly.
   5. Package tendon bundle at plant in heavy plastic, sealed shut, to prevent physical damage to tendons and to positively protect from moisture and corrosion during transit and storage.
      a. Use heavy padding such as carpeting to protect sheathing from being cut by binding materials. Cardboard is not acceptable.
      b. Use filament tape, not wire binding.
   6. Inspect products on delivery to determine compliance with Contract Documents and to determine that products are undamaged and properly protected.
      a. Inspect tendons before unloading and replace damaged tendons or tendons with corrosion by-product. Any damage to shop-assembled tendon-encapsulating system, such as sheathing tears or cuts beyond that specified as repairable; sheathing withdrawn from connecting sleeves; or connecting sleeves withdrawn from fixed anchorages shall be cause for rejection.
      b. Inspect sheathing before installation. Reject tendons with sheathing damaged over more than ten percent of length. Damaged length need not be continuous.

C. Storage:
   1. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
   2. Store products that are subject to weather damage under cover in weathertight enclosure above ground, with ventilation adequate to prevent condensation.
   3. Protect prestressing steel from moisture and corrosion. Bare steel coated with corrosion inhibitor is acceptable. Protect cut ends from moisture infiltration with cap or other means. Protect stored products from damage and stored liquids from freezing.
   4. Store products to allow for inspection and measurement of quantity or counting of units.
   5. Store materials in manner that will not endanger Project structure, away from edge of Project structure.
   6. Provide secure location and enclosure at Site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner’s Representative.
   7. Move stored products that interfere with operations of Owner or other Contractors.

1.8 PROJECT CONDITIONS

A. Verify existing dimensions and details prior to start of post-tensioning repair Work. Notify Engineer of conditions found to be different than those indicated in the Contract Documents. Engineer will review situation and inform Contractor and post-tensioning repair Subcontractor of changes, if required.

B. Comply with Owner's limitations and restrictions for Site use and accessibility.

C. Handle and install materials in strict accordance with safety requirements required by manufacturer; SDS; and local, state, and federal rules and regulations.

1.9 CHANGES IN WORK

A. During rehabilitation work, existing conditions may be encountered which are not known or are at variance with the Contract Documents. Such conditions may interfere with the Work and may consist of damage or deterioration of the substrate or surrounding materials that could jeopardize the integrity or performance of the installed Work.
   1. Notify Engineer of conditions that may interfere with proper execution of the Work or jeopardize the performance of the installed Work, prior to proceeding with Work.

1.10 WARRANTY

A. Written warranty, signed by Contractor, including:
   1. Repair or replacement of post-tensioning tendon repairs installed by Contractor:
      a. That do not comply with Contract Documents.
      b. With corroded or fractured prestressing steel or corroded post-tensioning accessories in repair area.
      c. With corroded or fractured prestressing steel or corroded post-tensioning accessories in areas away from repair, which are directly due to post-tensioning repairs installed by Contractor.
   2. Removal and replacement of concrete necessary to remedy distress of post-tensioning repairs and access to work are covered by warranty.
   3. Removal and replacement of architectural finishes necessary to access work are covered by warranty.
   4. Repair or replacement, to satisfaction of Owner's Representative, of other work or items which may have been displaced or damaged as consequence of defective work.
   5. Make immediate emergency repairs within 48 hours of notice of defective post-tensioning repairs.
   6. Owner will reimburse Contractor for reasonable costs if post-tensioning distress is not due to Work performed by Contractor.
   7. Warranty Period: 5 years after Substantial Completion date.

PART 2 PRODUCTS

2.1 EXISTING POST-TENSION SYSTEM

A. Refer to Section 01 11 00 – Summary of Work and Drawings for a description of the existing post-tensioning system.

2.2 PRESTRESSING STEEL

A. Prestressing Steel: ASTM A416, Grade 270; seven-wire, uncoated, low-relaxation steel strand; minimum ultimate strength, P_U, of 270,000 pounds per square inch; diameter to match existing; manufactured by PTI-certified plant.

2.3 AUXILIARY MATERIALS

A. Anchorages:
   1. If possible, use existing anchorage plates with new wedges. New wedges shall be fully compatible with existing anchorage plates and approved by anchor supplier's technical representative. Wedges shall preclude premature failure of prestressing steel due to notch or pinching effects under static and dynamic load conditions.
   2. Furnish new anchorage plates and wedges, from single manufacturer, to develop at least ninety-five percent of actual ultimate strength of prestressing steel without exceeding anticipated set.

B. Coupler and Central Stressing Coupler Hardware: Provided by Dywidag-Systems International, VStructural, LLC, or approved equal; approved by Engineer.
   1. Designed for and compatible with 7-wire-strand tendon system.
   2. Capable of developing at least 95 percent of actual ultimate tensile strength of prestressing steel.
   3. Encapsulated

C. Post-Tensioning Coating: Per ACI 423.7, Paragraph 2.1, 5.2 and 7.2

D. Sheathing for New Prestressing Steel: Seamless, extruded, high-density polypropylene complying with ACI 423.7, Paragraph 8.2.

E. Split Sheathing for Repair at Existing Prestressing Steel:
   1. Watertight, chemically stable, and non-reactive with prestressing steel, post-tensioning coating, and reinforcing steel.
   2. Color shall contrast with post-tensioning coating so that sheathing tears will be readily visible.
   3. Use 6 mil (0.006 inch) polyethylene sheet or polyethylene or polypropylene tubing.
      a. Tubing:
         1) Minimum thickness of 0.050 inches.
         2) Inside diameter at least 0.030 inches greater than prestressing steel diameter.
         3) Slit tubing longitudinally for sheathing repairs at continuous prestressing steel.

F. Protection at Couplers and Center Stressing Couplers:
   1. Heat-shrinkable tubing to encapsulate couplers and splicing hardware at intermediate stressing locations.
   2. Watertight, chemically stable, and non-reactive with prestressing steel, post-tensioning coating, and reinforcing steel.
   3. Use one of the following or approved equal:
      a. IMCSN Medium Wall Heat Shrink Tubing manufactured by 3M.
      b. SpliceSeal manufactured by RJD Industries, LLC.

G. Sheathing Repair Tape: Moisture-proof self-adhesive tape, compatible with and capable of forming moisture-tight seal with existing and new sheathing. Use primer if recommended by manufacturer. Use one of the following or approved equal:

1. Polyken #900 2 inch wide General Utility Pipeline Tape manufactured by Berry Global, Inc.
2. Scotch Solvent Resistant Masking Tape 226 manufactured by 3M.

H. Corrosion-Inhibiting Coating: For steel components not protected by sheathing or encapsulation system:
1. Per Section 03 01 31.

I. Other post tensioning accessories:
1. Provide encapsulation caps with proper gaskets for encapsulated post-tensioning system anchors.
2. Provide watertight sleeves and other accessories as required to restore encapsulated post-tensioning system in compliance with ACI 423.7.

J. Grout at End Anchorage: Use one of the following or approved equal:
1. MasterFlow 928 manufactured by Master Builders Solutions Construction Systems US, LLC.
2. SikaGrout 212 manufactured by Sika Corporation.

K. Grout for Positioning Tendon: Use one of the following or approved equal:
1. MasterFlow 713 manufactured by Master Builders Solutions Construction Systems US, LLC.
2. Five Star Grout manufactured by Five Star Products, Inc.

L. Temporary tendon moisture protection: Use the following or approved equal:
1. Liquid Plasti Dip (non-aerosol), by Plasti Dip International

M. Cable-barrier system repairs, stressing hardware: Grabb-it Cable Splice supplied by Prestress Supply Inc.; approved by Engineer.

2.4 EQUIPMENT

A. Stressing Equipment: Hydraulic stressing jacks calibrated with a pressure gauge, shall be capable of gripping prestressing steel and be capable of stressing the prestressing steel to the specified force. Maintain equipment in safe, working condition.
1. Provide calibrated stressing equipment with means to cross check accuracy constantly.
2. Provide current (not to exceed 6 months) jack calibration for each jack relating the gauge pressure reading to the jacking force.
3. Exercise care in handling of stressing equipment.

B. Necessary equipment to detension, cut, and splice/couple prestressing steel.

C. Provide equipment and use appropriate methods to expose the embedded post-tensioning. The demolition to expose embedded post-tensioning shall not compromise the structural integrity of the slab and shall minimize damage to the tendon sheathing. The following equipment, or an approved equal, may be used on this project.
1. Chipping hammers of nominal 15-lb class or less for removal of concrete to expose tendon sheathing.
2. Compressed air equipment capable of removing dust and dirt from concrete repair areas.

D. All equipment is to be operated and maintained according to the manufacturer's recommendations or the approved testing procedures.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Repair Subcontractor if applicable, for compliance with requirements and other conditions affecting installation or performance of post-tensioning repair Work.
   1. Ensure that work done by other trades is complete and ready for post-tensioning repair Work.
   2. Verify that areas and conditions under which post-tensioning repair Work is to be performed permit proper and timely completion of Work.
   3. Notify Engineer in writing of conditions which may adversely affect installation or performance of post-tensioning repair Work and recommend corrections.
   4. Do not proceed with post-tensioning repair Work until adverse conditions have been corrected and reviewed by Engineer.
   5. Commencing post-tensioning repair Work constitutes acceptance of Work surfaces and conditions.

3.2 SAFETY PRECAUTIONS

A. Prestressing steel under stress has significant stored energy. Exercise care in concrete removal, detensioning and stressing operations.
   1. Erect and maintain work platforms in safe condition, in conformance with Government regulations.
   2. Protect areas around, adjacent to, and below Work area, including vehicular traffic, from damage.
   3. Do not allow personnel to stand behind hydraulic jack or near prestressing steel which is being detensioned.
   4. After stressing, when releasing jack pressure to transfer force to wedges, keep laborers' fingers clear of assembly.
   5. All work areas in and around an occupied space shall temporarily be cleared of tenants/occupancy prior and during the completion of any post-tensioning remedial work that could result in the accidental or planned detensioning or release of prestressing steel.

3.3 PROTECTION

A. Take precautions to ensure safety of people, including building users, passers-by, and construction personnel, and animals, and protection of property, including adjacent building elements, landscaping, and motor vehicles.

B. Prevent construction debris and other materials from coming into contact with pedestrians, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.

C. Protect paving and sidewalks, and adjacent building areas from mechanical damage due to scaffolding and other equipment.

D. Limit access to Work areas.

E. Erect temporary protective canopies, as necessary, over walkways and at points of pedestrian and vehicular access that must remain in service during Work.

F. Assume responsibility for injury to persons or damage to property due to Work, and remedy at no cost to Owner.

3.4 PREPARATION

A. Provide copy of PTI M10.3 at Site.

B. Erect and maintain work platforms in safe condition, in conformance with government regulations.

C. Prior to concrete removal, locate prestressing steel nondestructively at four locations along length in each bay. Mark prestressing steel locations on top slab surface for reference during Work.

D. Identify and clearly mark fractured, corroded, or otherwise damaged sections of prestressing steel. Create exploratory openings in concrete as necessary to locate fractured sections and as approved by Engineer. Provide access for Engineer. Engineer will inspect damaged prestressing steel and determine repair details.

E. Install shoring or sequence repairs as required to perform Work and as indicated by Engineer. See Section 02 01 11.

F. Remove unsound concrete per Section 03 01 31 and as approved by Engineer. Exercise care to avoid damaging prestressing steel, sheathings, anchorages, and remaining sound concrete. Do not remove concrete at post-tensioning anchorages unless directed to do so by Engineer.

G. Maintain tendon profile. Use grout or other means as necessary to securely maintain tendon position during Work.

H. Identify damaged sheathing and document locations and approximate length for review by Engineer.

3.5 TENDON WATER INTRUSION PROTECTION

A. Protect exposed tendons from water intrusion into sheathing at all times during construction.

B. At the completion of work each day, provide temporary seal at ends of sheathing exposed in concrete repair areas where post-tensioning tendons are to be performed.

C. At the completion of work each day, apply temporary sheathing repair materials to all tears and holes in sheathing within concrete repair areas to temporarily seal sheathing.

3.6 SHEATHING REPAIR

A. Remove concrete to expose sheathing at least 6 inches beyond damaged portion and to create gap around sheathing. Exercise care to avoid further damage to sheathing or displacement of prestressing steel.

B. Exposed corrosion on prestressing steel shall be reviewed by the Engineer prior to completing any sheathing repairs and may require the following addition Work:
   1. Lightly abrasive blast prestressing steel to SSPC-SP6/NACE NO. 3, Commercial Blast Cleaning, to remove rust. Protect existing sheathing from damage.
   2. Perform splice repairs per Par. 3.7 as determined by the Engineer.

C. For small, localized areas of sheathing damage, as determined by Engineer:
   1. Remove rough portions of sheathing at damaged area.
   2. Fill sheathing and cover exposed prestressing steel with post-tensioning coating.
   3. Clean and prepare sheathing per tape manufacturer's recommendations. Sheathing shall be dry and free of post-tensioning coating.
   4. Tape damaged area of sheathing. Wrap tape spirally around sheathing to provide at least two layers of tape. Overlap tape edges a minimum of 1/4 inch. Extend tape at least 3 inches beyond damaged area.

D. For larger areas of sheathing damage, as determined by Engineer:
   1. Remove damaged portion of sheathing. Protect a minimum of 6 inches of existing sheathing at each end of the exposed tendon within the repair opening.
   2. Coat exposed prestressing steel with post-tensioning coating.
   3. Clean and prepare existing sheathing per tape manufacturer's recommendations. Sheathing shall be dry and free of post-tensioning coating.
   4. Install new sheathing.
      a. Wrap split tubing around prestressing steel to provide a continuous layer over prestressing steel and PT coating. Position edges of tubing with shingle overlap (i.e., with upper portion overlapping lower portion).
      b. Extend new sheathing at least 3 inches over existing sheathing.
   5. Tape new sheathing.
      a. Wrap tape spirally around sheathing to provide a minimum of two layers of tape.
      b. Overlap tape edges a minimum of 1/4 inch.
      c. Extend tape at least 3 inches onto existing sheathing.

E. Protection of Couplers and Center Stressing Couplers
   1. Unless supplied with encapsulation, protect all new couplers in a watertight enclosure.
      a. If heat-shrink tubing is used to provide watertight enclosure, place heat-shrink tubing over coupler, central stressing coupler, or tendon during assembly of spliced tendon repair. Do not shrink tubing into final position until stressing is completed. Shrink tubing using a heat gun; open flames shall not be permitted. Provide 3 inch minimum overlap with sheathing for adjacent section of tendon.
      b. For other hardware, before stressing, coat elements with epoxy that will become inaccessible after stressing except the portions of those elements that must remain uncoated for stressing operations. After stressing, coat exposed elements with epoxy that are not already coated, and repair previous coating that was damaged.
   2. All new encapsulated center stressing couplers shall be supplied fully encased in protective plastic cover with plastic encapsulation caps to provide for full encapsulation of center stressing coupler.

F. Protection of Anchorages
   1. All new encapsulated end anchor castings shall be supplied fully encased in protective plastic cover, with plastic sleeve and plastic-covered encapsulation cap, to provide for full encapsulation of the new anchor.
   2. For hardware that is not encapsulated: Before stressing, coat elements with epoxy that will become inaccessible after stressing, except the portions of those elements that must remain uncoated for stressing operations. After stressing, coat exposed elements with epoxy that are not already coated, and repair previous coating that was damaged.

G. Sheathing repairs shall be watertight and approved by Engineer.

3.7 REMOVAL AND REPLACEMENT, OR SPLICING PRESTRESSING STEEL

A. Discuss detensioning and splicing procedures with Engineer prior to Work to ensure that concrete is not overstressed during prestressing steel removal or stressing.
   1. Limit slab concrete excavation along any column line or construction joint to not more than 50 percent of the concrete slab cross-section at one time when adjacent tendons are holding tension.
   2. Tendon repairs shall be phased and scheduled such that the structural load carrying capacity of the garage is not impaired at any time.

B. Provide access to the tendon as necessary to allow the removal of the prestressing steel in order to repair the tendon.

C. Detension prestressing steel as necessary by sawcutting, preferably while steel is still embedded in concrete. Provide protection at the end anchorages to prevent anchorage, wedges, or prestressing steel from rebounding during detensioning and causing damage to property or passerby.

D. Remove sufficient concrete to expose length of prestressing steel that is not deteriorated, on both sides of deteriorated prestressing steel section, and to permit installation of coupling hardware. Exercise care to avoid damaging remaining sound concrete and sheathing. If prestressing steel drapes into concrete section, submit method of removing prestressing steel to Engineer and proceed only using approved method.

E. Remove deteriorated section of prestressing steel.

F. Clean interior of sheathing that will remain in place and receive new prestressing steel by removing old post-tensioning coating and potential corrosion byproduct within sheathing. Thread new prestressing steel with PT coating through existing sheathing.

G. If existing fixed or stressing end anchors will remain and are exposed, clean exposed steel surfaces to SSPC-SP6/NACE NO. 3, Commercial Blast Cleaning finish.

H. Install new end anchorages and backup reinforcement. Provide new wedges and hardware compatible with new anchor.

I. Form, as necessary, and cast concrete replacements, per Section 03 01 34, that are necessary for stressing prestressing steel. Do not stress prestressing steel until replacement concrete has achieved at least seventy-five percent of specified 28-day compressive strength or a minimum compressive strength of 3,000 pounds per square inch (psi), whichever is greater.

J. Prepare existing prestressing steel.
   1. Coat exposed existing prestressing steel with post-tensioning coating.
   2. Restore sheathing per Par. 3.5.

K. Install splice materials.
   1. Pull ends of existing prestressing steel taut.
   2. Install couplers with new section of prestressing steel.

L. Stress prestressing steel per Par. 3.8.

M. When stressing operation has been completed, repair sheathing and install protections on couplers and central stressing couplers per Par. 3.5.

N. Prepare blockouts and concrete repair areas per Section 03 01 31, and form and cast concrete replacements per Section 03 01 34.
   1. Inspect sheathing for damage and for watertight seal between sheathing and anchor and inspect anchors for correct installation.
      a. Repair sheathing damage to watertight condition and correct anchor deficiencies, as required.
      b. Do not leave tendons exposed to weather for more than seven days prior to concrete placement.
   2. Coat exposed prestressing steel, including stressing tails at anchorages, with post-tensioning coating, and install sheathing per Par. 3.5.
   3. Abrasive blast clean exposed concrete and steel surfaces. Protect tendons from damage during abrasive blasting.
   4. Coat exposed steel, including tendon anchorages, with corrosive-inhibiting material per Section 03 01 31.
   5. Install adhesive anchored dowels as required.
   6. Add supplemental adhesive anchored reinforcing as directed by Engineer.

O. At encapsulated anchors, install encapsulation caps over strand tails and secure. Fill stressing pockets with grout. When grout will be visible, trowel smooth and rub to match adjoining surface.

3.8 STRESSING PRESTRESSING STEEL

A. Exercise care in handling stressing equipment to maintain accuracy of calibration.

B. When stressing at existing end anchorage, expose existing stressing end anchorage and remove wedges without damaging anchorage.

C. Before stressing, verify that prestressing steel is free-moving along its length. Orient wedges in the wedge cavity such that the seating plunger of the jack engages both wedge sections perpendicular to the jack position during stressing.

D. Stress tendon to achieve an effective tensile stress of 0.7 P_u with hydraulic jack.
   1. Calculate elongation for specified tensile stress for each tendon.
   2. Sequence stressing as necessary.
   3. Monitor hydraulic pressure and convert to jacking force with jack calibration curve.
   4. Measure prestressing steel elongation at various jacking forces and compare with calculated elongation.
      a. If difference is more than seven percent for given gauge pressure, immediately recalibrate gauges.
      b. If, after recalibration, measured and calculated elongations for given gauge pressure still differ by more than seven percent, cease stressing operations until cause of deviation is found and corrected.
   5. When specified tensile stress has been attained, anchor prestressing steel with wedges. Place both wedges at same time.
   6. If required, perform lift-off test in presence of Engineer after stressing and setting of wedges to confirm force in tendon. If difference between measured and calculated elongations after stressing is more than seven percent, perform lift-off test at least 24 hours after stressing.

E. For cable barrier stressing if turnbuckle-type coupler is used, stress tendon per the manufacturer's recommendations.
   1. Calculate elongation for specified force for each tendon.
   2. Restress tendon using calibrated torque wrench. Stress to designated force using calculated correlation between applied torque and force.
   3. Measure prestressing steel elongation at various levels of force and compare with calculated elongation.
   4. If measured and calculated elongations differ by more than +/- 7%, cease stressing operations until cause of deviation is found and corrected.
   5. Record applied torque, determine calculated force, and submit to LDP for review and approval.
   6. The stressing records should be available for use by the stressing crew and inspector whenever stressing is in progress.

F. Maintain stressing records at Site during stressing operations.

G. After Engineer has approved stressing records, cut off tails of prestressing steel.
   1. Clean prestressing steel, anchorages, and concrete pockets of post-tensioning coating with non-corrosive solvent.
   2. Cut end of prestressing steel within stressing pocket, providing for at least 3/4 in. of concrete cover to the strand tail or to the length specified by the prestressing steel supplier for installation of encapsulation components if encapsulated tendons are used.
      a. Do not use oxyacetylene torch.
      b. Do not damage prestressing steel, anchorage, or concrete. Leave prestressing steel end clean and free of burrs.
      c. Do not cut strand tails less than 1/2 in. from the face of the anchor casting.
   3. Install encapsulation cap on cut ends at encapsulated components.
   4. Prestressing steel ends shall be accessible for inspection prior to and during cutting, and prior to placement of protective caps and grout or restoration of concrete in blockouts.

3.9 FIELD QUALITY CONTROL

A. Maintain stressing records during stressing operations and submit to Engineer. Include the following information:
   1. Project name
   2. Date of stressing operation
   3. Serial or identification number of jack and gauges
   4. Date and identification of approved shop drawings used for installation and stressing
   5. Specified and actual concrete compressive strengths at time of jacking
   6. Tendon number correlated to plan view showing tendon locations
   7. Calculated elongation, and allowable range of elongation, at specified tensile force
   8. Calculated gauge pressure to achieve specified tensile force, based on calibration chart
   9. Measured elongation at specified tensile force
   10. Gauge pressure at end of stressing
   11. Name and signature of jack operator or inspector

B. Maintain as-built drawings and submit to Engineer. Show the locations and types of repairs performed to the post-tensioning systems.

C. Engineer or testing agency retained by Owner will inspect installed Work prior to concrete placement, including:
   1. Prestressing steel size, spacing, cover, and drape

2. Type and condition of sheathing, including damage and repairs
3. Condition of anchorages and splicing hardware
4. Length of cut prestressing steel tail and proper seating of encapsulation cap

3.10 CLEANING

A. At the end of each workday, clean Site and Work areas and place rubbish, empty cans, rags, and other discarded materials in appropriate containers.

B. After completing post-tensioning repair Work:
   1. Repair surfaces stained, marred, or otherwise damaged during post-tensioning repair Work.
   2. Clean up debris and surplus materials and remove from Site.

END OF SECTION 03 01 24

SECTION 03 01 31
CONCRETE REMOVAL AND SURFACE PREPARATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Concrete removal and surface preparation prior to concrete repair, including:
   1. Removal of unsound and sound concrete
   2. Preparation of concrete and steel surfaces
   3. Coating reinforcing bars and embedded steel with corrosion-inhibiting material
   4. Supply and installation of supplemental epoxy-coated reinforcing bars.

B. Related Sections:
   1. Section 01 22 00 - Unit Prices
   2. Section 02 01 11 - Shoring
   3. Section 03 01 24 - Unbonded Post-Tensioning Repairs
   4. Section 03 01 34 - Concrete Repair

1.2 UNIT PRICES

A. Perform the Work on a unit price basis as described in Section 01 22 00.

1.3 REFERENCES

A. Reference Standards: Latest edition.
   1. American Concrete Institute (ACI)
      a. 315: Details and Detailing of Concrete Reinforcement
      b. 318: Building Code Requirements for Structural Concrete
      c. 562: Assessment, Repair, and Rehabilitation of Existing Concrete Structures
      d. 563: Specifications for Repair of Concrete in Buildings
   2. SSPC: The Society of Protective Coatings:
      a. SSPC-SP 6/NACE No. 3: Commercial Blast Cleaning.
      b. SSPC-SP 15: Commercial Grade Power Tool Cleaning.

B. Reference Guides: Latest edition as of Specification date.
   1. American Concrete Institute (ACI)
      a. 546R: Concrete Repair Guide
   2. International Concrete Repair Institute (ICRI):
      a. 310.1R: Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion
      b. 310.2R: Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays and Concrete Repair
      c. 310.3R: Guide for the Preparation of Concrete Surfaces for Repair using Hydrodemolition Methods

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordinate with Owner's Representative and with other trades to ensure that adjacent areas are not adversely affected by concrete removal or surface preparation Work.

1.5 SUBMITTALS

A. Product Data: Manufacturer's literature and technical data for corrosion-inhibiting coating material, indicating applicability of product for proposed use.

B. Confinement, Collection, and Disposal Plan (for information only): Written plan for confining, collecting, and disposing of broken concrete, abrasive blast grit, dust, debris, existing reinforcing, and other waste material resulting from removal operations and surface preparation.

1.6 QUALITY ASSURANCE

A. Mockups: Demonstrate adequacy of concrete removal and surface preparation procedures as part of mockups in 03 01 34.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in original containers and packaging with seals unbroken, labeled with manufacturer's name, product brand name and type, date of manufacture, lot number, directions for storing, and complete manufacturer's written instructions.

B. Keep materials dry and do not allow materials to be exposed to moisture during transportation, storage, handling, or installation. Reject and remove from Site new materials which have been exposed to moisture to their detriment.

C. Store and handle materials in accordance with manufacturer's written instructions, safety requirements, and all applicable laws and regulations. Remove from Site, and replace at no cost to Owner, any materials that are damaged or otherwise negatively affected by not being stored or handled in accordance with manufacturer's written instructions.

D. Store materials in original, undamaged containers and packaging in clean, dry, location on raised platforms and protected from weather, within temperature range required by manufacturer. Protect stored materials from direct sunlight and sources of ignition. Manufacturer's standard packaging and covering alone is not considered adequate weather protection.

E. Locate materials in a secure location approved by Owner's Representative

F. Conspicuously mark damaged containers, containers with contaminated materials, damaged materials, and materials that cannot be used within stated shelf life and remove from Site as soon as possible. Replace discarded materials in a timely manner at no cost to Owner.

G. Limit stored materials on structures so as to preclude damage to materials and structures.

H. Maintain copies of all applicable Safety Data Sheets (SDS) with materials in storage area, such that they are available for ready reference on Site.

1.8 PROJECT CONDITIONS

A. Verify existing dimensions and details prior to start of concrete removal Work. Notify Architect/Engineer of conditions found to be different than those indicated in the Contract Documents. Architect/Engineer will review situation and inform Contractor and Installer how to proceed.

B. Comply with Owner's limitations and restrictions for Site use and accessibility.

C. Dust, Fume, and Noise Controls:
   1. Confine dust and debris to Work area and prevent from entering portions of facility that remain in use.
   2. Direct equipment exhaust away from occupied spaces. Vent equipment operating within structure to outside or condition exhaust gases with catalytic converter.
   3. Operate equipment at noise levels conforming to requirements of city, state, and federal laws and codes, and Owner limitations.

D. Maintain adequate ventilation during preparation and application of materials.

1.9 CHANGES IN WORK

A. During rehabilitation work, existing conditions may be encountered, which are not known or are at variance with the Contract Documents. Such conditions may interfere with the Work and may consist of damage or deterioration of the substrate or surrounding materials or improper location of embedded elements such as reinforcing steel, which could jeopardize the integrity or performance of the Work.
   1. Notify Architect/Engineer prior to proceeding with the Work of conditions that may interfere with, preclude proper execution of, or jeopardize the performance of the Work.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Corrosion-Inhibiting Coating Materials: Use material specifically intended for reinforcing steel embedded in concrete. Provide material with pigmented color that is clearly different than the color of the reinforcement.
   1. Cementitious Coating:
      a. Sika Armatec 110 EpoCem by Sika Corporation
      b. MasterEmaco P 124 supplied by Sika Corporation
      c. Approved equal
   2. Epoxy:
      a. Sikadur 32 Hi-Mod by Sika Corporation
      b. Approved equal
   3. Zinc-rich Steel Primer:
      a. MasterProtect P 8100AP by Sika Corporation
      b. Sika Armatec -10 ZR supplied by Sika Corporation
      c. ECB - Electro-Chemical Barrier, supplied by Conproco
      d. Approved Equal

2.2 EQUIPMENT

A. Pneumatic chipping hammers of nominal 15-lb class or less for removal of concrete from beneath and adjacent to reinforcing steel, and for detail excavation work.

B. Pneumatic chipping hammers of nominal 30-lb class or less for removal of concrete at repair openings, and where conventional reinforcement has been exposed and will not be damaged by jackhammering.

C. Abrasive blasting equipment capable of removing all rust from the exposed steel reinforcement, and laitance, dirt and debris from exposed concrete surfaces.

D. High pressure, oil-free compressed air equipment capable of removing dust, dirt, and water from concrete repair areas, and exposed concrete surfaces.

E. Pressure power washing equipment (1,000-5,000 psi).

F. Sawing equipment shall be capable of sawcutting the existing concrete to the specified depth.

G. Percussive or rotary drilling equipment for making holes in concrete substrate for dowel installation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements and other conditions affecting concrete removal Work.
   1. Ensure that work done by other trades is complete and ready for concrete removal Work.
   2. Verify that areas and conditions under which concrete removal Work is to be performed permit proper and timely completion of Work.
   3. Notify Architect/Engineer in writing of conditions which may adversely affect concrete removal Work and recommend corrections.
   4. Do not proceed with concrete removal Work until adverse conditions have been corrected and reviewed by Architect/Engineer.
   5. Commencing concrete removal Work constitutes acceptance of Work surfaces and conditions.

3.2 PROTECTION

A. Take precautions to ensure safety of people (including building users, passers-by, and workers) and protection of property (including adjacent building elements, landscaping, and motor vehicles).

B. Erect temporary protective canopies and walls, as necessary, at walkways and at points of pedestrian and vehicular access that must remain in service during Work.

C. Take precautions to protect against air-borne materials and run-off.

D. Protect paving, sidewalk, and adjacent building areas from mechanical damage due to scaffolding and other equipment.

E. Prevent dust, debris, coating overspray/spatter, and other construction materials from coming into contact with pedestrians, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.

F. Limit access to Work areas.

G. Assume responsibility for injury to persons or damage to property due to Work, and remedy at no cost to Owner.

H. Protect from damage, all elements of completed work and original construction to remain.

3.3 CONCRETE REMOVAL AND SURFACE PREPARATION

A. Sound concrete surfaces and mark with paint, or other clearly visible weatherproof media, areas of unsound concrete. Architect/Engineer will review markings before concrete removal Work begins.

B. Prior to concrete removal Work:
   1. Remove or temporarily shore plumbing and electrical lines and associated fixtures that interfere with Work. Reattach at completion of Work.
   2. Install shoring as specified or directed by Architect/Engineer.
   3. Implement plan for confining and disposing of broken concrete and other debris from removal Work.
   4. Locate embedded post-tensioned tendons to not damage tendons or tendon profile during concrete removal work per Section 03 01 24.

C. Concrete Removal Areas:
   1. Where possible, make rectangular in shape in plan.
   2. Avoid re-entrant corners.
   3. Extend at least 4 inches beyond edge of unsound concrete.
   4. Extend full-depth areas at least 2 inches over nearby supports such as beams, girders, joists, and drop panels, as directed by Architect/Engineer.

D. Create square edges of removal areas.
   1. Sawcut 3/4 inches at top surface removal areas, depending on the concrete clear cover. For post-tensioned slabs and beams, saw cut or chip square edges to a depth of 1/2 inch.
      a. Do not damage reinforcing steel, embedded electrical conduits, or other embedments. Reduce sawcut depths if concrete clear cover is less than specified sawcut depth to prevent damage.
   2. Sawcut square edges of overhead and vertical removal areas at least 1/2 inches deep.

E. Remove unsound concrete and, as necessary, sound concrete to create:
   1. A minimum removal depth of 2 inches, unless otherwise specified.
   2. Remove concrete around and under exposed reinforcing bars to provide a clearance of 3/4 inches minimum, measured radially, between the reinforcing bars and the existing concrete substrate.
   3. Avoid abrupt changes in depth of removal.
   4. For partial depth repairs, exercise care to avoid cracking underlying sound concrete or punching through member.
   5. Leave roughened surface to match CSP 7 or higher as defined by ICRI 310.2R. Meet repair material manufacturer requirement if greater than value specified here.
   6. Limit chipping hammer size and impact angle to minimize damage to sound concrete. Impact angle shall be no more than 60 degrees to surface.
   7. Protect existing tendon sheathing per Section 03 01 24.

F. At full-depth removal areas, slope removal area edges downward and inward at a slope of 1:1.

G. Inspect and sound concrete surfaces in and around removal areas. Remove additional unsound concrete. Sawcut or chip square new removal area perimeter as necessary.

H. Clean and prepare surfaces of removal area, including vertical edges, to remove surface contaminants, and loose pieces of concrete. Preparation shall remove all concrete that is bruised or micro-fractured. Final clean removal area surfaces with dry, oil-free compressed-air jet.

1. Allow Architect/Engineer at least 48 hours to observe prepared and cleaned surfaces prior to concrete placement.
2. Acceptable concrete surface preparation methods include:
   a. Abrasive blasting. If wet abrasive blasting is used, the concrete surface shall be immediately pressure washed to removal all cement paste, abrasive grit, contaminants, and surface laitance, and the surfaces dried with high-pressure air blasting.
   b. Needle scaling.
   c. Pressure water blasting. Pressures between 1,000 and 5,000 psi, or as necessary to meet the requirements above.
3. Inspect prepared concrete surfaces and remedy defects.
4. Protect tendon sheathing per Section 03 01 24.

3.4 REINFORCEMENT PREPARATION

A. Leave existing reinforcing in place unless otherwise directed by Architect/Engineer.

B. Notify Architect/Engineer of reinforcing bars that are incorrectly located or have less than 1 inch of concrete cover; are damaged or fractured; or have lost more than ten percent of their original cross-sectional area at any point. Architect/Engineer will determine remedial action, await direction prior to proceeding with repair at these locations.

C. Notify Architect/Engineer of post-tensioned tendons that are incorrectly located or have less than 1 inch of concrete cover; are damaged or fractured; have damaged sheathing; or have any evidence of corrosion. Architect/Engineer will determine remedial action, await direction prior to proceeding with repair at these locations.

D. Prepare exposed steel surfaces, including existing exposed reinforcement and steel embedments. Exercise care to prepare undersides of reinforcing bars. Use one of the following methods:
   1. Commercial blast clean, to SSPC-SP 6/NACE No. 3 finish. Remove all concrete debris.
   2. Commercial grade power tool clean, to SSPC-SP 15, at locations explicitly approved by Architect/Engineer in writing. Remove all concrete debris.

E. Clean steel surfaces with dry, oil-free compressed-air jet. Exercise care to clean undersides of reinforcing bars.

F. Inspect prepared steel surfaces and clean remaining contaminants. Allow Architect/Engineer at least 48 hours to observe prepared surfaces prior to coating steel.

G. Apply two coats of corrosion-inhibiting material on exposed steel surfaces (reinforcing and embedded items).
   1. Batch, mix, and apply material according to recommendations of material supplier.
   2. Exercise care to coat difficult-to-reach surfaces, such as undersides of reinforcing bars.
   3. Apply uniformly as to not reduce deformations on reinforcing.
   4. Minimize spillage on concrete surfaces. Remove materials that will act as bond breaker by chipping or other means.
   5. Inspect coated steel surfaces and apply additional coats to uncoated or thinly coated areas. Allow Architect/Engineer at least 48 hours to observe prepared coated surfaces prior to concrete placement.
   6. Comply with coating manufacture’s maximum open time prior to installation of concrete repair material.

3.5 CLEANING

A. After completing Concrete Removal and Surface Preparation Work:
   1. Clean all materials resulting from Work that are not intended to be part of the finished Work using appropriate cleaning agents and procedures. Exercise care to avoid damaging surfaces.
   2. Repair at no cost to Owner all items damaged during the Work.
   3. Remove and legally dispose of debris and surplus materials from Site.

END OF SECTION 03 01 31

SECTION 03 01 34
CONCRETE REPAIR

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Supply and placement of ready-mix concrete and packaged cementitious materials for repair applications, including formwork, reinforcement, concrete repair materials, mix design, batching procedures, placement procedures, finishes, curing, and protection.

B. Related Sections:
1. Section 01 22 00 – Unit Prices
2. Section 02 01 11 – Shoring
3. Section 03 01 24 – Unbonded Post-Tensioning Repairs
4. Section 03 01 31 – Concrete Removal and Surface Preparation
5. Section 03 15 11 – Expansion Joint Seals
6. Section 07 18 00 – Traffic Coating
7. Section 07 19 17 – Silane Water Repellant
8. Section 07 92 00 – Joint Sealants

1.2 UNIT PRICES

A. Perform the following Work on unit price basis as described in Section 01 22 00.

1.3 REFERENCES

A. Standards latest edition of date of Specification or as referenced in applicable building code.

B. Reference Guides:
1. American Concrete Institute (ACI):
   a. 305R: Guide to Hot Weather Concreting
   b. 306R: Guide to Cold Weather Concreting
   c. 315R: Guide to Presenting Reinforcing Steel Design Details
   d. 347R: Guide to Formwork for Concrete
   e. 546R: Guide to Concrete Repair
   f. 546.4R: Guide for Job Site Quality Control and Quality Assurance of Cementitious Packaged Materials
2. International Concrete Repair Institute (ICRI):
   a. 310.3R Guide for Using In-Situ Tensile Pull-off Tests to Evaluate Bond of Concrete Surface Materials
   b. 320.1R: Guideline for Selecting Application Methods for the Repair of Concrete Surfaces
   c. 320.2R: Guide for Selecting and Specifying Materials for Repair of Concrete Surfaces
   d. 320.5R: Pictorial Atlas of Concrete Repair Equipment

C. Reference Standards:
1. American Concrete Institute (ACI):
   a. 117: Specification for Tolerances for Concrete Construction and Materials and Commentary

b. 301: Specifications for Structural Concrete
c. 318: Building Code Requirements for Structural Concrete
d. 562: Code Requirements for Assessment, Repair and Rehabilitation of Existing Concrete Structures
e. 563: Specifications for Repair of Concrete in Buildings

2. ASTM International:
a. A615: Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
b. A775: Standard Specification for Epoxy-Coated Steel Reinforcing Bars
c. A884: Standard Specification for Epoxy-Coated Wire and Welded Wire Reinforcing
d. A1064: Standard Specification for Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
e. C31: Standard Practice for Making and Curing Concrete Test Specimens in the Field.
f. C33: Standard Specification for Concrete Aggregates
g. C39: Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
h. C94: Standard Specification for Ready-Mixed Concrete
i. C143: Standard Test Method for Slump of Hydraulic-Cement Concrete
j. C150: Standard Specification for Portland Cement
k. C171: Standard Specification for Sheet Materials for Curing Concrete
l. C172: Standard Practice for Sampling Freshly Mixed Concrete
m. C231: Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
n. C260: Standard Specification for Air-Entraining Admixtures for Concrete
o. C494: Standard Specification for Chemical Admixtures for Concrete
p. C595: Standard Specification for Blended Hydraulic Cements
q. C1064: Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
r. D3963: Standard Specification for Fabrication and Jobsite Handling of Epoxy-Coated Reinforcing Steel Bars

3. Concrete Reinforcing Steel Institute (CRSI):
a. Manual of Standard Practice

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordinate Work to ensure that adjacent areas are not adversely affected. Coordinate:
1. With Owner’s Representative.
2. With other trades:
a. To ensure that work done by other trades is complete and ready for concrete repair Work.
b. To avoid or minimize work on, or in immediate vicinity of, concrete repair Work in progress.
c. To ensure that subsequent work will not adversely affect completed concrete repairs.

B. Pre-construction Meeting:
1. Conduct meeting prior to start of Work
2. Review requirements for concrete repair work, including:
a. Construction schedule
b. Availability of materials, personnel, equipment, and facilities needed to make progress and avoid delays
c. Site use, access, staging, and set-up location limitations

d. Concrete removal, surface preparation, and substrate condition
e. Repair types and proposed material/approaches for repair
f. Required submittals
g. Testing and inspection requirements
h. Hold points for observation by Architect/Engineer

C. Pre-placement Meeting:
1. Conduct meeting at Site
2. Review requirements for concrete repair Work, including:
a. Construction schedule
b. Availability of materials, personnel, equipment, and facilities needed to make progress and avoid delays
c. Site use, access, staging, and set-up location limitations
d. Forecast weather conditions
e. Concrete removal, surface preparation, and substrate condition.
f. Placement procedures
g. Special details
h. Minimum cure period
i. Testing and inspection requirements
j. Temporary protection and repair of damaged concrete repairs.
k. Structural loading limitations
l. Government regulations
3. Contractor's Site superintendent, Owner's Representative, and Architect/Engineer shall attend.

1.5 SUBMITTALS

A. Contractor Qualifications (for information only): Evidence that Contractor's existing company has minimum 5 years of continuous experience in similar concrete repair work; list of at least 5 representative, successfully-completed projects of similar scope and size, including:
1. Project name
2. Owner's name
3. Owner's Representative name, address, and telephone number
4. Description of work
5. Types of concrete repair
6. Project supervisor
7. Total cost of concrete repair work and total cost of project
8. Completion date

B. Mock-up Plan (for information only): Prior to field execution of mock-ups, provide detailed description of materials, methods, techniques, equipment, sequence of operations, and quality control procedures to be used during the mock-up, including but not limited to the following:
1. Schedule
2. Protection of surrounding materials on project site
3. Concrete removal and surface preparation
4. Concrete mixing
5. Concrete placement
6. Concrete curing

C. Product Data for Packaged Materials and adhesive for adhesive anchored items:

1. Manufacturer's literature including written instructions for evaluating, preparing, and treating substrate; technical data including tested physical and performance properties; and mixing and application or placement instructions.
2. Include temperature ranges for storage and application of materials, and special cold-weather application requirements or limitations for information only.
3. Include Safety Data Sheets (SDS) for information only; safety restrictions are sole responsibility of Contractor.

D. Epoxy-Coated Reinforcing Steel:
1. Mill test reports for steel reinforcement, indicating conformance with ASTM A615.
2. Certification from CRSI indicating that coating applicator is certified by CRSI Epoxy Plant Certification Program.
3. Certification statement from coating applicator that material, coating process, and coating properties conform to ASTM A775/A775M, including preheat temperatures, cure times, thickness checks, holidays detected, and bend test results for each bar size.

E. Certificate for installer of adhesive anchored dowels. Shall be ACI-CRSI Certification or approved equal.

F. Design Mixes (ready-mix concrete): For each concrete mix, including required test reports.
1. Proportions of materials
2. Mill tests and certification for cement, fly ash, and slag cement. Certification for silica fume
3. Sieve analysis for fine and coarse aggregate
4. Test results for deleterious substances in aggregates and potential aggregate reactivity

G. Provide test results necessary to demonstrate concrete and aggregates do not exceed chloride ion limits.

H. Slump during laboratory tests (anticipated for arrival at site). Indicate if superplasticizers are proposed for use at the site, what the maximum dosage can be without adversely affecting hardened concrete, and what the target slump shall be after superplasticizer addition.
1. Air content during laboratory tests.
2. Three-, seven-, and 28-day laboratory compression test results. Minimum three cylinders at each test age.
3. Indicate:
   a. Target slump at time of placement
   b. Amount of mix water to be withheld for later addition at Site.

I. Field Quality Control:
1. Batch tickets for ready-mix concrete.
2. Batch logs for packaged materials.

1.6 QUALITY ASSURANCE

A. Contractor Qualifications: Experienced firm that has successfully completed concrete repair work similar in material, design, and extent to that indicated for the Project. Must have successful construction with specified materials in local area in use for minimum of five years.
1. Employ foreman with minimum five years of experience as foreman on similar projects, who is fluent in English, to be on Site at all times during the Work. Do not change foreman during the course of the Project except for reasons beyond the control of Contractor; inform Architect/Engineer in advance of any changes.

2. Qualifications for Installer of Adhesive Anchored Items: Experienced individual with current ACI-CRSI certification as Adhesive Anchor Installer.
    a. Applicable only for anchors in horizontal or upwardly inclined orientations.

B. Ready-Mix Supplier Qualifications: ASTM C94; Certification of Production Facilities and Delivery Vehicles by National Ready Mixed Concrete Association.

C. Mock-ups: Construct mock-ups to demonstrate construction procedures, quality of Work, and aesthetic effects.
    1. Provide Owner and Architect/Engineer with a schedule for mock-up activities at least one week prior to start of mock-up work. Clearly define sequence of work including required hold point observations. Group all mock-ups such that visits for different repair types are prepared and ready for review during the same visits. Additional visits to review hold points may be charged to the Contractor or withheld from payment. Allow Architect/Engineer 24 hours to observe work at each hold point.
    2. Construct at least 10 square feet of repairs for each type of repair specified unless otherwise approved by Architect/Engineer, including each orientation of repair, and method of repair material placement. Use personnel, equipment, materials, and procedures proposed for use on Project.
    3. Construct mock-ups on existing members**,** at locations designated by Architect/Engineer, under same environmental conditions expected during Work. Provide access to mock-up locations. Use personnel, equipment, materials, and procedures proposed for use on Project.
    4. Provide access to mock-up locations during Work, and after, to allow for completion of observations and testing.
    5. Hold Points: Architect/Engineer may observe the following conditions prior to the Contractors work proceeding on mock-up.
        a. Hold Point 1:
            1) Concrete and steel surface preparation
            2) Prepared and cleaned concrete removal areas including prepared concrete and steel surfaces (prior to coating)
            3) Reinforcing steel coating application
        b. Hold Point 2:
            1) Completed reinforcing steel coating installation
            2) Installation of concrete repair material
                a) Batching (packaged)
                b) Testing
                c) Finishing
            3) Installation of curing and protection measures
    6. Photograph concealed portions of mock-up before concealing, and retain photographs at Site, regardless of observation by Architect/Engineer and inspection by Testing Agency or Special Inspector.
    7. Coordinate performance of, or perform, quality measures and testing as required by this section; including, but not limited to:
        a. Reinforcing steel special inspections
        b. Fresh or plastic concrete repair material testing
        c. Compressive strength testing
    8. If Architect/Engineer or Owner’s Representative determines mock-up does not comply with requirements, modify mock-up or construct new mock-up until mock-up is approved. Remove and replace mock-ups that are not approved.

9. Approved mock-ups shall be maintained in undisturbed condition throughout Project as basis for acceptance of completed work and may become part of completed Work if undisturbed at time of Substantial Completion.

D. Hold points for Architect/Engineer Observation during work:
   1. Identification of repair areas.
   2. Concrete and reinforcing steel reinforcing surface preparation.
   3. Reinforcing steel coating installation.
   4. Concrete Placement
      a. Batching
      b. Finishing
      c. Curing and protection

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle materials according to manufacturer's recommendations and in such manner as to prevent damage to materials or structure.

B. Limit stored materials on structures to safe loading capacity of structure at time materials are stored, and to avoid permanent deck deflection.

C. Handle and place materials in strict accordance with safety requirements required by material manufacturers; Safety Data Sheets (SDS); and local, state, and federal rules and regulations. Maintain SDS with materials in storage area and available for ready reference on Site.

D. Deliver, store, and handle reinforcing steel to prevent bending and damage.
   1. Avoid damaging reinforcement coating.
   2. Repair damaged reinforcement coating according to ASTM D3963.

E. For packaged materials:
   1. Deliver materials to Site in original bags and containers with seals unbroken, labeled with manufacturer's name, product brand name and type, date of manufacture, lot number, and directions for storing and mixing with other components.
   2. Store materials in original, undamaged bags or containers in a clean, dry, protected location on raised platforms with weather-protective coverings, within temperature range required by manufacturer. Manufacturer's standard packaging and covering is not considered adequate weather protection.
   3. Keep materials dry and do not allow materials to be exposed to moisture during transportation, storage, or handling. Reject and remove from Site new materials which have been exposed to moisture or exhibit evidence of moisture contamination.
   4. Conspicuously mark damaged, contaminated or opened bags or containers and remove from Site as soon as possible.
   5. Remove materials that cannot be applied within stated shelf life from Site and replace with new materials.

1.8 PROJECT CONDITIONS

A. Verify existing dimensions and details prior to the start of concrete repair Work. Notify Architect/Engineer of conditions found to be different than those indicated in the Contract Documents. Architect/Engineer will review situation and inform Contractor of changes.

B. Comply with Owner's limitations and restrictions for Site use and accessibility.

1.9 CHANGES IN WORK

A. During rehabilitation work, existing conditions may be encountered which are not known or are at variance with the Contract Documents. Such conditions may interfere with the Work and may consist of damage or deterioration of the substrate or surrounding materials that could jeopardize the integrity or performance of the Work.
   1. Notify Architect/Engineer of conditions that may interfere with proper execution of the Work or jeopardize performance of the Work, prior to proceeding with the Work.

1.10 WARRANTY

A. A joint and several warranty shall be signed by the Subcontractor, the General Contractor, and manufacturer.

B. Time Period: The warranty shall cover labor for 2 years and materials for 2 years. Period shall begin on date of completion and acceptance of the Work by the Owner.

C. Terms: All materials, labor, tools, and equipment necessary for repair, restoration, or replacement of all new work damaged or deficient as a result of defects, imperfections, or faults in materials and workmanship, or as a result of Contractor correcting of same. All materials, labor, tools and equipment necessary to obtain access to defective work, including but not limited to the removal and replacement of overlying work or embedded elements damaged or clogged by the epoxy, shall be included in the terms.

D. Correction of defects, imperfections, and faults shall not relieve the Contractor from his responsibility for additional corrective work during the remaining portion of the warranty time period.

PART 2 PRODUCTS

2.1 FORM MATERIALS

A. Forms: Plywood, lumber, metal, plastic, or another approved material.
   1. Provide plywood and lumber dressed on at least two edges and one side for tight fit.
   2. Do not use rust-stained, steel, form-facing material.
   3. Use panels that will provide continuous, true, and smooth concrete surfaces meeting the finish requirements specified herein. Do not use form-facing materials with raised grain, torn surfaces, worn edges, dents, or other defects that will impair texture of concrete surface.
   4. Furnish panels in largest practicable sizes to minimize number of joints.

B. Accessories:
   1. Chamfer Strips: Wood, metal, PVC, or rubber strips, match adjacent concrete work or as specified on the construction documents.
   2. Form Ties: Factory-fabricated; removable or snap-off metal or glass-fiber-reinforced plastic form ties; designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
      a. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of the exposed concrete surface.
      b. Furnish ties that, when removed, will leave holes not larger than 1 inch in diameter in the concrete surface.

c. Furnish ties with integral water-barrier plates for walls indicated to receive dampproofing or waterproofing.

3. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect the concrete surface and will not impair subsequent treatments of the concrete surface.
   a. Formulate form-release agent with rust inhibitor for steel, form-facing materials.

2.2 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A615, Grade 60, deformed
   1. Epoxy-Coated Reinforcing Bars: ASTM A775; coated before fabrication

B. Welded Wire Reinforcing (WWR): ASTM A1064, fabricated from as-drawn steel wire with 65,000 pounds per square inch minimum yield strength
   1. Provide welded wire reinforcing in flat sheets, not rolls
   2. Epoxy-coated WWR: ASTM A884

C. Adhesive Anchored Dowels:
   1. Dowels as specified on drawings:
      a. ASTM A615, Grade 60, uncoated steel bars, cut true to length with ends square and free of burrs.
      b. ASTM F593, Group 2 (Type 316) stainless steel; 1/4 inch diameter, threaded rods.
   2. Adhesive:
      a. HIT-RE 500 V3 epoxy adhesive by Hilti, Inc.
      b. Pure 110+ epoxy adhesive by Dewalt
      c. SET-3G epoxy adhesive by Simpson Strong Tie, Inc.
      d. Approved equal.

D. Accessories:
   1. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcing in place. Manufacture bar supports according to CRSI Manual of Standard Practice from steel wire, plastic, or precast concrete or fiber-reinforced concrete of greater compressive strength than specified for the repair.
      a. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected or CRSI Class 2 stainless steel bar supports.
      b. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.
   2. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A775/A884.

2.3 CONCRETE MATERIALS

A. Source Limitations: Obtain each type or class of cementitious material of same brand from same manufacturer's plant, each aggregate from one source, and admixtures through one source from single manufacturer.

B. Portland Cement: ASTM C150/C150M, Type I or II.

C. Portland Limestone Cement: ASTM C595, Type IL

D. Fly Ash: ASTM C618, Class F or C.

E. Ground-Granulated Blast-Furnace Slag (GGBFS): ASTM C595.

F. Silica Fume: ASTM C1240, amorphous silica.

G. Aggregates: ASTM C33; from single source with documented record of at least 10 years of satisfactory service using similar aggregates and cementitious materials in similar applications and service conditions.
   1. Coarse Aggregates: Uniformly graded; 3/8 inch nominal maximum size; Class 4S.
   2. Alkali Reactivity: Coarse and fine aggregates shall have expansion indicative of innocuous behavior; that is, less than 0.08 percent expansion after 16 days when tested according to ASTM C1260.
      a. ASTM C1293 or ASTM C1567 procedures may be substituted for ASTM C1260.
      b. If one or more of the aggregate expansions exceed 0.08 percent at 16 days per ASTM C1260, then perform ASTM C1567 testing of that aggregate including supplementary cementitious material type and replacement percent showing mitigation of expansive reaction per ASTM C1778. The expansion of the test specimens, tested in accordance with ASTM C1567 as required, shall not exceed 0.08 percent at 16 days.
      c. If ASTM C1567 testing is required to mitigate expansion, the concrete mixtures containing that aggregate must contain the same supplementary cementitious material type and minimum proportion showing mitigation in the ASTM C1567 testing.
      d. All testing shall be performed within the last year.

H. Water: Potable

I. Admixtures:
   1. General: Admixtures certified by manufacturer to contain no more than 0.1 percent chloride ions and to be compatible with other admixtures and cementitious materials. Do not use admixtures containing calcium chloride.
      a. Air-Entraining Admixture: ASTM C260
      b. Water-Reducing Admixture: ASTM C494, Type A
      c. High-Range, Water-Reducing Admixture: ASTM C494, Type F
      d. Water-Reducing and Accelerating Admixture: ASTM C494, Type E
      e. Water-Reducing and Retarding Admixture: ASTM C494, Type D

2.4 CONCRETE MIXES

A. Prepare design mixes for each type and strength of concrete determined by either laboratory trial mixes or field-test data, according to ACI 301.
   1. Use qualified independent testing agency conforming to requirements of ASTM C1077 for preparing, testing, and reporting proposed mix designs for laboratory trial mix basis.

B. Partial Depth and Full Depth Repairs: Proportion normal-weight concrete mix as follows:
   1. For Exposure Categories (ACI 318): F3, S0, W1, C2
   2. Minimum 28-day Compressive Strength: 5,000 pounds per square inch.
   3. Maximum cementitious materials content of 600 pounds per cubic yard.
   4. Supplementary cementitious materials may be provided according to the requirements of ACI 301 for the exposure(s) specified.
   5. Maximum Water-Cementitious Materials Ratio, by weight: 0.45
   6. Minimum Water-Cementitious Materials Ratio, by weight: 0.38
   7. Air Content: Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having air content of 7.5 percent for 3/8 inch nominal

aggregate size and 6.0 percent for 3/4 inch nominal aggregate size, unless otherwise indicated.

8. Admixtures: Use admixtures according to manufacturer's written instructions.
   a. Use water-reducing admixture. Alternately use high-range, water-reducing admixture (superplasticizer), as required, for placement and workability.
   b. Use retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
9. No chlorides shall be intentionally introduced into concrete mix.
   a. In hardened concrete, limit acid-soluble chloride ion content to 0.10 percent by weight of cement when tested according to ASTM C1152, or water-soluble chloride ion content to 0.08 percent by weight of cement when tested according to ASTM C1218.
   b. If hardened concrete exceeds chloride ion limits above, limit water-extractable chloride ion content to 0.08 percent by weight of cement when tested according to ASTM C1524.

2.5 PACKAGED REPAIR MATERIALS

A. For Formed Vertical and Overhead Repairs: Final repair shall contain coarse aggregate either pre-blended by manufacturer or added during batching. Use one of the following, or approved equal:
   1. SikaEmaco 440/CI/MC manufactured by Sika Corporation.
   2. MS-S10 Self-Consolidating Concrete by King Packaged Materials Company.
   3. Sikacrete-211 SCC Pl manufactured by Sika Corporation.
   4. FormFlo P-38 manufactured by JE Tomes & Associates.

B. For Horizontal Partial-Depth and Full-Depth Repair: Final repair shall contain coarse aggregate either pre-blended by manufacturer or added during batching. Use one of the following or approved equal:
   1. MS-S10 Self-Consolidating Concrete by King Packaged Materials Company.
   2. Sikacrete-211 SCC Pl by Sika Corporation.

C. For Trowel-Applied Repairs on Vertical and Overhead Surfaces: Polymer- or silica-fume-modified, cementitious, non-sag mortar that is specifically designed for this application. Only to be used at locations approved by Architect/Engineer. Use one of the following, or approved equal:
   1. SikaTop-123 Plus manufactured by Sika Corporation.
   2. Mapei Planitop X, by Mapei.
   3. SikaQuick VOH, by Sika Corporation.

D. For Top Surface Repairs: Final repair shall contain coarse aggregate either pre-blended by manufacturer or added during batching. Use one of the following, or approved equal:
   1. SikaEmaco S 466 manufactured by Sika Corporation
   2. SikaTop-111 Plus manufactured by Sika Corporation

E. Rapid Setting Top Surface Repairs: Final repair shall contain coarse aggregate either pre-blended by manufacturer or added during batching. Only to be used at locations approved by Architect/Engineer. Use one of the following, or approved equal:
   1. SikaEmaco 1061/DR/EX manufactured Sika Corporation
   2. SikaQuick-1000 manufactured by Sika Corporation

F. Do not use proprietary repair materials that contain added gypsum.

G. Provide all like materials with the same manufacturer lot number.

H. Aggregates added to packaged repair materials shall:
   1. Be from a single source with documented record of at least ten years of satisfactory service when used with similar cementitious materials in similar applications and service conditions.
   2. Meet the size and durability requirements of the repair material manufacturer to which they are being added.

2.6 CURING MATERIALS

A. Water: Potable.

B. Moisture-Retaining Cover: ASTM C171, white burlap-polyethylene sheet

C. Membrane-Forming Curing Compound (For use at non-formed vertical and overhead repairs only):
   1. Comply with ASTM C309, Type 1.
   2. VOCs less than 350 g/L and legal limits compatible with new coating.
   3. Silicate materials shall not be used.

2.7 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI Manual of Standard Practice.

B. Welded Wire Reinforcing shall conform to the recommendations of the Wire Reinforcing Institute WWR 400-R-03.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements and other conditions affecting installation or performance of concrete repairs.
   1. Ensure that work done by other trades is complete and ready for concrete repair Work.
   2. Verify that areas and conditions under which concrete repair Work is to be performed permit proper and timely completion of the Work.
   3. Notify Architect/Engineer in writing of conditions which may adversely affect installation or performance of concrete repairs and recommend corrections.
   4. Do not proceed with concrete repair Work until adverse conditions have been corrected and reviewed by Architect/Engineer.
   5. Commencing concrete repair Work constitutes acceptance of Work surfaces and conditions.

B. Surface preparation shall be in accordance with Section 03 01 31, Concrete Removal and Surface Preparation, prior to placing concrete repairs.

3.2 PROTECTION

A. Take precautions to ensure the safety of people, including building users, passers-by, and workers, and animals, and protection of property, including adjacent building elements, landscaping, and motor vehicles.

B. Prevent construction debris and other materials from coming into contact with pedestrians, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.

C. Protect paving and sidewalks, and adjacent building areas from mechanical damage due to scaffolding and other equipment.

D. Limit access to Work areas.

E. Erect temporary protective canopies, as necessary, over walkways and at points of pedestrian and vehicular access that must remain in service during Work.

F. Assume responsibility for injury to persons or damage to property due to Work, and remedy at no cost to Owner.

3.3 FORMWORK

A. Design, erect, shore, brace, and maintain formwork according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until concrete structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated.
   1. Form openings, chases, offsets, keyways, reglets, blocking, screeds, and bulkheads required in Work.
   2. Chamfer corners to match existing or as specified on the Construction Documents.
   3. Construct forms tight enough to prevent loss of concrete paste.

C. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical. Kerf wood inserts for forming keyways, reglets, and recesses, for easy removal.

D. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

E. Provide temporary openings for cleanouts, venting and inspection ports (witness holes) where the interior area of the formwork is inaccessible. Close openings with panels or dowels tightly fitted to forms and securely braced to prevent loss of concrete paste. Locate temporary openings in forms at inconspicuous locations.

F. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris immediately before placing concrete.

G. Retighten forms and bracing before placing concrete to prevent mortar leaks and maintain proper alignment.

H. Removing and reusing forms
   1. General: Formwork, for sides of beams, walls, columns, and similar parts of the Work, that does not support the weight of concrete, may be removed after cumulatively curing at not less than 50 degrees Fahrenheit for 24 hours after placing concrete, provided concrete is hard enough not to be damaged by form-removal operations and provided curing and protection operations are maintained.

2. Leave formwork for beam soffits, joists, slabs, and other structural elements that support the weight of concrete in place until concrete has achieved at least 75 percent of its 28-day design compressive strength and a minimum of 7 days.
3. Clean and repair surfaces of forms to be reused in the Work. Do not use split, frayed, delaminated, or otherwise damaged form-facing material, or patched forms, for exposed surfaces.

3.4 STEEL REINFORCEMENT

A. General: Comply with CRSI Manual of Standard Practice for placing reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

D. Do not weld reinforcement unless specifically approved by Architect/Engineer.

E. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

F. Install welded wire reinforcing in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing plus two inches. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire. Use only sheets, not rolls.

G. Epoxy-Coated Reinforcement: Use epoxy-coated steel wire ties to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D3963.

3.5 EMBEDDED ITEMS

A. Place and secure items to be embedded in concrete.

3.6 INSTALLATION OF ADHESIVE ANCHORED STEEL ITEMS

A. Remove unsound concrete at anchored item locations.

B. Drill, clean and install adhesive and anchored item in accordance with ESR and adhesive material manufacture’s printed installation instructions, and those listed below. If a conflict exists between the requirements of these specifications and the adhesive manufacturer, notify Architect/Engineer and request direction.

C. Dry drill holes perpendicular to concrete surface.
1. Locate existing reinforcement with reinforcing bar locator and position holes to avoid existing reinforcement.
2. Do not damage existing reinforcement.
3. Drill hole diameter larger than anchored item diameter as required by adhesive manufacturer.

D. Clean holes with stiff brush and dry, oil-free compressed-air jet to remove loose concrete, dust, and debris.

E. Inject adhesive with tube into back of hole and fill hole to front, withdrawing tube.
   1. Carefully proportion and mix two-part adhesives according to manufacturer's directions. Scrape out entire contents of both containers to assure accurate proportions.
   2. Mix adhesive for approximately three minutes with paint stirrer attached to low speed (400 to 600 rpm) electric or pneumatic drill, unless otherwise specified by manufacturer. Move stirrer up and down and around sides of mixing container until even, streak-free color is attained. Do not whip in air.
   3. Install sufficient adhesive material to completely fill annular space around item.

F. Insert item to bottom of hole and secure in center of hole, perpendicular to surface, until adhesive has set.

G. Promptly remove excess adhesive.

H. Apply two coats of corrosion-inhibiting material on exposed steel surfaces.

3.7 BATCHING AND MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C94, and furnish batch ticket information.
   1. Deliver concrete to Site and discharge within 90 minutes or before 300 revolutions of mixer drum, whichever comes first, after introduction of mix water. When air temperature is between 85 and 90 degrees Fahrenheit, reduce mixing and delivery time to 75 minutes; when air temperature is above 90 degrees Fahrenheit, reduce mixing and delivery time to 60 minutes. Due to the nature of the Work, trucks with short loads may be required. Concrete that exceeds the specified time limits shall be rejected.
   2. High range water-reducing admixtures may be added on site to increase slump, but only at the guidance of the ready-mix producer. Introduce high-range, water-reducing admixture at the Site with additional mixing per the manufacturer’s recommendations. If unspecified, 70 revolutions of the drum shall be required to ensure proper mixing. Do not add water and superplasticizer at the same time.
   3. Site added water shall be only that amount withheld during initial batching as trim or held water and be clearly indicated on the batch ticket. Water shall only be added at the guidance of the ready-mix producer. Do not exceed mix design w/cm with site added water. Water addition at site shall be performed only once, meaning initial discharge, water addition, mixing, and second/final discharge. If unspecified by ready-mix producer, 70 revolutions of the drum shall be required to ensure proper mixing.
   4. Air adjustments may be made once at the site after initial discharge of material. Air adjustments shall be made only at the guidance of the ready-mix producer.
   5. All tests of record shall be performed after all changes or additions to the concrete have occurred.

B. Packaged Materials Mixing: Measure, batch, and mix concrete materials according to the repair material manufacturers requirements, and this section.
   1. Develop batching and mixing operations so that quality control is assured.
   2. Designate one or two individuals to batch and mix materials. Fully instruct these individuals on batching and mixing procedures.
   3. Ensure that all materials have been stored and pre-conditioned to proper temperatures as required by the packaged repair material manufacturer.
   4. Maintain accurate mix proportions. Batch materials by weight on the basis of whole bags or containers of packaged repair material. Maintain a calibrated scale at the Site during concrete placement operations and weigh packaged materials. Notify manufacturer and

Engineer of materials which are not within 2 percent of their published weight and await direction.

5. Mix concrete repair materials in appropriate drum, mortar, or drill-type batch machine mixer as recommended by the manufacturer.
   a. Follow mixing procedures, pause points, and procedures recommended the manufacture of the packaged material.
   b. Ensure that all mixer elements are cleaned of all materials from previous batch, and mixer components have been pre-wetted, or charged, prior to batching.
   c. Provide a sufficient number of mixers, including reserve mixers, so that placement operations will proceed uninterrupted, and each repair is completely cast before repair concrete achieves initial set.
   d. Ensure uniform consistency
6. Compile a Batch Log for each batch of material. A sample batch log containing the minimum information required is attached to this Section.

3.8 PLACEMENT

A. Before placing repair, verify the following:
   1. Installation of formwork, reinforcement, and embedded items is complete
   2. Concrete surfaces and forms are clean of frost, ice, mud, debris, and water
   3. Forms are thoroughly wetted or oiled
   4. Reinforcement is securely tied in place and thoroughly cleaned of ice and other coatings that may reduce or destroy bond with concrete
   5. Required inspections have been performed
   6. Equipment for transporting concrete is clean
   7. Vibrators are operational, if required.

B. Cast concrete repair against saturated surface dry concrete substrate. Ensure the surface is free of standing water and that surface pore water is not present.

C. Convey material from the mixer to the place of deposit in a manner such that no segregation or loss of materials occurs.

D. Place concrete as near as possible to its final position to avoid segregation due to re-handling or flowing.
   1. Do not allow repair material to fall a vertical distance greater than 4-feet from the point of discharge to the point of deposit.
   2. Do not allow repair material to disturb or displace reinforcing bars, floor drains, or other embedment's.

E. Place concrete at a rate so that it is plastic and flows readily into corners of forms and into spaces around reinforcing bars.

F. Place concrete continuously until the repair volume or section is completed, with no cold joints.
   1. Dispose of concrete that has partially set prior to placement or that has been contaminated by foreign material.

G. Consolidate concrete with mechanical vibrating equipment, so that the concrete is thoroughly worked around reinforcement and other embedded items and into corners.
   1. Use internal vibrators with minimum speed of 7,000 vibrations per minute and that are sufficiently narrow to fit into spaces between reinforcing bars, formwork, and existing concrete. Have extra vibrators at the Site in case a vibrator does not work.

2. Do not use vibrators to transport concrete.
3. Insert and withdraw vibrators vertically at uniformly spaced locations no farther apart than the visible effectiveness of the vibrator.
4. At each insertion, limit the duration of the vibration to the time necessary to consolidate the concrete without causing mix constituents to segregate.

H. Cold-Weather Placement: Protect concrete Work from physical damage or reduced strength due to frost, freezing, or low temperatures. Refer to ACI 306R for guidance and comply with the following.
1. When the air temperature has fallen or is expected to fall below 40 degrees Fahrenheit, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 degrees F and not more than 80 degrees Fahrenheit at the point of placement. Mix water and aggregates together before adding cement. Do not add cement if the temperature of the water/aggregate mixture exceeds 70 degrees Fahrenheit.
2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators, unless otherwise specified and approved in mix design.

I. Hot-Weather Placement: Protect concrete Work from physical damage or reduced strength due to rapid evaporation or overheating of concrete. Refer to ACI 305R for hot-weather conditions that may adversely affect concrete placement, finishing, and curing. Do not allow the temperature of the concrete at the time of placement to exceed 90 degrees Fahrenheit. When hot-weather conditions exist, use one or more of the following procedures:
1. Place concrete at night or early in morning.
2. Cool ingredients before mixing to maintain the concrete temperature below 90 degrees Fahrenheit at the time of placement. Chilled mixing water or chopped ice may be used to control the temperature; include the water equivalent of the ice in the mixing water quantity. Use liquid nitrogen to cool the concrete at Contractor's option.
3. Cover steel reinforcement with water-soaked burlap so the steel temperature will not exceed the ambient air temperature immediately before embedding in concrete.
4. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep the subgrade moisture uniform without standing water, soft spots, or dry areas.
5. Provide windbreaks or sunshades, or both.

3.9 FINISHING NON-FORMED SURFACES

A. Do not wet concrete surfaces or add cement.

B. Do not use finishing aids of any kind, or any other product or material added to the surface and worked into the concrete during finishing.

C. Float and broom finish.
1. Float finish: Consolidate the surface with a power-driven float or by hand floating if the area is small or inaccessible to a power-driven float. Restraighten, cut down high spots, and fill low spots. Repeat float passes and re-straightening until the surface is left with uniform, smooth, granular texture.
2. Medium-Broom Finish: Apply medium-broom finish, perpendicular to traffic flow, on top surfaces subjected to vehicular or pedestrian traffic.

D. The finished surface flatness shall be such that the measured gaps between the repair (and adjacent) surface and an unleveled, freestanding, 10-foot-long straightedge, resting on two high spots and placed anywhere on the surface, does not exceed 1/4 inch.

E. Edge of repair shall be flush with adjacent concrete surface.

F. At the tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

G. Hot-Weather Conditions: Fog the surface with water if hot, dry, or windy conditions cause moisture loss approaching 0.2 pounds per square foot per hour before or during finishing operations (value may be estimated using ACI 305R-20 Figure 4.1.4).

3.10 FINISHING FORMED SURFACES

A. Provide surface finish 2.0 (SF-2.0) unless otherwise specified.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams.

C. Edge of repair shall be flush with adjacent concrete surface within 1/8 inch tolerance.

D. Do not apply rubbed finish.

E. Surface Finish Type Definitions:
   1. Surface Finish-1.0 (SF-1.0): Repair voids larger than 1½ inch wide or 1/2 inch deep. Limit abrupt (over 1 inch or less) or gradual (5 foot straight edge) concrete surface irregularities to 1 inch (ACI 117 Class D).
   2. Surface Finish-2.0 (SF-2.0): Repair voids larger than 3/4 inch wide or 1/2 inch deep. Repair or patch all form tie holes and similar construction related blemishes. Limit abrupt (over 1 inch or less) or gradual (5 foot straight edge) concrete repair surface irregularities to 1/4 inch (ACI 117 Class B).
   3. Surface Finish-3.0 (SF-3.0): Repair voids larger than 3/4 inch wide or 1/2 inch deep. Repair or patch all form tie holes and similar construction related blemishes. Limit abrupt (over 1 inch or less) or gradual (5 foot straight edge) concrete repair surface irregularities to 1/8 inch (ACI 117 Class A).

F. After concrete has gained sufficient strength to be unaffected by grinding, grind off fins, other projections, and high areas to meet finish requirements

3.11 CURING AND PROTECTION

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
   1. Maintain concrete above 55 degrees Fahrenheit and in a moist condition for at least 7 days after placing for ready-mix concrete.
   2. Maintain concrete above 55 degrees Fahrenheit and in moist condition for at least 7 days after placing packaged repair materials.
   3. In cold weather, protect concrete from falling below 55 degrees F with insulating blankets or heated enclosures vented to the outside. If used, vent heaters to outside of the enclosure around the concrete replacement.

B. Unformed Top Surfaces: Use moisture-retaining cover.
   1. Begin curing within 30 minutes after finishing concrete.

2. Place cover in widest practicable width, with sides and ends lapped at least 12 inches.
3. Seal sides and ends of cover by holding down with soil, concrete pieces, or some other weight, or by using waterproof tape or adhesive.
4. Immediately repair holes or tears in cover during curing period, using cover material and waterproof tape.
5. Re-wet concrete surface at least twice daily or as necessary to maintain moist condition.

C. Unformed Vertical and Overhead Surfaces: Apply a curing compound uniformly in a continuous operation by power spray or roller according to manufacturer's written instructions and recommended coverage rate. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.12 QUALITY CONTROL

A. Submit batch tickets for ready-mix concrete and batch logs for packaged materials.

B. Contractor shall engage a qualified independent testing and inspecting agency to sample materials and perform tests prior to, during, and after concrete placement.

C. Provide:
1. Access to Work
2. Materials for sampling
3. Site facilities for sampling, testing, and storage of materials
4. Incidental labor
5. Disposal of concrete or materials related to testing
6. Cleaning or washout materials and facilities

D. Testing Services: Sampling and testing of composite samples of fresh concrete repair material shall be performed according to the following requirements:
1. Testing Frequency: Obtain one composite sample of each concrete mix for each day's pour.
2. Take samples from ready-mix truck or mixer during discharge according to ASTM C172. Take samples at other locations if directed by Architect/Engineer**.**
3. Slump: Per ASTM C143; one test for each composite sample, but not less than one test for each day's pour of each concrete mix. Perform additional tests when concrete consistency appears to change. If high-range, water-reducing admixture is used, perform one test prior to adding admixture.
4. Air Content: Per ASTM C231; one test for each composite sample, but not less than one test for each day's pour of each concrete mix. No testing required for packaged repair materials.
5. Concrete Temperature: Per ASTM C1064
    a. On ready-mix concrete perform one test for each composite sample; and one test hourly when air temperature is 40 degrees Fahrenheit and below or 80 degrees Fahrenheit and above.
    b. For packaged repair materials, perform with each batch and record in batch log.
6. Compression Test Specimens: ASTM C31. Use 4-inch by 8-inch cylinders.
    a. Cast and test 5 standard cure cylinder specimens for each composite sample.
    b. If requested by Architect/Engineer, cast and test 3 additional cylinder specimens for each composite sample and field cure in the vicinity of the area that they represent and in the same manner as that portion of the repair.
7. Compressive-Strength Tests: ASTM C39.
    a. Test one standard cured specimen at 7 days and three at 28 days. Hold the final specimen in reserve in case additional testing is required.

b. Test one field cured specimen at 7 days and two at 28 days.

8. Test results shall be reported in writing to Owner's Representative, Architect/Engineer, concrete supplier, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain:
   a. Name of concrete testing and inspecting agency.
   b. Project identification name.
   c. Date of concrete placement.
   d. Specific location of concrete batch in Work.
   e. Concrete mix number, design compressive strength at 28 days, design slump range, and design air content range.
   f. Specimen number, cylinder size, dates of compression tests, compressive breaking strengths and types of break for seven- and 28-day tests, and measured slump, air content, and air and concrete temperatures.
   g. Statement that indicates whether test results are in conformance with Specifications.
9. Concrete strength is satisfactory if the average of the 28-day standard-cured compressive-strength tests equals or exceeds the specified 28-day compressive strength and no test value is more than 500 pounds per square inch less than the specified 28-day strength. Strength tests confirming 28-day strength are acceptable at earlier ages.
10. When the compressive strength of field cured specimens is less than 85 percent of the companion standard cured cylinders, evaluate operations and provide corrective procedures for protecting and curing the in-place concrete.
11. Non-Conforming Concrete:
    a. If tests indicate that concrete is not in conformance with the Specification, remove and replace non-conforming concrete or perform additional testing, acceptable to Architect/Engineer, to verify conformance with the Specification, at no cost to Owner.
    b. Procure core samples in accordance with ASTM C42. Diameter and length as determined by Architect/Engineer.
    c. If tests indicate that the slump, air entrainment, or other requirements have not been met, examine core samples petrographically, according to ASTM C856, to evaluate hardened concrete characteristics. Design intent for desired hardened concrete properties shall be based on the Specification, and applicable portions of ACI 201.2R, as determined by Architect/Engineer.
    d. If compressive-strength tests do not meet the acceptance requirements, procure three core samples from each portion of the structure represented by the unsatisfactory test(s), and test in compression. The strength of concrete in the area represented by core tests is satisfactory if the average of three compressive strength tests equals or exceeds 85 percent of the specified 28-day compressive strength and no compressive-strength test value is less than 75 percent of the specified 28-day compressive strength. If strength acceptance criteria are not met, remove and replace non-conforming concrete areas at no cost to Owner.
    e. Perform additional inspection and testing, at no cost to the Owner, to determine the compliance of replaced or additional work with the specified requirements.

3.13 CONCRETE REPAIR DEFECTS

A. Repair defective areas designated by Architect/Engineer. Remove and replace concrete that cannot be repaired to Architect/Engineer's satisfaction.

B. Perform sound testing by chain drag or hammer tapping of repaired areas after sufficient cure time and strength gain. Remove and replace delaminations, damaged, or unsound concrete using

repair procedures defined in the construction documents and as directed by Architect/Engineer at no cost to the Owner.

C. Surface defects on exposed surfaces include:
   1. Voids, spalls, air bubbles, honeycomb, rock pockets, and form-tie voids, more than 1/2 inch in any dimension in solid concrete but not less than 1 inch deep. Any item which covers more than two percent of the surface.
   2. Cracks at least 0.015-inch wide and any that penetrate to the depth of the reinforcing or completely through the repair section.
   3. Surface finish not meeting the requirements above.

D. Repair latent defects that affect concrete's durability and structural performance as determined by Architect/Engineer.

E. Verify that concrete curbs, expansion joints, and transitions from one surface plane to another (inside and outside corners), as applicable, are cleanly formed and free of broken edges and excess concrete.

F. Cut out spalls, air bubbles, honeycombs, rock pockets, and voids. Make edges of cuts perpendicular to concrete surface. Clean voids and fill with repair mortar according to the manufacturer's recommendations. Use polymer- or silica fume-modified, cementitious, non-sag mortar that is specifically intended for this application. Use one of the following or approved equal:
   1. SikaTop-123 Plus manufactured by Sika Corporation.

G. Fill cracks with high-molecular-weight methacrylate, or low-viscosity methyl methacrylate or epoxy. Use one of the following or approved equal:
   1. Concrete Protector & Restorer CP&R 5741 Hi Mod Low Odor or 5742LO Low Mod manufactured by 3M.
   2. Sikalastic-630 manufactured by Sika Corporation.
   3. SikaPronto 19 TF manufactured by Sika Corporation.

H. Repair materials and installation not specified above may be used if approved by Architect/Engineer.

3.14 CLEANING

A. At the end of each workday, clean the Site and Work areas and place rubbish, empty cans, rags, and other discarded materials in appropriate containers.

B. After completing the concrete repair Work:
   1. Clean soiling from adjacent surfaces. Exercise care to avoid scratching or damage to surfaces.
   2. Repair surfaces stained, marred, or otherwise damaged during concrete repair Work.
   3. Clean up debris and surplus materials and remove from Site.

END OF SECTION 03 01 34

SAMPLE BATCH LOG (MINIMUM INFORMATION SHOWN)

Project

Project Name:

Project Number:

Date:

Mixer/Batching Team Name(s):

Repair Application (Form-and-pump overhead, top surface, top surface rapid-set, etc.):

Mixer Type:

Prepackaged Repair Material Information

Name:

Lot #:

Minimum WT or Volume of Water:

Maximum WT or Volume of Water

Admix volume required:

Aggregate

Name/Description:

Manufacturer or Supplier:

Size (in):

Batch #	Time	Ambient Air Temp	Prepackaged Material Temp	Prepackaged Material Weight (bag wt.)	Prepackaged Material Admixture Volume	Aggregate Weight	Aggregate Moisture Condition (SSD, etc.)	Water Weight or Volume	Mixing Time	Final Mixture Temp	Notes (batch where testing was performed, etc.)

SECTION 03 15 11
EXPANSION JOINT SEALS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Surface preparation, supply, and installation of expansion joint seals in concrete structures.

B. Related Sections:
   1. Section 01 22 00 – Unit Prices
   2. Section 03 01 31 – Concrete Removal and Surface Preparation
   3. Section 03 01 34 – Concrete Repair
   4. Section 07 92 00 – Joint Sealants

1.2 UNIT PRICES

A. Perform the following Work on unit price basis as described in Section 01 22 00.

1.3 COORDINATION

A. Coordinate Work to ensure that adjacent areas are not adversely affected. Coordinate:
   1. With Owner's Representative.
   2. With other trades:
      a. To ensure that work done by other trades is complete and ready for joint seal installation.
      b. To avoid or minimize work on, or in immediate vicinity of, joint seal Work in progress.
      c. To ensure that subsequent work will not adversely affect completed joint seal installation.

1.4 FULL RESPONSIBILITY

A. Expansion joint manufacturer will have the full responsibility for:
   1. Instructing the Contractor on proper joint installation procedure
   2. Reviewing and approving joints or surfaces prior to installing the expansion joint seals
   3. Reviewing the joint configurations and specifying, detailing and/or designing the proper joint sizes and turns.

B. The Contractor shall instruct the expansion joint manufacturer of these responsibilities.

1.5 SUBMITTALS

A. Product Data: Joint-seal manufacturer's literature including written instructions for evaluating, preparing, and treating substrate; technical data including material descriptions and dimensions of individual components; and installation instructions and construction details.

B. Shop Drawings: For each joint system specified.

C. Template Drawings: Showing typical expansion joint cross-sections indicating dimensions and relationship to adjacent construction.

D. Certification: Signed by joint-seal manufacturer, certifying that Installer has been trained and approved by manufacturer to install joint seal.

E. Field Quality Control: Written report with joint locations, joint width measurements, date and time of measurements, high and low daily temperatures for week preceding measurements, and recommended joint-seal size.

F. Installer Qualifications: Evidence that Installer's *existing company* has minimum 5 years of continuous experience in application of specified materials; list of at least five representative, successfully completed projects of similar scope and size, including:
   1. Project name.
   2. Owner's name.
   3. Owner's Representative name, address, and telephone number.
   4. Description of work.
   5. Expansion joint seals used.
   6. Project supervisor.
   7. Total cost of expansion joint seal work and total cost of project.
   8. Completion date.

G. Following completion of the Work, submit completed joint-seal warranty.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Qualified firm that is approved, authorized, or licensed by joint-seal manufacturer to install joint seal. Must have successful installations of specified materials in local area in use for minimum of five years.
   1. Employ foreman with minimum five years of experience as foreman on similar projects, who is fluent in English, to be on Site at all times during the Work. Do not change foremen during the course of the Project except for reasons beyond the control of Installer; inform Architect/Engineer in advance of any changes.

B. Mockups: Install first section of each joint seal to demonstrate installation procedures and quality of installation.
   1. Architect/Engineer will observe installation and completed joint seal. Notify Architect/Engineer and Owner's Representative seven days in advance of mockup installation.
   2. If Architect/Engineer determines mockup does not comply with requirements, modify mockup or construct new mockup until mockup is approved.
   3. Approved mockup will be standard for judging completed Work.
   4. Approved mockups may become part of completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle materials according to manufacturer's recommendations and in such a manner as to prevent damage to materials or structure.

B. Deliver materials to Site in original packages with seals unbroken, labeled with joint-seal manufacturer's name, product brand name and type, date of manufacture, lot number, and directions for storing and mixing with other components.

C. Store materials in original, undamaged containers in clean, dry, protected location on raised platforms with weather-protective coverings, within temperature range required by joint-seal manufacturer.

D. Limit stored materials on structures to safe loading capacity of structure at time materials are stored, and to avoid permanent deck deflection.

E. Conspicuously mark damaged or opened containers, containers with contaminated materials, or damaged materials, and remove from Site as soon as possible.

F. Remove materials that cannot be applied within stated shelf life from Site and replace with new materials.

1.8 PROJECT CONDITIONS

A. Verify existing dimensions and details prior to start of joint seal Work. Notify Architect/Engineer of conditions found to be different than those indicated in the Contract Documents. Architect/Engineer will review situation and inform Contractor and Installer of changes.

B. Comply with Owner's limitations and restrictions for Site use and accessibility.

C. Environmental Limitations: Install joint seals when existing and forecast weather conditions permit joint seal system to be installed according to joint-seal manufacturer's written instructions and warranty requirements.
   1. Verify joint gap at installation will permit proper functioning of joint seal.

1.9 CHANGES IN WORK

A. During rehabilitation work, existing conditions may be encountered which are not known or are at variance with the Contract Documents. Such conditions may interfere with the Work and may consist of damage or deterioration of the substrate or surrounding materials that could jeopardize the integrity or performance of the Work.
   1. Notify Architect/Engineer of conditions that may interfere with the proper execution of the Work or jeopardize the performance of the Work, prior to proceeding with Work.

1.10 WARRANTY

A. Contractor's Warranty:
   1. Written warranty, signed by Contractor, including:
      a. Repair or replace joint-seal components that do not comply with requirements; that do not remain watertight; that fail in adhesion, cohesion, or general durability; or that deteriorate in a manner not clearly specified by submitted joint-seal manufacturer's data as an inherent quality of the material for the application indicated.
      b. Labor and materials to perform warranty work.
      c. Replace entire joint seal lengths unless high-quality, durable field splices can be installed.
   2. Warranty Period: 5 years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 JOINT SEALS

A. Elastomeric Seal with Elastomeric Nosing: Neoprene or thermoplastic-rubber seal, cast in elastomeric-concrete nosings; seal sizes to be determined by Contractor based on joint locations and actual joint widths, and approved by Architect/Engineer. Use one of the following or approved equal.
   1. Delcrete Elastomeric Concrete/Strip Seal Expansion Joint System manufactured by D. S. Brown.
   2. Iso-Flex Winged Expansion Joint manufactured by LymTal International, Inc.
   3. WaboCrete Membrane (ME, MM, MX) manufactured by Sika Corporation.

B. Premolded Urethane or Polyurethane Seal: Set on aluminum, traffic-support plate and adhered with polymeric nosing material; seal sizes to be determined by Contractor based on joint locations and actual joint widths, and approved by Architect/Engineer. Use one of the following or approved equal.
   1. Iso-Flex Factory Molded Expansion Joint manufactured by LymTal International, Inc.
   2. Wabo UreFlex (T) manufactured by Sika Corporation.

C. Joint Seal Size:
   1. Measure average, maximum, and minimum joint widths at every joint.
   2. Submit in writing joint locations, joint width measurements, date and time of measurements, high and low daily temperatures for week preceding measurements, and recommended joint seal size to Architect/Engineer for approval. Assume 160-degree thermal change, from -20 to 140 degrees, in sizing seal.

D. Silicone-Coated, Precompressed Seal: See Section 07 92 00.

E. Accessories: Primers, bedding materials, bonding agents, lubricants, adhesives, sealants, and other accessories supplied or approved by joint-seal manufacturer.

2.2 FABRICATION

A. Prior to fabrication, field measure existing conditions to ensure proper fit.

B. Provide continuous joint seals in longest practical lengths, with minimum number of end joints.
   1. For straight sections, provide continuous lengths.
   2. Fabricate directional changes in shop whenever possible; use mitered and adhered or heat-welded corners.
   3. Fabricate with end closures, transitions, and intersections to provide continuous assembly.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions with Installer and joint-seal manufacturer’s representative for compliance with requirements and for other conditions affecting installation or performance of joint seals.
   1. Ensure that work done by other trades is complete and ready for joint seal Work, including concrete construction and replacement.

2. Verify that areas and conditions under which joint seal Work is to be performed permit proper and timely completion of Work.
3. Notify Architect/Engineer in writing of conditions which may adversely affect installation or performance of joint seals and recommend corrections.
4. Do not proceed with joint seal Work until adverse conditions have been corrected and reviewed by Architect/Engineer.
5. Commencing joint seal Work constitutes acceptance of Work surfaces and conditions.

3.2 PROTECTION

A. Take precautions to ensure the safety of people, including building users, passers-by, and workers, and animals, and protection of property, including adjacent building elements, landscaping, and motor vehicles.

B. Prevent construction debris and other materials from coming into contact with pedestrians, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.

C. Limit access to Work areas.

D. Erect temporary protective canopies, as necessary, over walkways and at points of pedestrian and vehicular access that must remain in service during Work.

E. Assume responsibility for injury to persons or damage to property due to Work, and remedy at no cost to Owner.

3.3 SURFACE PREPARATION

A. Prepare substrates according to joint-seal manufacturer’s written instructions.

B. Provide clean, sound, dry concrete surfaces.
1. Remove existing joint seals.
2. Sawcut or form sides of joints straight and parallel. Adjust joint widths for temperature. Create shoulders for joint seals.
3. Repair unsound concrete along joints to provide solid surface of clean, sound concrete, free of voids and honeycombing.
4. Install grout bed or other leveling device to accurately position joint seal.
5. Clean concrete surfaces by sandblast or other means recommended by joint-seal manufacturer, to remove contaminants including form release agents, laitance, surface dirt and rust, and old sealant. Remove dust and other contaminants with compressed air.
6. Allow concrete and concrete replacement materials to fully cure prior to joint seal installation.

3.4 INSTALLATION

A. Install joint seal according to manufacturer’s written instructions. Field splices to be coordinated with and approved by joint-seal manufacturer.

B. Verify that joint widths are suitable for seal size and movement capability.

C. Do not proceed with Work under adverse weather conditions or when temperatures are below or above manufacturer's recommended limitations for installation. Ambient temperature shall not be below 40°F during installation. No installation may be performed in rainy weather, or

when rain is expected for one hour before installation. All surfaces must be completely dry prior to applying adhesive.

D. Elastomeric Seals with Elastomeric Nosings:
   1. Unpack seal and lay in relaxed position to relieve temporary coiling.
   2. Adhere or heat-weld seal pieces together to create field splices.
   3. Mask edges of concrete.
   4. Center joint seal over joint and install elastomeric nosings.
   5. Ensure that seals and wings are fully seated, with no gaps between the wing and the concrete substrate.

E. Premolded Urethane or Polyurethane Seals:
   1. Unpack seal and lay in relaxed position to relieve temporary coiling.
   2. Set and accurately level aluminum plate.
   3. Center joint seal over joint and mask edges of seal and concrete.
   4. Install nosing compound or sealant along edges of seal and in butt splices.

F. Silicone-Coated, Precompressed Seal: See Section 07 92 00.

3.5 FIELD QUALITY CONTROL

A. Water Test:
   1. Construct water-retention barriers along sides of joints. Include elastomeric nosing material in water test.
   2. Pond water on top of joint seal for 24 hours and observe underside of deck for leakage.
   3. Repair leaking portions of joint seal and re-test.

3.6 CLEANING

A. Clean excess primer, adhesive, sealant, other products, and soiling from components and adjacent surfaces.

B. Repair surfaces stained, marred, or otherwise damaged during concrete replacement work.

C. Clean up debris and surplus materials and remove from Site.

3.7 PROTECTION

A. Protect the joint seal system during construction. Heavy construction vehicles will not be permitted to cross the joint without specific and written permission by the Owner's Representative. Subsequent damage to the system shall be repaired at the Contractor's expense.

B. Protection shall be provided until complete cure of epoxy adhesive or header material.

END OF SECTION 03 15 11

SECTION 04 01 20
MASONRY AND CONCRETE CLEANING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Cleaning brick masonry and concrete.
   1. Purpose of cleaning is to remove as much atmospheric deposits, soil, staining, corrosion staining, efflorescence, grease, oil, and other contaminants as possible without damaging substrates.
   2. Concrete substrates to be cleaned include below the corroded steel decking at elevator landings.
   3. Masonry substrates to be cleaned include brick masonry facade and site walls.

B. Related Sections:
   1. Section 01 11 00 – Summary of Work
   2. Section 01 22 00 – Unit Prices
   3. Section 04 01 21 – Brick Masonry Repair and Replacement
   4. Section 05 02 00 – Miscellaneous Structural Steel
   5. Section 07 92 00 - Joint Sealants

1.2 PAYMENT

A. Provide the following on a lump sum or unit price basis as described in Sections 01 11 00 and 01 22 00.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordinate Work to ensure that adjacent areas are not adversely affected. Coordinate:
   1. With Owner's Representative.
   2. With other trades:
      a. To ensure that work done by other trades is complete and ready for cleaning Work.
      b. To avoid or minimize work in immediate vicinity of cleaning Work in progress.
      c. To ensure that subsequent work will not adversely affect cleaned surfaces.

B. Notify Architect/Engineer of conflicts between Specifications and cleaning material manufacturer's recommendations. Perform Work according to Specifications unless Architect/Engineer authorizes changes in writing.

C. Sequencing: Perform cleaning and repair Work in the following sequence:
   1. Prior to cleaning, inspect for open mortar or sealant joints and other potential sources of water infiltration, and perform repairs necessary to prevent intrusion of water and other cleaning materials into wall.
   2. Clean walls and apply biocide as specified.
   3. Perform remaining repairs as specified.

D. Pre-construction Meeting:
   1. Conduct meeting at Site.
   2. Review requirements for cleaning Work, including:

a. Construction schedule.
b. Availability of materials, cleaning personnel, equipment, and facilities required.
c. Site use, access, staging, and set-up location limitations.
d. Sequencing of Work.
e. Test application and selection procedures.
f. Possible weather restrictions during proposed duration of Work.
g. Surface preparation, substrate condition, and pretreatment.
h. Cleaning procedures.
i. Testing and inspection requirements.
j. Temporary protection.
k. Government regulations.

3. Contractor, subcontractor, Owner's Representative, and Architect/Engineer shall attend.

1.4 SUBMITTALS

A. Product Data: List of products proposed for use, with Manufacturer's product literature and application instructions.

B. Chemical Test Report on Water: List of chemicals and other additives in water, identifying items which may render water unsuitable for use on cleaning Project.

C. Cleaning System Descriptions: Modify specified requirements based on approved trials and submit complete written descriptions of cleaning systems, including materials and procedures.

D. Protection Plan: Written plan describing protection measures proposed for use on Project.

E. Containment, Collection, and Disposal Plan: Written plan describing methods for containing, collecting, and disposing of runoff during cleaning operations.

F. Cleaning Contractor Qualifications: Evidence that Contractor's *existing company* has minimum 5 years of continuous experience in use of specified cleaning system; list of at least 5 representative, successfully-completed, projects of similar scope and size, including:
1. Project name.
2. Owner's name.
3. Owner's Representative name, address, and telephone number.
4. Description of work.
5. Cleaning system, including materials and procedures, used.
6. Project supervisor.
7. Total cost of cleaning work and total cost of project.
8. Completion date.

1.5 QUALITY ASSURANCE

A. Cleaning Contractor Qualifications: Experienced firm that has successfully completed cleaning work similar in material, design, and extent to that indicated for the Project. Must have successful use of specified cleaning system in local area for minimum of 5 years.
1. Employ trained foreman with a minimum 5 years of experience as foreman on similar projects, who is fluent in English, to be on Site at all times during the Work. Do not change foreman during the course of the Project except for reasons beyond the control of Contractor; inform Architect/Engineer in advance of any changes.
2. Employ laborers with training and at least 3 years of experience with the specified cleaning system.

B. Mockups: Apply cleaning system at 3 locations selected by Architect/Engineer to demonstrate procedures and effectiveness.
   1. Mockups to be approximately 25 square feet. Test areas shall be in unobtrusive locations.
   2. Prepare mockups on existing walls, at locations designated by Architect/Engineer and in presence of Architect/Engineer, under same weather conditions expected during Work. Provide access to mockup locations.
   3. Test adjacent materials and other materials that may be affected by cleaning system, to determine if materials need to be protected.
   4. Include protection systems and devices proposed for use to counteract adverse effects of cleaning system, in mockup.
   5. Allow period of at least 14 days after mockup preparation for evaluation of effectiveness of cleaning system and for negative reactions.
   6. If Owner's Representative and Architect/Engineer determine mockup does not comply with requirements, modify mockup or construct new mockup until mockup is approved. Modifications may include minor adjustments to application methods, dilutions, and dwell times of products within limits recommended by manufacturers.
   7. Approved mockups shall be maintained in an undisturbed condition throughout the Project as a basis for acceptance of completed work and may become part of completed Work if undisturbed at time of Substantial Completion.
   8. Record locations and materials and methods used for mockups on drawings and in field reports for reference as Work proceeds.
   9. Do not order materials or proceed with Work until mockups have been approved by Architect/Engineer and Owner's Representative.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in original containers and packaging with seals unbroken, labeled with manufacturer's name, product brand name and type, date of manufacture, lot number, directions for storing, and complete manufacturer's written instructions.

B. Keep materials dry and do not allow materials to be exposed to moisture during transportation, storage, handling, or installation. Reject and remove from Site new materials which have been exposed to moisture to their detriment.

C. Store and handle materials in accordance with manufacturer's written instructions, safety requirements, and all applicable laws and regulations. Remove from Site, and replace at no cost to Owner, any materials that are damaged or otherwise negatively affected by not being stored or handled in accordance with manufacturer's written instructions.

D. Store materials in original, undamaged containers and packaging in clean, dry, location on raised platforms and protected from weather, within temperature range required by manufacturer. Protect stored materials from direct sunlight and sources of ignition. Manufacturer's standard packaging and covering alone is not considered adequate weather protection.

E. Locate materials in a secure location approved by Owner's Representative

F. Conspicuously mark damaged or opened containers, containers with contaminated materials, damaged materials, and materials that cannot be used within stated shelf life and remove from Site as soon as possible. Replace discarded materials in a timely manner at no cost to Owner.

G. Limit stored materials on structures so as to preclude damage to materials and structures.

H. Maintain copies of all applicable Safety Data Sheets (SDS) with materials in storage area, such that they are available for ready reference on Site.

1.7 PROJECT CONDITIONS

A. Verify existing dimensions and details prior to start of Work. Promptly notify Architect/Engineer of conditions found to be different than those indicated in the Contract Documents. Architect/Engineer will review situation and inform Contractor and Installer how to proceed.

B. Comply with limitations and restrictions for Site use, accessibility, and work hours imposed by codes, ordinances, rules, regulations, orders, laws, and other legal requirements of public authorities having jurisdiction, and by Owner.
   1. Comply with city, state, water department, and Federal regulations covering protection and wastewater disposal.

C. Environmental Limitations:
   1. Perform cleaning Work when air temperature is 40 degrees Fahrenheit or above and is predicted to remain so for at least seven days after completion of cleaning.
   2. Do not perform chemical cleaning when air temperature is greater than 90 degrees Fahrenheit.
   3. Do not perform cleaning Work when winds are sufficiently strong to spread cleaning materials to unprotected areas.

D. Maintain adequate ventilation during preparation and application of cleaning materials.

1.8 CHANGES IN WORK

A. During rehabilitation work, existing conditions may be encountered which are not known or are at variance with the Contract Documents. Such conditions may interfere with the Work and may consist of damage or deterioration of the substrate or surrounding materials that could jeopardize the performance of the Work.
   1. Notify Architect/Engineer of conditions that may interfere with or preclude proper execution of the Work or jeopardize the performance of the Work, prior to proceeding with the Work.

PART 2 PRODUCTS

2.1 CLEANING MATERIALS

A. Water for Prewetting, Cleaning, and Rinsing:
   1. Clean, potable water, with iron content of less than two parts per million by weight.
   2. Provide chemical test results to confirm local water is suitable for use on cleaning Work.
   3. Notify Architect/Engineer and Owner's Representative of local water conditions that may make it unsuitable for cleaning, including presence of additives, water softeners, or other agents.

B. Mild Detergent: Use one of the following or approved equal:
   1. Tri-Sodium-Phosphate-Type Detergent; Mix 2/3 cup detergent with 3 gallons hot water.
   2. Enviro Klean 2010 All Surface Cleaner by Prosoco, Inc. Mix one part cleaner with ten parts water by volume.

3. Safe n' Easy Ultimate Stone and Masonry Cleaner by Dumond Chemicals, Inc. Apply per manufacturer recommendations.
4. Approved equal.

C. One-Step Chemical Cleaner: Use one of the following or approved equal:
1. Sure Klean Limestone & Masonry Afterwash by Prosoco, Inc.; Mix one part afterwash with two parts water by volume.
2. Sure Klean Light Duty Concrete Cleaner by Prosoco, Inc.; Mix one part cleaner with two to three parts water by volume.
3. Oxalic acid; Mix ten percent acid with water by volume.
4. Approved equal.

D. Biocide: Use one of the following or approved equal:
1. D/2 Biological Solution as manufactured by D/2 Biological Solutions, Inc.
2. Enviro Klean ReKlaim; mix one part Cleaner with three parts water and one part Activator by volume, followed by one part Sure Klean Limestone & Masonry Afterwash with two parts water by volume, both by Prosoco, Inc.
3. Approved equal.

E. Iron Stain Remover:
1. Iron Stain Remover by Prosoco, Inc. Apply per manufacturer recommendations.
2. Approved equal.

2.2 AUXILIARY MATERIALS:

A. pH Indicator: Litmus paper or other indicator capable of identifying neutral solutions.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions with Cleaning Contractor and representatives of cleaning materials manufacturers and cleaning equipment suppliers, as applicable, for compliance with requirements and other conditions affecting performance of cleaning Work.
1. Ensure that Work done by other trades is complete and ready for cleaning Work.
2. Verify that areas and conditions under which cleaning Work is to be performed permit proper and timely completion of Work.
3. Notify Architect/Engineer in writing of conditions which may adversely affect cleaning Work and recommend corrections.
4. Do not proceed with cleaning Work until adverse conditions have been reviewed by Architect/Engineer and, if necessary, corrections have been made.
5. Commencing cleaning Work constitutes acceptance of Work surfaces and conditions.

3.2 PROTECTION

A. Protect the following elements:
1. Surfaces being cleaned from cleaning materials not designated for use on those surfaces.
2. Decorative features, such as entrances, planters, signs, awnings, canopies, and signs.
3. Paving and sidewalks from staining or damage from cleaning operations.
4. Windows, doors, joints, and other openings from infiltration of water or cleaning materials.
5. Waterproofing and roofing system components.

B. Comply with cleaning-material manufacturer's written instructions for protecting building and other surfaces against damage from exposure to its products.

C. Cover adjacent surfaces with materials that are proven to resist cleaners being used unless cleaners will not damage adjacent surfaces.

D. Take precautions to ensure safety of people (including building users, passers-by, and workers) and protection of property (including adjacent building elements, landscaping, and motor vehicles).

E. Erect temporary protective canopies and walls, as necessary, at walkways and at points of pedestrian and vehicular access that must remain in service during Work.

F. Take precautions to protect against air-borne materials and run-off.

G. Protect paving, sidewalk, and adjacent building areas from mechanical damage due to scaffolding and other equipment.

H. Prevent dust, debris, coating overspray/spatter, and other construction materials from coming into contact with pedestrians, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.

I. Limit access to Work areas.

J. Assume responsibility for injury to persons or damage to property due to Work, and remedy at no cost to Owner.

K. Protect from damage, all elements of completed work and original construction to remain.

3.3 EQUIPMENT

A. Spray Equipment: With pressure gages at compressor and spray nozzle, and volume meter at spray nozzle; ability to adjust pressure and volume at nozzle.
   1. For chemical cleaner, use low-pressure tank or pump recommended by chemical cleaner manufacturer, equipped with cone-shaped spray nozzle.

3.4 CLEANING, GENERAL

A. Perform cleaning Work in compliance with applicable codes and regulations that govern Work, including city, state, water department, OSHA, and Federal regulations, and with requirements of material manufacturers.

B. Use only cleaning products and methods indicated for wall material and location and approved by mockups. Do not use wire brushes or scrapers.

C. Perform cleaning Work in a systematic manner, proceeding from the top of the wall to the bottom in each access area and from one end of the elevation to the other.

D. Perform cleaning Work to achieve uniform coverage of surfaces, including corners, moldings, and interstices, and to produce uniform effect without streaking or damaging wall surface.

E. Keep wall wet below area being cleaned to prevent streaking from runoff.

F. Perform cleaning Work in strict accordance with approved mockup materials and procedures. Propose modifications to materials or methods as necessary to meet or exceed level of cleaning in mockups. Perform mockups of proposed modifications; do not proceed with modifications until approved in writing by Owner's Representative and Architect/Engineer.

G. Prewetting and Rinsing Procedures:
   1. For prewetting and rinsing:
      a. Prewet and rinse surfaces with warm water at minimum flow rate of 4 gallons per minute. Use hot water, if approved, to improve effectiveness of cleaning and rinsing. Do not use higher pressures or lower flow rates unless approved by mockups.
         1) Prewet surfaces at maximum pressure of 100 pounds per square inch.
         2) Rinse surfaces at maximum pressure of 400 pounds per square inch.
      b. Use stainless steel nozzle with 45-degree fan spray, held at least 12 inches from surface.
      c. Apply water in a horizontal sweeping motion, overlapping previous strokes vertically to produce uniform coverage.
   2. On hot days, in direct sunlight, or as necessary, prewet multiple times so cleaning solution is applied to wet surface.
   3. Rinse off cleaning solution and soil residue, moving upward from bottom to top of surface at each access location.
      a. Continue rinsing until pH of surface has returned to neutral, 6.5 to 7.5.
      b. Periodically test pH of rinse water running off surface with pH paper.
      c. Repeat application of neutralizing afterwash if specified and rinsing as necessary until neutral pH is measured.
      d. Measure pH of surface 48 hours after cleaning has been completed, when wall is dry. If pH is not neutral, rinse surface until neutral pH is achieved.

H. Chemical Cleaner Application Methods: Apply chemical cleaner to surfaces in conformance with chemical cleaner manufacturer's written instructions and approved mockups.
   1. Use brush or spray application methods, at Contractor's option. Use brushes that are resistant to chemical cleaners being used.
   2. Do not spray apply at pressures exceeding 50 pounds per square inch, or less as determined by mockups.
   3. Adjust pressure and volume of spray to ensure that cleaning methods do not damage wall material.
   4. Do not allow chemical cleaners to remain on surface for periods longer than those recommended by chemical-cleaner manufacturer or specified.
   5. Control wind drift of chemical cleaners.

I. Collect and legally dispose of cleaning materials and debris.
   1. Neutralize alkaline and acid wastes for disposal off Owner's property.
   2. Dispose of runoff from cleaning operations by legal means, in manner that prevents soil erosion, undermining of pavement and foundations, damage to landscaping, and water penetration into building interior.

3.5 CLEANING, MASONRY AND CONCRETE

A. Removal of Plant Growth: Carefully and completely remove vines, moss, shrubs, and plant growth from wall surfaces.
   1. Cut at roots and allow to dry for as long as possible before removal.
   2. Remove loose soil and debris from open joints.

B. Preliminary Cleaning: Before beginning general cleaning, remove extraneous substances that are resistant to cleaning methods being used, including sealant, asphalt, and tar.
   1. Carefully remove heavy accumulations of material from wall surface with wood scraper. Do not scratch or chip wall surface.

C. Cleaning with Mild Detergent or Chemical Cleaner:
   1. Follow manufacturer's instructions.
   2. Prewet surface.
   3. Liberally apply cleaning solution to surface with soft, nylon-bristle brush or as recommended by manufacturer, being careful to completely cover surface, including crevices.
   4. Allow to dwell for approximately 15 minutes. Keep surface moist by misting as necessary during dwell time.
   5. Immediately prior to rinsing, gently scrub surface with brush.
   6. Rinse thoroughly until pH returns to neutral. Scrub surface with brush during rinsing as recommended by manufacturer.
   7. Test pH of surface to confirm surface has returned to neutral.
   8. Repeat cleaning sequence as necessary until cleaning standard is achieved.
   9. Water pressure for second rinse is usually very low, below 100 psi.
   10. Within one hour after first rinse, rinse second time with water at 100 psi pressure or less for at least two minutes to remove cleaner residue.

D. Cleaning with Biocide or Iron Remover:
   1. Dry-brush with soft, nylon-bristle brush to remove dense biological growth and iron buildup.
   2. Prewet surface thoroughly.
   3. Liberally apply product with soft, nylon-bristle brush, being careful to completely cover surface, including crevices.
   4. Allow to dwell for ten minutes or as required by manufacturer. Keep surface moist by misting as necessary during dwell time.
   5. Immediately prior to rinsing, gently scrub with surface brush.
   6. Rinse thoroughly to return pH to neutral.
   7. Test pH of surface to confirm surface has returned to neutral.

3.6 FIELD QUALITY CONTROL

A. Architect/Engineer will monitor progress and quality of cleaning Work, possibly including:
   1. Observe completed Work and compare to approved mockups.
   2. Observe wall material with field microscope for damage.
   3. Test pH of runoff and wall surfaces.
   4. Test samples of cleaning products and mixed solutions for conformance with Specifications and approved mockups.

B. Contactor Responsibilities:
   1. Test pH of runoff and wall surfaces to verify neutral pH.
   2. Provide access to Work for Architect/Engineer, Owner’s Representative, and other consultants hired by Owner.
   3. Notify Architect/Engineer at least 48 hours in advance of when lift devices or scaffolding will be relocated. Do not relocate lift devices or scaffolding until Architect/Engineer has observed completed Work.

4. Upon request, provide samples of cleaning products and mixed solutions to Architect/Engineer.

C. Failure to use cleaning products and mix solutions as specified and approved are grounds for immediate termination of Contract Agreement.

D. Remedy areas that do not satisfy requirements at no additional cost to Owner. Modify cleaning procedures as required and approved by Architect/Engineer.

3.7 SITE CLEANING

A. At the end of each workday:
   1. Broom-clean Site and Work areas and place all items to be discarded in appropriate containers.
   2. Thoroughly rinse sidewalks to remove chemicals, dirt, pollutants, and other materials washed off building.

B. After completing cleaning Work:
   1. Carefully remove protection materials, including tape, adhesive marks, and residue.
   2. Clean spillage and soiling from adjacent surfaces using cleaning agents and procedures recommended by manufacturer of affected surface. Exercise care to avoid scratching or damage to surfaces.
   3. Return building surfaces, landscaping, and grounds to condition prior to cleaning Work, including painted and glass surfaces, to satisfaction of Architect/Engineer at no additional cost to Owner.
   4. Repair at no cost to Owner all items damaged during the Work.
   5. Remove debris and surplus materials from Site.

C. Waste Management:
   1. Collect surplus cleaning materials that cannot be reused and deliver to recycling or disposal facility.
   2. Treat materials that cannot be reused as hazardous waste and dispose of per manufacturer's instructions.

END OF SECTION 04 01 20

SECTION 04 01 21
BRICK MASONRY REPAIR AND REPLACEMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Brick masonry removal and replacement at wall repair locations and brick masonry repointing.

B. Products Installed but Not Supplied Under this Section:
   1. Masonry Mortar: Section 04 05 01
   2. Sealants: Section 07 92 00

C. Related Sections:
   1. Section 01 11 00 – Summary of Work
   2. Section 01 22 00 – Unit Prices
   3. Section 02 01 11 – Shoring
   4. Section 04 01 20 – Masonry and Concrete Cleaning
   5. Section 04 01 27 – Repointing with Cement-Lime Mortar
   6. Section 04 01 40 – Stone Restoration
   7. Section 04 05 01 – Masonry Mortar
   8. Section 07 62 00 – Sheet Metal Flashing and Trim
   9. Section 07 65 00 – Flexible Flashing
   10. Section 07 92 00 – Joint Sealants

1.2 PAYMENT

A. Include the following on a lump sum or unit price basis as described in Sections 01 11 00 and 01 22 00.

1.3 REFERENCES

A. Definitions:
   1. Collar joint: The space between the back face of the exterior wythe of masonry and the exterior face of inner wythe.
   2. Drainage cavity: The space between the back face of the exterior wythe of masonry and the waterproofing layer.
   3. Existing mortar: Mortar currently in joint, including original setting mortar and pointing mortar, and subsequent repair mortar.
   4. Half-moon: Concave configuration of mortar resulting from removal of mortar by grinding only middle portion of joint.
   5. Header: Brick units installed to span between adjacent wythes.
   6. Joint reinforcement: Small diameter welded metal assemblies installed in bed joints that span between wythes.
   7. Masonry ties/brick ties: Assemblies or components used to resist lateral loads between the exterior wythe and the backup.
   8. Rake out mortar joint: Removal of hardened mortar from joint.
   9. Repair anchors: Retrofit anchors generally installed perpendicular, or slightly angled, to tie the exterior wythe to the backup.

10. Repointing: Process of raking out mortar joint to specified depth and placing fresh mortar; also called tuck-pointing.
11. Thumbprint hard: Mortar that has reached initial set. Time required to achieve initial set varies based on masonry characteristics, weather conditions, and mortar composition.
12. Low-pressure water spray: 100 to 400 pounds per square inch; 4 to 6 gallons per minute.
13. Very-low-pressure water spray: less than 100 pounds per square inch.
14. Veneer anchors: Similar to masonry ties.
15. Wythe: A single vertical layer of brick (or other masonry).

B. Reference Codes and Standards: Latest edition as of Specification date.
   1. ASTM International:
      a. C62: Standard Specification for Building Brick (Solid Masonry Units Made from Clay or Shale).
      b. C67: Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile.
      c. C216: Standard Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale).
      d. C1314: Standard Test Method for Compressive Strength of Masonry Prisms.
      e. C1405: Standard Specification for Glazed Brick (Single Fired, Brick Units).
      f. F593: Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
   2. The Brick Industry Association (BIA):
      a. Technical Notes on Brick Construction.
      b. Technical Notes 1 - Cold and Hot Weather Construction
      c. Technical Note 7B - Water Resistance of Brick Masonry - Construction and Workmanship
   3. SSPC: The Society for Protective Coatings:
      a. SSPC-SP 2: Hand Tool Cleaning.
      b. SSPC-SP 3: Power Tool Cleaning.
   4. International Building Code (IBC).
   5. The Masonry Society (TMS)/American Concrete Institute (ACI)/Structural Engineering Institute of American Society of Civil Engineers (ASCE):
      a. TMS 602/ACI 530.1/ASCE 6: Specification for Masonry Structures.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Pre-installation Meeting.
   1. Participate in meeting at Site.
   2. Review requirements for brick masonry repairs, including:
      a. Construction schedule.
      b. Availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
      c. Site use, access, staging, and set-up location limitations.
         1) Anticipated schedule for Architect/Engineer inspections.
      d. Approved mockup procedures.
      e. Forecast weather conditions.
      f. Surface preparation and substrate condition and pretreatment.
      g. Installation procedures.
      h. Special details.
      i. Testing and inspection requirements.
      j. Site protection measures.
      k. Governing regulations.

3. Contractor's Site superintendent, job foreperson, Owner's Representative, and Architect/Engineer shall attend.

1.5 SEQUENCING

A. Order materials at earliest possible date, to avoid delaying completion of Work.

B. Perform restoration Work in the following sequence:
   1. Clean masonry and remove plant growth per Section 04 01 20.
   2. Architect/Engineer inspections.
   3. Install brick masonry repairs, including replacement.
   4. Repoint mortar joints.
   5. Install sealant joints.
   6. Architect/Engineer final inspections.

C. Repair anchor holes as scaffolding is removed, if applicable.

1.6 SUBMITTALS

A. Product Data: Material specifications and installation instructions for all materials to be used in Work, including.
   1. Brick masonry units: Include description of allowable cleaning products and blending ratios.
   2. Mortar.
   3. Veneer anchors/brick ties.
   4. Repair anchors.
   5. Joint reinforcement.
   6. Weep product.

B. Samples: Before erecting mockup, submit samples for each type of specified product:
   1. Face brick, in straps of five or more bricks, from at least two potential brick sources selected by Contractor. Five bricks shall show extremes of variation in color and texture.
   2. Special brick shapes.
   3. Veneer anchors.
   4. Weep product.

C. Material Certificates: Statement of material properties indicating compliance with requirements, including statement that no coatings have been applied to masonry units during manufacture. Provide for each type and size of unit.

D. Test Reports:
   1. Brick Masonry Units: Test units from same run of brick that will be used on Project, or on similar brick run, in opinion of Architect/Engineer, with tests performed in last 2 years.
      a. Brick size variation data, confirming that actual range of sizes satisfies specified tolerances.
      b. Test reports from independent testing laboratory showing the following test results:
         1) Compressive strength.
         2) 24-hour cold-water absorption.
         3) 5-hour boil absorption.
         4) Saturation coefficient.
         5) Initial rate of absorption.
         6) Efflorescence.

7) Freeze-thaw testing.

E. Restoration Program:
1. Provide detailed description of materials, methods, equipment, and sequence of operations to be used, including protection of surrounding areas on building and Site.

F. Contractor Qualifications: Evidence that Contractor's *existing company* has minimum 5 years of continuous experience in similar repair work; list of at least 5 representative, successfully-completed projects of similar scope and size, including:
1. Project name.
2. Owner's name.
3. Owner's Representative name, address, and telephone number.
4. Description of brick masonry repair work.
5. Project supervisor.
6. Total cost of brick masonry repair work and total cost of project.
7. Completion date.

1.7 QUALITY ASSURANCE

A. Contractor Qualifications: Experienced firm that has successful completed repair work similar in material, design, and extent to that indicated for the Project. Must have successful construction with specified materials in local area in use for minimum of five years.
1. Employ foreman with minimum five years of experience as foreman on similar projects, who is fluent in English, to be on Site at all times during the Work. Do not change foremen during the course of the Project except for reasons beyond the control of Contractor; inform Architect/Engineer in advance of any changes.
2. Employ masons with minimum two years of experience in similar repair work. Fully supervise apprentices with experienced masons.

B. Mockups: Construct mockups to demonstrate construction procedures, quality of Work, and aesthetic effects.
1. Construct wall repair in at least one area approximately 36 inches high by 48 inches wide for each type of repair specified.
2. Construct mockups on existing walls, at locations designated by Architect/Engineer and in presence of Architect/Engineer, under same weather conditions expected during Work. Provide access to mockup locations.
3. Photograph concealed portions of approved mockup before concealing and retain photographs at Site.
4. If Architect/Engineer or Owner's Representative determines mockup does not comply with requirements, modify mockup or construct new mockup until mockup is approved.
5. Approved mockups shall be maintained in undisturbed condition throughout Project as basis for acceptance of completed Work and may become part of completed Work if undisturbed at time of Substantial Completion.
6. If Owner's Representative and Architect/Engineer determine mockup does not comply with requirements, modify mockup or construct new mockup until mockup is approved.
7. Do not order materials or proceed with repair Work until mockups have been approved by Architect/Engineer and Owner's Representative.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in original containers and packaging with seals unbroken, labeled with manufacturer's name, product brand name and type, date of manufacture, lot number, directions for storing, and complete manufacturer's written instructions.

B. Keep materials dry and do not allow materials to be exposed to moisture during transportation, storage, handling, or installation. Reject and remove from Site new materials which have been exposed to moisture to their detriment.

C. Store and handle materials in accordance with manufacturer's written instructions, safety requirements, and all applicable laws and regulations. Remove from Site, and replace at no cost to Owner, any materials that are damaged or otherwise negatively affected by not being stored or handled in accordance with manufacturer's written instructions.

D. Store materials in original, undamaged containers and packaging in clean, dry, location on raised platforms and protected from weather, within temperature range required by manufacturer. Protect stored materials from direct sunlight and sources of ignition. Manufacturer's standard packaging and covering alone is ***not*** considered adequate weather protection.

E. Locate materials in a secure location approved by Owner's Representative

F. Conspicuously mark damaged containers, containers with contaminated materials, damaged materials, and materials that cannot be used within stated shelf life and remove from Site as soon as possible. Replace discarded materials in a timely manner at no cost to Owner.

G. Limit stored materials on structures so as to preclude damage to materials and structures.

1.9 PROJECT CONDITIONS

A. Verify existing dimensions and details prior to start of Work. Promptly notify Architect/Engineer of conditions found to be different than those indicated in the Contract Documents. Architect/Engineer will review situation and inform Contractor how to proceed.

B. Comply with Owner's limitations and restrictions for Site use and accessibility.

C. Masonry Environmental Limitations: Install repairs only when air temperature is between 40 degrees F and 90 degrees F and is forecast to remain so for at least seven days after completion of Work, unless precautions acceptable to Architect/Engineer are taken.
   1. Protect materials from temperature, humidity, and wind conditions that may prevent proper application and curing.
      a. Adjust application and curing procedures as necessary to account for temperature, humidity, and wind conditions.
      b. Do not allow uncured materials to freeze.
   2. Do not apply to damp, wet, or frozen substrate.

1.10 CHANGES IN WORK

A. During rehabilitation work, existing conditions may be encountered which are not known or are at variance with the Contract Documents. Such conditions may interfere with the Work and may consist of damage or deterioration of the substrate or surrounding materials that could jeopardize the integrity or performance of the Work.

1. Notify Architect/Engineer of conditions that may interfere with or preclude proper execution of the Work or jeopardize the performance of the Work prior to proceeding with the Work.

PART 2 PRODUCTS

2.1 GENERAL

A. Source Limitations: Obtain each type of material from one source with resources to provide materials of consistent quality in appearance and physical properties.

B. For units that will be exposed in completed Work, use units with uniform texture and color, within accepted ranges for these characteristics.

C. Defective Units: Referenced brick masonry unit standards may allow a certain percentage of units to exceed tolerances and to contain chips, cracks, or other defects exceeding the limits stated in the standards. Do not use units where such defects, including dimensions that vary from specified dimensions by more than the stated tolerances, will be exposed in completed Work or will impair the quality of completed brick masonry.

2.2 BRICK MASONRY UNITS

A. Contractor is to salvage, clean, and store existing sound brick units where possible. Existing cleaned brick units are to be used at localized replacement locations and at rebuild areas distributed amongst new brick units. Contractor and Architect/Engineer to coordinate new and existing brick unit installation during construction. Assume a 50% salvage rate.

B. Face Brick: ASTM C216, Grade SW, Type FBS; ASTM C67; use where brick is exposed, unless otherwise indicated.
   1. Unit Compressive Strength: Minimum average compressive strength of 5000 pounds per square inch, based on net area.
   2. Initial Rate of Absorption (IRA): Less than 25 grams per 30 square inches of surface area per minute. Individual units shall not vary by more than 5 percent.
   3. The “Absorption Alternate” in paragraph 6.1.2 of ASTM C216 shall not be used to illustrate conformance with these project specifications. Also, for units where the 24-hour cold water absorption is greater than 8%, the saturation coefficient must be less than 0.68 (average) and 0.70 (individual).
   4. Efflorescence: Rated “not effloresced.”
   5. Match color range, texture, sheen, and size of existing adjacent brickwork.
      a. Special sizes are anticipated.
   6. Coatings: Units shall not have coatings, penetrating sealers, or other clear water repellants without written approval of Architect/Engineer.
   7. Provide shapes indicated and as follows:
      a. For ends of sills, corners, and caps, and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs, with exposed surfaces finished.
      b. Provide special shapes for applications where stretcher units cannot accommodate special conditions, including those at corners, movement joints, bond beams, sashes, and lintels.

C. Building (Common) Brick: ASTM C62, Grade SW; ASTM C67; use at concealed locations. Face brick complying with requirements for grade, compressive strength, and size indicated for building brick may be substituted for building brick.
   1. Unit Compressive Strength: Minimum average compressive strength 5000 pounds per square inch, based on net area.
   2. Initial Rate of Absorption: Less than 25 grams per 30 square inches of surface area per minute. Individual units shall not vary by more than 5 percent.
   3. The "Absorption Alternate" in paragraph 6.1.2 of ASTM C216 shall not be used to illustrate conformance with these project specifications. Also, for units where the 24-hour cold water absorption is greater than 8%, the saturation coefficient must be less than 0.68 (average) and 0.70 (individual).
   4. Size: Match size of existing units

2.3 MORTAR

A. Mortar: Type N; Section 04 05 01.

2.4 JOINT REINFORCING, VENEER ANCHORS, AND REPAIR ANCHORS

A. Joint Reinforcement: Hot-dip galvanized steel; sized for wall thickness, cavity, and collar joint conditions. Use one of the following or approved equal:
   1. Ladder-Type:
      a. Ladder-Type Wall Reinforcement (1100) by Heckmann Building Products, Inc.
      b. 220 Ladder Mesh Reinforcement, Hot-dip galvanized steel by Hohmann & Barnard Company.

B. Brick Ties: Type 304 stainless steel; sized for cavity and collar joint conditions. Use one of the following or approved equal:
   1. 345-BT-Flexible Ties by Hohmann & Barnard, Inc.
   2. Pos-I-Tie Brick Veneer Anchoring System by Heckmann Building Products, Inc.
   3. 2-Seal Concrete Ties by Hohmann & Barnard, Inc.
   4. HB-213 Adjustable Veneer Anchor by Hohmann & Barnard, Inc.

C. Fasteners for Brick Ties: Type 304 stainless steel, manufactured by Hilti Corporation or approved equal.
   1. Self-drilling; Self tapping anchor.
   2. Expansion/Sleeve anchor.
   3. Epoxy anchor.
   4. Epoxy sleeve anchor with nylon or stainless steel sleeve and threaded rod.
   5. Nail- anchor with lead sleeve.

D. Expansion Repair Anchors: 1/4 inch diameter, Type 304 stainless-steel rods with brass expanding shells and water-shedding washer; intended for anchoring brick veneer to backup masonry.
   1. Expanding shells shall provide positive mechanical anchorage to veneer on one end and backup masonry on the other end. Expanding shell in veneer shall have larger diameter than expanding shell in backup masonry. Washer diameter shall be equal to veneer expanding-shell diameter; washer shall be placed between backup-masonry expanding shell and nut.

E. Helical Repair Anchors: Type 304 stainless steel spiral rods; intended for anchoring brick veneers to backup masonry or concrete. Embedment length as shown on Drawings.

1. Use one of the following or approved equal:
   a. 10 mm DryFix Ties by Helifix Inc.
   b. 10 mm Spira-Loks by Hohmann & Barnard, Inc.

F. Epoxy-Grouted Repair Anchors: Anchor system, including threaded rods, screen tubes, and epoxy; intended for anchoring brick veneer to backup masonry.
   1. Threaded Rods: ASTM F593, Group 2 (Type 316) stainless steel; 1/4-inch diameter.
   2. Use HIT-HY 270 hybrid adhesive by Hilti, Inc., or approved equal.

2.5 AUXILIARY MATERIALS

A. Weeps: Match height, depth, and thickness of head joints. Use one of the following or approved equal.
   1. 343 Weep Holes by Hohmann & Barnard, Inc.
   2. 343W - Wilko Weep Holes by Hohmann & Barnard, Inc.
   3. QV - Quadro-Vents by Hohmann & Barnard, Inc.
   4. No 85 Cell Vents by Heckmann Building Products, Inc.

B. Expansion Joint Filler: ASTM D1056; preformed, closed cell, expanded neoprene. Use one of the following or approved equal.
   1. NS - Closed Cell Neoprene Sponge, by Hohmann & Barnard, Inc.

C. Cleaning Materials: Refer to Section 04 01 20 - Masonry Cleaning

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements and other conditions affecting installation or performance of repair Work.
   1. Ensure that work done by other trades is complete and ready for repair Work.
   2. Verify that areas and conditions under which repair Work is to be performed permit proper and timely completion of Work.
   3. Notify Architect/Engineer in writing of conditions which may adversely affect installation or performance of repair Work and recommend corrections.
   4. Do not proceed with repair Work until adverse conditions have been corrected and reviewed by Architect/Engineer.
   5. Commencing repair Work constitutes acceptance of Work surfaces and conditions.

B. Remove and discard brick units that are chipped, broken, stained, or otherwise damaged beyond specified tolerances, or that do not match submitted sample.
   1. Intact units not meeting approved color range can be used in concealed areas if approved in writing by Architect/Engineer.

3.2 PROTECTION

A. Prevent mortar from staining face of surrounding brick masonry and other surfaces.
   1. Cover sills, ledges, and projections to protect from mortar droppings.
   2. Keep wall area below Work area wet to discourage mortar from adhering.
   3. Immediately remove mortar in contact with exposed brick masonry and other surfaces.

B. Remove downspouts adjacent to Work and store. Reinstall when Work is complete.
   1. Provide temporary rain drainage during Work.

C. Take precautions to ensure safety of people (including building users, passers-by, and workers) and protection of property (including adjacent building elements, landscaping, and motor vehicles).

D. Erect temporary protective canopies and walls, as necessary, at walkways and at points of pedestrian and vehicular access that must remain in service during Work.

E. Take precautions to protect against air-borne materials and run-off.

F. Protect paving, sidewalk, and adjacent building areas from mechanical damage due to scaffolding and other equipment.

G. Prevent dust, debris, coating overspray/spatter, and other construction materials from coming into contact with pedestrians, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.

H. Limit access to Work areas.

I. Assume responsibility for injury to persons or damage to property due to Work, and remedy at no cost to Owner.

J. Protect from damage, all elements of completed work and original construction to remain.

3.3 BRICK REMOVAL AND REPLACEMENT

A. Remove bricks at locations indicated on Drawings and as designated by Architect/Engineer that are cracked, spalled, displaced, or deteriorated.
   1. Prior to beginning Work, notify Architect/Engineer and Owner's Representative of locations of damaged or deteriorated brick that are not indicated for repair in Contract Documents.

B. Demolish and remove entire units and mortar from joint to joint, without damaging surrounding brick masonry, in manner that permits replacement with full-size units. Remove and replace sound bricks that are damaged during Work at no cost to Owner.

C. Remove whole brick units without damaging, for reuse.
   1. Remove mortar, loose particles, and soil from brick with hand chisels, brushes, and water.
   2. Clean remaining mortar residue using procedures outlined in Section 04 01 20. Abrasive methods or harsh chemical cleaners should not be used.
   3. Store brick for reuse.
   4. Deliver cleaned brick not required for reuse to Owner, unless otherwise directed.

D. Support and protect brick masonry and other construction in and around removal areas.
   1. For removal areas larger than 2 feet by 4 feet, support brick masonry above with temporary bracing.
   2. Maintain flashings, reinforcement, lintels, and adjoining construction in undamaged condition.

E. Notify Architect/Engineer of detrimental conditions including voids, cracks, bulges, displacements, and loose units in masonry backup, rotted wood, corroded metal, and other deteriorated conditions.

F. Cover openings and partially completed Work with strong waterproof material at the end of each day, if precipitation is imminent, or when Work is not in progress. Extend waterproof material at least 2 feet beyond edges of opening and secure in place.

G. Clean brick masonry surrounding removal areas by removing mortar, dust, and loose particles.

H. Brick Installation:
   1. Install brick to match existing bonding and coursing pattern. Provide expansion joints at locations indicated on the Drawings.
   2. If cutting is required, use motor-driven saw designed to cut brick masonry with clean, sharp, unchipped edges.
   3. Lay replacement brick as plumb and true to line as adjacent surfaces will permit; new brickwork shall be flush with existing.
   4. Lay replacement brick with completely filled bed, head, and collar joints, where applicable. Do not furrow bed joints. Butter ends with sufficient mortar to fill head joints, and shove into place.
   5. Maintain joint width to match existing joints.
      a. When mortar is thumbprint hard, tool exposed mortar joints in repair areas with round jointer slightly larger than width of joint. Tool joints to match adjacent existing joints.
      b. Rake out mortar used for laying brick before mortar sets. Repoint joints in repair area with repointing of surrounding wall area.
   6. Do not pound corners and jambs to fit stretcher units after they are set in position. Where adjustment must be made after brick has been placed, remove and replace mortar.
   7. Install mortar at top and ends of repair by packing layers of mortar into joints with tuck pointer's tool.
   8. Install continuous joint reinforcement every third course of brick, where applicable.
      a. Place joint reinforcement directly on brick masonry and place mortar over wire to form bed joint.
      b. Lap reinforcement 6 inches minimum at splices.
      c. Install prefabricated corners and tees with 6 inch laps onto straight runs of reinforcement.
   9. Install brick ties/veneer anchors 16 inches on center horizontally and vertically.
      a. Install anchors 8 inches on center around perimeter of repair and adjacent to vertical expansion joint.
      b. Embed anchors in mid-thickness of joint, with 3/4 inches minimum and 1 3/4 inches maximum cover from exterior face of veneer.
   10. Construct weeps 24 inches maximum on center, in head joints in first course immediately above flashing or as indicated by Architect/Engineer. Keep weeps free of mortar droppings.
   11. Keep wall cavity (collar joint) free of mortar as applicable. Back bevel bed joints down toward cavity to prevent mortar from extruding into cavity when units are placed. As Work progresses, trowel mortar fins against veneer face.
   12. If brick placement is stopped while in progress, either at the end of the day or for some other reason, stop horizontal runs by raking back mortar in each course one half unit length; do not terminate in vertical tooth pattern.

I. Hot- and Cold-Weather Requirements: When ambient air temperature is below 40 degrees F, exceeds 100 degrees F, or exceeds 90 degrees F with wind velocity greater than 8 miles per

hour, suspend Work or comply with requirements of TMS 602/ACI 530.1/ASCE 6 and governing codes.

3.4 EXPANSION JOINTS

A. At locations shown on Drawings, construct expansion joints for full length indicated, through full wythe thickness.
   1. Match mortar joint width.
   2. Cut brick masonry full thickness in straight line. Cuts shall be plumb or level, and parallel to corners, openings, shelf angles, or floor beams.
   3. Chisel out mortar at ends of joint. If joint does not coincide with mortar joint at end, remove brick units and install two cut portions of brick unit on both sides of joint. Do not damage adjacent brick masonry or other materials.
   4. Units at the top and bottom of the joint that abut adjacent materials should be removed, cut, and reinstalled to avoid damage to the adjacent material.

B. Remove mortar and debris from joint and install joint filler.

C. Form expansion joints with joint filler.

D. Install sealant as specified in Section 07 92 00.

3.5 RE-ANCHORING BRICK VENEER

A. Install repair anchors according to anchor manufacturer's written instructions and using equipment recommended by anchor manufacturer.
   1. Locate at not more than 16 inches-on-center vertically and 16 inches-on-center horizontally.
   2. Locate in mortar joints at intersection of head and bed joints.
   3. Install only at locations that will not penetrate flashing.

B. Drill hole through veneer and into backup masonry or concrete.
   1. Do not spall face or back of brick.
   2. Do not displace loose masonry.
   3. Do not damage brick masonry adjacent to anchor holes.
   4. If steel is encountered, stop drilling and relocate hole 4 inches maximum from first hole. Fill first hole with mortar.
   5. In some cases, hole in veneer may be larger than hole in backup.

C. Clean holes of dust and debris and install anchors.
   1. Recess anchors at least 5/8 inch from surface of mortar joint.

D. Clean recess of dust and debris and fill with pointing mortar. Tool mortar flush with surrounding mortar surface.

3.6 FIELD QUALITY CONTROL

A. Notify Architect/Engineer:
   1. Of field conditions that deviate from repair details.
   2. At least 24 hours in advance of when lift device or scaffolding will be relocated. Do not relocate lift device or scaffolding until Architect/Engineer has observed completed Work at lift device or scaffold location.

B. Allow Architect/Engineer use of lift device or scaffolding to observe progress and quality of Work.

3.7 CLEANING

A. At the end of each workday:
   1. At the end of each workday, broom-clean Site and Work areas and place all items to be discarded in appropriate containers.

B. Clean repair areas 24 to 48 hours after completion of Work.

C. Clean per Section 04 01 20.

3.8 BRICK MASONRY SALVAGE AND WASTE DISPOSAL

A. Unless otherwise indicated, excess brick units are Owner's property. At completion of masonry repair Work, store units in location approved by Owner's Representative.

B. Remove scaffolding, equipment, surplus materials, debris, and refuse from Site and dispose of legally.

C. Repair all anchor holes in masonry after removing scaffolding.

END OF SECTION 04 01 21

SECTION 04 01 27
REPOINTING WITH CEMENT-LIME MORTAR

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Repointing brick masonry and stone at locations designated on Drawings.

B. Products installed but not supplied under this Section.
   1. Masonry mortar: Section 04 05 01

C. Related Sections:
   1. Section 01 22 00 – Unit Prices
   2. Section 04 01 21 – Brick Masonry Repair and Replacement
   3. Section 04 05 01 – Masonry Mortar

1.2 UNIT PRICES

A. Include the following on a unit price basis as described in Sections 01 22 00.

1.3 REFERENCES

A. The Masonry Society (TMS): TMS 602/ACI 530.1/ASCE 6

1.4 DEFINITIONS

A. Existing mortar: Mortar currently in joint, including original setting mortar and pointing mortar, and subsequent repair mortar.

B. Half-moon: Concave configuration of mortar resulting from removal of mortar by grinding only middle portion of joint.

C. Joint profile: Finished profile of joint following repointing or original installation.

D. Rake out mortar joint: Removal of hardened mortar from joint.

E. Repointing: Process of raking out mortar joint to specified depth and placing fresh mortar; also called tuckpointing.

F. Deep repointing: Repointing that exceeds 2.5 times the joint width; typically exceeds 1.5 inches and up to half the depth of the masonry unit.

G. Thumbprint hard: Mortar that has reached initial set. Time required to achieve initial set varies based on masonry characteristics, weather conditions, and mortar composition.

1.5 ADMINISTRATIVE REQUIREMENTS

A. Coordinate Work to ensure that adjacent areas are not adversely affected. Coordinate:
   1. With Owner's Representative.
   2. With other restoration and cleaning work.

3. With other trades:
   a. To ensure that work done by other trades is complete and ready for repointing Work.
   b. To avoid or minimize work in immediate vicinity of repointing Work in progress.
   c. To ensure that subsequent work will not adversely affect repointed surfaces.

B. Scheduling:
   1. Order materials at earliest possible date, to avoid delaying completion of Work.
   2. Order sand for repointing mortar immediately after approval of mockups. Take delivery of and store at Site a sufficient quantity of sand to complete Project.

1.6 SUBMITTALS

A. Repointing Subcontractor Qualifications: Evidence that Subcontractor's existing company has minimum 10 years of continuous experience in similar repointing work; list of at least 5 representative, successfully-completed projects of similar scope and size, including:
   1. Project name.
   2. Owner's name.
   3. Owner's Representative name, address, and telephone number.
   4. Description of repointing work.
   5. Project supervisor.
   6. Total cost of repointing work and total cost of project.
   7. Completion date.

1.7 QUALITY ASSURANCE

A. Repointing Subcontractor Qualifications: Experienced firm that has successfully completed repointing Work similar in material, design, and extent to that indicated for the Project. Must have successful construction with specified materials in project-based climate zone in use for minimum of 5 years.
   1. Employ foreman with minimum 5 years of experience as foreman on similar projects, who is fluent in English, to be on Site at all times during the Work. Do not change foremen during the course of the Project except for reasons beyond the control of Subcontractor; inform Architect/Engineer in advance of any changes.
   2. Employ masons with minimum 2 years of experience in placement of repointing mortar. Fully supervise apprentices with experienced masons.

B. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

C. Mockups: Each mason to rake out joints in wall area approximately 3 feet high by 6 feet wide, and repoint joints in half of area, to demonstrate surface preparation, execution quality, and aesthetic effect while observed by Architect/Engineer.
   1. Prepare mockup for each type of repointing required.
   2. Maintain and protect mockups and label with dates and unique identifications for each.
   3. Include cleaning mortar from masonry units adjacent to joints.
   4. Allow mockups to cure fourteen days minimum prior to inspection by Owner's Representative and Architect/Engineer.
   5. If Owner's Representative or Architect/Engineer determines mockup does not comply with requirements, modify mockup or construct new mockup until mockup is approved.
   6. Approved mockups will be standard for judging completed Work.
   7. Approved mockups may become part of completed Work if undisturbed at time of Substantial Completion.

1.8 PROJECT CONDITIONS

A. Verify existing dimensions and details prior to start of repointing Work. Notify Architect/Engineer of conditions found to be different than those indicated in the Contract Documents. Architect/Engineer will review situation and inform Contractor and Repointing Subcontractor of how to proceed.

B. Comply with Owner's limitations and restrictions for Site use and accessibility.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements and other conditions affecting installation or performance of repointing Work.
   1. Ensure that work done by other trades is complete and ready for repointing Work.
   2. Verify that areas and conditions under which repointing Work is to be performed permit proper and timely completion of Work.
   3. Notify Architect/Engineer in writing of conditions which may adversely affect installation or performance of repointing Work and recommend corrections.
   4. Do not proceed with repointing Work until adverse conditions have been corrected and reviewed by Architect/Engineer.
   5. Commencing repointing Work constitutes acceptance of Work surfaces and conditions.

3.2 PROTECTION

A. Prevent mortar from staining face of surrounding masonry and other surfaces.
   1. Cover sills, ledges, and projections to protect from mortar droppings. Do not extend coverings into mortar joints.
   2. Keep wall area wet below rebuilding and repointing Work to discourage mortar from adhering.

B. Remove gutters and downspouts adjacent to and in Work area and store. Reinstall when Work is complete. Provide temporary rain drainage to direct water away from building.

C. Cleaning materials may include chemicals and may be subject to dispersion by wind and other weather features.

D. Protect the following elements in accordance with cleaning-material manufacturer's written instructions:
   1. Surfaces from cleaning chemicals.
   2. Paving and sidewalks from staining or damage.
   3. Windows, doors, joints, and other openings.
   4. Roofing system components.

E. Take precautions to ensure safety of people (including building users, passers-by, and workers).

F. Take precautions to protect against air-borne materials and run-off.

G. Protect paving, sidewalk, and adjacent building areas from mechanical damage due to scaffolding and other equipment.

H. Prevent dust, debris, coating overspray/spatter, and other construction materials from coming into contact with pedestrians, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.

I. Limit access to Work areas.

J. Assume responsibility for injury to persons or damage to property due to Work, and remedy at no cost to Owner.

K. Protect from damage, all elements of completed work and original construction to remain.

3.3 REPOINTING MORTAR JOINTS

A. Remove mortar from joints and repoint joints in areas indicated on Drawings and as directed by Architect/Engineer.
   1. Do not rake out and repoint joints where not required.

B. Remove existing mortar from joints as demonstrated in approved mockup:
   1. Remove mortar from joints to a uniform depth of 3/4 inch or 2 times the joint width, whichever is greater, from face of unit, to expose sound, un-weathered mortar. Continue to remove mortar until sound mortar is reached. If unsound mortar extends more than 1 inch from face of units, stop Work and notify Architect/Engineer.
   2. Remove mortar to provide reveals with square backs and to expose clean masonry surfaces. Do not leave half-moons.
   3. Demonstrate ability of operators to use tools without damaging masonry.

C. Remove sealant from joints and from the edges of adjacent masonry units as demonstrated in approved mockup. Do not damage or alter the surface of the existing masonry.

D. Do not spall edges of masonry units or widen joints. Replace damaged masonry units as directed by Architect/Engineer.

E. Brush, vacuum, or flush joints with water to remove dirt and loose debris.

F. Notify Architect/Engineer of unforeseen detrimental conditions including voids in mortar joints, cracks, loose units, rotted wood, rusted metal, and other deteriorated items.

G. When there is the potential for inclement weather within the subsequent 24 hours, protect ground-out areas that have not yet been fully repointed when Work is not in progress.
   1. Extend cover 24 inches minimum beyond ground-out area.
   2. Hold cover securely in place.

H. Masonry units adjacent to repair areas that are damaged during Work shall be removed and replaced at Contractor’s expense and to acceptance of Architect/Engineer and Owner’s Representative.

I. Repoint joints:
   1. Remove loose mortar and dust from prepared joints by approved methods as demonstrated in approved mockup. Rinse joint surfaces with very low pressure water spray to remove residual dust and mortar particles.

a. Use dust collecting grinders or other means of capturing dust as dictated by local jurisdictions.

2. Prewet joints such that joints are damp but free of standing water at time of repointing.
3. Place mortar in areas with greater removal depths than surrounding areas, until uniform depth is achieved.
   a. Fill voids up to 1-1/2 inches from the surface of the masonry.
   b. Fully compact the mortar fill and allow to become thumbprint hard before applying the outer layers.
4. After deeper removal areas have been filled, place mortar in joints.
   a. Place in layers not greater than 1/4 inch.
   b. Fully compact each layer and allow to become thumbprint hard before applying next layer.
   c. Where existing masonry has worn or rounded edges, slightly recess finished mortar surface from face of masonry to avoid wider joints.
   d. Take care not to spread mortar onto exposed masonry surfaces or to featheredge mortar.
5. Mix and place mortar in accordance with Section 04 05 01.
6. When mortar is thumbprint hard, tool joints as approved in repointing mockup. Remove excess mortar from edges of joints by brushing.

J. Cure mortar by maintaining in damp condition for at least 72 hours, including weekends and holidays.
   1. Acceptable curing methods include covering with wet burlap and plastic sheeting; periodic hand misting; or periodic mist spraying using system of pipes, mist heads, and timers.
   2. Adjust curing method to ensure that repointing mortar is damp throughout its depth without eroding surface mortar.
   3. Allow wall to thoroughly dry prior to re-wetting.
   4. Keep mortar from drying out too quickly or from becoming too wet. Protect from direct sun and high winds for 72 hours after installation and from driving rain for 24 hours after installation.
   5. Maintain air movement and air circulation, particularly when using plastic.

K. Do not begin cleaning work, specified in Section 04 01 20 until mortar has cured at least 28 days.

3.4 FIELD QUALITY CONTROL

A. Owner may retain Architect/Engineer or qualified independent inspection agency to observe the progress and quality of Work and prepare inspection reports.
   1. Allow inspector use of lift devices and scaffolding to access Work areas.
   2. Notify inspector at least 48 hours in advance of times when lift devices and scaffolding will be relocated.

3.5 CLEANING

A. Within one hour of final tooling of an area of repointing, remove mortar from exposed masonry and other surfaces.
   1. Wipe excess mortar from masonry surfaces adjacent to mortar joints with damp sponge or cloth.
      a. Use only sponge or cloth that is damp, not wet or saturated. When tightly squeezed, water should not run from damp sponge or cloth. Surface of masonry shall not have visible accumulation of water immediately following cleaning.

b. Do not touch or disturb newly-installed repointing mortar during cleaning.
c. Clean until mortar and mortar haze are removed from adjacent masonry surfaces.

2. Wash adjacent woodwork and other non-masonry surfaces with detergent and soft brushes or cloths.

B. Within seven days of final tooling, thoroughly rinse wall surfaces affected by repointing Work to remove dust and other surface residue resulting from repointing Work. Use very low pressure water spray.
1. Remove excess mortar and foreign matter from exposed masonry surfaces with wood scrapers, stiff-nylon or fiber brushes, and water spray.
a. Do not use metal scrapers or brushes or other non-approved materials or methods.
b. Do not use acidic or alkaline cleaners unless specified herein or approved by Architect/Engineer.
2. Perform small trial of cleaners prior to full cleaning to ensure there is no damage to masonry materials.

C. Clean mortar splatters from scaffolding at the end of the day.

D. Patch anchor holes as scaffolding is removed.

E. Remove debris from Work from roof, gutters, and downspouts. Rinse off roof and flush gutters and downspouts.

F. At the end of each workday, broom-clean Site and Work areas and place all items to be discarded in appropriate containers.

G. Return building surfaces, landscaping, and grounds to condition prior to cleaning Work, to satisfaction of Architect/Engineer at no additional cost to Owner.

H. At conclusion of repointing Work, remove scaffolding and equipment used in Work.

I. Repair at no cost to Owner all items damaged during the Work.

J. Remove debris and surplus materials from Site.

K. Refer to Section 04 01 20.

END OF SECTION 04 01 27

SECTION 04 01 40
STONE RESTORATION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Replacement of deteriorated brick coping units with limestone.

B. Related Sections:
1. Section 01 11 00 – Summary of Work
2. Section 04 05 01 – Masonry Mortar
3. Section 07 62 00 – Sheet Metal Flashing and Trim
4. Section 07 65 00 – Flexible Flashing
5. Section 07 92 00 - Joint Sealants
6. Section 09 97 13– Steel Coating

1.2 PAYMENT

A. Provide the following on a lump sum basis as described in Section 01 11 00 (Work Alternate).

1.3 REFERENCES

A. Indiana Limestone Institute of America, Inc. (ILI):
1. Indiana Limestone Handbook (Handbook).

B. Definitions: ASTM C119.
1. Cut stone: Stone fabricated to specific dimensions.
2. Dimension stone: Natural stone that has been selected and fabricated to specific sizes or shapes.
3. Dressed stone: See cut stone and finished stone.
4. Dutchman: Piece of stone used to repair larger stone panel.
5. Exfoliation: Fracture of stone to form thin sheet parallel to surface.
6. Finished stone: Dimension stone with one or more mechanically exposed surfaces.
7. Seam: Naturally filled or bonded feature in stone, such as streak or vein, which may or may not adversely affect strength of stone.
    a. Open seam: Unfilled fissure or naturally occurring crack in stone.
8. Snip: Area of stone surface from which chip, or irregularly shaped fragment, has been dislodged.
9. Spall: Fragment or chip from piece of dimension stone.
10. Veining: Presence in otherwise homogeneous stone of bands, streaks, or irregular bodies of contrasting color or appearance, and frequently having different mineralogical composition to predominant material. “Veining” does not apply to gneiss, commercial granite types, and slate.

C. Reference Standards: Latest edition as of Specification date.
1. ASTM International:
    a. A276: Standard Specification for Stainless Steel Bars and Shapes.
    b. C97/C97M: Standard Test Methods for Absorption and Bulk Specific Gravity of Dimension Stone.

c. C99/C99M: Standard Test Method for Modulus of Rupture of Dimension Stone.
d. C119: Standard Terminology Relating to Dimension Stone.
e. C144: Standard Specification for Aggregate for Masonry Mortar.
f. C150/C150M: Standard Specification for Portland Cement.
g. C170/C170M: Standard Test Method for Compressive Strength of Dimension Stone.
h. C207: Standard Specification for Hydrated Lime for Masonry Purposes.
i. C568/C568M: Standard Specification for Limestone Dimension Stone.
j. C880/C880M: Standard Test Method for Flexural Strength of Dimension Stone.
k. C1354/C1354M: Standard Test Method for Strength of Individual Stone Anchorages in Dimension Stone.
l. D1729: Standard Practice for Visual Appraisal of Colors and Color Differences of Diffusely Illuminated Opaque Materials.
m. F593: Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.

1.4 SUBMITTALS

A. Product Data: Manufacturer's literature including material properties; test data substantiating that products comply with requirements; recommendations for storage and handling; installation procedures; and recommendations for field testing. Include VOC content of components.
1. New Stone: Product data including test results no more than two years old and certification that stone to be supplied has specified minimum properties.
2. Anchors.

B. Shop Drawings:
1. Replacement Limestone Elements: Complete cutting and setting drawings showing:
a. Sizes, sections, and dimensions of stone.
b. Joint locations.
c. Anchoring details.
d. Other necessary details.

C. Samples:
1. Replacement Stone: Sets of at least three 12-inch-by-12-inch samples for color and texture and demonstrating range of variations in stone appearance.
a. Approved samples are for comparison of texture, finish, and color of new stone supplied for Project.
b. Owner's Representative to select limestone color and finish.
c. Resubmit samples until approved by Owner's Representative.
2. Samples of each product:
a. Hardware with nuts, bolts, and washers.
b. Compressible filler materials.
c. Anchors.
d. Shims.

D. Qualifications:
1. Contractor: Evidence that Contractor's *existing company* has minimum 5 years of continuous experience in similar stone restoration work; list of at least five representative, successfully-completed projects of similar scope and size, including:
a. Project name.
b. Owner's name.
c. Owner's Representative name, address, and telephone number.

d. Description of stone restoration work.
e. Project supervisor.
f. Total cost of stone restoration work and total cost of project.
g. Completion date.

2. Stone Fabricator: Evidence that Fabricator's *existing company* has minimum 5 years of continuous experience in similar stone fabrication work; list of at least five representative, successfully-completed projects of similar scope and size, including:
   a. Project name.
   b. Owner's name.
   c. Owner's Representative name, address, and telephone number.
   d. Description of stone fabrication work.
   e. Project supervisor.
   f. Total cost of stone fabrication work and total cost of project.
   g. Completion date.

1.5 QUALITY ASSURANCE

A. Qualifications:
   1. Contractor: Experienced firm that has successful completed stone restoration work similar in material, design, and extent to that indicated for the Project. Must have successful construction with specified materials in local area in use for minimum of five years.
      a. Foreman: Minimum 5 years of experience as foreman on similar projects, who is fluent in English, to be on Site at all times during the Work. Do not change foremen during the course of the Project except for reasons beyond the control of Contractor; inform Architect/Engineer in advance of any changes.
      b. Stone masons: Minimum five years of experience as stone mason on similar projects.
   2. Stone Fabricator: Minimum 5 years of experience in fabrication of stone similar to that indicated for Project; member in good standing with Indiana Limestone Institute of America.

B. Mockups: Perform mockup of repair Work to demonstrate quality of surface preparation, repair installation, and execution, and completed repair appearance.
   1. Mockups shall include a minimum 10 -foot length of coping installation including all typical details.
   2. Construct mockups on existing walls, at locations designated by Architect/Engineer under same weather conditions expected during Work. Provide access to mockup locations.
   3. Demonstrate specified materials and methods, using tools and equipment intended for use by workmen who will perform Work.
   4. Photograph concealed portions of approved mockup before concealing and retain photographs at Site.
   5. If Architect/Engineer determines mockup does not comply with requirements, modify mockup or construct new mockup until mockup is approved.
   6. Approved mockups shall be maintained in undisturbed condition throughout Project as basis for acceptance of completed Work and may become part of completed Work if undisturbed at time of Substantial Completion.
   7. At direction of Architect/Engineer, remove unacceptable mockups.
   8. Do not order materials or proceed with repair Work until mockups have been approval by Architect/Engineer and Owner's Representative.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store limestone above ground on non-staining wood skids or other suitable surfaces, with polyethylene sheet between stone and supporting surface. Cover limestone with waterproof paper, clean canvas, or polyethylene sheet. Store limestone per recommendations in ILI Handbook.
   1. Use skids constructed of cypress, white pine, poplar, or yellow pine without excessive amount of resin.
   2. Do not use skids constructed of chemically-treated wood.
   3. Do not use skids constructed of wood containing tannin, such as chestnut, walnut, oak, or fir, or other substances that might stain stone.

B. Do not use liquids that have frozen, or cementitious materials that were exposed to moisture.

C. Store sand to maintain grading and other required characteristics and avoid contamination.

D. Limit stored materials on structures so as to preclude damage to materials and structures. Do not store large numbers of limestone elements on structure unless approved in advance by Architect/Engineer.

E. Deliver materials to Site in original containers and packaging with seals unbroken, labeled with manufacturer's name, product brand name and type, date of manufacture, lot number, directions for storing, and complete manufacturer's written instructions.

F. Keep materials dry and do not allow materials to be exposed to moisture during transportation, storage, handling, or installation. Reject and remove from Site new materials which have been exposed to moisture to their detriment.

G. Store and handle materials in accordance with manufacturer's written instructions, safety requirements, and all applicable laws and regulations. Remove from Site, and replace at no cost to Owner, any materials that are damaged or otherwise negatively affected by not being stored or handled in accordance with manufacturer's written instructions.

H. Store materials in original, undamaged containers and packaging in clean, dry, location on raised platforms and protected from weather, within temperature range required by manufacturer. Protect stored materials from direct sunlight and sources of ignition. Manufacturer's standard packaging and covering alone is ***not*** considered adequate weather protection.

I. Locate materials in a secure location approved by Owner's Representative

J. Conspicuously mark damaged or opened containers, containers with contaminated materials, damaged materials, and materials that cannot be used within stated shelf life and remove from Site as soon as possible. Replace discarded materials in a timely manner at no cost to Owner.

K. Maintain copies of all applicable SDS (Safety Data Sheets) with materials in storage area, such that they are available for ready reference on Site.

1.7 PROJECT CONDITIONS

A. Verify existing dimensions and details prior to start of restoration Work. Notify Architect/Engineer of conditions found to be different than those indicated in the Contract Documents. Architect/Engineer will review situation and inform Contractor how to proceed.

B. Comply with Owner's limitations and restrictions for Site use and accessibility.

C. Environmental Limitations: Apply materials when existing and forecast weather conditions permit materials to be installed according to material manufacturer's written instructions.
   1. Place cementitious materials only when substrate and ambient temperatures are above 40 degrees F and below 90 degrees F and predicted to remain so during curing period, unless precautions approved by Architect/Engineer are taken.
   2. Protect cementitious materials from excessive evaporation of water after placement.

1.8 CHANGES IN WORK

A. During rehabilitation work, existing conditions may be encountered which are not known or are at variance with the Contract Documents. Such conditions may interfere with the Work and may consist of damage or deterioration of the substrate or surrounding materials that could jeopardize the integrity or performance of the Work.
   1. Notify Architect/Engineer of conditions that may interfere with proper execution of the Work or jeopardize the performance of the Work prior to proceeding with the Work.

PART 2 PRODUCTS

2.1 GENERAL

A. Source Limitations: Obtain each type of material, including stone, cement, and sand, from one source with resources to provide material of consistent quality in appearance and physical properties.

2.2 NEW STONE

A. Material:
   1. New Stone: Color, finish, and appearance as approved by Owner.
   2. Limestone: ASTM C568/C568M, medium density with minimum modulus of rupture of 700 pounds per square inch; select grade-based ILI Handbook.
      a. Coefficient of thermal expansion: 0.000003 inch/inch-degree F maximum.
      b. Ultimate shear strength: 900 pounds per square inch minimum.
      c. Stone dimensions as shown on Drawings to match approximate dimension of existing brick coping units with modified back-slope and drip edge for drainage. When handrail posts are anchored into top of coping, stone unit lengths to correlate with post positions.

B. Fabrication
   1. General:
      a. Measure field dimensions necessary for fabrication.
      b. Follow jointing shown on Drawings, 3 feet unit lengths minimum or at railing post positions, unless modified by approved shop drawings.
      c. Cut accurately to shape and dimension.

d. Dress exposed faces true.
e. Drill holes in units for anchors as shown on Drawings, 2 min per unit, unless modified by approved shop drawings.

2. Limestone:
a. Cut with grain running horizontally, so that when units are installed, they will be set on their "natural bed."
b. Fabrication tolerances: ILI Handbook.
c. Power wash with clean water at pressure not greater than 200 pounds per square inch prior to shipping.

3. Finish: As approved by Owner's Representative.

C. Other Materials:
1. Setting Mortar: See Section 04 05 01.
2. Sealant: See Section 07 92 00.

2.3 REPAIR MATERIALS

A. Crack Repair Materials:
1. Mortar: See Section 04 05 01.
2. Sealant: Silicone sealant per Section 07 92 00.

B. Water: Clean, potable; iron content less than two parts per million, by weight.

C. Anchors and Dowels: Type 304 stainless steel.
1. Expansion Anchors (for concrete substrate only):
a. Hilti Kwik Bolt 3, Type 304 stainless steel, by Hilti, Inc., or approved equal.
2. Adhesive Anchors and Dowels: Anchoring system tested and recommended for Project materials and conditions.
a. Threaded rods, fasteners, and components: Type 304 stainless steel.
b. Adhesive Grout: Use the following or approved equal:
1) Concrete substrate:
a) HIT-HY 200-R hybrid adhesive by Hilti, Inc.
b) AC 100+ Gold vinylester injection adhesive by Dewalt, Inc.
2) Masonry substrate:
a) HIT-HY 270 hybrid adhesive by Hilti, Inc.
3) Use screen tubes as recommended by manufacturer.

2.4 AUXILIARY MATERIALS

A. Hardware: ASTM A276, Type 304 stainless steel.
1. Fabrication:
a. Bending: Cold-formed bending with maximum inside bend radius of two times nominal material thickness.
b. Cutting: Use reciprocating saw; do not use saw blades or cutting tools used to cut other materials. Do not flame cut or use other methods involving high temperatures.
c. Holes: Drilled or punched.
2. Extrusions, straps, and plates:
a. Sizes and thicknesses shown on Drawings.
b. Remove cutting oils prior to installation.

B. Shims: High-density polyethylene, such as Korolath; thickness as required.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements and other conditions affecting installation or performance of restoration Work.
   1. Ensure that work done by other trades is complete and ready for restoration Work.
   2. Verify that areas and conditions under which restoration Work is to be performed permit proper and timely completion of Work.
   3. Notify Architect/Engineer in writing of conditions which may adversely affect installation or performance of restoration Work and recommend corrections.
   4. Do not proceed with restoration Work until adverse conditions have been corrected and reviewed by Architect/Engineer.
   5. Commencing restoration Work constitutes acceptance of Work surfaces and conditions.

3.2 PROTECTION

A. Take precautions to ensure safety of people (including building users, passers-by, and workers) and protection of property (including adjacent building elements, landscaping, and motor vehicles).

B. Erect temporary protective canopies and walls, as necessary, at walkways and at points of pedestrian and vehicular access that must remain in service during Work.

C. Take precautions to protect against air-borne materials and run-off.

D. Protect paving, sidewalk, and adjacent building areas from mechanical damage due to scaffolding and other equipment.

E. Prevent dust, debris, coating overspray/spatter, and other construction materials from coming into contact with pedestrians, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.

F. Limit access to Work areas.

G. Assume responsibility for injury to persons or damage to property due to Work, and remedy at no cost to Owner.

H. Protect from damage, all elements of completed work and original construction to remain.

3.3 EQUIPMENT

A. Drilling Holes into Concrete, Masonry, and Stone: Use high-speed, three-jaw-chuck-type, rotary-percussion drill; or coring drill with diamond core bits. Special-direct-system (SDS) hammer drills are not permitted.

3.4 GENERAL

A. Allow Architect/Engineer to inspect Work before permanently covering or concealing.

B. Maintain limestone elements in secure and stable position at all times.

C. Protection of Work:

1. Temporarily mask adjacent surfaces to prevent staining from repair materials. Promptly remove spilled materials and clean soiled surfaces.
2. Protect wall from mortar droppings and promptly remove.
3. At the end of the day or when Work is not in progress, cover openings and partially completed Work to prevent infiltration of moisture, insects, or animals.
    a. Extend cover beyond edges of openings or Work and secure tightly.

D. Build Work to the dimensions and profiles indicated.

3.5 PREPARATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of stone.

B. Examine the substrate and conditions under which the work is to be performed and notify the Architect/Engineer in writing of any condition detrimental to the proper and timely completion of the work.

C. Prior to installation of the units, verify on-site the dimensions affecting proper installation of the work.
1. Bring to the Architect's attention any discrepancies between design dimensions and field dimensions that could adversely affect proper installation as required.
2. Do not proceed with the installation until dimensional discrepancies are corrected and accepted by the Architect/Engineer.

D. Lay out:
1. Lay out the work in advance of setting in wall so as to ensure accurate spacing of units with uniform joint widths and for accurate location of openings, movement type joints, returns, and offsets.
2. Lay out walls in advance to coordinate with other masonry work.

3.6 SETTING STONE UNITS

A. Support stone elements for gravity and lateral loads.
1. Install anchors, supports, fasteners, and other attachments indicated or necessary to secure units in place.
2. Isolate dissimilar metals.
3. Fill dowel holes, slots, and other anchor penetrations into the stone with sealant or mortar. Do not use non-shrink grout.
4. Fill kerfs completely with sealant.

B. Install stone plumb, square, and true to line and as shown on shop drawings.
1. Align with adjacent vertical joints.
2. Notify Architect/Engineer prior to deviating from specified alignment.
3. Adjust anchors, supports, and accessories as necessary to position stone.
4. Shim stone units where indicated on shop drawings.
    a. Size shims to avoid overstressing stone.
    b. Use single shim of required thickness where possible.
    c. If shim stack is required, use shim thickness combination resulting in fewest shims. Adhere or pin together shim stacks.
    d. Maximum thickness of shim stack: 1 inch or as indicated on shop drawings.
5. For mortar-joint installations:

a. Set stone in full bed of setting mortar.
b. Fill vertical joints with setting mortar and shush full.
c. Maintain vertical joints to receive sealant completely clear of mortar for full depth and height.
d. After mortar has achieved initial set, rake out mortar to depth of 3/4 inch and point joints in accordance with Section 04 05 01.

6. Maintain cavities and collar joints open where unfilled space is indicated between back of stone veneer and back-up.

C. Install backer rod and sealant in joints designated to be sealed in accordance with Section 07 92 00.

3.7 CRACK REPAIRS

A. Install pointing mortar or install sealant as directed by Architect/Engineer, in cracks identified for repair.

B. Pointing Mortar Installation: For cracks wider than 1/8 inch:
1. Remove crack fillers, taking care not to damage stone surfaces.
2. Rout or grind out crack to square cross-sectional profile; V-shaped profile is not acceptable.
3. Wash crack surfaces with clean water to remove dust and loose or deleterious material.
4. Mix, place, finish, and cure mortar per manufacturer's written instructions; finish to match adjacent mortar surfaces.

C. Crack Sealant:
1. Rout crack to V-shaped or square profile with minimum width at surface of 3/8 inch. Carefully follow crack path.
2. Clean dust and debris from crack with oil-free compressed air.
3. Install bond breaker tape in square-profiled grooves.
4. Install sealant per Section 07 92 00.

3.8 MISCELLANEOUS REPAIRS

A. Exposed Steel Elements:
1. Paint exposed steel elements per Section 09 97 13.
2. Repair visible voids in stone with dutchman repairs. For holes less than 1 inch in diameter, install repair mortar.

B. Spall Repair at Sealant Joint: Install sealant in edge spalls along sealant joints, as directed by Architect/Engineer.
1. Remove joint sealant adjacent to edge spall.
2. Remove loose stone fragments and grind edges of spall smooth.
3. Prepare surfaces; install bond breaker tape or backer rod in joint; and install sealant in joint and spall per Section 07 92 00.

3.9 FIELD QUALITY CONTROL

A. Inspect new fabricated limestone elements for dimensional accuracy, finish, color, and defects, and replace stone that does not meet requirements or approved samples. Verify acceptability of color in accordance with ASTM D1729.
1. Inspection by Architect/Engineer and Owner's Representative:

a. Notify Architect/Engineer and Owner's Representative of arrival of stone at Site.
b. Architect/Engineer and Owner's Representative may inspect limestone elements, rebates, kerfs, and dowel holes. Move stone as necessary to facilitate inspection.
c. Do not install limestone elements until inspected by Architect/Engineer and Owner's Representative.

2. Pay additional costs to acquire new stone to replace rejected stone, including costs related to removing and replacing stone installed on building prior to review and acceptance by Architect/Engineer and Owner's Representative.

B. Inspect installed repairs for soundness and conformance with requirements. Remove and replace repairs that are unsound, defective, or do not meet requirements.

C. Provide access to Work area for Architect/Engineer to observe progress and quality of installed Work. Notify Architect/Engineer at least 48 hours in advance of time when access equipment will be relocated.

3.10 CLEANING

A. After completing stone restoration Work:
1. Clean affected stone cladding by rubbing with fiber brushes and clean water.
2. Remove Contractor-provided scaffolding and equipment, and patch anchor holes.

B. At the end of each workday, broom-clean Site and Work areas and place all items to be discarded in appropriate containers.

C. Return building surfaces to condition prior to cleaning Work, to satisfaction of Architect/Engineer at no additional cost to Owner.

D. Repair at no cost to Owner all items damaged during the Work.

E. Clean up debris, refuse, and surplus material; remove from premises; and dispose of legally.

END OF SECTION 04 01 40

SECTION 04 05 01
MASONRY MORTAR

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Supply and preparation of mortar for brick masonry and stone masonry.

B. Related Sections:
1. Section 01 11 00 – Summary of Work
2. Section 01 22 00 – Unit Prices
3. Section 04 01 21 – Brick Masonry Repair and Replacement
4. Section 04 01 27 – Repointing with Cement-Lime Mortar
5. Section 04 01 40 – Stone Restoration

1.2 PAYMENT

A. Include the following on a lump sum or unit price basis as described in Sections 01 11 00 and 01 22 00.

1.3 REFERENCES

A. Reference Standards: Latest edition as of Specification date.
1. ASTM International
   a. C33 – Standard Specification for Concrete Aggregates
   b. C91 – Standard Specification for Masonry Cement
   c. C144 – Standard Specification for Aggregate for Masonry Mortar
   d. C150 – Standard Specification for Portland Cement
   e. C207 – Standard Specification for Hydrated Lime for Masonry Purposes
   f. C270 – Standard Specification for Mortar for Unit Masonry
   g. C780 – Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry
   h. C1093 – Standard Practice for Accreditation of Testing Agencies for Masonry
   i. C1324 – Standard Test Method for Examination and Analysis of Hardened Mortar
   j. C1329 – Standard Specification for Mortar Cement
   k. C1586 – Standard Guide for Quality Assurance of Masonry Mortars
   l. C1714 – Standard Specification for Preblended Dry Mortar Mix for Unit Masonry
2. Brick Institute of America (BIA)
   a. BIA Technical Notes 8 - Mortars for Brickwork
3. The Masonry Society (TMS):
   a. TMS 402/602 Building Code Requirements and Specifications for Masonry Structures, the latest edition as required by applicable Building Code.

1.4 DEFINITIONS

A. Existing mortar: Mortar present in existing construction.

B. Cement-lime mortar: A mortar containing only portland cement, lime, and sand with strictly no additives, except for pigments to produce a desired color.

C. Masonry cement mortar: A preblended product, consisting of a mix of portland or blended hydraulic cement, and plasticizing materials (such as limestone, hydrated or hydraulic lime) together with one or more additives introduced to enhance certain properties such as setting time, workability, water retention, or durability. The maximum air content for Type N is 21 percent by volume (See ASTM C91).

D. Mortar cement mortar: A preblended product that meets all the requirements for masonry cement with the addition of a flexural bond strength requirement. The minimum twenty-eight day flexural bond strength for Type N is 70 PSI (See ASTM C1329).

E. Preblended cement-lime mortar: A factory-blended product containing only portland cement and lime with strictly no additives, except for pigments to produce a desired color. Sand may be included in the factory preblended product, depending on the regional customs and availability.

F. Repointing: Process of raking out mortar joint to specified depth and replacing mortar.

1.5 SUBMITTALS

A. Product Data: Supplier's literature indicating compliance with specified requirements.
   1. Pigments: Product name and type, and name of manufacturer.
   2. Preblended Mortar: Types and volumetric proportions of ingredients.

B. Material Certificates: Prior to delivery, submit to Architect/Engineer certificates attesting to compliance with the following:
   1. Portland cement. Include brand, type, and name of manufacturer.
   2. Hydrated lime. Include brand, type, and name of manufacturer
   3. Aggregate. Include type, sieve analysis and supplier.
   4. Color admixtures. Include brand, type, and name of manufacturer.

C. Mix Designs: For each type of mortar. Include description of type and proportions of ingredients.

D. Test Reports: For aggregates, indicating type, gradation, impurities, and source.

E. Masonry Subcontractor Qualification Data:
   1. Evidence that Subcontractor's existing company has a minimum of 10 years of continuous experience in masonry work with cement-lime mortar.
      a. List at least 5 representative projects of similar scope and size, including:
         1) Project name
         2) Owner's name
         3) Owner Representative's name and current contact information
         4) Description of the masonry work performed
         5) Project supervisor's name
         6) Total cost of masonry work
         7) Completion date
      b. Supervisory personnel/foreperson must have not less than 5 years' experience in supervising this type of work and must commit to be present at all times. Do not change supervisory personnel during the course of the Project except for reasons beyond the control of Subcontractor; inform Architect/Engineer in advance of any changes. Supervisory personnel must be fluent in English. Provide the following:
         1) Name(s) of supervisory personnel

2) Their resumes of experience

c. Employ masons with a minimum of 2 years' experience in similar work. Fully supervise apprentices with experienced masons.

F. Test Agency Qualification Data: Provide agency name and documentation of accreditation.

1.6 QUALITY ASSURANCE

A. Mockup Requirements for New Work.
1. Approximately 4 foot long by 3 foot high, showing the proposed color range, texture, bond, mortar, and workmanship of the unit masonry Work.
a. With the Architect/Engineer present, prepare a batch of mortar and erect the mockup before the installation of materials.
b. Provide a separate mockup panel for each type of unit masonry or mortar to be used.
c. Allow mockup to cure fourteen days minimum prior to final observation by Architect/Engineer.
d. If Architect/Engineer determines mockup does not comply with requirements, modify mockup or construct new mockup until mockup is approved.
e. Do not destroy or move the mockup until Work is completed and accepted by the Owner.

B. Mockup Requirements for Repointing.
1. Reference Section 04 01 27, Quality Assurance.

C. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in original containers and packaging with seals unbroken, labeled with manufacturer's name, product brand name and type, date of manufacture, lot number, directions for storing, and complete manufacturer's written instructions.

B. Store and handle materials in accordance with manufacturer's written instructions, safety requirements, and all applicable laws and regulations. Store materials in original, undamaged containers in clean, dry, location on raised platforms and protected from weather, within temperature range required by manufacturer. Protect stored materials from direct sunlight and sources of ignition. Manufacturer's standard packaging alone is not considered adequate weather protection.

C. Keep materials dry and do not allow materials to be exposed to moisture during transportation, storage, or handling. Discard any cementitious materials that have been exposed to moisture to their detriment.

D. Locate materials in a secure location approved by Owner's Representative.

E. Limit stored materials on structures so as to preclude damage to materials and structures.

F. Conspicuously mark damaged containers, containers with contaminated materials, damaged materials, and materials that cannot be used within stated shelf life and remove from Site as soon as possible. Replace discarded materials in a timely manner at no cost to Owner.

PART 2 PRODUCTS

2.1 MATERIALS

A. Cement-Lime Mortar formulated to match existing mortar:
   1. Masonry or mortar cements will not be allowed.
   2. Portland Cement: ASTM C150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
   3. Hydrated Lime: ASTM C207, Type S.
   4. Pigments shall not exceed 10 percent of portland cement by weight; pigments containing carbon black shall not exceed two percent of portland cement by weight.

B. Aggregate:
   1. Mortar: ASTM C144: washed aggregate consisting of natural sand or crushed stone, to match existing.
      a. White-Mortar Aggregate: Natural white sand or crushed white stone.
      b. Colored-Mortar Aggregate: Natural sand or crushed stone of color necessary to produce required mortar color.
   2. Aggregate shall contain no more than 50 parts per million of chloride ions and shall be free of organic contaminants.

C. Water: Clean and potable; free from deleterious amounts of acids, alkalis, or organic materials.

D. Admixtures: Do not use admixtures without written approval, unless otherwise specified, including:
   1. Calcium chloride or admixtures containing calcium chloride.
   2. Air-entraining admixtures or material containing air-entraining admixtures.
   3. Antifreeze compounds.
   4. Pozzolans, including naturally derived and artificially derived, such as fly ash.

E. Pigment: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with record of satisfactory performance in masonry mortar.
   1. Use one of the following or approved equal:
      a. Bayferrox iron oxide pigments by Lanxess Corporation.
      b. True Tone Sweet 16 Mortar Colors by Davis Colors, Inc.
      c. SGS Mortar Colors by Solomon Colors, Inc.

2.2 MORTAR MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.
   1. Do not use calcium chloride in mortar.
   2. Limit cementitious materials in mortar to Portland cement and lime.

B. Mortar: Comply with ASTM C270, proportioned by volume as follows. Provide Type N mortar for all applications.
   1. Portland Cement: 1 part.
   2. Hydrated Lime:
      a. Type N: Over 1/2 to 1 1/4 parts.

3. Aggregate: Not less than 2 1/4 and not more than 3 times sum of volumes of Portland cement and hydrated lime.
4. Water: Maximum amount consistent with optimum workability.
5. Color: Match color of mortar to the existing adjacent mortar joints, unless specified otherwise.

C. Preblended Cement-Lime Mortar: ASTM C270. A factory packaged dry blend of portland cement, lime, and sand may be used in lieu of site-mixed mortar. Preblended cement-lime mortar may not contain any other ingredients, except pigment, if required.
1. Use one of the following or approved equal:
a. SPEC MIX Portland Lime and Sand N by SPEC MIX.
b. Mortamix Rainbow Custom Color Cement-Lime Type N by Holcim, Inc.
c. Eaglebond Portland and Lime Type N by Lafarge North America, Inc.
d. Custom Color Portland/Lime Cement Type N by Lehigh Hanson, Heidelberg Cement Group.

D. Pigmented Mortar: Use colored cement product containing only metallic oxides. Do not add pigments to colored cement products.
1. Mix to match existing original or adjacent mortar, subject to approval of Owner's Representative and Architect/Engineer.

E. Colored Aggregate Mortar: Produce required mortar color by using colored aggregate and natural color or white cement as necessary.
1. Mix to match existing original or adjacent mortar, subject to approval of Owner's Representative and Architect/Engineer.

PART 3 EXECUTION

3.1 SITE MIXING

A. Except as specified herein, mix in accordance with requirements of BIA Tech Note 8 Table 1, which can be provided at the pre-construction conference if requested in advance.

B. Develop batching and mixing operations so that quality control is assured.

C. Designate one or two individuals to batch and mix mortar. Fully instruct these individuals on batching and mixing procedures. No other persons shall batch or mix mortar without prior notification to Architect/Engineer.

D. Maintain accurate mix proportions. Batch materials by volume with containers of known volume. Do not measure materials by shovel.
1. Incorporate approved admixtures into mix in manner recommended by manufacturer and approved by Architect/Engineer. Measure with accuracy of +/-3 percent. Add each admixture separately.
2. Do not top-off sand brought to the site in pre-measured containers as this may result in oversanding of the mortar.

E. Combine and mix materials in appropriate drum-type batch machine mixer to uniform consistency.
1. Mix mortar for three to five minutes after materials are in mixer.

2. Provide sufficient number of mixers, including reserve mixers, so that mortar placement operations will proceed uninterrupted.
3. Hand-mixing is permitted upon prior written approval of Architect/Engineer.

3.2 PRE-BLENDED MORTAR MIXING

A. Develop mixing operations so that quality control is assured.

B. Designate one or two individuals to mix mortar. Fully instruct these individuals on mixing procedures. No other persons shall mix mortar without prior notification to Architect/Engineer.

C. Mix materials in appropriate drum-type batch machine mixer to uniform consistency as recommended by manufacturer.
1. Mix mortar for three to five minutes after materials are in mixer.
   a. Dry preblended mortar may require a longer mixing period to overcome the water affinity of oven dry sand and subsequent workability loss in the mortar.
2. Provide sufficient number of mixers, including reserve mixers, so that mortar placement operations will proceed uninterrupted.
3. Hand-mixing is permitted upon prior written approval of Architect/Engineer.

3.3 REPOINTING MORTAR MIXING

A. Pre-hydrate mortar:
1. Thoroughly mix ingredients except water.
2. Continue mixing, adding only enough water to produce damp workable mix which will retain its form when pressed into ball.
3. Maintain mortar in dampened condition for 1 to 1-1/2 hours.

B. Add sufficient water to bring mortar to proper consistency; that is, somewhat drier than conventional masonry mortars.

C. Refer to Section 04 01 27 for repointing process.

3.4 MORTAR INSTALLATION LIMITATIONS

A. If mortar begins to stiffen, it may be retempered with water as frequently as needed to restore consistency.

B. Discard mortar not placed within 2-1/2 hours after initial mixing.

3.5 FIELD QUALITY CONTROL

A. Inspection Requirements:
1. Contractor to verify daily by observation that the method of measuring material quantities accurately maintains the required proportions. Provide a log to the Architect/Engineer at the completion of the project indicating inspection of the mixing process.

END OF SECTION 04 05 01

SECTION 05 02 00
STRUCTURAL STEEL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Fabrication and installation of structural steel elements.
   2. Connection to, or alteration of, existing steel elements.

B. Related Sections include the following:
   1. Section 01 22 00 – Unit Prices
   2. Section 03 01 34 – Concrete Repair
   3. Section 09 97 13 – Steel Coating

1.2 UNIT PRICES

A. Perform the following Work on unit price basis as described in Section 01 22 00.

1.3 REFERENCES

A. Definitions:
   1. Installer: Used interchangeably for installer or erector.
   2. SSPC: Procedures in SSPC Painting Manual.
   3. WPS: Welding Procedure Specification.

B. Reference Standards
   1. American Institute of Steel Construction (AISC):
      a. 303: Code of Standard Practice for Steel Buildings and Bridges.
      b. 360: Specification for Structural Steel Buildings.
   2. American Society of Civil Engineers (ASCE)
      a. ASCE/SEI-7: Minimum Design Loads for Buildings and Other Structures
   3. American Welding Society (AWS):
      a. D1.1/D1.1M: Structural Welding Code - Steel.
   4. The Society for Protective Coatings
      a. SSPC Painting Manual

1.4 ADMINISTRATIVE REQUIREMENTS

A. Preconstruction Meeting:
   1. Conduct meeting at Project site.

B. Coordinate Work to ensure that adjacent areas are not adversely affected. Coordinate:
   1. With Owner's Representative.
   2. With other trades:
      a. To ensure that work done by other trades is complete and ready for joint seal installation.
      b. To avoid or minimize work on, or in immediate vicinity of, joint seal Work in progress.

c. To ensure that subsequent work will not adversely affect completed joint seal installation.

1.5 SUBMITTALS

A. Shop Drawings: Show fabrication and installation details of steel stair elements, including:
   1. Dimensions, shapes, and material using reference standards such as ASTM properties.
   2. Details of cuts, connections, splices, camber, openings, and other pertinent data.
   3. Weld sizes, lengths, and types by standard AWS symbols, including shop or field weld designation.
   4. Type, size, and length of bolts; indicate pretensioned or slip-critical bolted connections including locations of Class A and Class B slip-critical faying surfaces; indicate shop or field bolted.

B. Product Data and Test Reports:
   1. Structural steel elements.
   2. Bolts, nuts, and washers.
   3. Anchor rods and threaded rods,

C. Certificates:
   1. Welding consumables - manufacturer’s certificates
   2. Welder Performance Qualification Record (WPQR):
      a. Current WPQR (welder certification), qualified in accordance with Clause 4, Qualification, of AWS D1.1, for welders who will perform shop or site welding.

D. Test Reports:
   1. Material Test Reports: For steel; signed by steel manufacturer certifying compliance with appropriate specification; include physical properties and chemical analysis.

E. Welding Qualification Data:
   1. Welding Procedure Specification (WPS) for each weld type, process, parameters (i.e. wire speed, voltage, amperage, etc.), and position, whether prequalified or qualified by testing by AWS D1.1, including the following:
      a. Certificate of conformance and product information sheet for consumables listed in the WPS.
      b. Supplemental welding procedures.
   2. Procedure Qualification Record (PQR) of satisfactory certification testing for each non-prequalified welding procedure.

F. Fabricator Qualifications: Evidence that fabricator's *existing company* has minimum five years of continuous experience in similar steel fabrication work; list of at least five representative, successfully-completed projects of similar scope and size, including:
   1. Project name.
   2. Owner's name.
   3. Owner's Representative name, address, and telephone number.
   4. Description of work.
   5. Types of steel fabrication work.
   6. Project supervisor.
   7. Total cost of steel fabrication work and total cost of project.
   8. Completion date.

G. Fabricator’s and erector’s, as applicable, written quality control manual that shall include, as a minimum:
   1. Material control procedures
   2. Quality control procedures
   3. Inspection procedures
   4. Nonconformance procedures

H. Fabricator’s and erector’s, as applicable, QC inspector qualifications

I. Installer Qualifications: Evidence that installer's *existing company* has minimum five years of continuous experience in similar steel installation work; list of at least five representative, successfully-completed projects of similar scope and size, including:
   1. Project name.
   2. Owner's name.
   3. Owner's Representative name, address, and telephone number.
   4. Description of work.
   5. Types of miscellaneous steel installation work.
   6. Project supervisor.
   7. Total cost of miscellaneous steel installation work and total cost of project.
   8. Completion date.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Experienced firm that has successfully completed miscellaneous steel installation work similar in material, design, and extent to that indicated for Project. Must have successful construction with specified materials in local area in use for minimum of five years.
   1. Employ foreman with minimum five years of experience as foreman on similar projects, who is fluent in English, to be on Site at all times during the Work. Do not change foremen during the course of the Project except for reasons beyond control of Contractor; inform Architect/Engineer in advance of any changes.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver store, and handle materials to prevent damage to materials or structure.

B. Store elements off ground and spaced with pallets, dunnage, or other supports and spacers. Store to permit easy access for inspection and identification.

C. Store fasteners in protected place. Clean bolts and nuts that become rusty before use per manufacturer's written recommendations.

D. Limit stored materials on structures to safe loading capacity of structure at time materials are stored, and to avoid damage or permanent structure deflection.

1.8 PROJECT CONDITIONS

A. Verify existing dimensions and details prior to installation of steel elements. Notify Architect/Engineer of conditions found to be different than those indicated in Contract Documents. Architect/Engineer will review situation and inform Contractor and Installer how to proceed

B. Comply with Owner's limitations and restrictions for Site use and accessibility.

C. Handle and install materials in strict accordance with safety requirements required by local, state, and federal rules and regulations.

1.9 CHANGES IN WORK

A. During rehabilitation work, existing conditions may be encountered which are not known or are at variance with the Contract Documents. Such conditions may interfere with the Work and may consist of damage or deterioration of the substrate or surrounding materials that could jeopardize the integrity or performance of the Work.
   1. Notify Architect/Engineer prior to proceeding with the Work of conditions that may interfere with, preclude proper execution of, or jeopardize the performance of the Work.

PART 2 - PRODUCTS

2.1 STEEL ELEMENTS

A. Channels and Angles: ASTM A36.

B. Plates and Bars: ASTM A36/A36M.

C. Corrugated Metal Decking:
   1. ASTM A653, zinc coated ASTM G90 (Z275).
   2. Size to match existing.
   3. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Nucor Corp.; Vulcraft Group
      b. Wheeling Corrugating Company; Div. of Wheeling-Pittsburg Steel Corporation
   4. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi (230 MPa), not less than 0.0359-inch (0.91-mm) design uncoated thickness, of same material and finish as deck; of profile indicated for application.

D. Hollow Structural Sections (HSS): ASTM A500, Grade B.

E. Welding filler metal: Minimum ultimate tensile strength of 70 ksi, low hydrogen

2.2 AUXILIARY MATERIALS

A. Welding Electrodes:
   1. Mild Steel: Comply with AWS D1.1 Table 3.1 requirements for Group II or higher steel specifications, and electrodes listed in approved WPSs.

B. High-Strength Bolts: ASTM F3125 Grade A490, Type 1, plain finish, heavy hex.
   1. Nuts: ASTM A563; Grade DH; plain finish.
   2. Washers: ASTM F436, Type 1, plain finish.
   3. Direct-tension indicators: ASTM F959, Type 490, plain finish.

C. Anchor Rods: ASTM F1554, Grade 36, Class 2A; plain finish; fully threaded.
   1. Nuts: ASTM A563, Grade B, hex, plain finish.
   2. Washers**:** ASTM F844, plain finish.

D. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 (4.8-mm) minimum diameter.

E. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.

F. Nonmetallic, Shrinkage-Compensating Grout: ASTM C1107; factory-packaged, nonmetallic aggregate, noncorrosive, nonstaining grout; mixed with water to consistency suitable for application and 30-minute working time.

G. Finishes: See Section 09 97 13.

2.3 CONCRETE TOPPING AND INFILL

A. See Section 03 01 34.

2.4 FABRICATION

A. Fabricate and assemble in shop to greatest extent possible. Comply with requirements of AISC 303, including tolerances.
   1. Cut, drill, and punch elements cleanly and accurately.
      a. Remove burrs.
   2. Holes: Fabricate bolt holes, holes required for securing other work to steel elements, and holes for other work to pass through steel elements.
      a. Cut, drill, or punch holes cleanly and accurately, perpendicular to steel surfaces.
   3. Grind edges of members to be coated to minimum radius of about 1/32 inch unless otherwise indicated. Members that will be shop coated only do not need to have edges ground.
   4. Exposed Elements: Fabricate with accurate angles, surfaces, and straight edges.
      a. Fabricate seams and other connections that will be exposed to moisture in manner to exclude moisture. Provide weep holes where moisture may accumulate.
      b. Remove sharp or rough areas on exposed surfaces.
   5. Accurately finish ends of members transmitting bearing loads in accordance with the AISC 303.
   6. Mark and match-mark pieces for field assembly.

B. Welded Connections, Structural Steel: Comply with AWS D1.1 for preheating, required profiles, tolerances, weld appearance, weld quality, and for methods used in correcting welding work.
   1. Perform welding in accordance with approved WPSs by properly certified welders.
   2. Remove dirt, grease, oil, and foreign matter by pickling, power brushing, degreasing, machining, or grinding, prior to welding.
   3. Preheat base metal and maintain interpass temperatures in accordance with AWS D1.1.
   4. Perform welding in a manner to:
      a. Minimize distortion of welded pieces.
      b. Obtain thorough fusion and required profile without cracking.
   5. Remove slag from completed welds, and clean adjacent weld metal by brushing or other suitable means.

C. Cleaning: After assembly, including welding:
   1. Clean steel surfaces that are to remain unpainted according to SSPC-SP 1, Solvent Cleaning.
   2. Clean and prepare steel surfaces that are to be shop coated according to SSPC-SP 1, Solvent Cleaning followed by SSPC-SP 2, Hand Tool Cleaning or SSPC-SP 3, Power Tool Cleaning.

D. Apply stand-along shop coat by suitable means to a minimum dry film thickness of 1 mil. Do not apply stand-alone shop coat to surfaces to be bolted with slip-critical connections, field welded, coated with fire-resistive materials, hot-dipped galvanized, stainless steel, or embedded in concrete or mortar.

E. Shop Quality Control
   1. Testing Agency: Owner will engage a qualified special inspector to verify and inspect aspects of the steel fabrication and to inspect welds, prior to application of stand-alone shop coat.
      a. Provide testing agency with access to places where Work is being fabricated or produced to perform inspections.
      b. Provide notice to testing agency of fabrication schedule.
   2. Welded Connections: Welds will be visually inspected according to AWS D1.1 and the requirements of the applicable building code. Acceptance criteria will be in accordance with AWS D1.1.
   3. Correct deficiencies in Work that inspection and testing indicate do not comply with Contract Documents.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions with Installer for compliance with requirements and other conditions affecting installation or performance of miscellaneous steel elements.
   1. Verify elevations of bearing surfaces and locations of anchor rods, bearing plates, and other embedments.
   2. Ensure that Work done by other trades is complete and ready for steel installation.
   3. Verify that areas and conditions under which Work is to be performed permit proper and timely completion of Work.
   4. Notify Architect/Engineer in writing of conditions which may adversely affect installation or performance of steel elements. Do not proceed with steel installation until adverse conditions have been corrected and reviewed by Architect/Engineer. Commencing miscellaneous steel Work constitutes acceptance of Work surfaces and conditions.

3.2 PROTECTION

A. Take precautions to ensure safety of people (including building users, passers-by, and workers) and protection of property (including adjacent building elements, landscaping, and motor vehicles).
   1. Erect temporary protective canopies and walls, as necessary, at walkways and at points of pedestrian and vehicular access that must remain in service during Work.

B. Protect paving and sidewalk, and adjacent building areas from mechanical damage due to scaffolding and other equipment.

C. Prevent dust, debris, coating overspray/spatter, and other construction materials from coming into contact with pedestrians, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.

D. Assume responsibility for injury to persons or damage to property due to Work, and remedy at no cost to Owner.

E. Limit access to Work areas.

F. Protect from damage, all elements of completed work and original construction to remain.

3.3 DEMOLITION

A. Do not use thermal cutting during installation unless approved by Architect/Engineer.

B. When thermal cutting is necessary, mechanically thermal cut to greatest extent possible. Grind thermally cut edges to be welded to comply with requirements in AWS D1.1. Do not damage existing structural steel elements to remain.

3.4 INSTALLATION

A. General:
   1. Install miscellaneous steel elements in accordance with requirements of AISC 303.
   2. Position steel elements accurately in location, alignment, and elevation indicated, with edges and surfaces level, plumb, true, and free of rack.
      a. Maintain erection tolerances specified by AISC 303.
      b. Perform cutting, drilling, and fitting required to install steel elements.
   3. Provide temporary support for elements during installation to keep elements secure, plumb, and in alignment. Do not remove temporary supports until the installation is complete.
   4. Align and adjust various members forming part of the assembly before permanently fastening.
      a. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with adjacent elements.
      b. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
      c. Make allowances for difference between temperature at time of installation and mean temperature when structure is completed and in service.
   5. Splice members only where indicated on Drawings or shop drawings approved by Architect/Engineer.
   6. Do not enlarge holes unless approved by Architect/Engineer. If approved, ream holes to enlarge.

B. Welded Connections, Structural Steel: Comply with AWS D1.1 for preheating, required profiles, tolerances, weld appearance, weld quality, and for methods used in correcting welding work.
   1. Perform welding in accordance with approved WPSs by properly certified welders. Take precautions for fire hazards at adjacent construction.
   2. Remove dirt, grease, oil, and foreign matter by pickling, power brushing, degreasing, machining, or grinding, prior to welding.
   3. Preheat base metal and maintain interpass temperatures.
   4. Perform welding in manner to:
      a. Minimize distortion of welded pieces.
      b. Obtain thorough fusion and required profile without cracking.
   5. Remove slag from completed welds, and clean adjacent weld metal by brushing or other suitable means.
   6. Where existing members are to be welded, shore existing members in accordance with Drawings. Do not heat existing members more than necessary to achieve a satisfactory weld. Place welding work lead as close as possible to weldment being executed.

C. Bolted Connections: Install high-strength bolts according to the RCSC Specification for joint conditions indicated on Drawings. Use snug-tight requirements unless noted otherwise.
   1. Snug-Tight Joints:
      a. Faying surfaces and surfaces adjacent to bolt head and nut shall be free of dirt and other foreign material.
      b. Install snug-tight joints such that connected plies are brought into firm contact by the bolts in the joint and bolts have been sufficiently tightened to prevent removal of nuts without the use of a wrench.

D. Corrugated Metal Decking: Install deck panels and accessories to applicable specifications and commentary in SDI Publication No. 31, manufacturer's written instructions, and requirements in this Section.
   1. Install deck panels and accessories to match the existing.
   2. Install temporary shoring before placing deck panels if required to meet deflection limitations.
   3. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.
   4. Place deck panels flat and square and fasten to supporting frame without warp or deflection.
   5. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.
   6. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.
   7. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

E. Bearing Plates (if needed):
   1. Clean bearing surfaces and bottom surface of plates of bond-reducing materials. Roughen concrete bearing surfaces prior to setting plates.
   2. Accurately set plates with wedges, shims, setting nuts, or leveling plates as required.
   3. Accurately position and plumb supported member.
   4. Install anchor rod washers and nuts and snug-tighten anchor rods.
   5. Promptly place grout to fill gaps between bearing surfaces and plates and shear lugs, if present, so no voids remain.
      a. Do not remove wedges or shims. Cut off protruding portions flush with edge of plate before or after dry packing with grout**.**
      b. Comply with grout manufacturer's written installation instructions.
      c. Neatly finish exposed surfaces; protect grout and allow to cure.

3.5 CONCRETE TOPPING AND INFILL

A. See Section 03 01 34.

3.6 FINISHES

A. See Section 09 97 13.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified special inspector to verify and inspect aspects of the steel installation and to inspect welds. Welding inspection and welding inspector qualifications shall be in accordance with AWS D1.1.

1. Provide testing agency with access to places where Work is being installed to perform inspections.
2. Provide notice to testing agency of installation schedule.

B. Welded Connections: Welds will be visually inspected according to AWS D1.1 and the requirements of the applicable building code. Acceptance criteria will be in accordance with AWS D1.1.

C. Bolted Connections: Bolted connections will be inspected and tested according to RCSC Specification Section 9 and the requirements of the applicable building code.
1. Prior to the start of Work, verify that fastener components meet the requirements of RCSC Specification Section 2 and connected plies meet the requirements of RCSC Specification Section 3.
2. Visually verify that connected plies are in firm contact and that washers are used as required in RCSC Specification Section 6.
3. For snug-tight connections verify that bolts have been tightened sufficiently to prevent turning of the nut without the use of a wrench, per RCSC Specification Section 9.1.

D. Correct deficiencies in Work that inspection and testing indicate do not comply with Contract Documents.

3.8 REPAIRS AND PROTECTION

A. Touchup Painting: Immediately after installation, clean exposed areas where stand-alone shop coat is damaged or missing and paint with same material used for stand-alone shop coat to comply with SSPC-PA 1 for touching up shop-painted surfaces.
1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

3.9 CLEANING

A. At the end of each workday, clean the Site and Work areas and place rubbish, empty cans, rags, and other discarded materials in appropriate containers.

B. After completing the miscellaneous steel Work:
1. Clean all materials resulting from Work that are not intended to be part of the finished Work using appropriate cleaning agents and procedures. Exercise care to avoid damaging surfaces.
2. Repair at no cost to Owner all items damaged during the Work.
3. Remove and legally dispose of debris and surplus materials from Site.

END OF SECTION 05 02 00

SECTION 07 18 00
TRAFFIC COATING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Surface preparation, supply, and application of traffic coating.

B. Related Sections:
1. Section 01 11 00 – Summary of Work
2. Section 01 22 00 – Unit Prices
3. Section 03 01 31 – Concrete Removal and Surface Preparation
4. Section 03 01 34 – Concrete Repair
5. Section 03 15 11 – Expansion Joint Seals
6. Section 07 19 17– Silane Water Repellent
7. Section 07 92 00 – Joint Sealants
8. Section 32 17 23.13 – Painted Pavement Markings

1.2 PAYMENT

A. Provide the following on a lump sum or unit price basis as described in Sections 01 11 00 and 01 22 00.

1.3 REFERENCES

A. Reference Standards: Latest edition as of Specification date.
1. ASTM International:
   a. C1127: Standard Guide for Use of High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane with an Integral Wear Surface
   b. D4258: Standard Practice for Surface Cleaning Concrete for Coatings.
   c. D4259: Standard Practice for Abrading Concrete.
   d. D4263: Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
   e. D7234: Standard Test Method for Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers
2. International Concrete Repair Institute (ICRI):
   a. Guideline 310.2R: Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordinate Work to ensure that adjacent areas are not adversely affected. Coordinate:
1. With Owner's Representative.
2. With other trades:
   a. To ensure that work done by other trades is complete and ready for traffic-coating Work.
   b. To avoid or minimize work on, or in immediate vicinity of, traffic-coating Work in progress.

c. To ensure that subsequent work will not adversely affect quality of completed traffic coating.

3. Review areas of sound coating to remain with Owner's Representative.

B. Pre-application Meeting:
1. Conduct meeting at Site.
2. Time, date, location, and attendee notification to be facilitated by Contractor.
3. Review requirements for traffic coating, including:
   a. Construction schedule.
   b. Availability of materials, Applicator's personnel, equipment, and facilities needed to make progress and avoid delays.
   c. Site use, access, staging, and set-up location limitations.
   d. Approved mockup procedures.
   e. Impact of forecast weather conditions.
   f. Ventilation requirements.
   g. Surface preparation and substrate condition.
   h. Application procedures.
   i. Special details and sheet flashings.
   j. Minimum curing period.
   k. Testing and inspection requirements.
   l. Governing regulations.
4. Contractor's Site superintendent, traffic-coating manufacturer's technical representative, Applicator's foreman, Owner's Representative, and Architect/Engineer shall attend.

1.5 SUBMITTALS

A. Product Data: Traffic-coating manufacturer's literature including written instructions for evaluating, preparing, and treating substrate; technical data including tested physical and performance properties; and application instructions. Include VOC content of components.
1. Include traffic-coating manufacturer's color chart.

B. Samples: For each type of traffic coating required, stepped samples on rigid backing large enough to illustrate build-up of traffic coatings, of same thickness and material indicated for Work.

C. Applicator Qualifications:
1. Certification signed by traffic-coating manufacturer, certifying that Applicator complies with manufacturer's requirements to install specified, warranted, traffic coating.
2. Evidence that Applicator's *existing company* has minimum 5 years of continuous experience in similar traffic-coating work; list of at least five representative, successfully-completed projects of similar scope and size, including:
   a. Project name.
   b. Owner's name.
   c. Owner's Representative name, address, and telephone number.
   d. Description of work.
   e. Traffic-coating materials used.
   f. Project supervisor.
   g. Total cost of traffic-coating work and total cost of project.
   h. Completion date.

D. Sample Warranties: Copies of traffic-coating manufacturer's warranty and Applicator's warranty, both stating obligations, remedies, limitations, and exclusions. Submitted with bid.

E. Following completion of the Work:
   1. Traffic-coating manufacturer's warranty inspection reports.
   2. Completed warranty from traffic-coating manufacturer.
   3. Completed warranty from Applicator.

F. Maintenance Program:
   1. Identify substrates and traffic-coating systems applied.
   2. Include recommendations for periodic inspections, cleaning, care, maintenance, and repair of traffic coating.

1.6 QUALITY ASSURANCE

A. Applicator Qualifications: Experienced firm that has successfully completed traffic-coating work similar in material, design, and extent to that indicated for Project; that is approved, authorized, or licensed by traffic-coating manufacturer to apply traffic coating; and that is eligible to receive traffic-coating manufacturer's warranty. Must have successful installations of specified materials in local area in use for minimum of 5 years.
   1. Employ foreman trained by traffic-coating manufacturer and with minimum 5 years of experience as foreman on similar projects, who is fluent in English, to be on Site during Work. Do not change foremen during course of Project except for reasons beyond control of Installer; inform Architect/Engineer in advance of any changes.

B. Mockups: Prior to start of Work or purchase of material, apply traffic coating to at least 200 square feet of each substrate, at locations determined by Architect/Engineer, to demonstrate surface preparation, leveling course installation, primer and detail coat installation, joint and crack treatment, thickness, texture, color, and standard of workmanship. The mockup shall include the proposed aggregate broadcast into the coating to demonstrate the slip resistance.
   1. Manufacturer's representative or testing agency shall determine tensile bond strength of membrane to substrate in accordance with ASTM D7234. Bond is satisfactory if bond strength is not less than 200 psi. Contractor to patch test areas with traffic coating system at no cost to Owner.
   2. If Architect/Engineer determines mockup does not comply with requirements, modify mockup or construct new mockup until mockup is approved.
   3. Approved mockup will be standard for judging completed Work.
   4. Maintain approved mockups in undisturbed condition during Work as standard for judging completed Work. Mockups, if undamaged at time of Substantial Completion, may be incorporated into Work.

C. Membrane Manufacture Quality Control:
   1. Membrane manufacturer shall provide a technical representative to be on site at beginning of installation of the membrane system to establish the standard quality to be used on the remaining portion of the membrane work.
   2. Manufacturer's representative shall review work in progress on a periodic basis (target at least one visit per phase).
   3. Manufacturer's representative shall inspect application of membrane including random measurements of membrane thickness.
   4. Manufacturer shall visit the site as needed or requested.
   5. Manufacturer's representative performs final inspection of completed work.

D. Daily Field Report: Contractor shall, during construction, complete a daily field installation report which includes, project name, date, weather and temperature data, material installed, location and square footage of material installed, codes or batch identification for the product

installed, any testing information including moisture testing of substrate, and any other relevant data or information.

1. This daily report will be completed each day of installation of the traffic membrane and submitted to the Architect/Engineer.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in original containers and packaging with seals unbroken, labeled with manufacturer's name, product brand name and type, date of manufacture, lot number, directions for storing, and complete manufacturer's written instructions.

B. Keep materials dry and do not allow materials to be exposed to moisture during transportation, storage, handling, or installation. Reject and remove from Site new materials which exhibit evidence of moisture during application or have been exposed to moisture to their detriment.

C. Store and handle materials in accordance with manufacturer's written instructions, safety requirements, and all applicable laws and regulations. Remove from Site, and replace at no cost to Owner, any materials that are damaged or otherwise negatively affected by not being stored or handled in accordance with manufacturer's written instructions.

D. Store materials in original, undamaged containers and packaging in clean, dry, protected location on raised platforms and protected from weather, within temperature range required by manufacturer. Protect stored materials from direct sunlight and sources of ignition. Manufacturer's standard packaging and covering alone is not considered adequate weather protection.

E. Locate materials in a secure location approved by Owner's Representative.

F. Conspicuously mark damaged or opened containers, containers with contaminated materials, damaged materials, and materials that cannot be used within stated shelf life and remove from Site as soon as possible. Replace discarded materials in a timely manner at no cost to Owner.

G. Limit stored materials on structures so as to preclude damage to materials and structures.

H. Maintain copies of all applicable Safety Data Sheets (SDS) with materials in storage area, such that they are available for ready reference on Site.

1.8 PROJECT CONDITIONS

A. Verify existing dimensions and details prior to start of traffic-coating Work. Notify Architect/Engineer of conditions found to be different than those indicated in the Contract Documents. Architect/Engineer will review situation and inform Contractor and Applicator how to proceed.

B. Comply with Owner's limitations and restrictions for Site use and accessibility.

C. Ensure that drains are operational at the end of each workday or if precipitation is forecast.

D. Environmental Limitations: Apply traffic coating when existing and forecast weather conditions permit traffic coating to be installed according to traffic-coating manufacturer's written instructions and warranty requirements. Do not apply traffic coating under the following conditions, unless otherwise recommended by traffic-coating manufacturer and approved by Architect/Engineer.

1. Apply only when substrate temperature is above 50 degrees F or more than 5 degrees F above dew point, or within range recommended by traffic-coating manufacturer.
2. Apply only when ambient temperature is above 40 degrees F or within range recommended by traffic-coating manufacturer.
3. Do not apply to damp or wet substrate; when relative humidity exceeds 85 percent; in snow, rain, fog, or mist; or when snow, rain, fog, or mist is forecast during application or curing period. Apply only to frost-free substrate.
4. Install during conditions that do not cause pinholing in individual coats of material.

E. Maintain adequate ventilation during preparation and application of traffic-coating materials. Notify Owner's Representative at least one week in advance of Work with materials with noxious vapors. Review application schedule and venting precautions with Owner's Representative prior to beginning application.

1.9 CHANGES IN WORK

A. During rehabilitation work, existing conditions may be encountered which are not known or are at variance with the Contract Documents. Such conditions may interfere with the Work and may consist of damage or deterioration of the substrate or surrounding materials that could jeopardize the integrity or performance of the Work.
   1. Notify Architect/Engineer of conditions that may interfere with the proper execution of the Work or jeopardize the performance of the Work prior to proceeding with the Work.

1.10 WARRANTIES

A. Manufacturer's Warranty:
   1. Written warranty, signed by traffic-coating manufacturer, including:
      a. Repair or replace traffic coating that does not comply with requirements; that does not remain watertight; that fails in adhesion, cohesion, or general durability; that experiences abrasion or tearing failure not due to misuse; that experiences surface crazing, fading or chalking; or that deteriorates in a manner not clearly specified by submitted traffic-coating manufacturer's data as an inherent quality of the material for the application indicated. Warranty does not include deterioration or failure of traffic coating due to failure of substrate prepared according to requirements, formation of new substrate cracks exceeding 1/16 inch in width, fire, vandalism, or snowplow abuse.
      b. Provide access to warranty repair and replacement areas.
   2. Warranty Period: 5 years after Substantial Completion date.

B. Applicator's Warranty:
   1. Written warranty on warranty form at the end of the Section signed by Applicator, including:
      a. Repair or replace traffic coating that does not comply with requirements; that does not remain watertight; that fails in adhesion, cohesion, or general durability; that experiences abrasion or tearing failure not due to misuse; that experiences surface crazing, fading, or chalking; or that deteriorates in a manner not clearly specified by submitted traffic-coating manufacturer's data as an inherent quality of the material for the application indicated. Warranty does not include deterioration or failure of traffic coating due to failure of substrate prepared according to requirements, formation of new substrate cracks exceeding 1/16 inch in width, fire, vandalism, or snowplow damage.
      b. Provide access to warranty repair and replacement areas.

c. Repair or replacement, to satisfaction of Owner, of other work or items which may have been displaced or damaged as consequence of defective Work.
d. Make immediate emergency repairs within 48 hours of notice of leakage.

2. Warranty Period: 5 years after Substantial Completion date.

PART 2 - PRODUCTS

2.1 TRAFFIC COATING

A. Source Limitations: Obtain materials through one source from single traffic-coating manufacturer. Provide materials not available from traffic-coating manufacturer from sources approved by traffic-coating manufacturer. Provide new materials.

B. VOC Content: Provide materials that comply with local VOC limits.

C. Use one of the following traffic coatings, or approved equal:
1. Dry thicknesses of each layer shall be the minimum of the values specified herein or the manufacturer's published thicknesses to achieve a heavy duty system.
2. Heavy-duty vehicular system:
a. Iso-Flex 750U-HL HVT Deck Coating System by LymTal International, Inc., consisting of 25 dry mils of base coat, 15 dry mils of wear course, 3/4 pound of sand per square feet, and 12 dry mils of lock coat.
b. Auto-Gard Vehicular Traffic-Bearing Waterproofing with double-texturing, by Neogard, consisting of 20 dry mils of base coat, 32 dry mils of wearing surface coat, and 20 to 30 pounds of aggregate per 100 square feet.
c. MasterSeal Traffic 1500 Extra-Heavy-Duty System by BASF Construction Chemicals, LLC, consisting of 20 dry mils of base coat, 20 dry mils of mid-coat, 15 dry mils of finish coat, and 50 to 70 pounds of aggregate per 100 square feet.
3. Heavy-duty vehicular system (two-component):
a. Iso-Flex 750U-HL HVT Deck Coating System by LymTal International, Inc., consisting of 25 dry mils of base coat, 15 dry mils of wear course, 3/4 pound of sand per square feet, and 12 dry mils of lock coat.
b. Auto-Gard FC T Vehicular Traffic-Bearing Waterproofing with double-texturing, by Neogard, consisting of 20 dry mils of base coat, 32 dry mils of wearing surface coat, and 20 to 30 pounds of aggregate per 100 square feet.
c. MasterSeal Traffic 2500 Extra-Heavy-Duty System by BASF Construction Chemicals, LLC, consisting of 20 dry mils of base coat, 20 dry mils of mid-coat, 15 dry mils of finish coat, and 50 to 70 pounds of aggregate per 100 square feet.
4. Top coat to be aliphatic (UV-stable).
5. Additional aggregate to be back-rolled into the top coat per manufacturer written instructions.
6. Heavy duty application at all locations recommended by manufacturer, including but not limited to: drive lanes and turning areas.

D. Primer: Traffic-coating manufacturer's factory-formulated epoxy or standard primer recommended for substrate under conditions of service and application, and compatible with Leveling Course.

E. Leveling Course: Traffic-coating manufacturer's recommended epoxy with sand aggregate broadcast to refusal. Epoxy-to-aggregate ratio as recommended by the manufacturer and as demonstrated and approved during mock-up.

F. Aggregate: Clean silica sand, uniform in gradation, and approved by traffic-coating manufacturer.

G. Top Coat Color: Approved in advance in writing by Owner's Representative. Owner to select from manufacturer's standard colors. Multiple colors may be selected, extent to be selected in the field.
   1. Specifically at the Level 1 pedestrian stairs and pedestrian bridges, a "tan" color may be selected in lieu of the standard "gray" used elsewhere in the structure.

H. Provide a highly slip-resistant final texture, with a wet coefficient of friction exceeding 0.9 when tested according to ASTM C1028.

2.2 RELATED MATERIALS

A. The manufacturer's recommended primer, detail coat, grit primer, metal primer, cleaning agent, and additional coatings.

B. Surface Divot Filling: Flexible epoxy mortar or sand loaded epoxy primer, as determined from mock-ups, recommended by traffic coating manufacturer, and approved by Architect/Engineer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions with Applicator and traffic-coating manufacturer's representative for compliance with requirements and other conditions affecting performance of traffic coating.
   1. Ensure that work done by other trades is complete and ready for traffic-coating Work.
   2. Verify compatibility with and suitability of substrates.
   3. Verify that areas and conditions under which traffic-coating Work is to be performed permit proper and timely completion of Work.
   4. Notify Architect/Engineer in writing of conditions which may adversely affect application or performance of traffic coating and recommend corrections.
   5. Do not proceed with traffic-coating Work until adverse conditions have been corrected and reviewed by Architect/Engineer.
   6. Commencing traffic-coating Work constitutes acceptance of Work surfaces and conditions.

3.2 PROTECTION

A. Comply with traffic coating manufacturer's written instructions for protecting building and other surfaces against damage from exposure to its products.

B. Cover adjacent surfaces with materials that are proven to resist traffic coating.

C. Take precautions to ensure safety of people (including building users, passers-by, and workers) and protection of property (including adjacent building elements, landscaping, and motor vehicles).

D. Take precautions to protect against air-borne materials and run-off.

E. Protect paving, sidewalk, and adjacent building areas from mechanical damage due to equipment.

F. Prevent dust, debris, coating overspray/spatter, and other construction materials from coming into contact with pedestrians, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.

G. Limit access to Work areas.

H. Assume responsibility for injury to persons or damage to property due to Work, and remedy at no cost to Owner.

I. Protect from damage, all elements of completed work and original construction to remain.

3.3 SURFACE PREPARATION

A. Equipment:
   1. Concrete cleaning equipment.
   2. Abrasive blasting equipment capable of removing contaminants and laitance from concrete surface.
   3. Compressed air equipment capable of removing dust and dirt from concrete surface.

B. Remove existing traffic coating in locations where it is installed and other materials to expose substrate.
   1. Existing traffic coating system is unknown.
   2. Remove only as much of existing traffic coating as can be prepared and new traffic coating installed in one day, unless provisions are implemented to maintain watertightness in interim or larger removal areas are approved by Owner's Representative.
   3. Provide temporary protection as needed if watertightness is compromised.
   4. Do not begin removal of existing traffic coating when weather conditions are not conducive to maintaining watertightness or for application of new traffic coating.

C. At transition to existing traffic coating, prepare edge of existing traffic coating in accordance with manufacturer's instructions.

D. At masonry vertical wall substrates, provide reglet cut (groove) at bed joint, 4 inches above the horizontal surface.

E. Clean and prepare concrete substrate according to traffic-coating manufacturer's written instructions and as specified in Section 03 01 31. Provide clean, dust-free, and dry substrate.
   1. Verify that concrete has cured and aged for minimum time period recommended by traffic-coating manufacturer.
   2. Verify that substrate is sound and is visibly dry and free of moisture. Test for moisture vapor emission by applying the base coat of traffic coating on one-foot-square test areas and monitoring for pinholes, blisters, and bubbles until the traffic coating has set; the number and locations of test areas shall be determined by Architect/Engineer based on project conditions. If pin-holing, blistering, or bubbling occurs, delay Work until later test areas are free of pinholes, blisters, and bubbles.
   3. Verify that concrete curbs, expansion joints, and transitions from one surface plane to another (inside and outside corners) are cleanly formed and free of broken edges and excess concrete.
   4. Remove concrete fins and projections, concrete splatter, and other irregularities which would prevent monolithic, continuous application of traffic coating.
   5. Properly repair substrate defects such as delaminations, spalls, voids, form tie holes, honeycombing, and cracks, with latex-modified concrete, epoxy or another material per

these specifications or an approved equal that is acceptable to traffic-coating manufacturer and Architect/Engineer.

6. Remove grease, oil, asphalt solids, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.
7. Abrasive blast or scarify substrate to provide clean surface, free of laitance, dirt, and other loose or foreign material. Use care to avoid pockmarking concrete surface.
8. Uniformly clean concrete surfaces by abrasive blast, according to ASTM D4259, to expose top surface of fine aggregate and provide sound surface, free of laitance, dirt, and other loose or foreign material. Use self-contained, recirculating, blast-cleaning apparatus. Remove remaining loose material and clean surfaces according to ASTM D4258. Produce surface texture equal to CSP 3 or 4 from ICRI Guideline 310.2R.
9. Abrasive blast clean curb, column, and wall surfaces that will receive traffic coating.
10. Thoroughly sweep substrate and clean with oil-free compressed air.

F. Rout cracks and joints designated by traffic-coating manufacturer's representative and verified by Architect/Engineer substrates per Section 07 92 00, and according to ASTM C1127 and traffic coating manufacturer's written recommendations. Remove existing sealant if present. Before coating surfaces, remove dust and dirt from joints and cracks according to ASTM D4258.

1. Cracks over 25 mils (0.025 inch) wide: Rout cracks to a minimum width and depth of 3/8 inch by 3/8 inch and fill with sealant. Tool sealant flush with surrounding surfaces. Comply with recommendations in ASTM C1193 for joint sealant installation.
    a. After sealant has cured, apply minimum 15 mil detail coat extending 2 inches to each side of crack.
2. Non-moving cracks less than 25 mils wide: Apply minimum 15 mil detail coat extending 2 inches to each side of crack.

G. Mask adjoining surfaces not receiving traffic coating to prevent spillage and overspray affecting other construction.

H. Close off deck drains and other deck penetrations to prevent spillage and migration of traffic-coating fluids.

I. Applicator and traffic-coating manufacturer's representative shall examine substrate to ensure that it is properly prepared and ready to receive traffic coating. Traffic-coating manufacturer's representative shall report in writing to Applicator and Architect/Engineer conditions which will adversely affect traffic-coating system application or performance. Do not proceed with traffic-coating application until these conditions have been corrected and reviewed by Architect/Engineer.

J. Proceed with application only after unsatisfactory conditions have been corrected. Commencing application constitutes acceptance of Work surface preparation and conditions.

3.4 TERMINATIONS AND PENETRATIONS

A. Prepare vertical and horizontal surfaces at terminations and penetrations through traffic coatings and at expansion joints, drains, sleeves and similar locations according to ASTM C1127, manufacturer's written recommendations, and the following.

B. Provide 3/4 inch minimum sealant cants (cove sealant) and minimum 15 mil detail coat at penetrations and at deck-to-wall cove joints.

C. Drains: Provide sealant joint at perimeter of all drains and a minimum 15 mil detail coat ring around drains, extending minimum 4 inches onto surrounding deck and extending onto drain body.

3.5 LEVELING COURSE

A. Level areas of surface scaling or rough, uneven areas with Leveling Course where surface roughness is unacceptable for traffic coating application, as determined by Manufacturer's Representative and Architect/Engineer.

B. Do not permit Leveling Course on sealant in joints.

3.6 PATCH VERTICAL SURFACES

A. Parge or patch vertical concrete surfaces at the base of wall prior to coating application.
   1. Extend repairs vertically 4 inches minimum.
   2. Parge with epoxy and sand per manufactures' requirements for shallow areas (less than 1 inch deep)
   3. Vertical concrete patch repair to be used at locations greater than 1 inch deep. Repair in accordance with Section 03 01 31 and 03 01 34.

3.7 APPLICATION

A. Provide and maintain barricades for vehicular and pedestrian traffic at traffic-coating areas during application and curing period.

B. Allow sealant and concrete replacement materials to fully cure prior to installing traffic coating, no less than three days.

C. Apply traffic coating material according to traffic-coating manufacturer's written recommendations.
   1. Start traffic-coating application in presence of traffic-coating manufacturer's representative.
   2. Install sealant cant (cove seal) at intersections of horizontal and vertical surfaces.
   3. Batch and thoroughly mix components as recommended by the traffic-coating manufacturer. Do not intentionally incorporate air into materials during mixing.
   4. Apply detail coat at intersections of horizontal and vertical surfaces, at drains and other deck penetrations, and at cracks and joints.
   5. Apply traffic-coating system.
      a. Prime surfaces as recommended by the traffic coating manufacturer and as approved during mock-up.
      b. Wipe detail coat to remove dust and contamination.
      c. Apply each coat in one uniform application, broadcast aggregate if required, and backroll for even coverage. Allow each coat to cure before applying next coat. Sweep or vacuum off excess aggregate.
      d. Apply base coat and top coat at least 4 inches up sides of columns, walls, and other vertical surfaces, and up curb faces and across top curb surfaces.
      e. Omit aggregate on vertical surfaces.
      f. If pinholes, blisters, or bubbles occur in base coat, apply additional base coat material using flat squeegee or other tool approved by traffic-coating manufacturer, to fill holes before proceeding with subsequent coats. Ensure that subsequent coats do not develop additional pinholes, blisters, or bubbles. Contact Architect/Engineer and

manufacturer's representative and do not proceed with installation until adverse conditions or techniques have been satisfactorily corrected.

g. Prevent contamination or damage during application and curing.

h. Verify that wet film thickness of each component coat complies with requirements every 100 square feet.

3.8 FIELD QUALITY CONTROL

A. The contractor shall measure and record the wet film thicknesses of the traffic membrane coats during each application of traffic membrane at representative areas. The location of each measurement shall be placed on a plan drawing. Provide the measurements to WJE throughout the duration and at the conclusion of the project.

B. Architect/Engineer will take a minimum of one sample (one-square inch) of new traffic-coating system for every 4,000 square feet of traffic-coating installed. Dry film thickness will be measured.

1. Dry film thickness is satisfactory if not less than minimum thickness specified by traffic-coating manufacture or this Section, whichever is greater.
2. If dry film thickness is too thin, apply additional material at no cost to Owner, or perform other remedial action recommended by traffic-coating manufacturer or Architect/Engineer.
3. Patch sample areas with traffic-coating system.

C. Architect/Engineer may perform bond strength testing to verify adequate bond strength in accordance with ASTM D7234 Standard Test Method for Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers.

1. Bond is satisfactory if bond strength is not less than 200 psi.
2. Contractor to patch test areas with traffic coating system at no cost to Owner.

D. Chain drag traffic-coating areas at conclusion of Work to locate debonded areas. Remove and replace debonded areas.

3.9 SAFETY PRECAUTIONS

A. Provide and maintain barricades and traffic control during installation and curing period to prevent vehicular and pedestrian traffic from entering application area.

B. Install protective membrane system material in strict accordance with all safety weather conditions required by the manufacturer's product literature or as modified by applicable rules and regulations of local, State and Federal authorities having jurisdiction.

C. The Owner's Representative shall be advised at least one (1) week in advance of any work with materials with noxious vapors. No materials with noxious vapors shall be used without prior review of application schedule by the Owner's Representative and venting precautions by the Contractor. Adequate ventilation must be provided by the Contractor during membrane installation and until vapors are gone. Ventilation precautions shall meet the requirements of the membrane manufacturer and the approval of the Owner's Representative.

D. Provide safety equipment, as required, for any workers in or immediately adjacent to the work areas.

3.10 CLEANING

A. At the end of each workday, clean Site and Work areas and place and place all items to be discarded in appropriate containers.

B. After completing traffic coating Work:
   1. Clean all materials resulting from Work that are not intended to be part of the finished Work using appropriate cleaning agents and procedures. Exercise care to avoid damaging surfaces.
   2. Repair at no cost to Owner all items damaged during the Work.
   3. Remove and legally dispose of debris and surplus materials from Site.

3.11 PROTECTION

A. Protect traffic-coating from damage and wear during remainder of construction period.

B. Replace Work or materials damaged beyond repair, in opinion of Architect/Engineer, at no cost to Owner.

END OF SECTION 07 18 00

APPLICATOR'S WARRANTY FOR

[_____]

We (Applicator) hereby warrant materials and workmanship of Work which we have installed at above-referenced Project for a period of five (5) years from date of substantial completion. We agree to repair or replace traffic coating which fails to remain watertight; or fails in adhesion, cohesion, or general durability; or experiences surface crazing, fading or chalking; or deteriorates in any other manner not clearly specified by submitted manufacturer's data as an inherent quality of the material for the application indicated. Warranty does not include deterioration or failure of traffic coating due to failure of substrate prepared according to requirements, formation of new substrate cracks exceeding 1/16 inch in width, fire, vandalism, or snowplow damage.

We also agree to repair or replace to satisfaction of Owner, other work or items which may be displaced or damaged as a consequence of defective Work.

In event of our failure to comply with foregoing conditions, within seven days after being notified in writing by Owner, we collectively or separately do hereby authorize Owner or his successor in interest to proceed to have said defects repaired and made good at our expense and we will honor and pay costs and charges therefore upon demand.

Date of Substantial Completion: _____

Applicator's signature: _____

Typed name and title of company official signing above and issuing this warranty:

Name: _____ Title: _____

Date of Signature: _____

Contractor's signature: _____

Typed name and title of company official signing above for Contractor:

Name: _____ Title: _____

Date of Signature: _____

SECTION 07 19 17
SILANE WATER REPELLENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Surface preparation, supply, and application of silane water repellent for concrete surfaces.

B. Related Sections:
1. Section 01 22 00 – Unit Prices
2. Section 03 01 31 – Concrete Removal and Surface Preparation
3. Section 03 01 34 – Concrete Repair
4. Section 03 15 11 – Expansion Joint Seals
5. Section 07 18 00 – Traffic Coating
6. Section 07 92 00 – Joint Sealants
7. Section 32 17 23.13 – Painted Pavement Markings

1.2 UNIT PRICES

A. Provide the following Work on a unit price basis as described in Section 01 22 00.

1.3 REFERENCES

A. Reference Guides: Latest edition as of Specification date.
1. International Concrete Repair Institute (ICRI):
a. 310.3R: Guide for the Preparation of Concrete Surfaces for Repair using Hydrodemolition Methods

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordinate Work to ensure that adjacent areas are not adversely affected. Coordinate:
1. With Owner's Representative.
2. With other trades:
a. To ensure that work done by other trades is complete and ready for water-repellent Work.
b. To avoid or minimize work on, or in immediate vicinity of, water-repellent Work in progress.
c. To ensure that subsequent work will not adversely affect quality of installed water repellent.

B. Pre-application Meeting:
1. Conduct meeting at Site.
2. Time, date, location, and attendee notification to be facilitated by Contractor.
3. Review requirements for water-repellent application, including:
a. Construction schedule.
b. Availability of materials, Applicator's personnel, equipment, and facilities needed to make progress and avoid delays.
c. Site use, access, staging, and set-up location limitations.

d. Protection of adjacent surfaces.
e. Approved mockup procedures.
f. Forecast weather conditions and impact on Work.
g. Surface preparation and substrate condition.
h. Application procedures.
i. Minimum curing period.
j. Testing and inspection requirements.
k. Governing regulations, including environmental regulations.

4. Contractor's Site superintendent, water-repellent manufacturer's technical representative, water-repellent Applicator's foreman, Owner's Representative, and Architect/Engineer shall attend.

1.5 SUBMITTALS

A. Product Data: Water-repellent manufacturer's literature including product description and written instructions for storage, handling, substrate preparation, protection of surrounding areas not to receive water-repellent, application, and final cleaning. Include VOC content.

B. Environmental Certification:
1. Environmental regulations applicable to Site.
2. Certification, signed by water-repellent manufacturer, that water repellent complies with environmental regulations applicable to Site.

C. Test Reports: Written results of field testing performed by water-repellent manufacturer or Applicator.

D. Applicator Qualifications:
1. Certification signed by water-repellent manufacturer, certifying that Applicator complies with manufacturer's requirements to install specified water repellent.
2. Evidence that Applicator's *existing company* has minimum 3 years of continuous experience in similar water-repellent work; list of at least 5 representative, successfully-completed projects of similar scope and size, including:
a. Project name.
b. Owner's name.
c. Owner's Representative name, address, and telephone number.
d. Description of work.
e. Water repellents used.
f. Project supervisor.
g. Total cost of water-repellent work and total cost of project.
h. Completion date.

1.6 QUALITY ASSURANCE

A. Applicator Qualifications: Experienced firm that has successfully completed water-repellent work similar in material, design, and extent to that indicated for Project; and that is approved, authorized, or licensed by water-repellent manufacturer to install water repellent. Must have successful installations of specified materials in local area in use for minimum of 3 years.
1. Employ foreman trained by water-repellent manufacturer and with minimum 3 years of experience as foreman on similar projects, who is fluent in English, to be on Site at all times during Work. Do not change foremen during the course of the Project except for reasons beyond the control of Installer; inform Architect/Engineer in advance of any changes.

B. Manufacturer Certifications: Water-repellent manufacturer shall certify that product to be used complies with VOC regulations at Site.

C. Site Tests: Water-repellent manufacturer and Applicator shall determine the need for and shall perform as necessary the following tests.
   1. Test surfaces not to be treated that are subject to possible contact with water repellent, to determine if protection is required.
   2. Verify application sequence, including surface preparation, installation of sealant in cracks and joints, and application of water repellent. Verify sealant adhesion and compatibility with water repellent.
   3. Record the coverage rates, and time to traffic for each test section. Report this information to the Architect/Engineer.
   4. Test pH level of concrete substrate to ensure reactivity of silane water repellent.

D. Mockups: Prior to the start of Work or purchase of material, in presence of Architect/Engineer and water-repellent manufacturer's representative, apply water repellent to at least 25 square feet of each substrate, at locations determined by the Architect/Engineer, to demonstrate surface preparation, application, finished appearance, and standard of workmanship.
   1. After 24 hours or when mockups are thoroughly dry, Architect/Engineer and Owner's Representative will evaluate finished appearance.
   2. After 7 days, at request of Architect/Engineer, procure core samples from mockups and wet freshly broken surface to demonstrate penetration of water repellent. Penetration depth must be a minimum of 0.25 inch and an average of 0.35 inch. Core samples shall be no less than 2 inches in diameter and 2 to 3 inches deep.
   3. If Architect/Engineer determines mockup does not comply with requirements, construct new mockup until mockup is approved.
   4. Approved mockups will be standard for judging completed Work.
   5. Approved mockups may become part of completed Work if undisturbed at time of Substantial Completion.
   6. Perform mockup, testing, and repair of test locations at no additional cost to the Owner.

E. Manufacturer's Field Representation:
   1. Provide an experienced, qualified, manufacturer's technical representative on-site to provide expert advice on storage, mixing, application, clean-up, and disposal of materials.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in original containers and packaging with seals unbroken, labeled with manufacturer's name, product brand name and type, date of manufacture, lot number, directions for storing, and complete manufacturer's written instructions.

B. Keep materials dry and do not allow materials to be exposed to moisture during transportation, storage, handling, or installation. Reject and remove from Site new materials which have been exposed to moisture to their detriment.

C. Store and handle materials in accordance with manufacturer's written instructions, safety requirements, and all applicable laws and regulations. Remove from Site, and replace at no cost to Owner, any materials that are damaged or otherwise negatively affected by not being stored or handled in accordance with manufacturer's written instructions.

D. Store materials in original, undamaged containers and packaging in clean, dry, location on raised platforms and protected from weather, within temperature range required by manufacturer.

Protect stored materials from direct sunlight and sources of ignition. Manufacturer's standard packaging and covering alone is ***not*** considered adequate weather protection.

E. Locate materials in a secure location approved by Owner's Representative.

F. Conspicuously mark damaged or opened containers, containers with contaminated materials, damaged materials, and materials that cannot be used within stated shelf life and remove from Site as soon as possible. Replace discarded materials in a timely manner at no cost to Owner.

G. Limit stored materials on structures so as to preclude damage to materials and structures.

H. Keep containers tightly sealed when not in use, as atmospheric moisture will react with and alter water-repellent solution.

I. Remove and replace materials that cannot be applied within stated shelf life, or that are damaged or otherwise unsuitable.

J. Conspicuously mark damaged or opened containers or containers with contaminated materials and remove from Site as soon as possible.

K. Dispose of unused or unsuitable materials in accordance with manufacturer's recommendations and governing environmental regulations. Do not flush debris or water repellent down existing drains.

1.8 PROJECT CONDITIONS

A. Verify existing dimensions and details prior to the start of water-repellent Work. Notify Architect/Engineer of conditions found to be different than those indicated in the Contract Documents. Architect/Engineer will review situation and inform Contractor and Applicator how to proceed.

B. Comply with Owner's limitations and restrictions for Site use and accessibility.

C. Environmental Limitations: Apply water repellent within range of ambient and substrate temperatures recommended by water-repellent manufacturer. Do not apply water repellent under the following conditions, unless otherwise recommended by water-repellent manufacturer and approved by Architect/Engineer.
   1. To substrates that are damp or wet, or that have dew, frost, snow, or ice on them.
   2. To substrates below 40 degrees F or less than 5 degrees F above dew point, or above 90 degrees F.
   3. When ambient temperature is below 40 degrees F, or is predicted to fall below 40 degrees F within eight hours after application, or is above 90 degrees F.
   4. When rain, snow, fog, or mist is predicted within 24 hours.
   5. When wind speeds are at or above 15 miles per hour, or if windy conditions exist that may cause water repellent to be blown onto vegetation or surfaces not intended to be treated.
   6. On new concrete for at least 30 days.

D. Handle and install materials in strict accordance with safety requirements required by water-repellent manufacturer; Material Safety Data (SDS) Sheets; and local, state, and federal rules and regulations.

E. Maintain adequate ventilation during preparation and application of water-repellent materials. Notify Owner's Representative at least one week in advance of Work with materials with noxious vapors. Review application schedule and venting precautions with Owner's Representative prior to beginning application.

1.9 CHANGES IN WORK

A. During rehabilitation work, existing conditions may be encountered which are not known or are at variance with the Contract Documents. Such conditions may interfere with the Work and may consist of damage or deterioration of the substrate or surrounding materials that could jeopardize the integrity or performance of the Work.
   1. Notify Architect/Engineer prior to proceeding with the Work of conditions that may interfere with, preclude proper execution of, or jeopardize the performance of the Work.

PART 2 - PRODUCTS

2.1 PENETRATING WATER REPELLENT

A. Silane: Clear, monomeric compound containing 100 percent solids. Use one of the following products or approved equal:
   1. Sikagard-740W by Sika Corporation.
   2. Iso-Flex 618-100 CRS by LymTal International, Inc.
   3. Sil-Act ATS-100 by Advanced Chemical Technologies, Inc.
   4. MasterProtect H 1000 by Sika Corporation.
   5. Protectosil Aqua-Treat 40 by Evonik Industries. Active content 40 percent.
   6. KlereSeal 9100-S by Pecora Corporation.
   7. Baracade Silane 100 by Euclid Chemical Company.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions with Applicator and water-repellent manufacturer's representative for compliance with requirements and other conditions affecting application or performance of water repellent.
   1. Ensure that work done by other trades is complete and ready for water-repellent Work.
   2. Verify that areas and conditions under which water-repellent Work is to be performed permit proper and timely completion of Work.
   3. Notify Architect/Engineer in writing of conditions which may adversely affect application or performance of water repellent and recommend corrections.
   4. Do not proceed with water-repellent Work until adverse conditions have been corrected and reviewed by Architect/Engineer.
   5. Commencing water-repellent Work constitutes acceptance of Work surfaces and conditions.

3.2 PROTECTION

A. Take precautions to ensure safety of people (including building users, passers-by, and workers) and protection of property (including adjacent building elements, landscaping, and motor vehicles).

1. Erect temporary protective canopies and walls, as necessary, at walkways and at points of pedestrian and vehicular access that must remain in service during Work.

B. Cover adjacent surfaces with materials that are proven to resist water repellent.

C. Protect paving and sidewalks, and adjacent building areas from mechanical damage due to scaffolding and other equipment.

D. Prevent dust, debris, coating overspray/spatter, and other construction materials from coming into contact with pedestrians, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.

E. Limit access to Work areas.

F. Comply with water-repellent manufacturer's written instructions for protecting building and other surfaces against damage from exposure to its products.

G. Assume responsibility for injury to persons or damage to property due to Work, and remedy at no cost to Owner.

H. Protect from damage, all elements of completed work and original construction to remain.

3.3 SURFACE PREPARATION

A. Equipment:
1. Abrasive blasting equipment capable of removing laitance, dirt, loose or foreign material, and surface contaminants and striping.
2. Water-blasting equipment capable of removing laitance, dirt, loose or foreign material, and surface contaminants from exposed concrete surfaces.
3. Compressed air equipment capable of removing dust, dirt, and water.

B. Clean and prepare concrete substrate according to water-repellent manufacturer's written instructions and as described below. Provide clean, dust-free, and dry substrate.
1. Verify that concrete has cured and aged for minimum time period recommended by water-repellent manufacturer.
2. Allow wet substrates to dry for at least 24 hours. Verify that substrate is sound and is visibly dry and free of moisture.
3. Remove grease, oil, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete. Use concrete cleaner approved by water-repellent manufacturer where necessary. If cleaner is used, rinse thoroughly to remove cleaner residue.
4. Abrasive blast concrete to provide clean surface, free of laitance, dirt, and other loose or foreign material and to achieve CSP 1 or 2 per ICRI Guideline 310.2. Remove all line striping and pavement markings. Allow water-blasted surfaces to dry. Use care to avoid pockmarking concrete surface.
5. Rout cracks and joints, remove existing sealant, and install new sealant. Allow sealant to cure for at least 7 days or as recommended by water-repellent and sealant manufacturers.
6. Thoroughly sweep substrate and clean with oil-free compressed air.

C. Clean and prepare concrete surfaces using procedure demonstrated in mockup and approved by Architect/Engineer and Owner's Representative. Provide clean, dust-free, and dry substrate.

Verify that mortar has cured and aged for minimum time period recommended by water-repellent manufacturer.

D. Proceed with application only after unsatisfactory conditions have been corrected. Commencing application constitutes acceptance of Work surfaces and conditions.

3.4 APPLICATION

A. Equipment:
   1. Low-pressure (15 to 25 pounds per square inch), airless spray equipment.
   2. Low-pressure (15 to 25 pounds per square inch), positive-displacement, garden-type spray equipment, fitted with fan-spray nozzle.
   3. Brushes and rollers.
   4. Brooms and squeegees.

B. Before beginning application:
   1. Provide and maintain traffic barricades and control measures, well outside limits of wind-drifting, during application and drying of water repellent to protect vehicular and pedestrian traffic from contact with water repellent. Enclose Work area to contain wind-blown overspray.
   2. Provide adequate ventilation during and after application of water repellent.
   3. Provide dry-chemical fire extinguishers and clearly post "NO SMOKING" signs in Work area.

C. Apply two coats of water repellent at coverage rate demonstrated in mockup, in a uniform manner, using low-pressure spray equipment, brushes, and rollers. Use brooms and squeegees to achieve even distribution. Do not alter or dilute material. Comply with manufacturer's written instructions for using airless spraying procedure.
   1. Prior to use, thoroughly clean spray equipment, tanks, and hoses, and make free of water, foreign matter, and oily residues. Flush with anhydrous alcohol or small amounts of silane.
   2. Apply to horizontal surfaces with spray bar. Use hand-spray unit at edges.
   3. On vertical surfaces, apply from bottom up, with controlled run-down of about 8 inches, with hand-spray unit, brushes, and rollers.
   4. At cracks, construction joints, and concrete repair perimeters not sealed with sealant or epoxy, adjust nozzle of hand-spray unit to produce concentrated stream of water repellent to saturate cracks and joints.
   5. Use brushes and rollers at edges of application area to avoid overspray on adjacent surfaces.
   6. Apply second coat "wet-on-wet" or after the first coat has penetrated and within a few minutes after the first coat appears dry, in accordance with the manufacturer's recommendations.
   7. If water-repellent application is not completed at one time, clearly mark location where application is terminated.
   8. Allow water repellent to dry for at least 12 hours before exposing to vehicular, construction, or pedestrian traffic.

3.5 FIELD QUALITY CONTROL

A. Water-repellent manufacturer's representative shall inspect and approve preparation of substrate and protection of adjacent surfaces before application of water repellent.

B. Architect/Engineer will observe water-repellent application and verify that minimum coverage rates are maintained. If minimum coverage rates are not maintained, apply another coat of water repellent at no cost to Owner.

C. Core Sampling and Testing: For every 10,000 square feet of treated surface, take one 2-inch-diameter-by-2-inch-minimum-deep core sample from treated surface. Remove sample intact and wet side to observe depth of penetration of water repellent. If depth of penetration is less than 0.25 inch, apply another coat of water repellent at no cost to Owner.
   1. Patch core hole per 03 01 34.

3.6 CLEANING

A. Immediately clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

B. At the end of each workday, broom-clean Site and Work areas and place all items to be discarded in appropriate containers.

C. After completing Work:
   1. Clean all materials resulting from Work that are not intended to be part of the finished Work using appropriate cleaning agents and procedures. Exercise care to avoid damaging surfaces.
   2. Repair at no cost to Owner all items damaged during the Work.
   3. Remove and legally dispose of debris and surplus materials from Site.

END OF SECTION 07 19 17

SECTION 07 53 23
EPDM MEMBRANE ROOFING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Surface preparation, supply, and installation of adhered, EPDM membrane roofing system; including roof-deck boards, temporary roof/vapor barrier, insulation, and cover boards.

B. Related Sections:
   1. Section 01 11 00 – Summary of Work
   2. Section 07 62 00 – Sheet Metal Flashing and Trim

1.2 PAYMENT

A. Provide the following on a lump sum basis as described in Sections 01 11 00.

1.3 REFERENCES

A. Definitions:
   1. Square: 100 square feet.

B. Reference Standards: Latest edition as of Specification date.
   1. American National Standards Institute (ANSI)/Single Ply Roofing Industry (SPRI):
      a. ANSI/SPRI FX-1: Standard Field Test Procedure for Determining the Withdrawal Resistance of Roofing Fasteners.
   2. American Society of Civil Engineers (ASCE)/Structural Engineering Institute (SEI):
      a. ASCE/SEI 7: Minimum Design Loads for Buildings and Other Structures.
   3. ASTM International:
      a. C1177/C1177M: Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing.
      b. C1289: Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.
      c. D4637/D4637M: Standard Specification for EPDM Sheet Used in Single-Ply Roof Membrane.
   4. E108: Standard Test Methods for Fire Tests of Roof Coverings.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordinate Work to ensure that new insulation and roofing materials and building interior are kept continuously dry; that continuous, watertight, new roofing system is provided; and that adjacent areas are not adversely affected. Coordinate:
   1. With Owner's Representative.
   2. With other trades:
      a. To ensure that work done by other trades is complete and ready for roofing Work.
      b. To avoid or minimize work on, or in immediate vicinity of, roofing Work in progress.
      c. To ensure that subsequent work will not adversely affect completed roofing.

B. Preliminary Roofing Meeting:
   1. Conduct meeting at Site.
   2. Review requirements for roofing system, including:
      a. Construction schedule.
      b. Availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
      c. Site use, access, staging, and set-up location limitations.
      d. Surface preparation and substrate condition and pretreatment.
      e. Installation procedures.
      f. Base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect roofing system.
      g. Testing and inspection requirements.
      h. Temporary protection and repair of roofing system.
      i. Structural loading limitations of roof deck.
      j. Governing regulations and requirements for insurance and certificates.
   3. Contractor's Site superintendent, roofing-system manufacturer's technical representative, roofing Installer's foreman, Owner's Representative, Architect/Engineer, and testing agency representative shall attend.

1.5 SUBMITTALS

A. Product Data: Roofing-system manufacturer's literature including written instructions for evaluating, preparing, and treating substrate; technical data including tested physical and performance properties; and application instructions.
   1. For membrane and base flashing materials, and bonding and cold, fluid-applied adhesives, primer, seaming material, lap sealant, water-cutoff mastic, and fasteners.
   2. Include temperature ranges for storage and application of materials, and special cold-weather application requirements or limitations.
   3. Include Safety Data Sheets (SDS) for information only; safety restrictions are sole responsibility of Contractor.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work; for details and fabrications not shown on Drawings.
   1. Membrane terminations and base flashings. Draw to scale.
   2. Tapered insulation, including slopes.
   3. Crickets, saddles, and tapered edge strips, including slopes.
   4. Insulation fastening patterns.
   5. Proposed temporary, watertight, tie-off details for each substrate type.

C. Manufacturer Certificate: Signed by roofing-system manufacturer, certifying that roofing system complies with specified requirements.
   1. Written approval by roofing-system manufacturer for use and performance of membrane over specified board insulation, including that materials supplied for Project comply with requirements of cited ASTM standards. Approval should also indicate materials are suitable for ASTM E108, Class 1A roof and meet specified wind uplift classification.
   2. Submit evidence that roofing system meets requirements.

D. Installer Qualifications:
   1. Certification signed by roofing-system manufacturer, certifying that Installer complies with manufacturer's requirements to install specified, warranted, roofing system.

2. Evidence that Installer's *existing company* has minimum five years of continuous experience in similar roofing work; list of at least five representative, successfully-completed projects of similar scope and size, including:
   a. Project name.
   b. Owner's name.
   c. Owner's Representative name, address, and telephone number.
   d. Description of work.
   e. EPDM materials used.
   f. Project supervisor.
   g. Total cost of roofing work and total cost of project.
   h. Completion date.

E. Sample Warranty: Copy of roofing-system manufacturer's warranty, stating obligations, remedies, limitations, and exclusions. Submitted with bid.

F. Following completion of the Work:
   1. Roofing-system manufacturer's inspection report of completed roofing installation.
   2. Completed warranty from roofing-system manufacturer.
   3. Completed warranty from Installer.
   4. Maintenance program recommended for roofing system.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Experienced firm that has successfully completed roofing work similar in materials, design, and extent to that indicated for Project; that is approved, authorized, or licensed by roofing-system manufacturer to install roofing system; and that is eligible to receive roofing-system manufacturer's warranty. Must have successful installations of specified materials in local area in use for minimum of five years.
   1. Employ foreman with minimum five years of experience as foreman on similar projects, who is fluent in English, to be on Site at all times during Work. Do not change foremen during the course of the Project except for reasons beyond the control of the Installer; inform Architect/Engineer in advance of any changes.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle materials according to manufacturer's recommendations and in such a manner as to prevent damage to materials or structure.

B. Deliver materials to Site in original containers and packaging with seals unbroken, labeled with manufacturer's name, product brand name and type, date of manufacture, lot number, and directions for storing and mixing with other components.

C. Keep materials dry and do not allow materials to be exposed to moisture during transportation, storage, handling, or installation. Reject and remove from Site new materials which exhibit evidence of moisture during application or which have been exposed to moisture.

D. Store materials in original, undamaged containers in clean, dry, protected location on raised platforms with weather-protective coverings, within temperature range required by manufacturer. Use canvas tarps for protection of moisture-sensitive roofing materials. Protect stored materials from direct sunlight. Manufacturer's standard packaging and covering are not considered adequate weather protection.

E. Store rolled materials on ends only, unless otherwise required by manufacturer's written instructions. Discard rolls that have been flattened, creased, or otherwise damaged.

F. Do not store materials at locations where new roofing materials have been installed.

G. Limit stored materials on structures to safe loading capacity of structure at time materials are stored, and to avoid permanent deck deflection.

H. Conspicuously mark damaged or opened containers, containers with contaminated materials, or wet or damaged materials, and remove from Site as soon as possible.

I. Remove and replace materials that cannot be applied within stated shelf life.

1.8 PROJECT CONDITIONS

A. Verify existing dimensions and details prior to start of roofing Work. Notify Architect/Engineer of conditions found to be different than those indicated in the Contract Documents. Architect/Engineer will review situation and inform Contractor and Installer of changes.

B. Comply with Owner's limitations and restrictions for Site use and accessibility.

C. Hazardous Materials: Testing of existing roofing materials for hazardous materials has been performed.
   1. Refer to report dated February 26, 2024 by ASTI Environmental for hazardous materials information.
   2. The Contractor shall be responsible for ensuring that personnel within the Work area and the public are protected from exposure to hazardous materials; preventing contamination of the building/site; and appropriately characterizing materials to allow for their handling and disposal in accordance with all applicable laws and regulations.

D. Protect existing roofing from damage from construction activities. Repair damage to existing roofing from construction activities that result in leakage.

E. Ensure that drains are operational at the end of each workday or if precipitation is forecast.

F. Environmental Limitations: Install roofing when existing and forecast weather conditions permit roofing system to be installed according to roofing-system manufacturer's written instructions and warranty requirements.
   1. Apply roofing when substrate temperature is falling, and when substrate and ambient temperatures are within range recommended by roofing-system manufacturer.
   2. Do not proceed with installation during inclement weather except for temporary work necessary to protect building interior and installed materials. Remove temporary work and Work that becomes moisture damaged.

G. Handle and install materials in strict accordance with safety requirements required by roofing-system manufacturer; Safety Data Sheets (SDS); and local, state, and federal rules and regulations. Maintain Safety Data Sheets (SDS) with materials in storage area and available for ready reference on Site.

H. Maintain adequate ventilation during preparation and application of roofing materials.

1.9 CHANGES IN WORK

A. During rehabilitation work, existing conditions may be encountered which are not known or are at variance with the Contract Documents. Such conditions may interfere with the Work and may consist of damage or deterioration of the substrate or surrounding materials that could jeopardize the integrity or performance of the Work.
   1. Notify Architect/Engineer of conditions that may interfere with the proper execution of the Work or jeopardize the performance of the Work prior to proceeding with the Work.

1.10 WARRANTY

A. Manufacturer's Warranty:
   1. Written warranty, signed by roofing-system manufacturer, including:
      a. Repair or replace components of roofing system that do not comply with requirements; that do not remain watertight; that fail in adhesion, cohesion, or general durability; or that deteriorate in a manner not clearly specified by submitted roofing-system manufacturer's data as an inherent quality of the material for the application indicated.
      b. Removal and replacement of roof-deck board, base sheet, temporary roof/vapor retarder, insulation, and walkway products. Warranty includes replacing materials as necessary.
      c. Labor and materials to perform warranty Work.
   2. Warranty Period: **20** years from date of completion of roofing system.

B. Roofing Installer's Warranty:
   1. Completed warranty form at the end of the Section, signed by Installer, including:
      a. Repair or replace components of roofing system that do not comply with requirements; that do not remain watertight; that fail in adhesion, cohesion, or general durability; or that deteriorate in a manner not clearly specified by submitted roofing-system manufacturer's data as an inherent quality of the material for the application indicated.
      b. Removal and replacement of roof-deck board, base sheet, temporary roof/vapor retarder, insulation, and walkway products. Warranty includes replacing materials as necessary.
      c. Labor and materials to perform warranty Work.
   2. Warranty Period: Two years from date of completion of roofing system.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Roofing-system manufacturer: use one of the following or approved equal:
   1. Carlisle SynTec Inc.
   2. Holcim Elevate.
   3. Johns Manville Roofing Systems.

2.2 EPDM ROOFING MEMBRANE

A. General:

1. Roofing-system Design: Provide roofing system that is identical to systems that have been successfully tested by qualified testing agency to resist uplift pressure calculated according to ASCE/SEI 7-10.
   a. Field-of-Roof Uplift Pressure: 28 pounds per square foot.
   b. Perimeter Uplift Pressure: 46 pounds per square foot.
   c. Corner Uplift Pressure: 69 pounds per square foot.
2. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by roofing-system manufacturer based on testing and field experience.
3. Source Limitations: Obtain components for roofing system from or approved by roofing-system manufacturer.

B. EPDM Roofing Membrane: ASTM D4637/D4637M, Type III scrim- or fabric-internally-reinforced, uniform, flexible sheet made from EPDM; 60 mils nominal thickness; Black exposed face color.

2.3 OTHER ROOFING-SYSTEM MATERIALS

A. Insulation:
   1. General: Provide preformed insulation boards that comply with requirements and referenced standards, selected from insulation manufacturer's standard sizes and of thicknesses indicated on Drawings.
   2. Polyisocyanurate Boards: ASTM C1289, Type II, glass-fiber mat facer on both major surfaces; 20-pounds-per-square-inch-minimum compressive strength.
   3. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/8 inch per 12 inches, unless otherwise indicated.
   4. Insulation Accessories:
      a. General: Insulation accessories recommended by insulation manufacturer for intended use and compatible with membrane roofing.
      b. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.
      c. Tapered Edge and Cant Strips: ASTM C728, perlite insulation board.

2.4 AUXILIARY MATERIALS

A. General: Auxiliary materials recommended by roofing-system manufacturer for intended use and compatible with membrane roofing.
   1. Liquid materials shall meet VOC limits of authorities having jurisdiction.

B. Sheet Flashing: 60-mil-thick EPDM, partially cured or uncured, according to application.

C. Bonding Adhesive: Manufacturer's standard bonding adhesive.

D. Cold, Fluid-Applied, Adhesives: Manufacturer's standard cold, fluid-applied, bonding adhesives, formulated to adhere roofing-system component to substrate.

E. Seaming Material: Manufacturer's standard, synthetic-rubber, polymer primer and 3-inch-wide-minimum, butyl splice tape with release film.

F. Lap Sealant: Manufacturer's standard single-component sealant, color to match roofing membrane.

G. Water Cutoff Mastic: Manufacturer's standard butyl mastic sealant.

H. Termination Bars: Roofing-system manufacturer's standard; Type-304-stainless-steel or aluminum bars, approximately 1-inch wide by 1/8-inch thick; with predrilled holes 8 inches on center.

I. Fasteners, General: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FM Global Class Number 4470, and acceptable to roofing-system manufacturer.
   1. Designed for fastening roofing-system components to substrate and tested by roofing-system manufacturer for required pullout strength.

J. Fasteners for Base Flashings:
   1. Wood and Plywood Substrates: 1-inch-minimum long, capped, galvanized-steel nails with ribbed shank of sufficient length to provide 1-inch-minimum embedment or pass through bottom side of wood or plywood. Use Square-Cap Nails-Steel Head with STORMGUARD double hot-dipped zinc coating manufactured by Maze Nails, or approved equal.
   2. Metal substrate: No. 12 x 1 1/2 inch, 410 stainless steel, self-drilling screws with 1-inch, stainless steel washers.

K. Miscellaneous Accessories: Provide preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, in-seam sealants, termination reglets, cover strips, and other accessories.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer and roofing-system manufacturer's representative for compliance with requirements and for other conditions affecting performance of roofing system.
   1. Ensure that work done by other trades is complete and ready for roofing Work, including:
      a. Roof openings and penetrations are in place and set and braced, and scuppers are secured in place.
      b. Wood cants, blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and nailers match thicknesses of insulation.
   2. Verify that areas and conditions under which roofing Work is to be performed permit proper and timely completion of Work.
   3. Notify Architect/Engineer in writing of conditions which may adversely affect installation or performance of roof system and recommend corrections.
   4. Do not proceed with roofing Work until adverse conditions have been corrected and reviewed by Architect/Engineer.
   5. Commencing roofing Work constitutes acceptance of Work surfaces and conditions.

3.2 PROTECTION

A. Take precautions to ensure safety of people, including building users, passers-by, and workmen, and animals, and protection of property, including adjacent building elements, landscaping, and motor vehicles.

B. Prevent construction debris and other materials from coming into contact with pedestrians, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.

C. Protect paving and sidewalks, and adjacent building areas from mechanical damage due to scaffolding and other equipment.

D. Limit access to Work areas.

E. Erect temporary protective canopies, as necessary, over walkways and at points of pedestrian and vehicular access that must remain in service during Work.

F. Comply with roofing-system manufacturer's written instructions for protecting building and other surfaces against damage from exposure to its products.

G. Cover adjacent surfaces with materials that are proven to resist roofing materials.

H. Assume responsibility for injury to persons or damage to property due to Work, and remedy at no cost to Owner.

3.3 SURFACE PREPARATION

A. Remove existing roofing system and other materials to expose substrate.
   1. Remove only as much of existing roofing as can be prepared and new temporary roof/vapor retarder or new roofing system installed in one day, unless provisions are implemented to maintain watertightness in interim or larger removal areas are approved by Owner's Representative.
   2. Provide temporary protection as needed if watertightness is compromised.
   3. Do not begin removal of existing roofing system when weather conditions are not conducive to maintaining watertightness or for application of new construction.
   4. Existing roofing consists of:
      a. Stair Tower A and B: stone ballast, loose laid EPDM, tapered wood fiber insulation
      b. Stair Tower C: Fully adhered EPDM, 1/2" thick wood fiber cover board, built-up roof membrane, tapered perlite insulation

B. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation, according to roofing-system manufacturer's written instructions. Remove sharp projections.

C. Repair or replace deteriorated sections of substrate.

D. Mask adjoining surfaces not receiving roofing system to prevent spillage or migration affecting other construction.

E. Close off scuppers and other penetrations to prevent materials from entering and clogging openings, and from spilling or migrating onto adjacent surfaces. Remove plugs when no work is taking place or when rain is forecast.

F. Installer and roofing-system manufacturer's representative shall examine substrate to ensure that it is properly prepared and ready to receive roofing system. Roofing-system manufacturer's representative shall report in writing to Installer and Architect/Engineer conditions which will adversely affect roofing-system installation or performance. Do not proceed with roofing-

system installation until these conditions have been corrected and reviewed by Architect/Engineer.

G. Proceed with installation only after unsatisfactory conditions have been corrected. Commencing installation constitutes acceptance of Work surfaces and conditions.

3.4 ROOFING-SYSTEM INSTALLATION, GENERAL

A. Install EPDM roofing membrane and base flashings according to roofing-system manufacturer's written instructions.

B. Install materials in strict accordance with safety requirements required by roofing-system manufacturer; Safety Data Sheets (SDS); and local, state, and federal rules and regulations.
   1. Follow safety procedures of OSHA and other applicable governing agencies. Assume responsibility for Work area safety at all times.
   2. Provide fully charged fire extinguishers, appropriately sized and rated, and water within the day's area of work.

C. Maintain adequate ventilation during installation of roofing materials. Notify Owner's Representative at least one week in advance of Work with materials with noxious vapors. Review application schedule and venting precautions with Owner's Representative prior to beginning application.

D. Substrate-Joint Penetrations: Prevent roofing asphalt from penetrating substrate joints, entering building, or damaging roofing-system components or adjacent building construction.

E. Coordinate installing roofing-system components so insulation and roofing membrane sheets are not exposed to precipitation, or left exposed at the end of the workday or when rain is forecast.
   1. Provide tie-offs at the end of each day's Work to cover exposed roofing membrane sheets and insulation with course of coated felt set in roofing cement or hot roofing asphalt with joints and edges sealed.
   2. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system.
   3. Remove and discard temporary seals before beginning Work on adjoining roofing.

F. Prohibit foot traffic and equipment movement over roofing system until adhesive has cured.

G. Cooperate with Architect/Engineer in performing inspections and testing of roofing system.

3.5 INSTALLATION OF INSULATION

A. Insulation Installation:
   1. Comply with roofing-system manufacturer's written instructions for installing insulation.
   2. Coordinate installation so insulation is not exposed to precipitation or left exposed at the end of the workday.
   3. Install tapered insulation to conform to slopes indicated.
   4. Install insulation with long joints in continuous, straight line; with end joints staggered between rows; and abutting edges and ends between boards.
      a. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
      b. Fill gaps exceeding 1/4 inch with insulation.

5. Install one or more layers of insulation to achieve required thickness. Where overall insulation thickness is 2 inches or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer at least 6 inches in each direction.
6. Trim surface of insulation where necessary at scuppers so finished surface is flush bottom of scupper and does not restrict flow of water.
7. Install and secure preformed, 45-degree insulation cant strips at junctures with vertical surfaces or angle changes greater than 45 degrees.
8. Install tapered edge strips at perimeter edges of roof that do not terminate at vertical surfaces.
9. Adhered Insulation: Set each layer of insulation in low-rise foam adhesive. Space beads of adhesive in accordance with manufacturer's requirements.

3.6 ROOFING MEMBRANE INSTALLATION

A. Unroll roofing membrane and allow to relax before installing.

B. Accurately align roofing membrane and maintain uniform side and end laps of minimum dimensions required by roofing-system manufacturer.
   1. Stagger end laps.
   2. Shingle side laps with slope of roof deck where possible.

C. Bonding Adhesive: Apply bonding adhesive to substrate and underside of roofing membrane at rate required by roofing-system manufacturer and allow to partially dry before installing roofing membrane. Do not apply bonding adhesive to splice area of roofing membrane.

D. Tape Seam Installation: Clean and prime both faces of splice areas, apply splice tape, and firmly roll side and end laps of overlapping roofing membrane sheets according to roofing-system manufacturer's written instructions, to ensure a watertight seam installation. Install membrane patch at T-joints.

E. Joint Cover Installation: Clean and prime area at field and flashing seams to receive joint covers. Apply joint cover and firmly roll into place in accordance with roofing-system manufacturer's written instructions. Install membrane patch at T-joints.

F. Adhesive Seam Installation: Clean both faces of splice areas, apply splicing cement, and firmly roll side and end laps of overlapping roofing membranes according to roofing-system manufacturer's written instructions, to ensure a watertight seam installation. Install membrane patch at T-joints. Apply lap sealant and seal exposed edges of roofing membrane terminations.
   1. Apply continuous bead of in-seam sealant before closing splice if required by roofing-system manufacturer.

G. Repair tears, voids, and lapped seams that are not completely sealed.

H. Install roofing membrane and auxiliary materials to tie in to existing roofing.

3.7 BASE FLASHING INSTALLATION

A. Base Flashing: Install base flashing over cant strips and other sloping and vertical surfaces, at roof edges, and at penetrations through roof, and adhere to substrates according to roofing-system manufacturer's written instructions.
   1. Apply bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply bonding adhesive to seam area of flashing.

2. Clean splice areas, apply splicing cement, and firmly roll side and end laps of overlapping sheets to ensure watertight seam installation. Apply lap sealant and seal exposed edges of sheet flashing terminations.
3. Terminate and seal upper edge of sheet flashings, and mechanically anchor to substrate with termination bars with fasteners spaced 8 inches on center and within 2 inches of end termination in base flashing.
4. Install sheet metal flashing or counterflashing at top termination of base flashing, per Section 07 62 00.

3.8 FIELD QUALITY CONTROL

A. Architect/Engineer will inspect roofing system at various stages of construction and at completion prior to installation of aggregate surfacing.

B. Final Roof Inspection: Arrange for roofing-system manufacturer's technical representative to inspect roofing installation on completion and submit report to Architect/Engineer. Notify Architect/Engineer and Owner's Representative 48 hours in advance of date and time of inspection.

C. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, and describe nature and extent of deterioration and damage in written report, with copies to Architect/Engineer and Owner's Representative.

D. Repair or remove and replace components of membrane roofing system where test results or inspections indicate that they do not comply with specified requirements.

E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional Work with specified requirements.

3.9 CLEANING

A. At the end of each workday, clean Site and Work areas and place rubbish, empty cans, rags, and other discarded materials in appropriate containers.

B. After completing roofing Work:
1. Clean spillage and soiling from adjacent surfaces using cleaning agents and procedures recommended by manufacturer of affected surface. Exercise care to avoid scratching or damage to surfaces.
2. Repair surfaces stained, marred, or otherwise damaged during roofing Work.
3. Clean up debris and surplus materials and remove from Site.

C. Waste Management:
1. Collect surplus roofing materials that cannot be reused and deliver to recycling or disposal facility.
2. Treat materials that cannot be reused as hazardous waste and dispose of in an appropriate manner.

3.10 PROTECTION

A. Protect roofing system from damage and wear during remainder of construction period.

END OF SECTION 07 53 23

ROOFING INSTALLER'S WARRANTY

WHEREAS **<Insert name>** of **<Insert address>**, herein called ***Roofing Installer***, has performed roofing and associated work, designated ***Work***, on the following project:

Owner: **<Insert name of Owner.>**
Address: **<Insert address.>**
Building Name/Type: **<Insert information.>**
Address: **<Insert address.>**
Area of Work: **<Insert information.>**
Acceptance Date: **<Insert date.>**
Warranty Period: Two years.
Expiration Date: **<Insert date.>**

AND WHEREAS Roofing Installer has contracted, either directly with Owner or indirectly as subcontractor, to warrant said Work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

NOW THEREFORE Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period it will, at its own cost and expense, make or cause to be made such repairs to or replacement of said Work as are necessary to correct faulty and defective Work and as are necessary to maintain said Work in watertight condition, and warrants against the following.

1. Components of roofing system that do not comply with requirements; that do not remain watertight; that fail in adhesion, cohesion, or general durability; or that deteriorate in a manner not clearly specified by submitted roofing-system manufacturer's data as an inherent quality of the material for the application indicated, regardless of whether the Work was previously accepted by Owner.
2. Damage by exposure to foreseeable weather; damage from leaks in roof system or related components; and damage by intrusion of foreseeable wind-borne moisture. Damage is understood to include accumulation of subsurface roof system moisture (i.e. wet insulation board), even if no other visible interior damage or moisture exists.

Warranty is made subject to the following terms and conditions:

1. Specifically excluded from Warranty are damages to Work and other parts of the building, and to building contents, caused by:
    a. lightning;
    b. peak gust wind speed exceeding 72 miles per hour;
    c. fire;
    d. failure of roof structure;
    e. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of Work;
    f. activity on roofing by others, including construction contractors and maintenance personnel, whether authorized or unauthorized by Owner's Representative.
2. When Work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Installer and until cost and expense thereof have been paid by Owner or by another responsible party so designated.
3. Roofing Installer is responsible for damage to Work covered by Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of Work.
4. During Warranty Period, if Owner allows alteration of Work by anyone other than Roofing Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, Warranty shall become null and void on date

of said alterations, but only to extent said alterations affect Work covered by Warranty. If Owner engages Roofing Installer to perform said alterations, Warranty shall not become null and void unless Roofing Installer, before starting said work, shall have notified Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate Work, thereby reasonably justifying limitation or termination of Warranty.

5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, Warranty shall become null and void on date of said change, but only to extent said change affects Work covered by Warranty.
6. Owner will promptly notify Roofing Installer of observed, known, or suspected leaks, defects, or deterioration and will afford reasonable opportunity for Roofing Installer to inspect Work and to examine evidence of such leaks, defects, or deterioration. Roofing Installer shall inspect leak, defect, or deterioration within 24 hours of notification.
7. If permanent repair or replacement of warranted condition cannot be made immediately, due to weather conditions, availability of appropriate labor or materials, building occupancy, etc., Roofing Installer must make, or cause to be made, immediate temporary repairs to prevent any further damage, deterioration, or unsafe conditions. Permanent repair or replacement of warranted condition shall be scheduled as soon thereafter as practical, and with Owner's consent and approval.
8. If Owner notifies Roofing Installer of warranted condition that requires immediate attention to prevent potential injury or damage, and Roofing Installer cannot or does not promptly inspect and repair same, either permanently or temporarily, then Owner may make, or cause to be made, such temporary repairs as may be essential and Roofing Installer will reimburse Owner for cost of such repairs. Such action will not relieve Roofing Installer of its obligation to perform any necessary permanent repairs, and Warranty shall remain in full force and effect for remaining portion of its original term.
9. Roofing Installer shall provide equipment, labor, and material required to remedy warranted conditions, including repair or replacement of damage to other work resulting therefrom, and removal and replacement of other work required to access warranted condition. Additional required work will be at Roofing Installer’s sole expense for full term of Warranty. Warranty includes removal and replacement of roof-deck boards, base sheets, temporary roof/vapor retarder, insulation, cover boards, walkway products, and work that conceals defect, for all components of roofing system.
10. Roofing Installer shall perform a thorough inspection of roof system and other Work, within 30 day period preceding first and second anniversaries of start of Warranty period, in presence of roofing-system manufacturer's representative and Owner's Representative. Roofing Installer shall make, or cause to be made, necessary repairs or replacement to remedy conditions noted during inspections, under the terms of this Warranty. Repairs to be made within 30 days of inspection date or as otherwise agreed by Owner, even if such time extends beyond Warranty period.
11. Warranty is recognized to be only Warranty of Roofing Installer on said Work and shall not operate to restrict or cut off Owner from other remedies and resources lawfully available to Owner in cases of roofing failure. Specifically, Warranty shall not operate to relieve Roofing Installer of responsibility for performance of original Work according to requirements of Contract Documents, regardless of whether Contract was directly with Owner or with Owner’s General Contractor.

IN WITNESS THEREOF, and intending to be legally bound hereby, Roofing Installer has caused this document to be executed by undersigned, duly-authorized officer.

_____ Corporate Seal:
(Roofing Installer)

By: _____

(Signature)

_____
(Name)

_____
(Date)

Subscribed and sworn to before me this ____day of _____, 20__

_____
Notary Public
My commission expires _____

SECTION 07 62 00
SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Supply, fabrication, and installation of roof, glazing, and masonry flashings and counter flashings, copings, scuppers, conductor heads, and downspouts.

B. Related Sections:
1. Section 01 11 00 – Summary of Work
2. Section 04 01 21 – Brick Masonry Repair and Replacement
3. Section 04 01 40 – Stone Restoration
4. Section 07 53 23 – EPDM Membrane Roofing
5. Section 07 92 00 – Joint Sealants
6. Section 08 80 00 – Glazing

1.2 PAYMENT

A. Provide the following on a lump sum basis as described in Sections 01 11 00.

1.3 REFERENCES

A. Reference Standards: Latest edition as of Specification date.
1. American Architectural Manufacturers Association (AAMA):
   a. 2604: Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels.
2. ASTM International:
   a. B209: Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   b. C920: Standard Specification for Elastomeric Joint Sealants.
   c. C1311: Standard Specification for Solvent Release Sealants.
3. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).
   a. Architectural Sheet Metal Manual, latest edition.
4. SSPC: The Society for Protective Coatings.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordinate Work to ensure that adjacent areas are not adversely affected. Coordinate:
1. With Owner's Representative.
2. With other trades:
   a. To ensure that work done by other trades is complete and ready for sheet-metal Work.
   b. To avoid or minimize work on, or in immediate vicinity of, sheet-metal Work in progress.
   c. To ensure that subsequent work will not adversely affect completed sheet-metal Work.
3. With interfacing and adjoining construction to provide leakproof, secure, and non-corrosive installation. Coordinate:
   a. Installation of roof drainage system with installation of roof perimeter flashing.
   b. Counterflashing installation with base flashing installation.

c. Installation of roof-penetration flashing with installation of roofing and other items penetrating roof.
d. Installation of wall-flashing with installation of masonry, traffic coating, and wall-opening components such as glazing.

1.5 SUBMITTALS

A. Product Data: For each product specified.
1. Include Safety Data Sheets (SDS) for information only; safety restrictions are sole responsibility of Contractor.

B. Shop Drawings: Show project specific layouts, profiles, shapes, seams, dimensions, and details for fastening, joining, supporting, interface conditions with other materials, and anchoring sheet-metal flashing and trim.

C. Samples: For each type of sheet-metal flashing and trim. Construct typical lap splice or seam for mechanically-jointed systems.

D. Installer Qualifications: Evidence that Installer's existing company has minimum 5 years of continuous experience in similar sheet-metal Work; list of at least five representative, successfully-completed projects of similar scope and size, including:
1. Project name.
2. Owner's name.
3. Owner's Representative name, address, and telephone number.
4. Description of work.
5. Sheet-metal members installed.
6. Project supervisor.
7. Total cost of sheet-metal work and total cost of project.
8. Completion date.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Experienced firm that has successfully completed sheet-metal work similar in material, design, and extent to that indicated for Project. Must have successful installations of specified materials in local area in use for minimum of five years.
1. Employ foreman with minimum five years of experience as foreman on similar projects, who is fluent in English, to be on Site at all times during Work. Do not change foremen during the course of the Project except for reasons beyond the control of the Installer; inform Architect/Engineer in advance of any changes.

B. Mockups: Build mockups to demonstrate aesthetic effects and set quality standards for fabrication and installation.
1. Build mockups of typical roof scupper, downspout, and edge condition (approximately 24 inches long), including supporting construction cleats, seams, attachments and accessories.
2. Build mockup of typical flashing conditions, approximately 48 inches long, including supporting construction cleats, seams, attachments, penetrations, anchorage, cladding, flashings, air, water, vapor, and thermal control layers, and accessories.
3. Approved mockups may become part of completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Sheet-Metal Members: Deliver, store, and handle materials in such a manner as to prevent damage to materials or structure.

B. Sealants, Coatings, and Miscellaneous Materials:
   1. Deliver materials to Site in original containers and packaging with seals unbroken, labeled with manufacturer's name, product brand name and type, date of manufacture, lot number, and directions for storing.
   2. Keep materials dry and do not allow materials to be exposed to moisture during transportation, storage, handling, and installation. Reject and remove from Site new materials which exhibit evidence of moisture during application, or have been exposed to moisture.
   3. Store materials in original, undamaged containers in clean, dry, protected location on raised platforms with weather-protective coverings, within temperature range required by manufacturer. Protect stored materials from direct sunlight. Manufacturer's standard packaging and covering is not considered adequate weather protection.
   4. Handle materials to avoid damage.
   5. Conspicuously mark damaged or opened containers or containers with contaminated materials and remove from Site as soon as possible.
   6. Remove and replace materials that cannot be applied within stated shelf life.

C. Limit stored materials on structures to safe loading capacity of structure at time materials are stored, and to avoid permanent deck deflection.

1.8 PROJECT CONDITIONS

A. Verify existing dimensions and details prior to start of sheet-metal Work. Notify Architect/Engineer of conditions found to be different than those indicated in the Contract Documents. Architect/Engineer will review situation and inform Contractor and Installer of changes.

B. Comply with Owner's limitations and restrictions for Site use and accessibility.

C. Environmental Limitations: Install sheet-metal members when existing and forecast weather conditions permit sealants, coatings, and miscellaneous materials to be installed according to sealant, coating, or miscellaneous material manufacturer's written instructions and warranty requirements.

D. Handle and install materials in strict accordance with safety requirements required by sheet-metal manufacturer; Safety Data Sheets (SDS); and local, state, and federal rules and regulations. Maintain Safety Data Sheets (SDS) with materials in storage area and available for ready reference on Site.

1.9 CHANGES IN WORK

A. During rehabilitation work, existing conditions may be encountered which are not known or are at variance with the Contract Documents. Such conditions may interfere with the Work and may consist of damage or deterioration of the substrate or surrounding materials that could jeopardize the integrity or performance of the Work.
   1. Notify Architect/Engineer of conditions that may interfere with the proper execution of the Work or jeopardize the performance of the Work prior to proceeding with the Work.

1.10 WARRANTY

A. Contractor's Warranty:
   1. Written warranty, signed by Contractor, including:
      a. Replace sheet-metal Work that does not comply with requirements; that has corroded surface, coating that fails cohesively or adhesively, or other surface defects or imperfections; or that deteriorates in a manner not clearly specified by material supplier's data as an inherent quality of the material for the application indicated.
      b. Remove and replace sealant that has failed cohesively or adhesively; or that deteriorates in a manner not clearly specified by sealant manufacturer's data as an inherent quality of the material for the application indicated.
      c. Repair or replacement, to satisfaction of Owner, of other work or items which may have been displaced or damaged as consequence of defective Work.
      d. Warranty does not include deterioration or damage from changes in sheet-metal environment from that reasonably anticipated at Substantial Completion, or physical damage from adjacent activities.
   2. Warranty Period: 2 years after Substantial Completion date.

B. Manufacturer's Warranty:
   1. Written warranty, signed by sheet-metal manufacturer, including:
      a. Replace sheet-metal Work that does not comply with requirements; that has corroded surface, coating that fails cohesively or adhesively, or other surface defects or imperfections; or that deteriorates in a manner not clearly specified by material supplier's data as an inherent quality of the material for the application indicated.
      b. Warranty does not include deterioration or damage from changes in sheet-metal environment from that reasonably anticipated at Substantial Completion, or physical damage from adjacent activities.
   2. Written warranty, signed by manufacturer against defects to the metal panels including color, fade, chalking, and film integrity.
   3. Warranty Period: 20 years after Substantial Completion date.

PART 2 PRODUCTS

2.1 SHEET METAL

A. For roof copings; downspouts; parapet scuppers; conductor heads, sheet metal copings, and glazing sill pans:
   1. Aluminum Sheet: ASTM B209, Alloy 3003, 3004, 3105, or 5005; temper suitable for forming and structural performance required, but not less than H14; 0.040- inches thick; finished as follows:
      a. High-performance-organic Finish: AAMA 2604, three-coat, thermocured system containing not less than 70 percent polyvinylidene fluoride resin by weight; green color as selected by Owner from manufacturer's full range.

B. For masonry through-wall flashings, base counterflashings, and drip edges:
   1. Stainless-Steel Sheet: ASTM A240/A240M, Type 304; 2D finish; 26 gage.

2.2 AUXILIARY MATERIALS

A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items required for installation.

B. Fasteners: Wood screws, annular-threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads. Size fasteners to provide penetration into substrate of at least 1 1/4 inches for nails and 3/4 inches for wood screws.
   1. Use stainless-steel fasteners, except that aluminum fasteners may be used with aluminum sheet metal, and copper or hardware bronze fasteners may be used with copper sheet metal.
   2. Exposed Fasteners: Heads match color of sheet metal by means of plastic caps or factory-applied coating.
   3. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws, gasketed, with hex washer head.
      a. Blind Fasteners: High-strength aluminum or stainless steel rivets.

C. Sealing Tape: Pressure-sensitive, 100-percent solids, polyisobutylene-compound sealing tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, non-staining tape.

D. Elastomeric Sealant: ASTM C920, elastomeric polyurethane sealant; of type, grade, class, and use classifications required to seal joints in sheet-metal flashing and trim and remain watertight.

E. Butyl Sealant: ASTM C1311, single-component, solvent-release, butyl-rubber sealant; polyisobutylene-plasticized; heavy-bodied for hooked-type expansion joints with limited movement.

F. Solder: ASTM B32.

G. Rough Carpentry: Dimension Lumber: Provide lumber of nominal sizes shown on Drawings, rip to size as needed.
   1. Kiln-dry material after treatment to maximum moisture content of 19 percent for lumber. Do not use material that is warped or does not comply with requirements for untreated material.

2.3 FABRICATION

A. Custom fabricate to comply with recommendations in SMACNA's Architectural Sheet Metal Manual, that apply to design, dimensions, metal, and other characteristics of item indicated. Conform to dimensions and profiles shown in SMACNA's Architectural Sheet Metal Manual, unless requirements that are more stringent are indicated.
   1. Obtain field measurements for accurate fit before fabrication.
   2. Shop fabricate items where practicable.
   3. Seams for Other than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.

B. Fabricate without excessive oil canning, buckling, or tool marks that are visually objectionable in opinion of Architect/Engineer, and true to line and levels indicated, with exposed edges folded back to form hems.
   1. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant. Rivet joints for additional strength.
   2. Seams for Other than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.

C. Sealed Joints: Form non-expansion but movable joints in metal to accommodate elastomeric sealant and in compliance with recommendations in SMACNA's Architectural Sheet Metal Manual.

D. Expansion Provisions: Use lapped or bayonet-type expansion provisions where possible; otherwise, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.

E. Conceal fasteners and expansion provisions, where possible, on exposed-to-view sheet-metal flashing and trim, unless otherwise indicated.

F. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, non-corrosive metal, and in thickness not less than that of metal being secured.

G. Roof Drainage Fabrications:
   1. Parapet Scuppers: Fabricate scuppers of dimensions required with closure flange trim to exterior, 4-inch-wide wall flanges to interior, and base extending 4 inches beyond cant or tapered strip into field of roof. Fasten gravel guard angles to base of scupper.
   2. Conductor Heads: Fabricate conductor heads with flanged back and stiffened top edge and of dimensions and shape indicated, complete with outlet tubes.
      a. Face width: 12”
      b. Face depth: 8”
      c. Height: 12”
      d. Style: Refer to SMACNA Fig 1-25F
   3. Downspouts: Fabricate rectangular downspouts complete with mitered elbows. Furnish with metal hangers from same material as downspouts, and anchors.
      a. Downspout Style: Corrugate rectangular, No. 4
      b. Manufactured Hanger Style: Refer to SMACNA Fig 1-35G

H. Low-Slope Roof Fabrications:
   1. Copings: Fabricate in minimum 8-foot-long, but not exceeding 10-foot-long, sections.
      a. Fabricate joint plates of same thickness as copings.
      b. Furnish with continuous cleats to support edge of external leg and drill elongated holes for fasteners on interior leg.
      c. Miter corners and seal watertight.

I. Fabrications for Glazing Sill Pan: See Drawings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions with Installer for compliance with requirements and other conditions affecting performance of sheet-metal flashings and trim.
   1. Ensure that work done by other trades is complete and ready for sheet-metal Work.
   2. Verify that areas and conditions under which sheet-metal Work is to be performed permit proper and timely completion of Work.
   3. Notify Architect/Engineer in writing of conditions which may adversely affect installation or performance of sheet-metal Work and recommend corrections.
   4. Do not proceed with installation of sheet-metal flashings and trim until adverse conditions have been corrected and reviewed by Architect/Engineer.
   5. Commencing sheet-metal Work constitutes acceptance of Work surfaces and conditions.

3.2 PROTECTION

A. Take precautions to ensure safety of people, including building users, passers-by, and workmen, and animals, and protection of property, including adjacent building elements, landscaping, and motor vehicles.

B. Prevent construction debris and other materials from coming into contact with pedestrians, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.

C. Protect paving and sidewalks, and adjacent building areas from mechanical damage due to scaffolding and other equipment.

D. Limit access to Work areas.

E. Erect temporary protective canopies, as necessary, over walkways and at points of pedestrian and vehicular access that must remain in service during Work.

F. Assume responsibility for injury to persons or damage to property due to Work, and remedy at no cost to Owner.

3.3 INSTALLATION

A. General: Install sheet-metal flashings and trim according to recommendations in SMACNA's Architectural Sheet Metal Manual and as indicated.

B. Install sheet-metal flashing and trim to fit substrates and to result in watertight performance.
   1. Install true to line and levels indicated.
   2. Where exposed, install without excessive oil canning, buckling, or tool marks.
   3. Provide uniform, neat seams with minimum exposure of solder, welds, or sealant.
   4. Do not torch cut sheet metal.

C. Provide for thermal expansion of exposed flashing and trim.
   1. Space movement joints no more than 10 feet apart, with no joint within 24 inches of corner or intersection.
   2. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with elastomeric sealant concealed within joints.

D. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by fabricator or manufacturers of dissimilar metals.

E. Anchor sheet-metal flashing and trim and other components of Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required.
   1. Space cleats not more than 12 inches apart. Anchor each cleat with two fasteners. Bend tabs over fasteners

F. Seal joints with butyl sealant as required for watertight construction.

G. Roof Drainage System Installation:
   1. Downspouts:
      a. Join sections with 1-1/2-inch-telescoping joints.

b. Provide fasteners designed to hold downspouts securely 1 inch away from walls; locate fasteners at top and bottom and at approximately 60 inches on center in between.

2. Parapet Scuppers: Install scuppers where indicated, through parapet.
   a. Set to correct elevation, continuously support scupper, and seal flanges to interior wall face, over cants or tapered edge strips and under roofing membrane.
3. Conductor Heads: Anchor securely to wall with elevation of conductor head rim 1 inch below scupper discharge.

H. Roof Flashing Installation:
1. General:
   a. Set units true to line and level as indicated.
   b. Provide concealed fasteners where possible.
   c. Install Work with laps, joints, and seams that will be permanently watertight.
2. Copings:
   a. Anchor to resist specified uplift and outward forces.
   b. Interlock exterior bottom edge of coping with continuous cleats anchored to substrate at 16-inch centers.
   c. Anchor interior leg of coping with screw fasteners and washers at 18-inch centers.
3. Counterflashing: Insert counterflashing in reglets or receivers and fit tightly to base flashing.
   a. Extend counterflashing 4 inches over base flashing.
   b. Secure in waterproof manner.
   c. Lap counterflashing joints at least 4 inches and bed with elastomeric sealant.
4. Roof-Penetration Flashing:
   a. Seal with elastomeric sealant and clamp to pipe, except for lead flashing on vent piping.

I. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to width of 1 1/2 inches except where pre-tinned surface would show in finished Work.

3.4 CLEANING

A. At the end of each workday, clean Site and Work areas and place rubbish, empty cans, rags, and other discarded materials in appropriate containers.

B. After completing sheet-metal Work:
1. Clean spillage and soiling from adjacent surfaces using cleaning agents and procedures recommended by manufacturer of affected surface. Exercise care to avoid scratching or damage to surfaces.
2. Repair surfaces stained, marred, or otherwise damaged during roofing Work.
3. Clean up debris and surplus materials and remove from Site.

3.5 PROTECTION

A. Protect sheet-metal flashings and trim from damage and wear during remainder of construction period.

END OF SECTION 07 62 00

SECTION 07 65 00
FLEXIBLE FLASHING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Preparation, supply, and installation of self-adhering flexible membrane flashing, including bonding cement, primers, and other components; at perimeter walls.

B. Related Sections:
   1. Section 07 62 00 - Sheet Metal Flashing and Trim: Sheet metal flashings.
   2. Section 07 92 00 - Joint Sealants: Joint sealant.

1.2 PAYMENT

A. Provide the following on a lump sum basis as described in Sections 01 11 00.

1.3 REFERENCES

A. Reference Standards: Latest edition as of Specification date.
   1. FM Global:
      a. Class Number 4470: Approval Standard for Single-Ply, Polymer-Modified Bitumen Sheet, Built-Up Roof (BUR) and Liquid Applied Roof Assemblies for use in Class 1 and Noncombustible Roof Deck Construction.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordinate Work to ensure that new flexible-flashing materials and building interior are kept continuously dry; that continuous, watertight, new flexible-flashing system is provided; and that adjacent areas are not adversely affected. Coordinate:
   1. With Owner's Representative.
   2. With other trades:
      a. To ensure that work done by other trades is complete and ready for flexible-flashing Work.
      b. To avoid or minimize work on, or in immediate vicinity of, flexible-flashing Work in progress.
      c. To ensure that subsequent work will not adversely affect completed flexible flashings.

1.5 SUBMITTALS

A. Product Data: Flexible-flashing manufacturer's literature including written instructions for evaluating, preparing, and treating substrate; technical data including tested physical and performance properties; and installation instructions.
   1. Include temperature ranges for storage and application of materials, and special cold-weather application requirements or limitations.
   2. Include Safety Data Sheets (SDS) for information only; safety restrictions are sole responsibility of Contractor.

B. Shop Drawings: Include sections, details, and attachments to other work; for details and fabrications not shown on Drawings.

1. Termination and tie-in conditions.
2. Substrate joints and cracks.
3. Inside and outside corners.

C. Samples: 3-inch-by-4-inch section of flexible flashing.

D. Manufacturer's Certificates:
1. Signed by flexible-flashing manufacturer, certifying that flexible flashing is appropriate for intended use and is compatible with substrates and adjacent materials, including joint sealant.
2. Signed by joint sealant manufacturer, certifying that joint sealant is appropriate for intended use and is compatible with substrates and adjacent materials.
3. Signed by flexible-flashing manufacturer, certifying that completed installation complies with manufacturer's requirements and recommendations.

E. Field Quality Control: Reports for site visits of flexible-flashing manufacturer's technical representative.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Experienced firm that has successfully completed flexible-flashing work similar in material, design, and extent to that indicated for Project; and that is approved, authorized, or licensed by flexible-flashing manufacturer to install flexible flashing. Must have successful installations of specified materials in local area in use for minimum of five years.
1. Employ foreperson with minimum five years of experience as foreperson on similar projects, who is fluent in English, to be on Site at all times during Work. Do not change foremen during the course of the Project except for reasons beyond the control of the Installer; inform Architect/Engineer in advance of any changes.

B. Mockups: Install at least three pieces of flexible flashing and mockup of flashing system, as indicated on Drawings, to demonstrate surface preparation and execution quality. Architect/Engineer may watertest mockup immediately after installation.
1. After flexible-flashing pieces have fully cured, cut along sides of loose tails of flexible-flashing pieces down to substrate, and pull tails until they lift up to demonstrate adhesion of flexible flashing to substrate.
2. If Architect/Engineer determines mockup does not comply with requirements, modify mockup or construct new mockup until mockup is approved.
3. Approved mockups may become part of completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle materials according to manufacturer's recommendations and in such a manner as to prevent damage to materials or structure.

B. Deliver materials to Site in original containers and packaging with seals unbroken, labeled with manufacturer's name, product brand name and type, date of manufacture, lot number, and directions for storing and mixing with other components.

C. Keep materials dry and do not allow materials to be exposed to moisture during transportation, storage, handling, or installation. Reject and remove from Site new materials which exhibit evidence of moisture during application or which have been exposed to moisture.

D. Store materials in original, undamaged containers in clean, dry, protected location on raised platforms with weather-protective coverings, within temperature range required by manufacturer. Protect stored materials from direct sunlight. Manufacturer's standard packaging and covering is not considered adequate weather protection.

E. Store rolled materials on ends only, unless otherwise required by manufacturer's written instructions. Discard rolls that have been flattened, creased, or otherwise damaged.

F. Limit stored materials on structures to safe loading capacity of structure at time materials are stored, and to avoid permanent deck deflection.

G. Conspicuously mark wet or damaged materials and remove from Site as soon as possible.

H. Remove and replace materials that cannot be applied within stated shelf life.

1.8 PROJECT CONDITIONS

A. Verify existing dimensions and details prior to start of flexible-flashing Work. Notify Architect/Engineer of conditions found to be different than those indicated in the Contract Documents. Architect/Engineer will review situation and inform Contractor and Installer of changes.

B. Comply with Owner's limitations and restrictions for Site use and accessibility.

C. Protect adjacent areas from damage from construction activities. Repair damage to adjacent areas from construction activities.

D. Environmental Limitations: Install flexible flashing when existing and forecast weather conditions permit flashing system to be installed according to flexible-flashing manufacturer's written instructions.
   1. Observe cold-weather precautions and guidelines recommended by flexible-flashing manufacturer when applying flashing materials below 40 degrees F.
   2. Do not proceed with installation during inclement weather except for temporary work necessary to protect building interior and installed materials. Remove temporary work and Work that becomes moisture damaged.

E. Handle and install materials in strict accordance with safety requirements required by flexible-flashing manufacturer; Safety Data Sheets (SDS); and local, state, and federal rules and regulations. Maintain Safety Data Sheets (SDS) with materials in storage area and available for ready reference at Site.

1.9 CHANGES IN WORK

A. During rehabilitation work, existing conditions may be encountered which are not known or are at variance with the Contract Documents. Such conditions may interfere with the Work and may consist of damage or deterioration of the substrate or surrounding materials that could jeopardize the integrity or performance of the Work.
   1. Notify Architect/Engineer of conditions that may interfere with the proper execution of the Work or jeopardize the performance of the Work prior to proceeding with the Work.

PART 2 PRODUCTS

2.1 FLEXIBLE FLASHINGS

A. Self-adhering, rubberized-asphalt, flexible flashing. Primer to be installed unless recommended otherwise by manufacturer: Use one of the following or approved equal:
   1. Perm-A-Barrier Wall Flashing or Vycor V40 Self-Adhered Flashing manufactured by Grace Construction Products.
   2. CCW-705-TWF manufactured by Carlisle Coatings & Waterproofing Inc.
   3. Ice & Water Shield Strips manufactured by Grace Construction Products.

B. When installed directly below sheet-metal flashings: Self-adhering membrane to be is to be high-temperature rated. Note, do not solder, weld, or apply high temperatures to sheet-metal flashings when installed over self-adhering membrane. Use one of the following or approved equal:
   1. Grace Ultra manufactured by Grace Construction Products.

C. Source Limitations: Obtain flexible-flashing materials through one source from single manufacturer.

2.2 AUXILIARY MATERIALS

A. General: Furnish auxiliary materials recommended by flexible-flashing manufacturer for intended use and compatible with flexible flashing.
   1. Furnish liquid-type auxiliary materials that comply with VOC limits of authorities having jurisdiction.

B. Primer: Liquid primer recommended for substrate.

C. Surface Conditioner: Liquid, waterborne, surface conditioner recommended for substrate.

D. Sheet Strips: Self-adhering, rubberized-asphalt composite sheet strips of same material and thickness as flexible flashing.

E. Liquid Membrane: Elastomeric, two-component, cold-fluid-applied, trowel-grade or low-viscosity as recommended for substrate.

F. Substrate Patching Membrane: Low-viscosity, two-component, asphalt-modified coating.

G. Mastic, Adhesives, and Tape: Liquid mastic and adhesives, and adhesive tapes.

H. Metal Termination Bar: Manufacturer’s standard; Type-304-stainless-steel or aluminum; approximately 1-inch wide by 1/8-inch thick; with predrilled holes 6 to 8 inches on center.

I. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FM Global Class Number 4470 and acceptable to flexible-flashing manufacturer.
   1. Designed for fastening flexible-flashing components to substrate.
   2. Wood and Plywood Substrates: 1-inch-minimum long, capped, galvanized-steel nails with ribbed shank of sufficient length to provide 1-inch-minimum embedment or pass through bottom side of wood or plywood. Use Square-Cap Nails-Steel Head with STORMGUARD double hot-dipped zinc coating, manufactured by Maze Nails, or approved equal.
   3. Masonry Substrate: Stainless steel with hex washer head.

a. 410 Stainless Steel Tapcon Anchors manufactured by ITW Red Head, Inc.
b. 304 Stainless Steel Tapper, 1/4-inch diameter with hex washer head, manufactured by Powers Fasteners.
c. 1 3/4 inch minimum length, or as noted on details.

4. Metal substrate: No. 12 x 1 1/2 inch, 410 stainless steel, self-drilling screws with 1-inch, stainless steel washers.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer and flexible-flashing manufacturer's representative for compliance with requirements and for other conditions affecting installation or performance of flexible flashings.
1. Ensure that work done by other trades is complete and ready for flexible-flashing Work.
2. Verify that areas and conditions under which flexible-flashing Work is to be performed permit proper and timely completion of Work.
3. Notify Architect/Engineer in writing of conditions which may adversely affect flexible installation or performance of flexible flashings and recommend corrections.
4. Do not proceed with flexible-flashing Work until adverse conditions have been corrected and reviewed by Architect/Engineer.
5. Commencing flexible-flashing Work constitutes acceptance of Work surfaces and conditions.

3.2 PROTECTION

A. Take precautions to ensure safety of people, including building users, passers-by, and workers, and animals, and protection of property, including adjacent building elements, landscaping, and motor vehicles.

B. Prevent construction debris and other materials from coming into contact with pedestrians, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.

C. Protect paving and sidewalks, and adjacent building areas from mechanical damage due to scaffolding and other equipment.

D. Limit access to Work areas.

E. Erect temporary protective canopies, as necessary, over walkways and at points of pedestrian and vehicular access that must remain in service during Work.

F. Assume responsibility for injury to persons or damage to property due to Work, and remedy at no cost to Owner.

3.3 SURFACE PREPARATION

A. Remove existing materials to expose substrate.
1. Remove only as much of existing flashing as can be prepared and new flexible-flashing system installed in one day, unless provisions are implemented to maintain watertightness in interim or larger removal areas are approved by Owner's Representative.
2. Provide temporary protection as needed if watertightness is compromised.

3. Do not begin removal of existing flashing system when weather conditions are not conducive to maintaining watertightness or for application of new construction.

B. Clean, prepare, and treat substrates according to flexible-flashing manufacturer's written instructions. Provide clean, sound, dust-free, and dry substrate.
   1. Repair or replace deteriorated sections of substrate.
   2. Fill divots, chips, spalls, and other irregularities in substrate. Fill in or cover gaps, joints, and cracks to provide continuous substrate for flexible flashing. Remove sharp projections.
   3. Remove grease, oil, and other surface contaminants and foreign materials.

C. Mask adjoining surfaces not receiving flexible-flashing system to prevent spillage or migration affecting other construction.

D. Close off roof drains and other penetrations to prevent materials from entering and clogging drains and conductors, and from spilling or migrating onto adjacent surfaces. Remove roof-drain plugs when no work is taking place or when rain is forecast.

E. Installer and flexible-flashing manufacturer's representative shall examine substrate to ensure that it is properly prepared and ready to receive flashing system. Flexible-flashing manufacturer's representative shall report in writing to Installer and Architect/Engineer conditions which will adversely affect flashing system installation or performance. Do not proceed with flashing system installation until these conditions have been corrected and reviewed by Architect/Engineer.

F. Proceed with installation only after unsatisfactory conditions have been corrected. Commencing installation constitutes acceptance of Work surfaces and conditions.

3.4 FLEXIBLE FLASHING INSTALLATION

A. General:
   1. Install flashing system according to flexible-flashing manufacturer's written instructions.
   2. Install materials in strict accordance with safety requirements required by flexible-flashing manufacturer; Safety Data Sheets (SDS); and local, state, and federal rules and regulations.
      a. Follow safety procedures of OSHA and other applicable governing agencies. Assume responsibility for Work area safety at all times.
      b. Provide dry-chemical or CO_2 fire extinguishers in Work area.
      c. Do not permit smoking in Work area.
      d. Store solvents in safety cans. Do not permit open solvent containers.
      e. Store cleaning rags and waste materials in metal containers with tight covers, or remove from Site each night.
   3. Maintain adequate ventilation during installation of flexible-flashing materials. Notify Owner's Representative at least one week in advance of Work with materials with noxious vapors. Review application schedule and venting precautions with Owner's Representative prior to beginning application.

B. Installation of Flexible Flashings:
   1. Supply and install sheet metal flashings.
   2. Prime surfaces by brush or roller, with primer at rate recommended by flexible-flashing manufacturer. Allow primer to dry one hour or until tack free. Reprime surfaces not covered within 36 hours.
   3. Fully adhere flexible flashing to substrate.
      a. Remove release paper.

b. Carefully position and install sheets to extend in a shingle-like manner from lower points to high points, with 3-inch minimum laps between sheets. Roll sheets, including lapped seams.

4. At flashing terminations, turn up ends at least 2 inches and make careful folds to form end dam, with seams sealed.
5. Tie flexible flashing into adjacent waterproofing where applicable.
6. Apply bead or trowel coat of mastic at top edge, seams, cuts, and penetrations.
7. Install termination bar at upper edge of flexible flashing and mechanically fasten 6 to 8 inches on center and within 2 inches of end of bar.
8. Inspect each layer of flexible flashing, with manufacturer's representative if required by flexible-flashing manufacturer, for tears, holes, debonding, and misaligned- or inadequately lapped seams.
9. Repair or remove and replace flexible flashing that does not comply with requirements. Patch holes in flexible flashing with minimum overlap of 6 inches, in accordance with flexible-flashing manufacturer's instructions.
10. Exercise care to prevent damage to flexible flashing.
11. Cover newly installed flexible flashing immediately to prevent exposure to UV degradation longer than indicated by flexible-flashing manufacturer.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage qualified, independent testing and inspecting agency to perform flashing inspections, and to prepare reports.

B. Architect/Engineer will inspect flashing installation at various stages of construction.

C. Site Visits by Flexible-Flashing Manufacturer's Technical Representative: Arrange for flexible-flashing manufacturer's technical representative to periodically inspect flexible-flashing installation and submit reports to Architect/Engineer.

D. Repair or remove and replace flexible flashing where test results or inspections indicate that it does not comply with specified requirements.

E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional Work with specified requirements.

3.6 CLEANING

A. At the end of each workday, clean Site and Work areas and place rubbish, empty cans, rags, and other discarded materials in appropriate containers.

B. After completing flexible-flashing Work:
1. Clean spillage and soiling from adjacent surfaces using cleaning agents and procedures recommended by manufacturer of affected surface. Exercise care to avoid scratching or damage to surfaces.
2. Repair surfaces stained, marred, or otherwise damaged during roofing Work.
3. Clean up debris and surplus materials and remove from Site.

END OF SECTION 07 65 00

SECTION 07 92 00
JOINT SEALANTS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Surface preparation and installation of sealant in joints and at designated voids as indicated in Drawings and Specifications.

B. Related Sections:
1. Section 01 11 00 – Summary of Work
2. Section 01 22 00 – Unit Prices
3. Section 03 01 34 – Concrete Repair
4. Section 03 15 11 – Expansion Joint Seals
5. Section 04 01 21 – Brick Masonry Repair and Replacement
6. Section 04 01 40 – Stone Restoration
7. Section 07 18 00 – Traffic Coatings
8. Section 07 19 17 – Silane Water Repellent
9. Section 08 80 00 – Glazing

1.2 PAYMENT

A. Perform the Work on a lump sum or unit price basis as described in Section 01 11 00 and Section 01 22 00.

1.3 REFERENCES

A. Reference Standards: Latest edition as of Specification date.
1. ASTM International:
   a. C920: Standard Specification for Elastomeric Joint Sealants.
   b. C1087: Standard Test Method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems.
   c. C1193: Standard Guide for Use of Joint Sealants
   d. C1248: Standard Test Method for Staining of Porous Substrate by Joint Sealants.
   e. C1330: Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants.
   f. C1472: Standard Guide for Calculating Movement and Other Effects When Establishing Sealant Joint Width.
   g. C1521: Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordinate Work to ensure that adjacent areas are not adversely affected; that new materials and building interior are kept continuously dry; and that continuous, watertight, new sealant installation is provided. Coordinate:
1. With Owner's Representative.
2. With other trades:
   a. To ensure that work done by other trades is complete and ready for sealant Work.

b. To avoid or minimize work on, or in immediate vicinity of, sealant Work in progress.
c. To ensure that subsequent work will not adversely affect completed sealant Work.

B. Pre-Installation Meeting:
1. Conduct meeting at Site.
2. Review requirements for sealant Work, including:
a. Construction schedule.
b. Availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
c. Site use, access, staging, and set-up location limitations.
d. Forecast weather conditions.
e. Surface preparation and substrate condition and pretreatment.
f. Installation procedures.
g. Special details and condition of other construction that will affect sealant Work.
h. Testing and inspection requirements.
i. Temporary protection and repairs of sealant Work.
j. Government regulations.
3. Contractor's Site superintendent, sealant manufacturer's technical representative, sealant Installer, Owner's Representative, Architect/Engineer, and testing agency representative shall attend.

1.5 SUBMITTALS

A. Product Data: Sealant manufacturer's literature including written instructions for evaluating, preparing, and treating substrate; technical data including tested physical and performance properties; and installation instructions.
1. Include temperature ranges for storage and application of materials, and special cold-weather application requirements or limitations.
2. Data sheet for substrate cleaner and substrate primer recommended by sealant manufacturer for specific substrate surface and conditions.

B. Samples: Sealant manufacturer's color sample card, either printed or with thin sealant beads, showing range of colors available for each product exposed to view.

C. Manufacturer's Reports and Certifications:
1. Prior to sealant installation, report from sealant manufacturer with results of sealant compatibility, sealant and substrate staining, and mockup adhesion evaluations. Report shall:
a. State that materials which come into contact with or in close proximity to sealant have been tested.
b. Include sealant manufacturer's interpretation of test results relative to material performance, potential staining of sealant and substrates, dirt accumulation of sealant, and dirt runoff from sealant.
c. Include sealant manufacturer's recommendations for substrate preparation and primer needed to obtain durable adhesion; required cure time before penetrating sealer or elastomeric coating can be applied; and installation procedures successfully used in mockups and field tests.
2. Product Certificates: For each sealant product, accessory, related products, joint type, and substrate, sealant manufacturers' written approval of their products' use for specified conditions; based on mockups and field tests.

D. Installer Qualifications:
   1. If required by the sealant manufacturer, letter signed by sealant manufacturer, certifying that Installer complies with requirements.
   2. Evidence that Installer's existing company has minimum 5 years of continuous experience in similar sealant work; list of at least five representative, successfully-completed projects of similar scope and size, including:
      a. Project name.
      b. Owner's name.
      c. Owner's Representative name, address, and telephone number.
      d. Description of work.
      e. Sealant used.
      f. Project supervisor.
      g. Total cost of sealant work and total cost of project.
      h. Completion date.

E. Sample Warranty: Copy of sealant manufacturer's warranty, stating obligations, remedies, limitations, and exclusions. Submitted with bid.

F. Following completion of the Work:
   1. Sealant manufacturer's inspection report of completed sealant installation.
   2. Completed warranty from sealant manufacturer.
   3. Completed warranty from Installer.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Experienced firm that has successfully completed sealant work similar in material, design, and extent to that indicated for Project; that is approved, authorized, or licensed by sealant manufacturer to install sealant; and that is eligible to receive sealant manufacturer's warranty. Must have successful installations of specified materials in local area in use for minimum of 5 years.
   1. Employ foreman with minimum 5 years of experience as foreman on similar projects, to be on Site at all times during Work. Do not change foremen during the course of the Project except for reasons beyond the control of the Installer; inform Architect/Engineer in advance of any changes.

B. Compatibility Tests: Include sealant and sealers or coatings that may come into contact with sealant following sealant installation.
   1. Conduct compatibility test according to ASTM C1087 to determine sealant compatibility when in contact with glazing and gasket materials.

C. Mockups: Install 10 feet of sealant in each type of joint to verify and set quality standards for materials and installation procedures, and to demonstrate aesthetic effects.
   1. Include each type of backing material, sealant, primer and other related products.
   2. Mockups shall be accessible or located as indicated by Owner's Representative.
   3. Notify Owner's Representative, Manufacturer's Representative, and Architect/Engineer at least 7 days in advance of date when mockups will be constructed.
   4. Sealant manufacturer's representative shall observe the preparation of the joints for the mock-up. The sealant manufacturer's representative provide written confirmation that the joint preparation is performed in accordance with the sealant manufacturer's recommendations.
   5. Field-Adhesion Evaluation: After sealants have fully cured, perform field-adhesion evaluation according to ASTM C1521.

a. Conduct evaluations for each type of sealant and joint substrate, with and without primer.
b. Arrange for evaluations to take place with sealant manufacturer's technical representative present.
c. Sealants not evidencing adhesive failure during the evaluation, in the absence of other indications of noncompliance with requirements, will be considered satisfactory. Use alternate materials or modify installation procedure, or both, for sealants that fail to adhere to substrates.

6. If Owner's Representative or Architect/Engineer determines mockup does not comply with requirements, modify mockup or construct new mockup until mockup is approved.
7. Mockups, when approved by Owner's Representative and Architect/Engineer, will become standard for Work.
8. Approved mockups may become part of completed Work if undisturbed at time of Substantial Completion.
9. Do not begin joint sealant Work until mockup is accepted by Owner's Representative and Architect/Engineer.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle materials according to manufacturer's recommendations and in such a manner as to prevent damage to materials or structure.

B. Deliver materials to Site in original packages with seals unbroken, labeled with manufacturer's name, product brand name and type, date of manufacture, lot number, and directions for storing and mixing with other components.

C. Keep materials dry and do not allow materials to be exposed to moisture during transportation, storage, handling, or installation. Reject and remove from Site new materials which exhibit evidence of moisture during application or which have been exposed to moisture.

D. Store materials in original, undamaged containers and packaging in clean, dry, protected location on raised platforms with weather-protective coverings, within temperature range required by manufacturer. Protect stored materials from direct sunlight. Manufacturer's standard packaging and covering is ***not*** considered adequate weather protection.

E. Limit stored materials on structures to safe loading capacity of structure at time materials are stored, and to avoid permanent deck deflection.

F. Conspicuously mark wet or damaged materials and remove from Site as soon as possible.

G. Remove and replace materials that cannot be applied within stated shelf life. Remove all expired sealant from Site.

1.8 PROJECT CONDITIONS

A. Verify existing dimensions and details prior to start of sealant Work. Notify Architect/Engineer of conditions found to be different than those indicated in the Contract Documents. Architect/Engineer will review situation and inform Contractor and Installer of changes.

B. Comply with Owner's limitations and restrictions for Site use and accessibility.

C. Hazardous Materials: Testing of existing joint sealants for hazardous materials has been performed.
   1. Refer to report dated February 26, 2024 by ASTI Environmental for hazardous materials information.
   2. The Contractor shall be responsible for ensuring that personnel within the Work area and the public are protected from exposure to hazardous materials; preventing contamination of the building/site; and appropriately characterizing materials to allow for their handling and disposal in accordance with all applicable laws and regulations.

D. Environmental Limitations: Install sealant when existing and forecast weather conditions permit sealant to be installed according to sealant manufacturer's written instructions and warranty requirements. Unless more restrictive limits are recommended by the manufacturer.
   1. Do not install sealant when ambient or substrate temperatures are below 40 degrees F or are expected to fall below 40 degrees F in next 12 hours.
   2. Do not proceed with installation during inclement weather except for temporary work necessary to protect building interior and installed materials. Remove temporary work and Work that becomes moisture damaged.

1.9 CHANGES IN WORK

A. During rehabilitation work, existing conditions may be encountered that are not known or are at variance with the Contract Documents. Such conditions may interfere with the Work and may consist of damage or deterioration of the substrate or surrounding materials that could jeopardize the integrity or performance of the Work.
   1. Notify Architect/Engineer of conditions that may interfere with the proper execution of the Work or jeopardize the performance of the Work prior to proceeding with the Work.

1.10 WARRANTY

A. Installer's Warranty:
   1. Completed warranty form at the end of the Section, signed by sealant Installer, including:
      a. Repair or replace sealant that does not comply with requirements; that does not remain watertight; that fails in adhesion, cohesion, or general durability; or that deteriorates in a manner not clearly specified by submitted sealant manufacturer's data as an inherent quality of the material for the application indicated.
      b. Removal and replacement with new bond breaker materials.
      c. Labor and materials to perform warranty Work.
      d. Warranty does not include sealant deterioration or failure due to the following:
         1) Excessive joint movement caused by structural settlement or errors attributable to design or construction, resulting in stresses in sealant exceeding sealant manufacturer's written specifications for sealant elongation or compression.
         2) Deterioration or failure of sealant due to failure of substrate prepared according to requirements.
         3) Mechanical damage caused by individuals, tools, or other outside agents.
         4) Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.
   2. Warranty Period: A minimum of 2 years from date of Substantial Completion.

B. Manufacturer's Warranty:
   1. Written warranty, signed by sealant manufacturer, including:
      a. Repair or replace sealant that does not comply with requirements; that does not remain watertight; that fails in adhesion, cohesion, or general durability; or that

deteriorates in a manner not clearly specified by submitted sealant manufacturer's data as an inherent quality of the material for the application indicated.

b. Removal and replacement with new bond breaker materials.
c. Labor and materials to perform warranty Work.
d. Warranty does not include sealant deterioration or failure due to the following:
    1) Excessive joint movement caused by structural settlement or errors attributable to design or construction, resulting in stresses in sealant exceeding sealant manufacturer's written specifications for sealant elongation or compression.
    2) Deterioration or failure of sealant due to failure of substrate prepared according to requirements.
    3) Mechanical damage caused by individuals, tools, or other outside agents.
    4) Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

2. Warranty Period: 5 years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 ELASTOMERIC JOINT SEALANTS

A. General:
1. Comply with ASTM C920 and other requirements indicated.
2. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer, based on testing on similar projects, mockups and preconstruction testing for Project, and field experience.
3. Select products based on mockups, preconstruction testing, and sealant manufacturer's previous testing and experience.
4. Source Limitations: Obtain each type of joint sealant through one source from single manufacturer.
5. Colors of Exposed Joint Sealants: Selected and approved in writing by Owner's Representative, from sealant manufacturer's full range.

B. Ensure sealant selected is compatible with coating and sealer products used. Use polyurethane sealants for concrete substrates and at locations scheduled to receive coating or sealer. Use hybrid sealant near pedestrian bridge expansion joints.

C. Single-Component, Non-sag, Polyurethane Sealants:
1. Iso-Flex 830 manufactured by LymTal International, Inc.
2. SikaFlex-1A manufactured by Sika Corporation.
3. Vulkem 116 manufactured by Tremco Commercial Sealants & Waterproofing.
4. Sikaflex NP 1 manufactured by Sika Corporation.
5. DynaTred manufactured by Pecora Corporation.

D. Single-Component, Pourable, Polyurethane Sealants:
1. Sikaflex SL 1 manufactured by Sika Corporation.
2. Sikaflex-1c SL manufactured by Sika Corporation.
3. Vulkem 45SSL manufactured by Tremco Commercial Sealants & Waterproofing.

E. Multi-Component, Non-sag, Polyurethane Sealants:
1. DynaTrol II manufactured by Pecora Corporation.
2. Iso-Flex 881 manufactured by LymTal International, Inc.

3. Sikaflex NP 2 manufactured by Sika Corporation.
4. SikaFlex-2c NS manufactured by Sika Corporation.

F. Multi-Component, Pourable, Polyurethane Sealants:
1. Iso-Flex 880 GB manufactured by LymTal International, Inc.
2. Sikaflex SL 2 manufactured by Sika Corporation.
3. Sikaflex-2c SL manufactured by Sika Corporation.
4. Urexpan NR-201 manufactured by Pecora Corporation.

G. For masonry work only: Single-component, Non-sag, Silicone Sealants:
1. DOWSIL 795 Silicone Building Sealant manufactured by Dow Chemical Company.
2. 864NST manufactured by Pecora Corporation.
3. SCS2000 SilPruf manufactured by General Electric Company.
4. Spectrem 2, manufactured by Tremco Commercial Sealants & Waterproofing.
5. Or approved equal.

H. For glazing sealant: See Section 07 92 00.

I. For pre-formed silicone sheets: See Section 07 92 00.

2.2 SILICONE-COATED, PRECOMPRESSED SEALS

A. Silicone-Coated, Precompressed, Primary Seals: Where movement joints are greater than 2 inches, in sizes to fit joint widths indicated.
1. Seismic Colorseal manufactured by Sika Corporation.
2. Iso-Flex Precom “C” manufactured by LymTal International, Inc.
3. Wabo Seismic Weatherseal (SWS) manufactured by Sika Corporation.
4. Silicone Covered Ethylene Foam System (SCE) manufactured by MM Systems.
5. CS-Series manufactured by Erie Metal Specialties.

B. Silicone: Field applied corner bead at face of seal to substrate interface, furnished by joint seal manufacturer, in same material and color as used in factory coating.

2.3 AUXILIARY MATERIALS

A. Sealant Backing:
1. Sealant Backing Material, General Non-Staining: Compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer.
2. Cylindrical Sealant Backings: ASTM C1330, Type B (bi-cellular material with surface skin, non-gassing, expanded polyethylene), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
a. Sof Rod manufactured by Nomaco, Inc.
b. Expand-O-Foam manufactured by Williams Products, Inc.
3. Bond Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

B. Joint Primer: Type recommended by the sealant manufacturer for the specific joint surface and conditions.

C. General: Sealant-backer materials, primers, surface cleaners, masking tape, and other materials recommended by sealant manufacturer for the specific joint surface and conditions, which are non-staining and compatible with substrates; based on mockups, preconstruction testing, and sealant manufacturer's previous testing and experience.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions with Installer and sealant manufacturer's representative for compliance with requirements and for other conditions affecting installation or performance of sealant.
   1. Verify dimensions of sealant joints at Site by field measurement so that proper sealant profiles will be accurately maintained.
   2. Ensure that work done by other trades is complete and ready for sealant Work.
   3. Verify that areas and conditions under which sealant Work is to be performed permit proper and timely completion of Work.
   4. Notify Architect/Engineer in writing of conditions which may adversely affect installation or performance of sealant, including joints with widths less than those allowed by sealant manufacturer for applications indicated, and recommend corrections.
   5. Do not proceed with sealant Work until adverse conditions have been corrected and reviewed by Architect/Engineer.
   6. Commencing sealant Work constitutes acceptance of Work surfaces and conditions.

3.2 PROTECTION

A. Take precautions to ensure safety of people, including building users, passers-by, and workmen, and animals, and protection of property, including adjacent building elements, landscaping, and motor vehicles.

B. Prevent construction dust, debris and other materials from coming into contact with pedestrians, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.

C. Protect paving and sidewalks, and adjacent building areas from mechanical damage due to scaffolding and other equipment.

D. Limit access to Work areas.

E. Comply with sealant manufacturer's written instructions for protecting building and other surfaces against damage from exposure to its products.

F. Cover adjacent surfaces with materials that are proven to resist sealant.

G. Assume responsibility for injury to persons or damage to property due to Work, and remedy at no cost to Owner.

3.3 SURFACE PREPARATION

A. Remove existing sealant, sealant residue, and other foreign material from joints. Care shall be used in the removal of sealants so as not to damage existing construction intended to remain.

B. Repair damaged or deteriorated substrate surfaces according to sealant manufacturer's written instructions and as approved by Architect/Engineer. Any surfaces which are found to be unsuitable for installation of the joint sealants shall be brought to the immediate attention of the Architect/Engineer for review.

C. Clean joint substrates immediately before installing sealant, to comply with sealant manufacturer's written instructions based on mockups and preconstruction evaluation and testing.
   1. Remove from substrate foreign material that could interfere with adhesion of sealant, including dirt, dust, existing sealant, oil, grease, and surface coatings.
   2. Provide dry substrate; prevent wetting of substrate prior to sealant installation.
   3. Clean porous substrates, such as concrete, masonry, stone, wood, by brushing, grinding, blast-cleaning, mechanical-abrading, or combination of methods to produce clean, sound substrate capable of developing optimum bond with sealant established in mockups. Remove laitance and form-release agents from concrete. Remove loose particles remaining after cleaning operations by vacuuming or blowing out joints with oil-free, compressed air.
   4. Clean nonporous surfaces, such as metal, with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of sealant.
   5. Mask surfaces adjacent to bonding substrates to limit cleanup of spillage and smears. Surfaces not intended to receive sealant should be kept clean.

D. Install masking or pressure sensitive tape on adjacent surfaces to prevent permanent staining or damage due to contact with sealant or cleaning methods to remove sealant smears. Install masking tape on sides of joints where sealant will be recessed**.** Remove tape immediately after tooling sealant, without disturbing sealant.

3.4 INSTALLATION OF SEALANT

A. General: Comply with sealant manufacturer's written installation instructions for products and applications indicated, based on mockups and preconstruction testing.

B. Temporarily mask surfaces adjacent to sealant joint to provide clean linear termination of the new sealant.

C. Joint Priming: Prime joint substrates unless recommended against in writing by sealant manufacturer, based on mockups and preconstruction evaluation and testing. Apply primer to comply with sealant manufacturer's written instructions.
   1. Confine primer to areas of sealant bond; do not allow spillage or migration onto adjoining surfaces.
   2. Limit priming to areas that will be covered with sealant in same day. Unless recommended otherwise by sealant manufacturer, reprime areas exposed for more than 24 hours.

D. Install sealant backer and position to produce cross-sectional shape and proper depth of installed sealant.
   1. Use properly sized backer. Do not use multiple-backer units or braided-backer units to accommodate wide joints.
   2. Use tools to install outer surface of backer to a consistent depth from substrate surface.
   3. Do not leave gaps between ends of sealant backers.
   4. Do not stretch, twist, puncture, or tear sealant backers.

5. Remove wet backers and replace with dry materials.

E. Install bond-breaker tape at back of designated joints.

F. Install sealant immediately after installing backer material; to produce uniform, cross-sectional shape and depth; to directly contact and fully wet joint sides and backer material; and to completely fill recesses in joint configuration.
   1. For non-sag Sealant:
      a. Install sealant flush with surface.
      b. Immediately after sealant application and before skinning or curing begins, tool joint with slightly concave surface, compressing sealant into joint to form smooth, uniform sealant bead; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Do not use tooling agent.
   2. For pourable sealants:
      a. Install sealant slightly below surface.
      b. Immediately after sealant application and before skinning or curing begins, lightly tool joint, compressing sealant into joint to form smooth, uniform sealant bead; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Do not use tooling agent.
      c. Remove excess sealant from surfaces adjacent to joints.

3.5 INSTALLATION OF SILICONE-COATED, PRECOMPRESSED SEALS

A. General: Comply with seal manufacturer's written installation instruction for products and applications indicated, based on mockups and preconstruction testing.

B. Remove joint seal from precompressed packaging, immediately insert into joint, and allow to expand.

C. Use temporary retainers if required to maintain joint seals in position until expansion is complete. Do not pull the seal during the installation process.

D. If factory-applied adhesive is not provided, apply manufacturer's recommended adhesive or sealant between the seal and the joint substrates.

E. Apply a fillet bead of sealant on each side of the silicone bellows surface.

F. Apply sealant at each end of segment prior to placing sequential segment. The sealant should be spread evenly along the entire end of both pieces. Butt segments tightly together.

3.6 INSTALLATION OF GLAZING SEALANTS

A. See Section 08 80 00.

3.7 INSTALLATION OF PRE-FORMED SILICONE SHEETS

A. See Section 08 80 00.

3.8 FIELD QUALITY CONTROL

A. Field-Adhesion Evaluation: Architect/Engineer will perform non-destructive and destructive field adhesion evaluations of sealant in accordance with ASTM C1521.
   1. Non-destructive testing:

a. Depress center of sealant bead with probing tool to depth of 50 percent of bead width or depress sealant bead near substrate bond-line until it appears visually that sealant is about to fail in cohesion.
b. Record if sealant failed and, if so, if failure was adhesive or cohesive and maximum surface depression as percent of joint width.
c. Perform test every 12 inches for first 10 linear feet of joint; if no test failure is observed, test every 24 inches thereafter.

2. Destructive testing:
a. Cut 6-inch-long tail of sealant loose from substrate.
b. Mark tail 1 inch from adhesive bond.
c. Grasp tail 1 inch from adhesive bond and pull until tail extends to 2 times the published movement capability of sealant. If sealant has not failed, continue pulling to failure.
d. Record elongation at failure and if failure was adhesive or cohesive.
e. Observe sealant for complete filling of joint with absence of voids, and for joint configuration in compliance with requirements. Record observations and sealant dimensions
f. Perform test every 100 feet for first 1,000 linear feet of joint; if no test failure at 2 times the movement capability occurs, test every 1,000 feet thereafter or approximately once per floor per elevation, whichever is more frequent.

3. Test reports shall include date when sealant was installed, name of person who installed sealant, test date, test location, and whether primer was used.
4. Immediately after testing, Contractor shall replace failed sealant in test areas. Neatly cut out and remove failed sealant, prepare and prime surfaces, and install new sealant. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.
5. Sealant not evidencing adhesive failure from testing or noncompliance with requirements will be considered satisfactory.
6. Where Architect/Engineer determines that sealant has failed adhesively from testing or does not comply with requirements, additional testing will be performed to determine extent of non-conforming sealant. Neatly cut out and remove non-conforming sealant, prepare and prime surfaces, and install new sealant. Perform field adhesion tests on new sealant. Additional testing and replacement of non-conforming sealant shall be at Contractor's expense.

B. At completion of Project, observe installed sealant for damage, deterioration, or air pockets within the sealant bead. If damage or deterioration occurs, neatly cut out and remove damaged or deteriorated sealant, prepare and prime surfaces, and install new sealant. Replace sealant immediately so new sealant is indistinguishable from original Work.

3.9 CLEANING

A. As sealant Work progresses, clean off excess sealant or sealant smears by methods and with cleaning materials approved in writing by sealant manufacturer and manufacturers of products in which joints occur. Exercise care to avoid scratching or damage to surfaces.

B. At the end of each workday, clean Site and Work areas and place rubbish, empty cans, rags, and other discarded materials in appropriate containers.

C. After completing sealant Work:
1. Repair surfaces stained, marred, or otherwise damaged during sealant Work.
2. Clean up debris and surplus materials and remove from Site.

3.10 PROTECTION

A. Protect sealant during and after curing period from contact with contaminating substances and from damage, so sealants are without deterioration or damage at time of Substantial Completion.

END OF SECTION 07 92 00

SEALANT INSTALLER'S WARRANTY

WHEREAS <**Insert name**> of <**Insert address**>, herein called ***Sealant Installer***, has performed sealant and associated work, designated ***Work***, on the following project:

Owner: <Insert name of Owner.>
Address: <Insert address.>
Building Name/Type: <**Insert information.**>
Address: <Insert address.>
Area of Work: <Insert information.>
Acceptance Date: <**Insert date.**>
Warranty Period: <Insert warranty period.>
Expiration Date: <**Insert date.**>

AND WHEREAS Sealant Installer has contracted, either directly with Owner or indirectly as subcontractor, to warrant said Work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

NOW THEREFORE Sealant Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period it will, at its own cost and expense, make or cause to be made such repairs to or replacement of said Work as are necessary to correct faulty and defective Work and as are necessary to maintain said Work in watertight condition, and warrants against the following.

1. Components of sealant system that do not comply with requirements; that do not remain watertight; that fail in adhesion, cohesion, or general durability; or that deteriorate in a manner not clearly specified by submitted sealant manufacturer's data as an inherent quality of the material for the application indicated, regardless of whether the Work was previously accepted by Owner.
2. Damage by exposure to foreseeable weather; and damage by intrusion of foreseeable wind-borne moisture.

Warranty is made subject to the following terms and conditions:

1. Specifically excluded from Warranty are damages to Work and other parts of the building, and to building contents, caused by:
    a. lightning;
    b. peak gust wind speed exceeding 90 miles per hour;
    c. fire;
    d. failure of sealant substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
    e. activity adjacent to sealant Work by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by Owner's Representative.
2. When Work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Sealant Installer and until cost and expense thereof have been paid by Owner or by another responsible party so designated.
3. Sealant Installer is responsible for damage to Work covered by Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of Work.
4. During Warranty Period, if Owner allows alteration of Work by anyone other than Sealant Installer, including cutting, patching, and maintenance, Warranty shall become null and void on date of said alterations, but only to extent said alterations affect Work covered by Warranty. If Owner engages Sealant Installer to perform said alterations, Warranty shall not become null and void unless Sealant Installer, before starting said work, shall have notified Owner in writing, showing reasonable cause

for claim, that said alterations would likely damage or deteriorate Work, thereby reasonably justifying limitation or termination of Warranty.

5. Owner will promptly notify Sealant Installer of observed, known, or suspected leaks, defects, or deterioration and will afford reasonable opportunity for Sealant Installer to inspect Work and to examine evidence of such leaks, defects, or deterioration. Sealant Installer shall inspect leak, defect, or deterioration within 24 hours of notification.
6. If permanent repair or replacement of warranted condition cannot be made immediately, due to weather conditions, availability of appropriate labor or materials, building occupancy, etc., Sealant Installer must make, or cause to be made, immediate temporary repairs to prevent any further damage, deterioration, or unsafe conditions. Permanent repair or replacement of warranted condition shall be scheduled as soon thereafter as practical, and with Owner's consent and approval.
7. If Owner notifies Sealant Installer of warranted condition that requires immediate attention to prevent potential injury or damage, and Sealant Installer cannot or does not promptly inspect and repair same, either permanently or temporarily, then Owner may make, or cause to be made, such temporary repairs as may be essential, and Sealant Installer will reimburse Owner for cost of such repairs. Such action will not relieve Sealant Installer of its obligation to perform any necessary permanent repairs, and Warranty shall remain in full force and effect for remaining portion of its original term.
8. Sealant Installer shall provide equipment, labor, and material required to remedy warranted conditions, including repair or replacement of damage to other work resulting therefrom, and removal and replacement of other work required to access warranted condition. Additional required work will be at Sealant Installer’s sole expense for full term of Warranty. Warranty includes removal and replacement of sealant-backer material and sealant.
9. Warranty is recognized to be only Warranty of Sealant Installer on said Work and shall not operate to restrict or cut off Owner from other remedies and resources lawfully available to Owner in cases of sealant failure. Specifically, Warranty shall not operate to relieve Sealant Installer of responsibility for performance of original Work according to requirements of Contract Documents, regardless of whether Contract was directly with Owner or with Owner’s General Contractor.

IN WITNESS THEREOF, and intending to be legally bound hereby, Sealant Installer has caused this document to be executed by undersigned, duly authorized officer.

_____ Corporate Seal

(Sealant Installer)

By: _____

(Signature)

_____

(Name)

_____

(Date)

Subscribed and sworn to before me this _____day of _____, 20__

_____

Notary Public

My commission expires _____

SECTION 08 80 00
GLAZING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:
   1. Windows.
   2. Glazed curtain walls.

B. Related Sections:
   1. Section 01 11 00 – Summary of Work
   2. Section 01 22 00 – Unit Prices
   3. Section 04 01 21 – Brick Masonry Repair and Replacement
   4. Section 07 62 00 – Sheet Metal Flashing and Trim
   5. Section 07 92 00 – Joint Sealants

1.2 PAYMENT

A. Perform the Work on a lump sum or unit price basis as described in Section 01 11 00 and Section 01 22 00.

1.3 DEFINITIONS

A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.

B. Glass Thicknesses: Verify in field to match existing by thickness designations in inches or mm according to ASTM C 1036.

1.4 COORDINATION

A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Glass Samples: For each type of glass product; 12 inches square.

C. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

D. Shop Drawings:
   1. Clearly illustrate all aspects of the curtain wall Work including:
      a. The relationship of the curtain wall Work to the building structure, roofing and waterproofing systems, interior finishes, and other adjacent construction.
      b. The arrangement of components.

c. The sequence and details of fabrication, assembly, and erection.
d. Include details of all connections and seals to contiguous work as approved by the Subcontractor for the work adjacent and include all assumptions regarding the tolerances of that work.

2. Provide fully coordinated shop drawings where work is subcontracted to others.
3. Provide manufacturer's installation instructions.
4. Clearly indicate all revisions to shop drawings on resubmissions.

E. Closeout Submittals:
1. Record Shop Drawings: At the completion of the project, digitally submit all final approved shop drawings.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Certificates: For glass.

C. Product Test Reports: For laminated glass, for tests performed by a qualified testing agency.
1. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.

D. Preconstruction adhesion and compatibility test report.

E. Sample Warranties.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications for Laminated Glass: A qualified laminated-glass manufacturer who is approved and certified by coated-glass manufacturer.

B. Installer Qualifications: A qualified installer who employs glass installers that have minimum of five years of continuous experience of successfully completed projects of similar size and scope.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

1.9 FIELD CONDITIONS

A. Hazardous Materials: Testing of existing sealants for hazardous materials has been performed.
1. Refer to report dated February 26, 2024 by ASTI Environmental for hazardous materials information.
2. The Contractor shall be responsible for ensuring that personnel within the Work area and the public are protected from exposure to hazardous materials; preventing contamination of the building/site; and appropriately characterizing materials to allow for their handling and disposal in accordance with all applicable laws and regulations.

B. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
   1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or are below 40 deg F.

1.10 WARRANTY

A. Manufacturer's Special Warranty for Laminated Glass: Manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.
   1. Warranty Period: 5 years from date of Substantial Completion.

B. Manufacturer’s Special Warranties for Structural and Weatherseal Sealants:
   1. Written warranties in which elastomeric sealant manufacturer agrees to furnish and install elastomeric joint sealants to repair or replace those that fail to provide airtight and watertight joints, or fail in adhesion, cohesion, abrasion resistance, stain resistance, weather resistance, or general durability or appear to deteriorate in any other manner not clearly specified in the manufacturers data as an inherent quality of the material.
   2. Warranty Period: 20 years from date of Substantial Completion

C. Installers Warranty: Written warranty in which Contractor agrees to replace glazing that does not comply with requirements or that fail in materials or workmanship within the specified warranty period.
   1. Warranty Period: 2 years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations for Glass: Obtain from single source from single manufacturer for each glass type.

B. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.

2.2 PERFORMANCE REQUIREMENTS

A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Thermal and Optical Performance Properties: Provide glass with performance properties to match existing.

2.3 GLASS PRODUCTS, GENERAL

A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.
   1. GANA Publications: "Laminated Glazing Reference Manual" and "Glazing Manual."

B. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than the thickness indicated.

C. Spandrel Glass: Provide unit to match existing size, profile, color, and performance characteristics.

D. Vision Glass: Provide unit to match existing size, profile, color, and performance characteristics.

E. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened float glass is indicated, provide heat-strengthened float glass or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where fully tempered float glass is indicated, provide fully tempered float glass. Fully tempered outboard lite of glass will only be acceptable if required for strength, mitigating thermal stress breakage, or safety glazing.

2.4 GLASS PRODUCTS

A. Clear Annealed Float Glass: ASTM C 1036, Type I, Class 1 (clear), Quality-Q3.
   1. Limits for distortion in ASTM C1036 shall apply regardless of glass thickness.

B. Fully Tempered Float Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
   1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated. Furnace with on-line distortion measurement system. Every piece measured.
   2. Roller distortion: Measured peak to valley, shall not exceed 0.003 inches in the central area or 0.008 inches within 10.5 inches of the leading or trailing edge.
   3. Bow/warp tolerance: 1/2 of that allowed per ASTM C1048

C. Heat-Strengthened Float Glass: ASTM C 1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
   1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated. Furnace with on-line distortion measurement system. Every piece measured.
   2. Roller distortion: Measured peak to valley, shall not exceed 0.003 inches in the central area or 0.008 inches within 10.5 inches of the leading or trailing edge.
   3. Bow/warp tolerance: 1/2 of that allowed per ASTM C1048

D. Spandrel Glass: Provide unit to match existing size, profile, color, and performance characteristics.

2.5 LAMINATED GLASS

A. Laminated Glass: ASTM C 1172. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.
   1. Construction: Laminate glass with polyvinyl butyral interlayer to comply with interlayer manufacturer's written instructions.
   2. Interlayer Thickness: Provide thickness not less than that existing and as needed to comply with requirements.
   3. Interlayer Color: Match existing.
   4. With PVB interlayer:
      a. Two lites of glass bonded to a 0.060 inch polyvinyl butyral (PVB) interlayer.
      b. Interlayer shall be compatible with all glazing sealants.
      c. Approved Products:
         1) Saflex, Eastman Chemical Co.
         2) Butacite or Trosifol, Kuraray
   5. With ionomer interlayer:
      a. Two lites of glass bonded to a 0.060 inch ionomer interlayer.
      b. Interlayer shall be compatible with all glazing sealants.
      c. Approved Products:
         1) SentryGlas, Kuraray

B. Glass Edges:
   1. Edges of heat-treated glass and of glass at butt joints: ground and seamed or seamed and polished.
   2. Exposed edges, such as at corners: seamed and polished.
   3. All other edges: high quality factory clean-cut edge.
   4. Conform to the following requirements:
      a. Shark teeth shall not penetrate more than half the glass thickness.
      b. Serration hackle shall not penetrate more than 10 percent of the glass thickness.
      c. Flare shall not exceed 1/16 inch as measured perpendicular to the glass surface at edge.
      d. Bevel shall not exceed 1/16 inch.
      e. Flake chips shall not exceed 1/16 inch in depth or 1/4 inch in diameter.
      f. Rough chips shall not exceed 1/16 inch in depth or 1/4 inch in diameter.

2.6 GLAZING SEALANTS

A. General:
   1. Compatibility: Compatible with one another and with other materials they contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
   2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
   3. Colors of Exposed Glazing Sealants: Black

B. Weatherseal Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, as recommended by glass fabricator.
   1. Single component:
      a. Acceptable products:

1) Dowsil 791/795, Dow Chemical Co.
2) GE SCS2000 Sealant, Momentive Performance Materials

C. Structural Sealant:
1. Neutral cure silicone, medium or high modulus, non-staining, matte finish, color to match architects' sample, and specifically intended for use specified.
2. Single component: ASTM C1184; ASTM C920, Type S, Grade NS, Class 25
a. Acceptable products:
1) Dowsil 995, Dow Chemical Co.
2) GE Ultraglaze 4000/4000AC, Momentive Performance Materials

2.7 PRE-FORMED SILICONE SHEET

A. Pre-Formed Silicone Sheet: ASTM C1518, Movement Class 200, Tear Class PT. Color: Black.
1. Dowsil 123 Silicone Seal, Dow Chemical Co.
2. Ultraspan, Momentive Performance Materials

2.8 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, with requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

C. Setting Plate: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

D. Shims:
1. Concealed: Solid PVC, polystyrene, or Nylon
2. Exposed to weather: Stainless steel

E. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.

2.9 FABRICATION OF GLAZING UNITS

A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.
1. Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.
a. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

B. Clean-cut or flat-grind vertical edges of butt-glazed lites to produce square edges with slight chamfers at junctions of edges and faces.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:
   1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
   2. Presence and functioning of weep systems.
   3. Minimum required face and edge clearances.
   4. Effective sealing between joints of glass-framing members.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that leave visible marks in the completed Work.

3.3 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.

C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

D. Install setting plate in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

F. Provide spacers for glass lites where length plus width is larger than 50 inches.
   1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
   2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

G. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

H. Set glass lites with proper orientation so that coatings face exterior or interior as specified.

I. Glazing setting plate sealant repair:
   1. Inspect setting plate for protruding conditions. Set flush or trim setting plate that protrude.
   2. Clean the area and install weather sealant cover seal over the setting plate. The cover seal is to be visually consistent across the Project.

3.4 SEALANT GLAZING (WET)

A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.5 STRUCTURAL GLAZING:

A. Comply with ASTM C 1401

B. Prior to undertaking any structural glazing, submit complete structural glazing procedures, including permissible conditions, temperatures, cure times, temporary restraint design, surface preparation and all other procedures, including quality control inspection program that may be employed.

3.6 SELECTIVE DEGLAZING

A. Remove existing glass and prepare the existing substrate. Reinstall the glass in accordance with the sealant manufacturer’s instructions.

B. Coordinate temporary storage of glass lites and mounting components to accommodate substrate repairs (i.e., masonry and concrete).

C. Coordinate substrate repairs to match with existing glass lite rough opening dimensions. If the existing lite dimensions do not fit in the new rough opening, then replace lite and mounting components in like kind.

3.7 PREFORMED SILICONE INSTALLATION

A. Clean existing substrates according to manufacturer’s instructions.

B. Install at a consistent elevation and profile to span over joint.

3.8 CLEANING AND PROTECTION

A. Immediately after installation remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.
   1. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.

C. Remove and replace glass that is damaged during construction period.

D. Wash glass on both exposed surfaces not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

END OF SECTION 08 80 00

SECTION 09 96 53
ELASTOMERIC COATING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Surface preparation and application of elastomeric coating on concrete surfaces over post-tensioned slab and beam grout pockets.

B. Related Sections:
   1. Section 01 22 00 – Unit Prices
   2. Section 03 01 24 – Unbonded Post-Tensioning Repairs
   3. Section 03 01 34 – Concrete Repair
   4. Section 07 18 00 – Traffic Coating
   5. Section 07 92 00 – Joint Sealants
   6. Section 09 97 24 – Architectural Coating

1.2 UNIT PRICES

A. Perform the following Work on unit price basis as described in Section 01 22 00.

1.3 REFERENCES

A. Definitions:
   1. Elastomeric coating: Coating that "exhibits the ability to stretch, and then recover its original shape as a dry film." (MPI Manual)

B. Reference Standards: Latest edition as of Specification date.
   1. ASTM International:
      a. D16: Standard Terminology for Paint, Related Coatings, Materials, and Applications.
      b. D3359: Standard Test Methods for Measuring Adhesion by Tape Test.
      c. D4541: Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.
   2. Master Painters Institute (MPI):
      a. Architectural Painting Specification Manual (MPI Manual).

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordinate Work to ensure that adjacent areas are not adversely affected. Coordinate:
   1. With Owner's Representative.
   2. With other trades:
      a. To ensure that work done by other trades is complete and ready for coating Work.
      b. To avoid or minimize work on, or in immediate vicinity of, coating Work in progress.
      c. To ensure that subsequent work will not adversely affect quality of completed coating Work.
   3. Includes coordination with traffic bearing membrane installation and architectural coating installation.

B. Review repair and surface treatment materials and primers specified in other sections to ensure compatibility with elastomeric coatings to be used. Notify Architect/Engineer in writing of concerns with materials or primers installed by others and recommend remedies.

C. Schedule surface preparation and coating application Work so that dust and other contaminants from surface preparation Work will not adversely affect wet, newly-coated surfaces.

1.5 SUBMITTALS

A. Product Data: For each coating, manufacturer's literature including written instructions for evaluating, preparing, and treating substrate; technical data including tested physical and performance properties; mixing and application instructions; safety precautions for handling, storing, applying, and disposing of materials; and instructions for protecting surrounding areas from overspray. Include:
   1. Surfaces to which materials will be applied.
   2. Materials List: Inclusive list of required materials for each coating system, including crack fillers, block fillers, and primers. Cross-reference coating system and application. Identify each material by manufacturer's catalog number and general classification.
   3. VOC content of components.
   4. Coating manufacturer's color chart showing full range of colors available.

B. Samples: 8-inch-square samples, on representative samples of actual substrates, of each coating system and color to be applied, with texture to simulate actual conditions. For review of color and texture only.
   1. Provide stepped samples, defining each separate coat, including block fillers and primers. Use representative colors when preparing samples for review. Resubmit until required color, sheen, and texture are achieved.
   2. Label each sample for location and application.
   3. Provide list of materials and applications for each coat of each sample.

C. Safety Plan: Written action plan that complies with applicable government regulations and covers operational requirements for safe application of coating materials; means of protection of surrounding areas from overspray and rebound; and handling, storage, and disposal of hazardous and toxic materials.
   1. For review by Owner's Certified Industrial Hygienist (CIH) or Contractor's CIH; review by Architect/Engineer and Owner's Representative for information only.

D. Applicator Qualifications: Evidence that Applicator's *existing company* has minimum 5 years of continuous experience in similar coating work; list of at least five representative, successfully-completed projects of similar scope and size, including:
   1. Project name.
   2. Owner's name.
   3. Owner's Representative name, address, and telephone number.
   4. Description of work.
   5. Elastomeric coating used.
   6. Project supervisor.
   7. Total cost of coating work and total cost of project.
   8. Completion date.

E. Sample Warranties: Copies of coating manufacturer's warranty and Contractor's warranty, both stating obligations, remedies, limitations, and exclusions. Submitted with bid.

F. Following completion of the Work:
   1. Coating manufacturer's inspection report of completed coating application.
   2. Completed warranty from coating manufacturer.
   3. Completed warranty from Applicator.

1.6 QUALITY ASSURANCE

A. Applicator Qualifications: Experienced firm that has successfully completed coating work with similar materials, design, and extent to that indicated for Project. Must have successful applications of specified materials in local area in use for minimum of 5 years.
   1. Employ foreman with minimum 5 years of experience as foreman on similar projects, who is fluent in English, to be on Site at all times during Work. Do not change foremen during the course of the Project except for reasons beyond the control of the Applicator; inform Architect/Engineer in advance of any changes.

B. Mockups: Prepare surface and apply elastomeric coating at location identified by Architect/Engineer to demonstrate surface preparation, crack and joint treatment, aesthetic affects, and quality of materials and execution. Leave portion of prepared surface and each coating layer exposed to view. Provide required color, sheen, and texture on each surface.
   1. Coating manufacturer's representative shall observe mockup and approve in writing surface preparation and coating application.
   2. Owner may, at its expense, verify coating thickness and perform adhesion and pull-off tests. Contractor shall, at no cost to Owner, repair coating and substrate damaged by testing.
   3. If Architect/Engineer determines mockup does not comply with requirements, modify mockup or construct new mockup until mockup is approved. Pay for additional testing requested by Owner. Do not proceed with Work until mockup is approved.
   4. Approved mockup will be acceptance standard for coating Work.
   5. Approved mockup may become part of completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle materials according to manufacturer's recommendations and in such a manner as to prevent damage to materials or structure.

B. Deliver materials to Site in original containers and packaging with seals unbroken, labeled with:
   1. Manufacturer's name.
   2. Product brand name and type
   3. Contents by volume for pigment and vehicle constituents.
   4. VOC content.
   5. Color name and number.
   6. Date of manufacture and batch number.
   7. Directions for storing, handling, mixing with other components, and application, including precautions.
   8. Thinning instructions (if permitted).

C. Store materials in original, undamaged containers and, if permitted, partially used materials in tightly covered containers in clean, dry, well-ventilated, protected location on raised platforms with weather-protective coverings, within temperature range required by manufacturer. Protect stored materials from direct sunlight, heat, sparks, and flames.

D. Limit stored materials on structures to safe loading capacity of structure at time materials are stored, and to avoid permanent deck deflection.

E. Conspicuously mark damaged or opened containers or containers with contaminated materials and remove from Site as soon as possible.

F. Remove and replace materials that cannot be applied within stated shelf life.

1.8 PROJECT CONDITIONS

A. Verify existing dimensions and details prior to start of coating Work. Notify Architect/Engineer of conditions found to be different than those indicated in the Contract Documents. Architect/Engineer will review situation and inform Contractor and Applicator of changes.

B. Comply with Owner's limitations and restrictions for Site use and accessibility.

C. Environmental Limitations: Apply coating when existing and forecast weather conditions permit coating to be applied according to coating manufacturer's written instructions and warranty requirements.
   1. Apply only when substrate and ambient temperatures are between 50 and 90 degrees F, or within range recommended by coating manufacturer. Maintain minimum substrate and ambient temperatures for at least 24 hours before and after coating application.
   2. Do not apply in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 degrees F above dew point; or when such conditions are imminent during the drying period.
   3. Do not apply to damp or wet substrate.
   4. Allow wet surfaces to dry thoroughly and attain temperature and conditions specified before starting or continuing coating operation.

D. Handle and apply materials in strict accordance with safety requirements required by coating manufacturer; Safety Data Sheets (SDS); and local, state, and federal rules and regulations. Maintain Safety Data Sheets (SDS) with materials in storage area and available for ready reference on Site.

E. Maintain adequate ventilation during preparation and application of coating materials.

1.9 CHANGES IN WORK

A. During rehabilitation work, existing conditions may be encountered which are not known or are at variance with the Contract Documents. Such conditions may interfere with the Work and may consist of damage or deterioration of the substrate or surrounding materials that could jeopardize the integrity or performance of the Work.
   1. Notify Architect/Engineer of conditions that may interfere with the proper execution of the Work or jeopardize the performance of the Work prior to proceeding with the Work.

1.10 WARRANTY

A. Manufacturer's Warranty:
   1. Written warranty, signed by coating manufacturer, including:
      a. Materials to replace coating that does not comply with requirements; that fails in adhesion, cohesion, or general durability; that cracks, checks, fades, or chalks; or that

deteriorates in a manner not clearly specified by submitted coating manufacturer's data as an inherent quality of the material for the application indicated.

b. New coating shall closely match color of existing coating. Extend new coating to reveals, surface edges, or other natural termination points to minimize differences in appearance between new and existing coating.

c. Warranty does not include debonding of existing coatings from substrate or from each other.

2. Warranty Period: 10 years after Substantial Completion date.

B. Contractor's Warranty:

1. Written warranty, signed by Contractor, including:

a. Repair or remove and replace coating that does not comply with requirements; that fails in adhesion, cohesion, or general durability; that cracks, checks, fades or chalks; or that deteriorates in a manner not clearly specified by submitted coating manufacturer's data as an inherent quality of the material for the application indicated.

2. New coating shall closely match color of existing coating. Extend new coating to reveals, surface edges, or other natural termination points to minimize differences in appearance between new and existing coating.

3. Warranty includes:

a. Providing access to warranty Work.

b. Necessary surface preparation work.

4. Warranty does not include debonding of existing coatings from substrate or from each other.

5. Warranty Period: 5 years after Substantial Completion date.

PART 2 PRODUCTS

2.1 GENERAL

A. Source Limitations: Obtain materials through one source from single coating manufacturer, or from sources approved by coating manufacturer.

B. Material Compatibility: Provide crack fillers, block fillers, primers, elastomeric coatings, and related materials that are compatible with one another and substrates indicated under conditions of application and service, as demonstrated by manufacturer based on testing and field experience.

C. Material Quality: Provide manufacturer's best-quality elastomeric coating materials that are factory formulated and are recommended by manufacturer for application indicated. Material containers not displaying manufacturer's product identification are not acceptable.

2.2 ELASTOMERIC COATING

A. Elastomeric Coating: Factory-formulated; internally plasticized, 100-percent-acrylic.

B. Smooth-finished Acrylic Coating: Use one of the following or approved equal.

1. Sika Thorolastic-750 manufactured by Sika Corporation.

2. Decra-Flex 300 Exterior Elastomeric Coating System, 2260 Smooth, manufactured by Akzo Nobel Paints LLC.

3. Perma-Crete Pitt-Flex Elastomeric Coating 4-110 manufactured by PPG Industries, Inc.

4. ConFlex SherLastic Elastomeric Coating manufactured by Sherwin Williams Company.

5. StoColor Lastic 80212 Smooth manufactured by Sto Corp.
6. Tammolastic Elastomeric, Protective and Decorative Coating, Smooth, manufactured by The Euclid Chemical Company.

C. Tinting: For multi-coat applications, tint material in each coat slightly lighter shade than material in succeeding coat, to facilitate determining full coverage of each coat.

2.3 AUXILIARY MATERIALS

A. Use block fillers, crack fillers and sealants, detail materials, and primers recommended by coating manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions with Applicator and coating manufacturer's representative for compliance with requirements and other conditions affecting application or performance of coating.
   1. Ensure that work done by other trades is complete, cured, and ready for coating Work.
   2. Verify that areas and conditions under which coating Work is to be performed permit proper and timely completion of Work.
   3. Verify compatibility with and suitability of substrates, including existing coatings.
   4. Verify adhesion of existing coatings.
   5. Notify Architect/Engineer in writing of conditions which may adversely affect application or performance of coating and recommend corrections.
   6. Do not proceed with coating Work until adverse conditions have been corrected and reviewed by Architect/Engineer.
   7. Commencing coating Work constitutes acceptance of Work surfaces and conditions.

3.2 PROTECTION

A. Remove hardware, light fixtures, and other items already installed that are not to be painted. Coordinate removal, labelling, and storage with Owner's Representative. If removal is impractical or impossible because of size or weight of the item, provide surface-applied protection before surface preparation and painting.
   1. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.

B. Take precautions to ensure safety of people, including building users, passers-by, and workmen, and animals, and protection of property, including adjacent building elements, landscaping, and motor vehicles.

C. Prevent construction debris, coatings, and other materials from coming into contact with pedestrians, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.

D. Protect paving and sidewalks, and adjacent building areas from mechanical damage due to scaffolding and other equipment.

E. Limit access to Work areas. Provide "Wet Paint" signs to protect newly coated surfaces.

F. Erect temporary protective canopies, as necessary, over walkways and at points of pedestrian and vehicular access that must remain in service during Work.

G. Take precautions against air-borne materials and runoff.

H. Masking and Preparation:
   1. Comply with coating manufacturer's written instructions for protecting building and other surfaces against damage from exposure to its products.
   2. Cover adjacent surfaces with materials that are proven to resist coating system.
   3. Mask off or protect from spatter, overspray, or other damage surfaces not scheduled to receive coating.
   4. Remove masking and other protective measures at completion of coating Work.

I. Assume responsibility for injury to persons or damage to property due to Work, and remedy at no cost to Owner.

3.3 SURFACE PREPARATION

A. Existing Coating:
   1. Remove unbonded or deteriorated coating.
   2. Feather edges by sanding, grinding, or as recommended by coating manufacturer.

B. Clean and prepare substrate according to coating manufacturer's written instructions. Provide clean, dust-free, dry, and sound substrate for coating application.
   1. Remove fins and projections, splatter, and other irregularities which would prevent monolithic, continuous application of coating.
   2. Properly patch substrate defects, such as voids, form tie holes, honeycombing, and cracks, with latex-modified concrete or another material acceptable to coating manufacturer and Architect/Engineer.
   3. Remove grease, oil, asphalt solids, form-release agents, curing compounds, and other contaminants or film-forming coatings that might impair bond of elastomeric coating. If chemical removal is necessary, rinse with clean water.
   4. Pressure wash concrete to provide clean surface, free of laitance, dirt, and other loose or foreign material, and to slightly roughen surface.
   5. Treat cracks, joints, changes in surface direction, and through-member penetrations with patching compound or sealant as recommended by coating manufacturer. Remove deteriorated existing sealant and other materials and replace with materials recommended by coating manufacturer.
   6. Fill pores, crevices, and voids in concrete masonry with block filler and allow filler to dry.

C. Applicator and coating manufacturer's representative shall examine substrate to ensure that it is properly prepared and ready to receive coating.
   1. Coating manufacturer's representative shall report in writing to Applicator and Architect/Engineer conditions which may adversely affect coating system application or performance and recommend corrections.
   2. Do not proceed with coating application until unsatisfactory conditions have been corrected and reviewed by Architect/Engineer.

D. Commencing application constitutes acceptance of Work surfaces and conditions. Inadequate removal/preparation efforts resulting in failure of new coatings within material warranty period are the responsibility of the Contractor.

3.4 APPLICATION

A. General: Prepare and apply materials according to coating manufacturer's written instructions, at recommended rates and coverages.
   1. Test prepared surfaces for alkalinity, moisture, and other conditions as recommended by coating manufacturer.

B. Mix materials thoroughly to uniform, smooth consistency. Do not thin or dilute unless permitted by coating manufacturer; use recommended thinners within recommended limits.
   1. Stir as required during application.
   2. If surface film forms, do not stir film into material. Remove film and strain coating material before using.
   3. Maintain containers used for mixing and applying coating in clean condition, free of foreign materials and residue.

C. Apply coating by roller, spray, or brush. Use applicator and technique best suited for substrate and type of material being applied.
   1. Apply materials as soon as practicable after completion of surface preparation or full curing of previous material application.
   2. Do not coat over conditions detrimental to formation of durable coating film, such as dirt, rust, scale, grease, or moist or scuffed surfaces.
   3. Apply barrier coat over incompatible primers or remove and re-prime.
   4. Prime surfaces as necessary.
   5. Apply elastomeric coating in one or two coats to provide thickness of 10 to 15 dry mils (0.010 to 0.015 inches) or as recommended by coating manufacturer. Do not apply second coat until first coat has fully cured. Select application method to avoid excessive coating thickness.
      a. If undercoats or other conditions show through final coat, apply additional coats until coating film is of uniform finish, color, and appearance, if approved by Architect/Engineer.
      b. Ensure that edges, corners, and crevices receive minimum dry film thickness.
      c. Brush Application: Work material into surface in even film. Eliminate cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Neatly draw lines at edges and color breaks.
      d. Roller Application: Keep cover wet; do not dry roll. Apply material in sections. Lay on required amount of material, working material into grooves and rough areas. Then level material, working it into surface.
      e. Spray Application: Use spray application only when permitted by manufacturer's written instructions and authorities having jurisdiction. Apply material to provide equivalent hiding of brush-applied coat. Do not double back, building up film thickness of two coats in one application.
   6. Do not coat over UL, FMG, or other labels.

3.5 FIELD QUALITY CONTROL

A. Material Coverage Rates.
   1. At beginning of application, calibrate material coverage rate with wet-mil thickness equivalent to minimum specified dry-mil thickness. Measure wet-mil thickness with thickness gauge.
   2. Measure wet-mil thickness at least once for every 200 square feet of surface coated. Adjust coverage rate to maintain minimum thickness.

B. Owner may, at its expense, perform the following tests. Contractor shall provide access to test locations determined by Architect/Engineer.
   1. Measure dry-film thickness of coating. Coating thickness is acceptable if within specified range.
   2. Perform adhesion tests per ASTM D3359, Test Method A, after coating has cured. Coating adhesion is acceptable if no peeling or coating removal occurs (Rating 5A).
   3. Perform pull-off tests per ASTM D7234, after coating has cured. Coating application is acceptable if test results are at least 100 pounds per square inch.
   4. If coating application is acceptable, Owner will pay Contractor to repair substrate and coating as necessary at test locations.
   5. If coating application is unacceptable, Architect/Engineer will determine remedy. Contractor shall remove and replace unacceptable coating or perform other remedial actions at no cost to Owner. Contractor shall also repair substrate and coating at test locations with unacceptable results at no cost to Owner. Contractor may, at own expense, perform additional measurements and testing to determine limits of areas with unacceptable coating.

C. Completed Work shall match approved mockup for color, texture, and coverage, in opinion of Architect/Engineer, and shall be free from flow lines, streaks, blisters, and other surface imperfections. Remove, refinish, or recoat Work not complying with specified requirements.

3.6 CLEANING

A. At the end of each workday, clean Site and Work areas and place rubbish, empty cans, rags, and other discarded materials in appropriate containers.

B. After completing coating Work:
   1. Clean spillage, overspray, and spatter from adjacent surfaces using cleaning agents and procedures recommended by manufacturer of affected surface. Exercise care to avoid scratching or damage to surfaces.
   2. Repair surfaces stained, marred, or otherwise damaged during coating Work.
   3. Clean up debris and surplus materials and remove from Site.

C. Waste Management:
   1. Collect surplus coating materials that cannot be reused and deliver to recycling or disposal facility.
   2. Treat materials that cannot be reused as hazardous waste and dispose of in an appropriate manner.

END OF SECTION 09 96 53

SECTION 09 97 13
STEEL COATING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Surface preparation and application of coating system on exterior structural steel surfaces, steel railings, vehicle guards, utilities, and metal door and curtainwall frames.

B. Related Sections include the following:
   1. Section 01 11 00 – Summary of Work
   2. Section 01 21 00 – Allowances
   3. Section 01 22 00 – Unit Prices
   4. Section 05 02 00 – Structural Steel
   5. Section 07 92 00 – Joint Sealant
   6. Section 09 97 24 – Architectural Coating

1.2 PAYMENT

A. Provide the following on a lump sum, unit price, or allowance basis as described in Sections 01 11 00, 01 21 00, and 01 22 00.

1.3 REFERENCES

A. Reference Standards: Latest edition as of Specification date.
   1. ASTM International:
      a. A780: Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
      b. D16: Standard Terminology for Paint, Related Coatings, Materials, and Applications
      c. D3359: Standard Test Methods for Measuring Adhesion by Tape Test.
      d. D4541: Standard Test Method for Pull-off Strength of Coatings Using Portable Adhesion Testers.
   2. SSPC: The Society for Protective Coatings:
      a. SSPC Painting Manual.
      b. SSPC-SP 3: Power Tool Cleaning.
      c. SSPC-SP 6 / NACE No. 3: Commercial Blast Cleaning

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordinate Work to ensure that adjacent areas are not adversely affected. Coordinate:
   1. With Owner's Representative.
   2. With other trades:
      a. To ensure that work done by other trades is complete and ready for coating Work.
      b. To avoid or minimize work on, or in immediate vicinity of, coating Work in progress.
      c. To ensure that subsequent work will not adversely affect completed coating.

B. Review repair and surface treatment materials and primers specified in other sections to ensure compatibility with steel coating to be used. Notify Architect/Engineer in writing of concerns with materials or primers installed by others and recommended remedies.

C. Review extents of painting work with Owner's Representative and Owner prior to application.

D. Sequence surface preparation and coating application Work so that dust and other contaminants from surface preparation Work will not adversely affect wet, newly coated surfaces.

1.5 SUBMITTALS

A. Product Data: For each coating, manufacturer's literature including written instructions for evaluating, preparing, and treating substrate; technical data including tested physical and performance properties; mixing and application instructions; safety precautions for handling, storing, applying, and disposing of materials; and instructions for protecting surrounding areas from overspray. Include:
   1. Surfaces to which materials will be applied.
   2. Materials List: Inclusive list of required materials for each coating system, including crack fillers, block fillers, and primers. Cross-reference coating system and application. Identify each material by manufacturer's catalog number and general classification.
   3. VOC content of components.
   4. Coating manufacturer's color chart showing full range of colors available.

B. Manufacturer's Certificate: Written certification from paint or stain manufacturer stating that specified surface preparation methods, paint materials, and application procedures are appropriate for applications intended.

C. Safety Plan: Written action plan that complies with applicable government regulations and covers operational requirements for safe application of coating materials; means of protection of surrounding areas from overspray and rebound; and handling, storage, and disposal of hazardous and toxic materials.
   1. For review by Owner's Certified Industrial Hygienist (CIH) or Contractor's CIH; review by Architect/Engineer and Owner's Representative for information only.

D. Applicator Qualifications: Evidence that Applicator's *existing company* has minimum 5 years of continuous experience in similar coating work; list of at least five representative, successfully-completed projects of similar scope and size, including:
   1. Project name.
   2. Owner's name.
   3. Owner's Representative name, address, and telephone number.
   4. Description of work.
   5. Coatings used.
   6. Project supervisor.
   7. Total cost of coating work and total cost of project.
   8. Completion date.

E. Sample Warranties: Copies of coating manufacturer's warranty and Contractor's warranty, both stating obligations, remedies, limitations, and exclusions. Submitted with bid.

F. Following completion of the Work:
   1. Coating manufacturer's inspection report of completed coating application.
   2. Completed warranty from coating manufacturer.
   3. Completed warranty from Applicator.

1.6 QUALITY ASSURANCE

A. Applicator Qualifications: Experienced firm that has successfully completed coating work similar in material, design, and extent to that indicated for Project; and that is approved by coating manufacturer to apply coating. Must have successful applications of specified materials in local area in use for minimum of 5 years.
   1. Employ foreman trained with minimum 5 years of experience as foreman on similar projects, who is fluent in English, to be on Site at all times during Work. Do not change foremen during the course of the Project except for reasons beyond the control of the Applicator; inform Architect/Engineer in advance of any changes.

B. Mockups: Prepare surface and apply coating system to each substrate at locations identified by Architect/Engineer to demonstrate surface preparation, aesthetic affects, and quality of materials and execution. Leave portion of prepared surface and each coating layer exposed to view.
   1. Coating manufacturer's representative shall observe mockup and approve in writing surface preparation and coating application.
   2. Owner may, at its expense, verify coating thickness and perform adhesion and pull-off tests. Contractor shall, at no cost to Owner, repair coating and substrate damaged by testing.
   3. If Architect/Engineer determines mockup does not comply with requirements, modify mockup or construct new mockup until mockup is approved. Pay for additional testing requested by Owner. Do not proceed with coating Work until mockup is approved.
   4. Approved mockup will be acceptance standard for remainder of coating Work.
   5. Approved mockup may become part of completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle materials according to manufacturer's recommendations and in such a manner as to prevent damage to materials or structure.

B. Deliver materials to Site in original containers and packaging with seals unbroken, labeled with:
   1. Manufacturer's name.
   2. Product brand name, type, and color.
   3. VOC content.
   4. Color name and number.
   5. Date of manufacture and batch number.
   6. Directions for storing, handling, mixing with other components, and application, including precautions.
   7. Thinning instructions if applicable.

C. Store materials in original, undamaged containers and, if permitted, partially used materials in tightly covered containers in clean, dry, well-ventilated, protected location on raised platforms with weather-protective coverings, within temperature range required by manufacturer. Protect stored materials from direct sunlight, heat, sparks, and flames.

D. Limit stored materials on structures to safe loading capacity of structure at time materials are stored, and to avoid permanent deck deflection.

E. Conspicuously mark damaged or opened containers or containers with contaminated materials and remove from Site as soon as possible.

F. Remove and replace materials that cannot be applied within stated shelf life.

1.8 PROJECT CONDITIONS

A. Verify existing dimensions and details prior to start of coating Work. Notify Architect/Engineer of conditions found to be different than those indicated in the Contract Documents. Architect/Engineer will review situation and inform Contractor and Applicator of changes.

B. Comply with Owner's limitations and restrictions for Site use and accessibility.

C. Hazardous Materials: Testing of existing coatings for hazardous materials has been performed.
   1. Refer to report dated February 26, 2024 by ASTI Environmental for hazardous materials information.
   2. The Contractor shall be responsible for ensuring that personnel within the Work area and the public are protected from exposure to hazardous materials; preventing contamination of the building/site; and appropriately characterizing materials to allow for their handling and disposal in accordance with all applicable laws and regulations.

D. Environmental Limitations: Apply coating when existing and forecast weather conditions permit coating to be applied according to coating manufacturer's written instructions.
   1. Do not apply when substrate and ambient temperatures are less than 50 degrees F or more than 95 degrees F, or outside of range recommended by coating manufacturer. Maintain minimum substrate and ambient temperatures for at least 24 hours before and after coating application.
   2. Do not apply to damp or wet substrates; in snow, rain, fog, or mist; when relative humidity exceeds 80 percent or maximum value recommended by coating manufacturer; or when substrate temperature is less than 5 degrees F above dew point.

E. Handle and install materials in strict accordance with safety requirements required by coating manufacturer; Safety Data Sheets (SDS); and local, state, and federal rules and regulations. Maintain Safety Data Sheets (SDS) with materials in storage area and available for ready reference on Site.

F. Maintain adequate ventilation during preparation and application of coating materials.

1.9 CHANGES IN WORK

A. During rehabilitation work, existing conditions may be encountered which are not known or are at variance with the Contract Documents. Such conditions may interfere with the Work and may consist of damage or deterioration of the substrate or surrounding materials that could jeopardize the integrity or performance of the Work.
   1. Notify Architect/Engineer of conditions that may interfere with the proper execution of the Work or jeopardize the performance of the Work prior to proceeding with the Work.

1.10 WARRANTY

A. Contractor Warranty:
   1. Written warranty, signed by Contractor, including:
      a. Repair or remove and replace coating that does not comply with requirements; that fails in adhesion, cohesion, or general durability; that cracks, checks, fades, or chalks; where visible rust occurs; or that deteriorates in a manner not clearly specified by

submitted coating manufacturer's data as an inherent quality of the material for the application indicated.

2. Warranty includes:
   a. Adhesive or cohesive failure of existing coating that remains in place.
   b. Providing access to warranty Work.
   c. Necessary surface preparation work.
3. Warranty Period: 3 years after Substantial Completion date.

B. Manufacturer's Warranty:
1. Written warranty, signed by coating manufacturer, including:
   a. Repair or replace of coating that does not comply with requirements; that fails in adhesion, cohesion, or general durability; that experiences abrasion or tearing failure not due to misuse; that experiences surface crazing, fading, or chalking; or that deteriorates in a manner not clearly specified by submitted coating manufacturer's data as an inherent quality of the material for the application indicated.
   b. New coating applied during warranty work shall closely match color of existing coating. Extend warranty coating to reveals, surface edges, or other natural termination points to minimize differences in appearance between new and existing coating.
   c. Warranty Period: 5 years after Substantial Completion date.

PART 2 PRODUCTS

2.1 MATERIALS FOR SURFACE PREPARATION

A. Cleaner/Degreaser:
1. As recommended by coating manufacturer and approved by the Architect/Engineer.

B. Abrasives used for blast cleaning shall meet the requirements of SSPC AB1, Type 1, Class A
1. Shall be clean, oil-free, dry mineral sand, mineral grit, or manufactured grit and shall have a size and gradation that the abrasive will produce a uniform profile within the specified range as required for the selected coating system.
2. Shall be free from contaminants such as excessive fine particles, paint, oils, moisture, chlorides, and heavy metals, or toxic material prohibited by OSHA or federal, Owner, or local regulations.
3. Abrasives resulting in an unacceptable degree of embedment will be rejected.
4. Abrasive shall have a chloride content no greater than 7 ppm when tested with the Chloride Ion Test Kit for Abrasive.
5. The abrasive material shall produce a dense, angular, and uniform profile acceptable for application of the intended coating.
6. Ferrous metallic abrasives are not allowed.

2.2 STEEL COATING MATERIALS

A. Source Limitations: Obtain materials through one source from single coating manufacturer, or from sources approved by coating manufacturer.

B. Material Compatibility: Provide primers, intermediate coats, finish coats, and related materials that are compatible with one another and substrates indicated under conditions of application and service, as demonstrated by manufacturer based on testing and field experience.

C. Material Quality: Provide manufacturer's best-quality coating materials that are factory formulated and are recommended by manufacturer for application indicated. Material containers not displaying manufacturer's product identification are not acceptable.

D. Surface Filler: Provide a compatible surface filler epoxy to minimize irregularity of the coated surface.
   1. Carboline Company: Carboguard 501
   2. Sherwin Williams: Steel Seam FT910
   3. Tnemec Co., Inc.: Series 215
   4. PPG Industries, Inc: Amercoat 114A

E. Two-part system with epoxy primer with acrylic urethane topcoat. Use one of the following systems or approved equal recommended by manufacturer:
   1. Sherwin Williams:
      a. Primer: Macropoxy 646 Fast Cure Epoxy or Macropoxy 400
      b. Finish Coat: Hi-Solids Polyurethane
   2. Tnemec Co., Inc.:
      a. Primer: Chembuild Series 135.
      b. Finish Coat: Endura-Shield Series 73.
   3. Pittsburgh Paints, PPG Architectural Finishes, Inc.:
      a. Primer: Speedhide 6-212.
      b. Finish Coat: Pitt-Tech 90-374.

F. Galvanizing Repair Paint: ASTM A 780, with dry film containing a minimum of 94 percent zinc dust by weight.

G. Color:
   1. Finish Coat
      a. Finish coat color as selected by Owner with approval by Coating Manufacturer in advance of sales order for coatings and application.
      b. Specific colors are anticipated based on element:
         1) Handrails, vehicle guards, stairwell framing, curtainwall framing, and other existing, green-colored elements: 'Birmingham Green'
         2) Drain lines: Black
         3) Potable water lines: Green or match existing
         4) Fire sprinkler systems: Red
         5) Other surfaces: White
   2. Primer and Intermediate Coats
      a. Use contrasting colors as recommended by the coating manufacturer to distinguish Primer, Intermediate, and Finish Coats.

H. Gloss:
   1. As selected by Owner with approval by Coating Manufacturer in advance of sales order for coatings and application.

I. Thinners only as permitted by coating manufacturer within recommended limits.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions with Applicator and coating manufacturer's representative for compliance with requirements and other conditions affecting application or performance of coating.
   1. Ensure that work done by other trades is complete and ready for coating Work.
   2. Verify that areas and conditions under which coating Work is to be performed permit proper and timely completion of Work.
   3. Verify compatibility with and suitability of substrates, including existing coatings.
   4. Verify adhesion of existing coatings.
   5. Notify Architect/Engineer in writing of conditions which may adversely affect application or performance of coating and recommend corrections.
   6. Do not proceed with coating Work until adverse conditions have been corrected and reviewed by Architect/Engineer.
   7. Commencing coating Work constitutes acceptance of Work surfaces and conditions.

3.2 PROTECTION

A. Remove hardware, light fixtures, and other items already installed that are not to be painted. Coordinate removal, labelling, and storage with Owner's Representative. If removal is impractical or impossible because of size or weight of the item, provide surface-applied protection before surface preparation and painting.
   1. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.

B. Prevent construction debris, coatings, and other materials from coming into contact with pedestrians, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.

C. Limit access to Work areas. Provide "Wet Paint" signs to protect newly coated surfaces. Take precautions to protect against air-borne materials and runoff.

D. Masking and Preparation:
   1. Comply with coating manufacturer's written instructions for protecting building and other surfaces against damage from exposure to its products.
   2. Cover adjacent surfaces with materials that are proven to resist coating system.
   3. Mask off or protect from spatter, overspray, or other damage surfaces not scheduled to receive coating.
   4. Remove masking and other protective measures at completion of coating Work.

E. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck, railing, or other elements with galvanized repair paint according to ASTM A780 and manufacturer's written instructions.

F. Assume responsibility for injury to persons or damage to property due to Work, and remedy at no cost to Owner.

3.3 SURFACE PREPARATION

A. All surfaces shall be prepared in accordance with SSPC-SP 6 – Commercial Blast Cleaning unless approved otherwise by Architect/Engineer.

B. Substrate (Dry Abrasive Blast Clean): Clean and prepare substrate according to coating manufacturer's written instructions. Provide clean, dust-free, dry, and sound substrate for coating application.
   1. Remove grease, oil, dirt, and other contaminants that might impair bond of coating in accordance with SSPC-SP 1. Use cleaner/degreaser or chemical removal as necessary, rinse thoroughly with copious amounts of clean water.
   2. Abrasive blast clean all surfaces to be painted in accordance with SSPC-SP 6 to provide an angular profile with minimum surface amplitude of 2.0 to 2.5 mils. Greater surface profiles may be required based on the material manufacturer's product data.
   3. For touch-up areas, feather edges of existing coating by sanding, grinding, or as recommended by coating manufacturer.

C. Substrate (Hand or Power Tool Clean): Clean and prepare substrate according to coating manufacturer's written instructions. Provide clean, dust-free, dry, and sound substrate for coating application.
   1. Remove grease, oil, dirt, and other contaminants that might impair bond of coating in accordance with SSPC-SP 1. Use cleaner/degreaser or chemical removal as necessary; rinse thoroughly with copious amounts of clean water.
   2. Remove loose rust, loose or deteriorated paint, and other loose foreign matter in accordance with SSPC-SP 3.
   3. Lightly sand existing coating to remove sheen and slightly roughen.
   4. Feather edges of existing coating by sanding, grinding, or as recommended by coating manufacturer.

D. Examine substrate with coating manufacturer to ensure that it is properly prepared and ready to receive coating.
   1. Coating manufacturer's representative shall report in writing to Applicator and Architect/Engineer conditions which may adversely affect coating system application or performance and recommend corrections.
   2. Do not proceed with coating application until unsatisfactory conditions have been corrected and reviewed by Architect/Engineer.

E. Commencing application constitutes acceptance of Work surfaces and conditions. Inadequate removal/preparation efforts resulting in failure of new coatings within material warranty period are the responsibility of the Contractor.

3.4 APPLICATION

A. General: Prepare and apply materials according to coating manufacturer's written instructions, at recommended rates and coverages.

B. Test prepared surfaces for moisture and other conditions as recommended by coating manufacturer. Verify that ambient air and substrate surface temperatures, relative humidity, and dew point are within ranges recommended by coating manufacturer and are forecast to remain within these ranges during coating curing period.

C. Mix materials thoroughly to uniform, smooth consistency. Do not thin or dilute unless permitted by coating manufacturer; use recommended thinners within recommended limits.
   1. Stir as required during application.
   2. If surface film forms, do not stir film into material. Remove film and strain coating material before using.
   3. Maintain containers used for mixing and applying coating in clean condition, free of foreign materials and residue.

D. Apply coating by roller, spray, or brush. Use applicator and technique best suited for substrate and type of material being applied.
   1. Apply materials as soon as practicable after completion of surface preparation or full curing of previous material application.
   2. Extend new coating to reveals, surface edges, or other natural termination points to minimize differences in appearance between new and existing coating.
   3. Do not coat over conditions detrimental to formation of durable coating film, such as dirt, rust, scale, grease, or moist or scuffed surfaces.
   4. Prime exposed steel surfaces to provide thickness of 2 to 3 dry mils or as recommended by coating manufacturer, whichever is greater.
   5. Apply finish coat in one or two coats to provide thickness of 2 to 3 dry mils or as recommended by coating manufacturer, whichever is greater, and to provide total thickness including primer of 4 to 6 dry mils or as recommended by coating manufacturer, whichever is greater. Do not apply second coat until first coat has fully cured. Select application method to avoid excessive coating thickness.
      a. If undercoats or other conditions show through final coat, apply additional coats until coating film is of uniform finish, color, and appearance, if approved by Architect/Engineer.
      b. Ensure that edges, corners, and crevices receive minimum dry film thickness.
      c. Brush Application: Work material into surface in even film. Eliminate cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Neatly draw lines at edges and color breaks.
      d. Roller Application: Keep cover wet; do not dry roll. Apply material in sections. Lay on required amount of material, working material into grooves and rough areas. Then level material, working it into surface.
      e. Spray Application: Use spray application only when permitted by manufacturer's written instructions and authorities having jurisdiction. Apply material to provide equivalent hiding of brush-applied coat. Do not double back, building up film thickness of two coats in one application.
   6. Do not coat over UL, FMG, or other labels.

3.5 FIELD QUALITY CONTROL

A. Material Coverage Rates.
   1. At beginning of application, calibrate material coverage rate with wet-mil thickness equivalent to minimum specified dry-mil thickness. Measure wet-mil thickness with thickness gauge.
   2. Measure wet-mil thickness at least once for every 10 square feet of surface coated. Adjust coverage rate to maintain minimum thickness.

B. Owner may, at its expense, perform the following tests. Contractor shall provide access to test locations determined by Architect/Engineer.

1. Measure dry-film thickness of coating. Coating thickness is acceptable if within specified range.
2. Perform adhesion tests per ASTM C3359, Test Method A, after coating has cured. Coating adhesion is acceptable if no peeling or coating removal occurs (Rating 5A).
3. Perform pull-off tests per ASTM D4541, after coating has cured. Coating application is acceptable if test results are at least 100 pounds per square inch.
4. If coating application is acceptable, Owner will pay Contractor to repair substrate and coating as necessary at test locations.
5. If coating application is unacceptable, Architect/Engineer will determine remedy. Contractor shall remove and replace unacceptable coating or perform other remedial actions at no cost to Owner. Contractor shall also repair substrate and coating at test locations with unacceptable results at no cost to Owner. Contractor may, at own expense, perform additional measurements and testing to determine limits of areas with unacceptable coating.

C. Completed Work shall match approved mockup for color, texture, and coverage, in opinion of Architect/Engineer, and shall be free from flow-lines, streaks, blisters, and other surface imperfections. Remove, refinish, or recoat Work not complying with specified requirements.

3.6 CLEANING

A. At the end of each workday, clean Site and Work areas and place rubbish, empty cans, rags, and other discarded materials in appropriate containers.

B. After completing coating Work:
1. Clean spillage, overspray, and spatter from adjacent surfaces using cleaning agents and procedures recommended by manufacturer of affected surface. Exercise care to avoid scratching or damage to surfaces.
2. Repair surfaces stained, marred, or otherwise damaged during coating Work.
3. Clean up debris and surplus materials and remove from Site.

C. Waste Management:
1. Collect surplus coating materials that cannot be reused and deliver to recycling or disposal facility.
2. Treat materials that cannot be reused as hazardous waste and dispose of in an appropriate manner.

END OF SECTION 09 97 13

SECTION 09 97 24
ARCHITECTURAL COATING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Surface preparation and application of architectural coating on the following substrates:
   1. Concrete
   2. Concrete masonry units (CMU)

B. Related Sections:
   1. Section 01 11 00 – Summary of Work
   2. Section 03 01 34 – Concrete Repair
   3. Section 07 18 00 – Traffic Coating
   4. Section 07 92 00 – Joint Sealants
   5. Section 09 96 53 – Elastomeric Coating
   6. Section 09 97 13 – Steel Coating

1.2 PAYMENT

A. Provide the following on a lump sum basis as described in Section 01 11 00.

1.3 REFERENCES

A. General
   1. All standards latest edition of the date of this Specification.

B. American Society for Testing and Materials (ASTM).
   1. D16: Standard Terminology for Paint, Related Coatings, Materials, and Applications.
   2. D3359: Standard Test Methods for Measuring Adhesion by Tape Test.
   3. D7234: Standard Test Method for Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers.
   4. Master Painters Institute (MPI):
      a. Architectural Painting Specification Manual (MPI Manual).

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordinate Work to ensure that adjacent areas are not adversely affected. Coordinate:
   1. With Owner's Representative.
   2. With other trades:
      a. To ensure that work done by other trades is complete and ready for coating Work.
      b. To avoid or minimize work on, or in immediate vicinity of, coating Work in progress.
      c. To ensure that subsequent work will not adversely affect completed coating.

B. Review repair and surface treatment materials and primers specified in other sections to ensure compatibility with architectural coating to be used. Notify Architect/Engineer in writing of concerns with materials or primers installed by others and recommended remedies.

C. Schedule surface preparation and coating application Work so that dust and other contaminants from surface preparation Work will not adversely affect wet, newly coated surfaces.

1.5 SUBMITTALS

A. Product Data: For each coating, manufacturer's literature including written instructions for evaluating, preparing, and treating substrate; technical data including tested physical and performance properties; mixing and application instructions; safety precautions for handling, storing, applying, and disposing of materials; and instructions for protecting surrounding areas from overspray. Include:
   1. Surfaces to which materials will be applied.
   2. Materials List: Inclusive list of required materials for each coating system, including crack fillers, block fillers, and primers. Cross-reference coating system and application. Identify each material by manufacturer's catalog number and general classification.
   3. VOC content of components.
   4. Coating manufacturer's color chart showing full range of colors available.

B. Samples: For each color and material to be applied, with texture and sheen to simulate actual conditions, on representative samples of the actual substrate.
   1. Provide stepped Samples, defining each separate coat, including block fillers and primers. Use representative colors when preparing Samples for review. Resubmit until required sheen, color, and texture are achieved.
   2. Provide a list of materials and applications for each coat of each Sample. Label each Sample for location and application.
   3. Submit 3 Samples for the Architect/Engineer's review of color, sheen, and texture.

C. Manufacturer's Certificate: Written certification from paint or stain manufacturer stating that specified surface preparation methods, paint or stain materials, and application procedures are appropriate for applications intended.

D. Safety Plan: Written action plan that complies with applicable government regulations and covers operational requirements for safe application of coating materials; means of protection of surrounding areas from overspray and rebound; and handling, storage, and disposal of hazardous and toxic materials.
   1. For review by Owner's Certified Industrial Hygienist (CIH) or Contractor's CIH; review by Architect/Engineer and Owner's Representative for information only.

E. Applicator Qualifications: Evidence that Applicator's *existing company* has minimum 5 years of continuous experience in similar coating work; list of at least 5 representative, successfully-completed projects of similar scope and size, including:
   1. Project name.
   2. Owner's name.
   3. Owner's Representative name, address, and telephone number.
   4. Description of work.
   5. Architectural coating used.
   6. Project supervisor.
   7. Total cost of coating work and total cost of project.
   8. Completion date.

F. Inspection Plan: Submit an inspection plan including a sample of a daily Quality Control log. Plan shall include list of testing and inspection equipment to be used and shall indicate the

number and frequency of site visits by manufacturer's technical representative. It shall also include but not be limited to:

1. Pre-surface preparation for obvious defects and contamination to be removed in accordance with the specified preparation.
2. Measurement of ambient conditions of temperature, humidity, and dew points.
3. Evaluation of surface preparation, application, and compressor equipment to verify cleanliness and avoid contamination.
4. Evaluation of surface preparation and profile for conformance with standards.
5. Observation of coating mixing and application for conformance to manufacturer's instructions and mock-up(s).
6. Determination of dry film thickness of each coat applied for conformance to manufacturer's instructions and mock-up(s).
7. Monitor cleanliness and time between coats. Each coat shall be inspected for cleanliness before application of subsequent coats.

G. Sample Warranties: Copies of coating manufacturer's warranty and Contractor's warranty, both stating obligations, remedies, limitations, and exclusions. Submitted with bid.

H. Following completion of the Work:
   1. Coating manufacturer's inspection report of completed coating application.
   2. Completed warranty from coating manufacturer.
   3. Completed warranty from Applicator.

1.6 EXTRA MATERIALS

A. Furnish and deliver to Owner 1 gallon of each color and finish of architectural coating materials applied. Provide materials in unopened, factory-sealed containers for storage and identify with labels describing contents.

1.7 QUALITY ASSURANCE

A. Manufacturer: Letter confirming use of coating system on project and compatibility with sealants and coatings specified elsewhere.

B. Applicator Qualifications: Experienced firm that has successfully completed coating work on all substrates included in this project with similar materials, design, and extent to that indicated for Project. Must have successful applications of specified materials in local area in use for minimum of 5 years.
   1. Employ foreman with minimum five years of experience as foreman on similar projects, who is fluent in English, to be on Site at all times during Work. Do not change foremen during course of Project except for reasons beyond control of Applicator; inform Architect/Engineer in advance of any changes.

C. Mockups: Prepare surface and apply architectural coating on 4-foot-by-4 foot area of cast-in-place column, ceiling, and wall, as well as a concrete masonry wall at locations identified by Architect/Engineer and using the full-scale work to demonstrate surface preparation, crack and joint treatment as applicable, aesthetic affects, and quality of materials and execution. Leave portion of prepared surface and each coating layer exposed to view.
   1. Mockups showing the color, texture, sheen, preparation, and application to each surface type shall cure the duration as required by manufacturer's written direction. Architect to compare finish for selection and approval.

2. Coating manufacturer's representative shall observe mockup and approve in writing surface preparation and coating application.
3. Notify Owner's Representative and Architect/Engineer seven days in advance of date when mockup will be constructed.
4. Owner may, at its expense, verify coating thickness and perform adhesion and pull-off tests. Contractor shall, at no cost to Owner, repair coating and substrate damaged by testing.
5. If Architect/Engineer determines mockup does not comply with requirements, modify mockup or construct new mockup until mockup is approved. Pay for additional testing requested by Owner. Do not proceed with Work until mockup is approved by the Owner's Representative.
6. Approved mockup will be acceptance standard for coating Work.
7. Approved mockups may become part of completed Work if undisturbed at time of Substantial Completion.

D. Pre-Installation Meeting: Contractor, applicator, manufacturer's representative, and Owner's Representative shall meet at the site to review procedures, acceptance of substrate surfaces, and coordination of Work with other trades.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle materials according to manufacturer's recommendations and in such manner as to prevent damage to materials and structure.

B. Deliver materials to Site in original containers and packaging with seals unbroken, labeled with:
1. Manufacturer's name.
2. Product brand name and type.
3. VOC content.
4. Color name and number.
5. Date of manufacture and batch number.
6. Directions for storing, handling, mixing with other components, and application, including precautions.
7. Thinning instructions (if permitted).

C. Store materials in original, undamaged containers and, if permitted, partially used materials in tightly covered containers in clean, dry, well-ventilated, protected location on raised platforms with weather-protective coverings, within temperature range required by manufacturer. Protect stored materials from direct sunlight, heat, sparks, and flames. Manufacturer's plastic wrapping is not considered to be an adequate weather-protective covering.

D. Limit stored materials on structures to safe loading capacity of structure at time materials are stored, and to avoid permanent deck deflection.

E. Conspicuously mark damaged or opened containers or containers with contaminated materials and remove from Site as soon as possible.

F. Remove and replace materials that cannot be applied within stated shelf life.

1.9 PROJECT CONDITIONS

A. Verify existing dimensions and details prior to start of coating Work. Notify Architect/Engineer of conditions found to be different than those indicated in Contract Documents. Architect/Engineer will review situation and inform Contractor and Applicator of changes.

B. Comply with Owner's limitations and restrictions for Site use and accessibility.

C. Hazardous Materials: Testing of existing coatings for hazardous materials has been performed.
   1. Refer to report dated February 26, 2024 by ASTI Environmental for hazardous materials information.
   2. The Contractor shall be responsible for ensuring that personnel within the Work area and the public are protected from exposure to hazardous materials; preventing contamination of the building/site; and appropriately characterizing materials to allow for their handling and disposal in accordance with all applicable laws and regulations.

D. Environmental Limitations: Apply coating when existing and forecast weather conditions permit coating to be installed according to coating manufacturer's written instructions.
   1. Apply only when substrate and ambient temperatures are between 50 and 90 degrees F, or within range recommended by coating manufacturer.
   2. Do not apply in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 degrees F above dew point; or when such conditions are imminent during the drying period.
   3. Do not apply to damp or wet substrate.
   4. Allow wet surfaces to dry thoroughly and attain temperature and conditions specified before starting or continuing coating operation.

E. Handle and install materials in strict accordance with safety requirements required by coating manufacturer; Safety Data Sheets (SDS); and local, state, and federal rules and regulations. Maintain Safety Data Sheets (SDS) with materials in storage area and available for ready reference on Site.

F. Maintain adequate ventilation during preparation and application of coating materials to keep concentration of volatile material below maximum allowable concentration prescribed by applicable local, state, and federal safety regulations.

1.10 CHANGES IN WORK

A. During rehabilitation work, existing conditions may be encountered which are not known or are at variance with Contract Documents. Such conditions may interfere with Work and may consist of damage or deterioration of substrate or surrounding materials that could jeopardize integrity or performance of Work.
   1. Notify Architect/Engineer of conditions that may interfere with proper execution of Work or jeopardize performance of Work prior to proceeding with Work.

1.11 WARRANTY

A. Manufacturer's Warranty:
   1. Written warranty, signed by coating manufacturer, including:
      a. Materials to replace coating that does not comply with requirements; that fails in adhesion, cohesion, or general durability; that cracks, checks, fades, or chalks; or

that deteriorates in manner not clearly specified by submitted coating manufacturer's data as inherent quality of material for application indicated.

b. Failure of existing coatings underneath new coating is included in warranty.

2. Warranty Period: 5 years after Substantial Completion date.

B. Contractor's Warranty:

1. Written warranty, signed by Contractor, including:
   a. Repair or remove and replace coating that does not comply with requirements; that fails in adhesion, cohesion, or general durability; that does cracks, checks, fades, or chalks; or that deteriorates in manner not clearly specified by submitted coating manufacturer's data as inherent quality of material for application indicated.
   b. Failure of existing coatings underneath new coating is included in warranty.
2. Warranty includes:
   a. Providing access to work area.
   b. Necessary surface preparation work.
3. Warranty Period: 5 years after Substantial Completion date.

PART 2 PRODUCTS

2.1 ARCHITECTURAL COATING

A. Source Limitations: Obtain materials through one source from single coating manufacturer, or from sources approved by coating manufacturer.

B. Material Compatibility:

1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, products shall be recommended in writing by top coat manufacturers for use in paint system and on substrate indicated.

C. Use the following or an approved equal; 2 coats minimum to achieve coverage excluding any necessary primers.

1. Tammscoat, manufactured by Euclid Chemical Company.
2. Series 180 W.B. Tneme-Crete manufactured by Tnemec.
3. Modac F manufactured by The Sherwin Williams Company.

D. Primers: As required by manufacturer. Provide primer with slightly lighter tint than finish coat to facilitate verification of topcoat coverage.

E. Finish Color: Match existing coating color or as selected and approved in writing by Owner's Representative from the manufacturer's full range.

2.2 AUXILIARY MATERIALS

A. Use block fillers, crack fillers and sealants, detail materials, and primers recommended by architectural coating manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions with Applicator and coating manufacturer's representative for compliance with requirements and other conditions affecting application or performance of coating.
   1. Ensure that work done by other trades is complete, cured, and ready for coating Work.
   2. Verify that areas and conditions under which coating Work is to be performed permit proper and timely completion of Work.
   3. Verify compatibility with and suitability of substrates, including existing coatings.
   4. Verify adhesion of existing coatings.
   5. Notify Architect/Engineer in writing of conditions which may adversely affect application or performance of coating and recommend corrections.
   6. Do not proceed with coating Work until adverse conditions have been corrected and reviewed by Architect/Engineer.
   7. Commencing coating Work constitutes acceptance of Work surfaces and conditions.

3.2 PROTECTION

A. Remove hardware, light fixtures, and other items already installed that are not to be painted. Coordinate removal, labelling, and storage with Owner's Representative. If removal is impractical or impossible because of size or weight of the item, provide surface-applied protection before surface preparation and painting.
   1. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.

B. Take precautions to ensure safety of people, including building users, passers-by, and workmen, and animals, and protection of property, including adjacent building elements, landscaping, and motor vehicles.

C. Prevent construction debris, coatings, and other materials from coming into contact with pedestrians, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.

D. Protect paving and sidewalks, and adjacent building areas from mechanical damage due to scaffolding and other equipment.

E. Limit access to Work areas. Provide "Wet Paint" signs to notify pedestrians newly coated surfaces.

F. Erect temporary protective canopies, as necessary, over walkways and at points of pedestrian and vehicular access that must remain in service during Work.

G. Take precautions to protect against air-borne materials and runoff.

H. Masking and Preparation:
   1. Comply with coating manufacturer's written instructions for protecting building and other surfaces against damage from exposure to its products.
   2. Cover adjacent surfaces with materials that are proven to resist coating system.
   3. Mask off or protect from spillage and overspray surfaces not scheduled to receive coating, including garage slab surfaces.

4. Mask off and protect conduit support hangers to prevent new paint from bonding to the hanger and restricting future movement.
5. Remove masking and other protective measures at completion coating Work.

I. Assume responsibility for injury to persons or damage to property due to Work, and remedy at no cost to Owner.

3.3 SURFACE PREPARATION

A. Existing Coatings:
1. Remove unbounded, peeling, flaking, or deteriorated coating by pressure washing or other means. Firmly adhered paint does not need to be removed.
2. Do not etch existing coatings.
3. Feather edges by sanding, grinding, or other means as recommended by manufacturer.
4. Do not use abrasive means that will create airborne particles if the existing coating contains lead. Follow local and federal regulations for proper removal and containment of lead coatings.

B. Clean and prepare substrate according to coating manufacturer's written instructions. Provide clean, dust-free, dry, and sound substrate for coating application.
1. Remove fins and projections, splatter, and other irregularities which would prevent monolithic, continuous application of coating.
2. Properly patch substrate defects (such as voids, form tie holes, honeycombing, and cracks) with latex-modified mortar or another material acceptable to coating manufacturer and Architect/Engineer.
3. Remove grease, oil, asphalt solids, form-release agents, curing compounds, and other contaminants or film-forming coatings that might impair bond of architectural coating. If chemical removal is necessary, rinse with clean water.
4. Pressure wash concrete to provide clean surface, free of laitance, dirt, and other loose or foreign material, and to slightly roughen surface.
5. Treat cracks, joints, changes in surface direction, and through-member penetrations with patching compound or sealant as recommended by coating manufacturer. Remove deteriorated existing sealant and other materials and replace with materials recommended by coating manufacturer.
6. Fill pores, crevices, and voids in concrete masonry with block filler and allow filler to dry.

C. Examine substrate with coating manufacturer to ensure that it is properly prepared and ready to receive coating.
1. Coating manufacturer's representative shall report in writing to Contractor and Architect/Engineer conditions which will adversely affect coating system installation or performance.
2. Do not proceed with coating application until these conditions have been corrected and reviewed by Architect/Engineer.

D. Commencing application constitutes acceptance of Work surfaces and conditions. Inadequate removal/preparation efforts resulting in failure of new coatings within material warranty period are the responsibility of the Contractor.

3.4 APPLICATION

A. General: Prepare and apply materials according to coating manufacturer's written instructions, at recommended rates and coverages.
   1. Test prepared surfaces for alkalinity, moisture, and other conditions as recommended by coating manufacturer. If surfaces are sufficiently alkaline to cause the finish paint to blister and burn, correct this condition before application. Do not paint surfaces if moisture content exceeds that permitted in manufacturer's written instructions.
   2. Verify that substrate has dried for minimum time period recommended by coating manufacturer.
   3. Verify that ambient air and substrate surface temperatures, relative humidity, and dew point are within ranges recommended by coating manufacturer and are forecast to remain within these ranges during coating curing period.
   4. Application of coating to occur within 7 days of completion of wash/preparation activities or following rain weather events where debris would be expected to wash down the parking structure. If application is initiated beyond 7 days after preparation, additional re-cleaning activities may be required at no additional cost to the owner.

B. Mix materials thoroughly to uniform, smooth consistency. Do not thin or dilute unless permitted by coating manufacturer; use recommended thinners within recommended limits.
   1. Stir as required during application.
   2. If surface film forms, do not stir film into material. Remove film and strain coating material before using.
   3. Maintain containers used for mixing and applying coating in clean condition, free of foreign materials and residue.

C. Apply coating by roller, spray, or brush. Use applicator and technique best suited for substrate and type of material being applied.
   1. Apply materials as soon as practicable after completion of surface preparation or full curing of previous material application.
   2. Do not coat over conditions detrimental to formation of durable coating film, such as dirt, dust, rust, scale, grease, or moist or scuffed surfaces.
   3. Apply barrier coat over incompatible primers or remove and reprime.
   4. Prime surfaces as necessary.
   5. Apply architectural coating in two coats to minimum thickness of 8 mils dry-film-thickness or as recommended by coating manufacturer, whichever is greater. Do not apply subsequent coats until the initial coat has fully cured.
      a. If undercoats or other conditions show through final coat, apply additional coats until coating film is of uniform finish, color, and appearance.
      b. Ensure that edges, corners, and crevices receive minimum dry film thickness.
      c. Brush Application: Work material into surface in even film. Eliminate cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Neatly draw lines at edges and color breaks.
      d. Roller Application: Keep cover wet; do not dry roll. Apply material in sections. Lay on required amount of material, working material into grooves and rough areas. Then level material, working it into surface.
      e. Spray Application: Use spray application only when permitted by manufacturer's written instructions and authorities having jurisdiction. Apply material to provide equivalent hiding of brush-applied coat. Do not double back, building up film thickness of 2 coats in 1 application.

f. Extend new coating to reveals, surface edges, or other natural termination points to minimize differences in appearance between new and existing coating.

6. Do not coat over UL, FMG, or other labels.

3.5 FIELD QUALITY CONTROL

A. Allow Owner, Owner's Representative, and Manufacturer's Representative access to observe progress and quality of portion of completed Work.

B. Material Coverage Rates.
   1. At beginning of application, calibrate material coverage rate with wet-mil thickness equivalent to minimum specified dry-mil thickness. Measure wet-mil thickness with thickness gauge.
   2. Measure wet-mil thickness at least once for every 200 square feet of surface coated, or at each individual location less than 200 square feet. Adjust coverage rate to maintain minimum thickness.

C. Owner may, at its expense, perform following tests. Contractor shall provide access to test locations determined by Architect/Engineer.
   1. Measure dry-film thickness of coating. Coating thickness is acceptable if within specified range.
   2. Perform adhesion tests per ASTM D3359, Test Method A, after coating has cured. Coating adhesion is acceptable if no peeling or coating removal occurs (Rating 5A).
   3. Perform pull-off tests per ASTM D7234, after coating has cured. Coating application is acceptable if test results are at least 100 pounds per square inch.
   4. If coating application is acceptable, Owner will pay Contractor to repair substrate and coating as necessary at test locations.
   5. If coating application is unacceptable, Architect/Engineer will determine remedy. Contractor shall remove and replace unacceptable coating or perform other remedial actions at no cost to Owner. Contractor shall also repair substrate and coating at test locations with unacceptable results at no cost to Owner. Contractor may, at own expense, perform additional measurements and testing to determine limits of areas with unacceptable coating.

D. Completed Work shall match approved mockup for color, texture, and coverage, in opinion of Architect/Engineer, and shall be free from flow lines, streaks, blisters, and other surface imperfections. Remove, refinish, or recoat work not complying with specified requirements.

3.6 CLEANING

A. At end of each workday, clean Site and Work areas and place rubbish, empty cans, rags, and other discarded materials in appropriate containers.

B. After completing coating Work:
   1. Clean spillage, overspray, spatter, and misplaced paint from surfaces and restore the affected areas to its original undamaged condition. Exercise care to avoid scratching or damage to surfaces.
   2. Repair surfaces stained, marred, or otherwise damaged during coating Work.
   3. Clean up debris and surplus materials and remove from Site.

C. Waste Management:

1. Collect surplus coating materials that cannot be reused and deliver to recycling or disposal facility.
2. Treat materials that cannot be reused as hazardous waste and dispose of in appropriate manner.

END OF SECTION 09 97 24

SECTION 32 17 23.13
PAINTED PAVEMENT MARKINGS

PART 1 GENERAL

1.1 DESCRIPTION

A. Section Includes: Supply and application of pavement-marking paint.

B. Related Sections:
1. Section 01 11 00 – Summary of Work
2. Section 03 01 34 – Concrete Repair
3. Section 07 18 00 – Traffic Coating
4. Section 07 19 17 – Silane Water Repellent

1.2 PAYMENT

A. Provide the following on a lump sum basis as described in Section 01 11 00.

1.3 REFERENCES

A. Reference Standards: Latest edition as of Specification date.
1. Federal Specifications.
a. A-A-2886: Paint, Traffic, Solvent Base.
b. TT-P-115: Paint, Traffic, Highway, White and Yellow (cancelled)
c. TT-P-1952: Paint, Traffic and Airfield Marking, Waterborne.

1.4 SUBMITTALS

A. Product Data: Pavement-marking-paint manufacturer's literature including written instructions for evaluating, preparing, and treating substrate; technical data including tested physical and performance properties; and application instructions. Include VOC content of components.

B. Compatibility: Manufacturer's written confirmation of compatibility with specified traffic coating and silane water repellent.

C. Shop Drawings: Drawings submitted for review and approval including, but not limited to: documentation of existing striping, directional arrows, and other pavement markings; new or modified striping, directional arrows, and other pavement markings identified in the Drawings; and new striping and other markings associated with new electric vehicle charger placement and modifications required to achieve ADA compliance (as approved by Owner after award of Contract and as communicated by Architect/Engineer by change order). Include proposed voluntary alternates or modifications, if any, and specifically identify alternates for review and approval by Owner and A/E. Indicate color of all paint.
1. Striping, directional arrows, and other pavement markings shown in Drawings are approximate and shall be verified, documented, and dimensioned by Contractor as part of shop drawing submittal.
2. CAD drawing files may be provided to Contractor upon request for Contractor's use and Contractor's acceptance of WJE's File Release. Accuracy of linework and geometry is not guaranteed and any use is upon the Contractor's risk. All linework shall be verified by Contractor.

D. Record Drawings: Drawings of final striping scope, locations, and colors for project record.

1.5 QUALITY ASSURANCE

A. Mockup: Apply pavement-marking paint on 1 square foot of each substrate to demonstrate surface preparation and application method.
   1. After pavement-marking paint has cured, Architect/Engineer will scrape paint with pocketknife or similar to verify adhesion.
   2. If Architect/Engineer determines mockup does not comply with requirements, construct new mockup until mockup is approved.

1.6 DELIVERY, HANDLING, AND STORAGE

A. Deliver, store, and handle materials according to manufacturer's recommendations and in such a manner as to prevent damage to materials or structure.

B. Deliver materials to Site in original containers and packaging with seals unbroken, labeled with manufacturer's name, product brand name and type, date of manufacture, lot number, and directions for storing and mixing with other components.

C. Keep materials dry and do not allow materials to be exposed to moisture during transportation, storage, handling, and installation. Reject and remove from Site new materials which exhibit evidence of moisture during application or have been exposed to moisture.

D. Store materials in original, undamaged containers, and coatings, thinners, and cleaners in tightly closed containers, in clean, dry, protected, well-ventilated location on raised platforms with weather-protective coverings, within temperature range required by pavement-marking-paint manufacturer. Protect stored materials from direct sunlight, sparks, and flame. Manufacturer's standard packaging and covering is not considered adequate weather protection.

E. Limit stored materials on structures to safe loading capacity of structure at time materials are stored, and to avoid permanent deck deflection.

F. Conspicuously mark damaged or opened containers or containers with contaminated materials and remove from Site as soon as possible.

G. Remove and replace materials that cannot be applied within stated shelf life.

1.7 PROJECT CONDITIONS

A. Prior to commencing Work, document with drawings and sketches existing pavement markings, including parking stall striping and numerals, traffic lines and arrows, accessible markings, and crosshatching.

B. Verify existing dimensions and details prior to start of pavement-marking Work. Notify Architect/Engineer of conditions found to be different than those indicated in the Contract Documents or to offer voluntary alternates of the defined scope. Architect/Engineer and Owner's Representative will review situation and inform Contractor of changes.

C. Comply with Owner's limitations and restrictions for Site use and accessibility.

D. Environmental Limitations: Apply pavement-marking paint when existing and forecast weather conditions permit pavement-marking paint to be applied according to pavement-marking-paint manufacturer's written instructions and warranty requirements.
   1. Do not apply when substrate or ambient temperature is outside of range recommended by pavement-marking-paint manufacturer.
   2. Do not apply to damp or wet substrate.

E. Handle and apply materials in strict accordance with safety requirements required by pavement-marking-paint manufacturer; Safety Data Sheets; and local, state, and federal rules and regulations. Maintain Safety Data Sheets with materials in storage area and available for ready reference on Site.

F. Maintain adequate ventilation during preparation and application of paint materials.

1.8 CHANGES IN WORK

A. During rehabilitation work, existing conditions may be encountered which are not known or are at a variance with the Contract Documents. Such conditions may interfere with the Work and may consist of damage or deterioration of the substrate or surrounding materials that could jeopardize the integrity or performance of the Work.
   1. Notify Architect/Engineer of conditions that may interfere with the proper execution of the Work or jeopardize the performance of the Work prior to proceeding with the Work.

1.9 WARRANTY

A. Applicator's Warranty:
   1. Prepare surface and replace pavement markings that fail in adhesion or cohesion or have unsatisfactory appearance, such as fading.
   2. Warranty does not include deterioration or failure of pavement-marking paint due to failure of substrate prepared according to requirements, fire, vandalism, or snowplow damage.
   3. Warranty Period: 1 year after Substantial Completion date.

PART 2 PRODUCTS

2.1 PAVEMENT-MARKING PAINT

A. General: 20-minute-maximum no-pick-up time.
   1. Chlorinated-rubber pavement-marking paint conforming to requirements of TT-P-115.
   2. Oil/alkyd pavement-marking paint conforming to requirements of A-A-2886 and TT-P-115.
   3. Acrylic-latex pavement-marking paint conforming to requirements of TT-P-1952.

B. Colors: To match existing, approved in advance in writing by Owner's Representative or Owner.
   1. Line striping and general pavement markings: White or Safety Yellow.
   2. Safety striping and other markings as indicated by the Owner: Safety Yellow.
   3. Accessibility striping: Blue.
   4. Electric vehicle charging station striping: To match existing if installed by Others prior to Work; or as otherwise directed and approved by Owner's Representative. Coordinate with Others as needed.

PART 3 EXECUTION

3.1 PREPARATION

A. Prior to removal of existing parking striping in preparation for other work, including concrete repairs, traffic-bearing membrane installation, and silane water repellent installation, record existing striping location, pattern, and orientation. Also record directional arrows and other painted signage to be replaced.

B. Examine substrates and conditions with applicator for compliance with requirements and other conditions affecting application or performance of pavement-marking Work.
   1. Ensure that work done by other trades is complete and ready for pavement-marking Work.
   2. Verify that areas and conditions under which pavement-marking Work is to be performed permit proper and timely completion of Work.
   3. Notify Architect/Engineer in writing of conditions which may adversely affect application or performance of pavement-marking Work and recommend corrections.
   4. Do not proceed with pavement-marking Work until adverse conditions have been corrected and reviewed by Architect/Engineer.
   5. Commencing pavement-marking Work constitutes acceptance of Work surfaces and conditions.

3.2 PROTECTION

A. Take precautions to ensure safety of people, including building users, passers-by, and workmen, and animals, and protection of property, including adjacent building elements, landscaping, and motor vehicles.

B. Prevent construction debris and other materials from coming into contact with pedestrians, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.

C. Limit access to Work areas.

D. Mask adjoining surfaces not receiving pavement-marking paint to prevent spillage and overspray affecting other construction.

E. Provide and maintain barricades for vehicular and pedestrian traffic at pavement-marking-paint areas during application and curing period.

F. Assume responsibility for injury to persons or damage to property due to Work, and remedy at no cost to Owner.

3.3 EQUIPMENT

A. Application equipment recommended by pavement-marking-paint manufacturer.

B. Provide and maintain hand-held, all-purpose fire extinguisher near paint storage and mixing area.

3.4 SURFACE PREPARATION

A. Clean and prepare substrate according to pavement-marking-paint manufacturer's written instructions. Provide clean, dust-free, and dry substrate.
   1. Verify that concrete, traffic coating, and silane water repellent has cured and aged for minimum time period recommended by pavement-marking-paint manufacturer.
   2. Verify that substrate is sound and is visibly dry and free of moisture.
   3. Remove grease, oil, asphalt solids, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from substrate.
   4. Thoroughly sweep substrate and clean with oil-free compressed air.

B. Examine substrate with applicator to ensure that it is properly prepared and ready to receive pavement-marking paint.
   1. Notify Architect/Engineer in writing of conditions which may adversely affect application or performance of pavement-marking paint and recommend corrections.
   2. Do not proceed with pavement-marking-paint application until adverse conditions have been corrected and reviewed by Architect/Engineer.
   3. Commencing application constitutes acceptance of Work surfaces and conditions.

3.5 APPLICATION

A. The paint shall be applied in accordance with the manufacturer's recommendations. No materials of different character or different manufacturer shall be intermixed. No materials shall be thinned, except as recommended by the manufacturer.

B. New striping shall match the existing striping in the area of work, as noted on Drawings, or as approved by Owner's Representative.

C. Provide solid parking stall stripes, center numerals, and other markings to match existing sizes, font, and other characteristics or as approved by Owner's Representative.

D. The Contractor shall paint arrows at intersections and corners, in the same orientation as existing. New arrows shall conform to the U.S. Department of Transportation's Manual on Uniform Traffic Control Devices.

E. Use appropriate masking, stencils and application equipment as required and as recommended by the manufacturer.

F. Provide the necessary traffic cones, barricades and other devices to protect the paint until it is sufficiently dry to withstand traffic.

G. Touch-up markings to provide clean, straight lines and surfaces throughout. Paint shall be removed or blocked out with an opaque paint matching the background color at all locations where the paint inadvertently splashed or tracked onto unintended locations.

3.6 CLEANING

A. At the end of each workday, clean Site and Work areas and place rubbish, empty cans, rags, and other discarded materials in appropriate containers.

B. After completing pavement-marking Work:

1. Clean or block out overspray, splatter, spillage, soiling, and paint on unintended locations.
    a. Use cleaning agents and procedures recommended by manufacturer of affected surface. Exercise care to avoid scratching or damage to surfaces.
    b. Block out with opaque pavement-marking paint matching substrate color.
2. Repair surfaces stained, marred, or otherwise damaged during pavement-marking Work.
3. Clean up debris and surplus materials and remove from Site.

C. Waste Management:
1. Collect surplus materials that cannot be reused and deliver to recycling or disposal facility.
2. Treat materials that cannot be reused as hazardous waste and dispose of in an appropriate manner.

END OF SECTION 32 17 23.13

SECTION 20 05 00
MECHANICAL GENERAL REQUIREMENTS

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to work of this Section.

1.2 SUMMARY

A. This Section includes mechanical general administrative and procedural requirements. The following requirements are included in this Section to supplement the requirements specified in Division 01 Specification Sections.

1.3 INDUSTRY STANDARDS

A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

B. AABC - Associated Air Balance Council; www.aabc.com.

1. AASHTO - American Association of State Highway and Transportation Officials; www.transportation.org.
2. ABMA - American Bearing Manufacturers Association; www.americanbearings.org.
3. ABMA - American Boiler Manufacturers Association; www.abma.com.
4. AGA - American Gas Association; www.aga.org.
5. AHRI - Air-Conditioning, Heating, and Refrigeration Institute (The); www.ahrinet.org.
6. AMCA - Air Movement and Control Association International, Inc.; www.amca.org.
7. ANSI - American National Standards Institute; www.ansi.org.
8. ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers; www.ashrae.org.
9. ASME - ASME International; (American Society of Mechanical Engineers); www.asme.org.
10. ASSE - American Society of Sanitary Engineering; www.asse-plumbing.org.
11. ASTM - ASTM International; www.astm.org.
12. AWS - American Welding Society; www.aws.org.
13. AWWA - American Water Works Association; www.awwa.org.
14. CDA - Copper Development Association; www.copper.org.
15. CGA - Compressed Gas Association; www.cganet.com.
16. CISPI - Cast Iron Soil Pipe Institute; www.cispi.org.
17. CSA - CSA International; (Formerly: IAS - International Approval Services); www.csa-international.org.
18. CSI - Construction Specifications Institute (The); www.csiresources.org.
19. CTI - Cooling Technology Institute; (Formerly: Cooling Tower Institute); www.cti.org.
20. FM Approvals - FM Approvals LLC; www.fmglobal.com.
21. HI - Hydraulic Institute; www.pumps.org.
22. ICC - International Code Council; www.iccsafe.org.
23. IEEE - Institute of Electrical and Electronics Engineers, Inc. (The); www.ieee.org.
24. IGSHPA - International Ground Source Heat Pump Association; www.igshpa.okstate.edu.
25. Intertek - Intertek Group; (Formerly: ETL SEMCO; Intertek Testing Service NA); www.intertek.com.
26. MSS - Manufacturers Standardization Society of The Valve and Fittings Industry Inc.; www.mss-hq.org
27. NADCA - National Air Duct Cleaners Association; www.nadca.com.
28. NAIMA - North American Insulation Manufacturers Association; www.naima.org.
29. NEBB - National Environmental Balancing Bureau; www.nebb.org.
30. NECA - National Electrical Contractors Association; www.necanet.org.
31. NEMA - National Electrical Manufacturers Association; www.nema.org.
32. NETA - InterNational Electrical Testing Association; www.netaworld.org.
33. NFPA - National Fire Protection Association; www.nfpa.org.
34. NSF - NSF International; www.nsf.org.
35. NSPE - National Society of Professional Engineers; www.nspe.org.
36. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association; www.smacna.org.
37. STI - Steel Tank Institute; www.steeltank.com.
38. TEMA - Tubular Exchanger Manufacturers Association, Inc.; www.tema.org.
39. UL - Underwriters Laboratories Inc.; www.ul.com.
40. USGBC - U.S. Green Building Council; www.usgbc.org.

C. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

D. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.

E. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

1.4 PERFORMANCE REQUIREMENTS

A. Systems Components Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

1.5 QUALITY ASSURANCE

A. Scope of Work: Furnish all labor, material, equipment, technical supervision, and incidental services required to complete, test and leave ready for operation the mechanical systems as specified and as indicated on Drawings.

B. Contract Documents are complimentary, and what is required by one shall be as binding as if required by all. In the event of inconsistencies or disagreements within the Construction Documents bids shall be based on the most expensive combination of quality and quantity of the work indicated.

C. Ordinances and Codes: Perform all Work in accordance with applicable Federal, State and local ordinances and regulations, the Rules and Regulations of ASHRAE, NFPA, SMACNA and UL, unless otherwise indicated.

D. Notify the Architect/Engineer in writing before submitting a proposal should any changes in Drawings or Specifications be required to conform to the above codes, rules or regulations.
   1. If the Contractor performs any work knowing it to be contrary to such laws, ordinances, rules and regulations, and without notice to A/E, the Contractor shall bear all costs arising from corrective measures.

E. Source Limitations: Obtain equipment and other components of the same or similar systems through one source from a single manufacturer.

F. Tests and Inspections: Perform all tests required by state, city, county and/or other agencies having jurisdiction. Provide all materials, equipment, etc., and labor required for tests.

G. Performance Requirements: Perform all work in a first class and workmanlike manner, in accordance with the latest accepted standards and practices for the trades involved.

H. Sequence and Schedule: Perform work to avoid interference with the work of other trades. Remove and relocate work which in the opinion of the Owner’s Representatives causes interference.

I. Labeling Requirement for Packaged Equipment: Electrical panels on packaged mechanical equipment shall bear UL label or label of other Nationally Recognized Testing Laboratory (NRTL) (Intertek, CSA, etc.).

1.6 CODES, PERMITS AND FEES

A. Unless otherwise indicated, all required permits, licenses, inspections, approvals and fees for Mechanical Work shall be secured and paid for by the Contractor. All Work shall conform to all applicable codes, rules and regulations.

B. Rules of local utility companies shall be complied with. Check with each utility company supplying service to the installation and determine all devices including, but not limited to, all valves, meter boxes, and meters which will be required and include the cost of all such items in proposal.

C. All work shall be executed in accordance with the rules and regulations set forth in local and state codes. Prepare any detailed drawings or diagrams which may be required by the governing authorities. Where the drawings and/or specifications indicate materials or construction in excess of code requirements, the drawings and/or specifications shall govern.

D. Refer to Division 22 Section “Domestic Water Piping” for purchase and installation of potable water meters.

1.7 DRAWINGS

A. The drawings show the location and general arrangement of equipment, piping and related items. They shall be followed as closely as elements of the construction will permit.

B. Examine the drawings of other trades and verify the conditions governing the work on the job site. Arrange work accordingly. Provide fittings, valves, and accessories as required to meet actual conditions.

C. Deviations from the drawings, with the exception of minor changes in routing and other such incidental changes that do not affect the functioning or serviceability of the systems, shall not be made without the written approval of the Architect/Engineer.

D. The Architectural and Structural Drawings take precedence in all matters pertaining to the building structure, Mechanical Drawings in all matters pertaining to Mechanical Trades and Electrical Drawings in all matters pertaining to Electrical Trades. Where there are conflicts or differences between the drawings for the various trades, report such conflicts or differences to the Architect/Engineer for resolution.

E. Drawings are not intended to be scaled for rough-in or to serve as shop drawings. Take all field measurements required to complete the Work.

1.8 MATERIAL AND EQUIPMENT MANUFACTURERS

A. Equipment: All items of equipment shall be furnished complete with all accessories normally supplied with the catalog items listed and all other accessories necessary for a complete and satisfactory operating system. All equipment and materials shall be new and shall be standard products of manufacturers regularly engaged in the production of plumbing, heating, ventilating and air conditioning equipment and shall be the manufacturer's latest design.

B. If an approved manufacturer is other than the manufacturer used as the basis for design, the equipment or product provided shall be equal in size, quality, durability, appearance, capacity, and efficiency through all ranges of operation, shall conform with arrangements and space

limitations of the equipment shown on the plans and/or specified, shall be compatible with the other components of the system and shall comply with the requirements for Items Requiring Prior Approval specified in this section of the Specifications. All costs to make these items of equipment comply with these requirements including, but not limited to, piping, sheet metal, electrical work, and building alterations shall be included in the original Bid.

C. All package unit equipment and skid mounted mechanical components that are factory assembled shall meet, in detail, the products named and specified within each section of the Mechanical and Electrical Specifications.

D. Changes Involving Electrical Work: The design of the mechanical systems is based on the equipment scheduled on the Drawings. Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified with no additional cost to project. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

E. Where equipment changes are made that involve additional Electrical Work (larger size motor, additional wiring of equipment, etc.) the Mechanical Trades involved shall compensate the Electrical Trades for the cost of the additional Work required.

1.9 INSPECTION OF SITE

A. Visit the site, examine and verify the conditions under which the Work must be conducted before submitting Proposal. The submitting of a Proposal implies that the Contractor has visited the site and understands the conditions under which the Work must be conducted. No additional charges will be allowed because of failure to make this examination or to include all materials and labor to complete the Work.

B. No contract sum adjustments or contract time extensions will be made for Contractor claims arising from conditions which were or could have been observable, ascertainable or reasonably foreseeable from a site visit or inquiry into local conditions affecting the execution of the work.

1.10 ITEMS REQUIRING PRIOR APPROVAL

A. Bids shall be based upon manufactured equipment specified. All items that the Contractor proposes to use in the Work that are not specifically named in the Contract Documents must be submitted for review prior to bids. Such items must be submitted in compliance with Division 01 specifications. Requests for prior approval must be accompanied by complete catalog information, including but not limited to, model, size, accessories, complete electrical information and performance data in the form given in the equipment schedule on the drawings at stated design conditions. Where items are referred to by symbolic designations on the drawings, all requests for prior approval shall bear the same designations.

B. Equipment to be considered for prior approval shall be equal in quality, durability, appearance, capacity and efficiency through all ranges of operation, shall fulfill the requirements of equipment arrangement and space limitations of the equipment shown on the plans and/or specified and shall be compatible with the other components of the system.
   1. All costs incurred to make equipment comply with other requirements, including providing maintenance, clearance, piping, sheet metal, electrical, replacement of other components, and building alterations shall be included in the original bid.

C. Voluntary alternates may be submitted for consideration, with listed addition or deduction to the bid, but will not affect the awarding of the contract.

1.11 ACTION SUBMITTALS

A. Submit for review in compliance with Division 01.

B. Equipment and material submittals required are indicated in the Mechanical; Fire Suppression; Plumbing; and Heating, Ventilating and Air Conditioning Sections. Refer to Division 01 for submittal quantities.

C. Submittals shall be in groupings of similar or related items. Plumbing fixture submittals shall be in one package including all fixtures intended to be used for this project. Incomplete submittal groupings will be returned "Rejected". Submit product data with identification mark number or symbol numbers as specified or scheduled on the Mechanical Drawings.

D. Submittals shall be project specific. Standard detail drawings and schedule not clearly indicating which data is associated with this Project will be returned "Rejected".

E. If deviations (not substitutions) from Contract Documents are deemed necessary by the Contractor, details of such deviations, including changes in related portions of the project and the reasons therefore, shall be included with the submittal for approval.

1.12 INFORMATIONAL SUBMITTALS

A. Shop Drawings:

B. Prepare shop drawings to scale for the Architect/Engineer for review.
   1. Shop drawings shall be reviewed by the Mechanical Contractor for completeness and accuracy prior to submitting to the Architect/Engineer for review. The shop drawings shall be dated and signed by the Mechanical Contractor prior to submission.
   2. No equipment shall be shipped from stock or fabricated until shop drawings for them have been reviewed by the Architect/Engineer. Review is only for general conformance with the design concept of the project and general compliance with the information given in the Contract Documents. Any action indicated is subject to the requirement of the plans and specifications.
      a. By the review of shop drawings, the Architect/Engineer does not assume responsibility for actual dimensions or for the fit of completed work in position, nor does such review relieve Mechanical Trades of full responsibility for the proper and correct execution of the work required.
      b. Contractor is responsible for:
         1) Dimensions, which shall be confirmed and correlated at the job site.
         2) Fabrication processes and techniques of construction.
         3) Quantities.
         4) Coordination of Contractor's work with all other trades.
         5) Satisfactory performance of Contractor's work.
         6) Temporary aspects of the construction process.

1.13 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Instructional Manuals:

B. Submit project specific Operation and Maintenance Instructional Manuals for review in compliance with Division 01 Specification Sections.
   1. Provide complete operation and maintenance instructional manuals covering all mechanical equipment herein specified, together with parts lists. Maintenance and operating instructional manuals shall be job specific to this project. Generic manuals are not acceptable. One copy of all manuals shall be furnished for Owner. Maintenance and operating instructional manuals shall be provided when construction is approximately 75 percent complete.
   2. Format: Submit operation and maintenance manuals in the following format:
      a. PDF electronic file. Assemble each manual into a composite electronically indexed file. Submit on digital media acceptable to Architect.
         1) Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically linked operation and maintenance directory.
         2) Enable inserted reviewer comments on draft submittals.

C. The operating and maintenance instructions shall include a brief, general description for all mechanical systems including, but not limited to:
   a. Routine maintenance procedures.
   b. Lubrication chart listing all types of lubricants to be used for each piece of equipment and the recommended frequency of lubrication.
   c. Trouble-shooting procedures.
   d. Contractor's telephone numbers for warranty repair service.
   e. Submittals.
   f. Recommended spare parts list.
   g. Names and telephone numbers of major material suppliers and subcontractors.
   h. System schematic drawings.

D. Record Drawings

E. Submit record drawings in compliance with Division 01.
   1. Contractor shall submit to the Architect/Engineer, record drawings on electronic media or vellum which have been neatly marked to represent as-built conditions for all new mechanical work.
   2. The Contractor shall keep accurate note of all deviations from the construction documents and discrepancies in the underground concealed conditions and other items of construction on field drawings as they occur. The marked up field documents shall be available for review by the Architect, Engineer and Owner at their request.

F. Warranties

G. Warranty: Comply with the requirements in Division 01 Specification Sections. Contractor shall warranty that the mechanical installation is free from defects and agrees to replace or repair, to the Owner’s satisfaction, any part of this mechanical installation which becomes defective within a period of one year (unless specified otherwise in other Mechanical; Fire Suppression; Plumbing; or Heating, Ventilating and Air Conditioning Sections) from the date of substantial completion following final acceptance, provided that such failure is due to defects in the equipment, material, workmanship or failure to follow the contract documents.
   1. File with the Owner any and all warranties from the equipment manufacturers including the operating conditions and performance capacities they are based on.

1.14 INSTRUCTION OF OWNER PERSONNEL

A. Before final inspection, instruct Owner's designated personnel in operation, adjustment, and maintenance of mechanical equipment and systems at agreed upon times. A minimum of 24 hours of formal instruction to Owner's personnel shall be provided for each building. Additional hours are specified in individual specification sections.

B. For equipment requiring seasonal operation, perform instructions for other seasons within six months.

C. Use operation and maintenance manuals as basis for instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.

D. In addition to individual equipment training provide overview of each mechanical system. Utilize the as-built documents for this overview.

E. Prepare and insert additional data in operation and maintenance manual when need for such data becomes apparent during instruction.

1.15 WARRANTY

A. Warranty: Comply with the requirements in Division 01 Specification Sections. Contractor shall warranty that the mechanical installation is free from defects and agrees to replace or repair, to the Owner’s satisfaction, any part of this mechanical installation which becomes defective within a period of one year (unless specified otherwise in other Mechanical; Fire Suppression; Plumbing; or Heating, Ventilating and Air Conditioning Sections) from the date of substantial completion following final acceptance, provided that such failure is due to defects in the equipment, material, workmanship or failure to follow the contract documents.

B. File with the Owner any and all warranties from the equipment manufacturers including the operating conditions and performance capacities they are based on.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 MECHANICAL DEMOLITION WORK

A. Demolition of existing mechanical equipment and materials shall be done by the Contractor unless otherwise indicated. Include items such as, but not limited to, existing piping, pumps, ductwork, supports, and equipment where such items are not required for the proper operation of the modified system.

B. Include draining of piping systems where required for demolition, modification of, or connection to existing systems.

C. In general, demolition work is indicated on the Drawings. However, the Contractor shall visit the job site to determine the full extent and character of this Work.

D. Unless specifically noted to the contrary, removed materials shall not be reused in the work. Salvaged materials that are to be reused shall be stored safe against damage and turned over to

the appropriate trade for reuse.

E. Salvaged materials of value that are not to be reused shall remain the property of the Owner unless such ownership is waived.
   1. Remove items from the systems and turn over to the Owner in their condition prior to removal. The Owner will move and store these materials.
   2. Items on which the Owner waives ownership shall become the property of the Contractor, who shall remove and legally dispose of same, away from the premises.

F. Work that has been cut or partially removed shall be protected against damage until covered by permanent construction.

G. Clean and flush the interior and exterior of existing relocated equipment and its related piping, valves, and accessories that are to be reused of mud, debris, pipe dope, oils, welding slag, loose mill scale, rust, and other extraneous material so that the existing equipment and accessories can be repainted and repaired as required for the proper operation and performance of the relocated equipment.

H. Where existing equipment is to be removed, cap piping under floor, behind face of wall, above ceiling, or at mains.

I. Cap ductwork and cap piping immediately adjacent to demolition as soon as demolition commences in order to allow existing systems to remain in operation.

J. Cap or plug piping with same or compatible piping material.
   1. Cap or plug ducts with same or compatible ductwork material.

3.2 REFRIGERANT HANDLING

A. Refrigerant Installation and Disposal: Perform all work related to refrigerant contained in chillers, cooling coils, air conditioners, and similar equipment, including related piping, in strict accordance with the following requirements:

B. ASHRAE Standard 15 and Related Revisions: Safety Code for Mechanical Refrigeration.
   1. ASHRAE Standard 34 and Related Revisions: Number Designation and Safety Classification of Refrigerants.
   2. United States Environmental Protection Agency (US EPA) requirements of Section 8 08 (Prohibition of Venting and Regulation of CFC) and applicable State and Local regulations of authorities having jurisdiction.

C. Recovered refrigerant is the property of the Contractor. Dispose of refrigerant legally, in accordance with applicable rules and regulations.

3.3 WORK IN EXISTING BUILDINGS

A. The Owner will provide access to existing buildings as required. Access requirements to occupied buildings shall be identified on the project schedule. The Contractor, once Work is started in the existing building, shall complete same without interruption so as to return work areas as soon as possible to Owner.

B. Adequately protect and preserve all existing and newly installed Work. Promptly repair any damage to same at Contractor's expense.

C. Consult with the Owner's Representative as to the methods of carrying on the Work so as not to interfere with the Owner's operation any more than absolutely necessary. Accordingly, all service lines shall be kept in operation as long as possible and the services shall only be interrupted at such time as will be designated by the Owner's Representative.

D. Prior to starting work in any area, obtain approval for doing so from a qualified representative of the Owner who is designated and authorized by the Owner to perform testing and abatement, if necessary, of all hazardous materials including but not limited to, asbestos. The Contractor shall not perform any inspection, testing, containment, removal or other work that is related in any way whatsoever to hazardous materials under the Contract.

3.4 TEMPORARY SERVICES

A. Provide temporary service as described in Division 01.

B. The existing building will be occupied during construction. Maintain mechanical services and provide necessary temporary connections and their removal at no additional cost to the Owner.

3.5 WORK INVOLVING OTHER TRADES

A. Certain items of equipment or materials specified in the Mechanical Division may have to be installed by other trades due to code requirements or union jurisdictional requirements. In such instances, the Contractor shall complete the work through an approved, qualified subcontractor and shall include the full cost for same in proposal.

3.6 ACCEPTANCE PROCEDURE

A. Upon successful completion of start-up and recalibration, but prior to building acceptance, substantial completion and commencement of warranties, the Architect/Engineer shall be requested in writing to observe the satisfactory operation of all mechanical control systems.

B. The Contractor shall demonstrate operation of equipment and control systems, including each individual component, to the Owner and Architect/Engineer.

C. After correcting all items appearing on the punch list, make a second written request to the Owner and Architect/Engineer for observation and approval.

D. After all items on the punch list are corrected and formal approval of the mechanical systems is provided by the Architect/Engineer, the Contractor shall indicate to the Owner in writing the commencement of the warranty period.

E. Operation of the following systems shall be demonstrated:

F. Refrigeration Systems.
   1. Heating Systems.
   2. Temperature Controls.
   3. Building Automation System.

G. For systems requiring seasonal operation, demonstrate system performance within six months when weather conditions are suitable.

END OF SECTION 20 05 00

SECTION 20 05 10
BASIC MECHANICAL MATERIALS AND METHODS

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections include the following:
1. Division 20 Section “Mechanical General Requirements.”
2. Division 22 Section “Domestic Water Piping” for flushing and cleaning of potable water piping.
3. Division 23 Section “Piping Systems Flushing and Chemical Cleaning” for flushing and cleaning of HVAC piping.

1.2 SUMMARY

A. This section includes mechanical materials and installation methods common to mechanical piping systems, sheet metal systems and equipment. This section supplements all other Division 20, 21, 22, and 23 Mechanical Sections, and Division 01 Specification Sections.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:
1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. CPVC: Chlorinated polyvinyl chloride plastic.
3. PE: Polyethylene plastic.
4. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:
1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Transition fittings.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Escutcheons.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Brazing Certificates: As required by ASME Boiler and Pressure Vessel Code, Section IX, or AWS B2.2.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with requirements in Public Law 111-380, "Reduction of Lead in Drinking Water Act," about lead content in materials that will be in contact with potable water for human consumption.

B. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for potable domestic water piping and components.

C. Comply with NSF 372, “Drinking Water System Components – Lead Content” for potable domestic water piping and components.

D. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

E. Duct Joint and Seam Welding: Qualify procedures and personnel according to the following:
1. AWS D9.1, "Sheet Metal Welding Code."

F. Structural Welding: Qualify procedures and personnel according to the following:
1. AWS D1.1, "Structural Welding Code--Steel."
2. AWS D1.2, "Structural Welding Code--Aluminum."
3. AWS D1.3, "Structural Welding Code--Sheet Steel."
4. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
5. AWS D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

G. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

H. Soldering: Qualify processes and operators according to AWS B2.3/2.3M, "Specification for Soldering Procedure and Performance Qualification."

I. Installer Qualifications:
1. Installers of Grooved Components: Installers shall be certified by the grooved component manufacturer as having been trained and qualified to join piping with grooved couplings, fittings, and specialties.
2. Installers of Pressure-Sealed Joints: Installers shall be certified by the pressure-seal joint

manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Storage and Protection: Provide adequate weather protected storage space for all mechanical equipment and materials deliveries to the job site. Storage locations will be designated by the Owner's Representative. Equipment stored in unprotected areas must be provided with temporary protection.
   1. Protect equipment and materials from theft, injury, or damage.
   2. Protect equipment outlets, pipe and duct openings with temporary plugs or caps.
   3. Materials with enamel or glaze surface shall be protected from damage by covering and/or coating as recommended in bulletin "Handling and Care of Enameled Cast Iron Plumbing Fixtures", issued by the Plumbing Fixtures Manufacturer Association, and as approved.
   4. Electrical equipment furnished by Mechanical Trades and installed by the Electrical Trades: Turn over to Electrical Trades in good condition, receive written confirmation of same.
   5. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
   6. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.8 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations. Coordinate with other trades to ensure accurate locations and sizes of mechanical spaces, chases, slots, shafts, recesses, and openings.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Install Work to avoid interference with work of other trades including, but not limited to, Architectural and Electrical Trades. Remove and relocate any work that causes an interference at Contractor's expense.

D. Coordinate requirements for and provide access panels and doors for mechanical items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

E. The mechanical trades shall be responsible for all damage to other work caused by their work or through the neglect of their workers.
   1. All patching and repair of any such damaged work shall be performed by the trades which installed the work. The cost shall be paid by the Mechanical Trades.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by the

manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 21, 22, and 23 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 21, 22, and 23 piping Sections for special joining materials not listed below.

B. Unions: Pipe Size 2 Inches and Smaller:
1. Ferrous pipe: Malleable iron ground joint type unions.
2. Unions in galvanized piping system shall be galvanized.
3. Copper tube and pipe: Bronze unions with soldered joints.

C. Flanges: Pipe Sizes 2-1/2 Inch and Larger:
1. Ferrous pipe: Standard weight, forged steel weld neck flanges.
2. Copper tube and pipe: Slip-on bronze flanges.

D. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
   a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
   b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

E. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated. Square head bolts and nuts are not acceptable.

F. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

G. Solder Filler Metals: ASTM B 32, lead-free, antimony-free, silver-bearing alloys. Include water-flushable flux according to ASTM B 813.

H. Brazing Filler Metals: Alloys meeting AWS A5.8.
1. Use Type BcuP Series, silver-bearing, copper-phosphorus alloys for joining copper or bronze socket fittings with copper pipe. Flux is prohibited unless used with bronze fittings.
2. Use Type Bag Series, cadmium-free silver alloys for joining copper with steel, stainless steel, or other ferrous alloys.

I. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

J. Welding Materials: Comply with Section II, Part C, of ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being

welded.

K. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493.

L. Solvent Cements for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

M. Solvent Cements for Joining ABS Piping: ASTM D 2235.

N. Solvent Cements for Joining PVC to ABS Piping Transition: ASTM D 3138.

O. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.4 PIPE THREAD COMPOUNDS

A. General: Pipe thread compounds for the fluid service compatible with piping materials provided.

B. Potable Water Service and Similar Applications: Compounds acceptable to U.S. Department of Agriculture (USDA) or Food and Drug Administration (FDA). Compounds containing lead are prohibited.

2.5 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
   1. Manufacturers:
      a. Cascade Waterworks Mfg. Co.
      b. Dresser Industries, Inc.; DMD Div.
      c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
      d. JCM Industries.
      e. Smith-Blair, Inc.
      f. Viking Johnson.
   2. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.
   3. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.
   4. Aboveground Pressure Piping: Pipe fitting.

B. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
   1. Manufacturers:
      a. IPEX Inc. (formerly Eslon Thermoplastics).

C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
   1. Manufacturers:
      a. Thompson Plastics, Inc.

D. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
   1. Manufacturers:
      a. NIBCO INC.
      b. NIBCO, Inc.; Chemtrol Div.

E. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.
   1. Manufacturers:
      a. Cascade Waterworks Mfg. Co.
      b. Fernco, Inc.
      c. Mission Rubber Company.
      d. Plastic Oddities, Inc.
      e. Can-Tex Industries Division of Harsco Corp. “CT-Adaptors”.
      f. Joint Inc., “Caulder”.

2.6 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Brass Unions, Brass Nipples, Brass Couplings: For systems up to 286 deg F.

D. Dielectric-Flange Kits: Include full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
   1. Manufacturers:
      a. Advance Products & Systems, Inc.
      b. Calpico, Inc.
      c. Capitol Manufacturing Co.
      d. GF Piping Systems; George Fischer Central Plastics.
      e. Epco Sales, Inc.
      f. Pipeline Seal and Insulator, Inc.
      g. Watts Water Technologies, Inc.; Watts Regulator Co.
      h. Zurn Industries, Inc.; Wilkins Div.
   2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

E. Dielectric Nipple/Waterway Fittings: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, male NPT threaded, or grooved ends; and 300-psig minimum working pressure at 230 deg F.
   1. Manufacturers:
      a. ASC Engineered Solutions; Gruvlok Manufacturing; DI-LOK Nipples.
      b. Elster Group; Perfection Corp.; ClearFlow.
      c. Precision Plumbing Products, Inc.; ClearFlow.
      d. Sioux Chief Manufacturing Co., Inc.
      e. Tyco Fire & Building Products; Grinnell Mechanical Products; Figure 407 ClearFlow.
      f. Victaulic Co. of America; Style 47 ClearFlow.

2.7 MODULAR MECHANICAL SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve or pipe and core drilled hole.
   1. Manufacturers:

a. Advance Products & Systems, Inc.; Innerlynx.
b. Calpico, Inc.
c. Metraflex Co.
d. Pipeline Seal and Insulator, Inc.; Thunderline Link Seal.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Stainless steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Stainless steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.8 SLEEVES

A. Steel Pipe: ASTM A53, Type E, Grade B, Schedule 40, and 0.375 inch wall black.

B. Steel Pipe: ASTM A53, Type E, Grade B, Schedule 40, and 0.375 inch wall galvanized, plain ends.

C. Water Stop: Cast or ductile-iron; fabricated steel; PVC; or rotationally molded HDPE pipe; with plain ends and integral water stop, unless otherwise indicated.
1. Manufacturers:
a. Advance Products & Systems, Inc.; Infinity and Gal-Vo-Plast Sleeves.
b. Calpico, Inc.
c. Metraflex Co.
d. Pipeline Seal and Insulator, Inc.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
1. Underdeck Clamp: Clamping ring with set screws.

2.9 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
1. New Piping:
a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
b. Chrome-Plated Piping or Piping in High Humidity Areas: One-piece, cast-brass type with polished chrome-plated finish.
c. Insulated Piping: One-piece, stamped-steel type with spring clips.
d. Bare Piping in Finished Spaces: One-piece, stamped-steel type.
e. Bare Piping in Unfinished Service Spaces or Equipment Rooms: Split-plate, stamped-steel type with concealed hinge and set screw.
2. Existing Piping: Use the following:
a. Chrome-Plated Piping or Piping in High Humidity Areas: Split-casting, cast-brass type with chrome-plated finish.
b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge and spring clips.
c. Bare Piping: Split-plate, stamped-steel type with set screw or spring clips.

2.10 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive,

nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.11 EPOXY BONDING COMPOUND

A. Two-component system suitable for bonding wet or dry concrete to each other and to other materials.

B. Manufacturers:
1. Euco 452 #450; Euclid Chemical Co.
2. Epobond; L & M Construction Chemicals.
3. Sikadur 87; Sika Corp.

2.12 LEAK DETECTOR SOLUTION

A. Commercial leak detector solution for pipe system testing.

B. Manufacturers:
1. American Gas and Chemicals Inc.; Leak Tec.
2. Cole-Parmer Inst. Co.; Leak Detector.
3. Guy Speaker Co. Inc.; Squirt 'n Bubbles.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Refer to piping application schedules on the Drawings.

B. Install piping according to the following requirements and Division 21, 22, and 23 Sections specifying piping systems, and in accordance with manufacturer’s instructions.

C. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. The Drawings shall be followed as closely as elements of construction will permit.

D. During the progress of construction, protect open ends of pipe, fittings, and valves to prevent the admission of foreign matter. Place plugs or flanges in the ends of all installed work whenever work stops. Plugs shall be commercially manufactured products.

E. Prior to and during laying of pipe, maintain excavations dry and clear of water and extraneous materials. Provide minimum 4 inches of clearance in all directions for pipe passing under or through building grade beams.

F. Weld-o-lets and thread-o-lets can be used for annular flow measuring devices, temperature control components, and thermal wells in steel pipe. Pipe taps shall be drilled and deburred. Torch cutting is not acceptable.

G. Brazolets can be used for annular flow measuring devices, temperature control components, and thermal wells in copper tube. Pipe taps shall be drilled and deburred. Torch cutting is not acceptable.

H. Clean and lubricate elastomer joints prior to assembly.

I. Clean damaged galvanized surfaces and touch-up with a zinc rich coating.

J. Install piping to conserve building space and not interfere with use of space.

K. Group piping whenever practical at common elevations.

L. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
   1. Install piping to allow for expansion and contraction at locations where piping crosses building or structure expansion joints.

M. Slope piping and arrange systems to drain at low points.

N. Slope horizontal piping containing non-condensable gases 1 inch per 100 feet, upward in the direction of the flow.

O. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

P. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

Q. In concealed locations where piping, other than black steel, cast-iron, or galvanized steel, is installed through holes or notches in studs, joists, rafters, or similar members less than 1-1/2 inches from the nearest edge of the member, the pipe shall be protected by shield plates. Protective shield plates shall be a minimum of 1/16 inch thick steel, shall cover the area of the pipe where the member is notched or bored, and shall extend a minimum of 2 inches above sole plates and below top plates.

R. Do not penetrate building structural members unless specifically indicated on drawings.

S. Install piping above accessible ceilings to allow sufficient space for ceiling panel and light fixture removal.

T. Install valves with stems upright or horizontal, not inverted.

U. Provide clearance for installation of insulation and access to valves and fittings.

V. Install piping to permit valve and equipment servicing. Do not install piping below valves and/or terminal equipment. Do not install piping above electrical equipment.

W. Install piping at indicated slopes. Provide drain valves with hose end connections and caps at all piping low points, where piping is trapped and at all equipment.

X. Install piping free of sags and bends.

Y. Install fittings for changes in direction and branch connections.

Z. Unless otherwise indicated or specified, install branch connections to mains using tee fittings in main pipe:

1. Branch connected to bottom of main pipe for HVAC systems. Side connection is acceptable. Connection above centerline of main is unacceptable. For up-feed risers, connect branch to top of main pipe.
2. Branch connected to top of main for steam and condensate, plumbing systems, compressible gasses, and vacuum.

AA. Install piping to allow application of insulation.

BB. Select system components with pressure rating equal to or greater than system operating pressure.

CC. After completion, fill, clean, and treat systems. Refer to Division 23 Sections “Hydronic Piping,” “Piping Systems Flushing and Chemical Cleaning,” and “HVAC Water Treatment.”

DD. Install escutcheons for penetrations of walls below ceiling, and ceilings.

EE. Sleeves are not required for core-drilled holes in poured concrete walls.

FF. Permanent sleeves are not required for holes formed by removable PE sleeves in poured concrete walls.

GG. Install sleeves for pipes passing through footings and foundation walls, masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
1. Cut sleeves to length for mounting flush with both surfaces of walls.
    a. Exception: Extend sleeves installed in floors 2 inches above finished floor level.
2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
    a. Schedule 40 Black Steel Sleeves: For pipes smaller than NPS 12 penetrating interior walls.
    b. 0.375 Inch Wall Black Steel Sleeves: For pipes NPS 12 and larger penetrating interior walls.
    c. Schedule 40 Galvanized Steel Sleeves: For pipes smaller than NPS 12 penetrating floors, and roof slabs.
    d. 0.375 Inch Wall Galvanized Steel Sleeves: For pipes NPS 12 and larger penetrating floors and roof slabs.
4. Seal sleeves in concrete floors roof slabs and masonry walls with grout.
5. Seal sleeves in plaster/gypsum-board partitions with plaster or dry wall compound and caulk with non-hardening silicone sealant to provide airtight installation.
6. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

HH. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and modular mechanical seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing modular mechanical seals.
1. Install Schedule 40 galvanized steel pipe for sleeves smaller than 12 inches in diameter.
2. Install 0.375 galvanized steel pipe for sleeves 12 inches and larger in diameter.
3. Modular Mechanical Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble modular mechanical seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

II. Existing Underground, Exterior-Wall and Slab on Grade Pipe Penetrations: Seal core drilled pipe penetrations using modular mechanical seals. Allow for 1-inch annular clear space between pipe and cored opening for installing modular mechanical seals.
   1. Modular Mechanical Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of cored hole. Assemble modular mechanical seals and install in annular space between pipe and cored opening. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

JJ. Pipe Roof Penetration Enclosures:
   1. Coordinate delivery of roof penetration enclosures to jobsite.
   2. Locate and set curbs on roof.
   3. Framing, flashing, and attachment to roof structure are specified under Division 07.
   4. Attach cap to curbs, cut pipe boots to fit pipe, and clamp boots to pipe or conduit.

KK. Verify final equipment locations for roughing-in.

LL. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 21, 22, and 23 Sections specifying piping systems.

B. Cut piping square.

C. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

D. Remove scale, slag, dirt, oil, and debris from inside and outside of pipe and fittings before assembly.

E. Clean damaged galvanized surfaces and touch-up with a zinc rich coating.

F. Use standard long sweep pipe fittings for changes in direction. No mitered joints or field fabricated pipe bends will be permitted. Short radius elbows may be used where specified or specifically authorized by the Architect.

G. Make tee connections with screwed tee fittings, soldered fittings or specified welded connections. Make welded branch connections with either welding tees or forged branch outlet fittings in accordance with ASTM A234, ANSI B16.9 and ANSI B16.11. For forged branch outlets, furnish forged fittings flared for improved flow where attached to the run, reinforced against external strains and to full pipe-bursting strength requirements. "Fishmouth" connections are not acceptable.

H. Use eccentric reducers for drainage and venting of pipe lines; bushings are not permitted.

I. Provide pipe openings using fittings for all systems control devices, thermometers, gauges, etc. Drilling and tapping of pipe wall for connections is prohibited.

J. Provide temperature sensing device thermal wells and similar piping specialty connections.

K. Provide instrument connections except thermal wells with specified isolating valves at point of connection to system.

L. Locate instrument connections in accordance with manufacturer's instructions for accurate read-out of function sensed. Locate instrument connections for easy reading and service of devices.

M. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."

N. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

O. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

P. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
   1. Weld-o-lets and thread-o-lets can be used for annular flow measuring devices, temperature control components, and thermal wells. Pipe taps shall be drilled and deburred. Torch cutting is not acceptable.

Q. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on gaskets and bolt threads.
   1. Assemble flanged joints with fresh-stock gasket and hex head nuts, bolts or studs. Make clearance between flange faces such that the connections can be gasketed and bolted tight without strain on the piping system. Align flange faces parallel and bores concentric; center gaskets on the flange faces without projection into the bore.
   2. Lubricate bolts before assembly to insure uniform bolt stressing. Draw up and tighten bolts in staggered sequence to prevent unequal gasket compression and deformation of the flanges. Do not mate a flange with a raised face to a companion flange with a flat face; machine the raised face down to a smooth matching surface and use a full face gasket. After the piping system has been tested and is in service at its maximum temperature, check bolting torque to provide required gasket stress.

R. Grooved Joints: Assemble joints with grooved-end-pipe or grooved-end-tube coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Galvanized piping shall be cut grooved to prevent damage to galvanizing on internal pipe surfaces. The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and installation of grooved joint products. The manufacturer's representative shall periodically visit the jobsite and review installation. Contractor shall remove and replace any joints deemed improperly installed.

S. Dissimilar-Metal Piping Joints: Construct joints using dielectric fittings compatible with both

piping materials. Refer to Application Schedules on the Drawings.

T. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
   3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
   4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
   5. PVC Nonpressure Piping: Join according to ASTM D 2855.
   6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.

U. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

V. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

W. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
   1. Plain-End Pipe and Fittings: Use butt fusion.
   2. Plain-End Pipe and Socket Fittings: Use socket fusion.

X. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

Y. Remake joints which fail pressure tests with new materials including pipe, fittings, gaskets and/or a filler.

3.3 EQUIPMENT CONNECTIONS

A. Make connections to equipment, fixtures, and other items included in the work in accordance with the submittals and rough-in measurements furnished by the manufacturers of the particular equipment furnished.
   1. Any and all additional connections not shown on the drawings but shown on the equipment manufacturer’s submittal or required for the successful operation of the equipment shall be installed as part of this Contract at no additional charge to the Owner.

B. All piping connections to pumps, coils, and other equipment shall be installed without strain at the pipe connection of this equipment. When directed, remove the bolts in flanged connections or disconnect piping to demonstrate that piping has been so connected.

3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:
   1. Install unions, in piping NPS 2 and smaller, where indicated on Drawings, at final connection to each piece of equipment and at all control valves.
   2. Install flanges, in piping NPS 2-1/2 and larger, where indicated on Drawings, at final connection to each piece of equipment and at all control valves.

3.5 INSTALLATION OF PIPE CONCEALMENT SYSTEM

A. Install cover system, brackets, and cover components for piping according to manufacturer's "Installation Manual."

3.6 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated. Housekeeping pad locations and sizes shall be coordinated by mechanical contractor prior to the placement of concrete slabs.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

E. For suspended equipment, furnish and install all inserts, rods, structural steel frames, brackets and platforms required. Obtain approval of Architect for same including loads, locations, and methods of attachment.

F. Equipment Rigging Over Roof Areas: Protect building structure against damage during equipment rigging. Make provisions to distribute load of equipment to main roof structure, and to prevent damage to roof decking, roofing, or purlins.

G. The Contract Documents indicate items to be purchased and installed. The items are noted by a manufacturer’s name, catalog number and/or brief description. The catalog number may not designate all the accessory parts for a particular application. Arrange with the manufacturer for the purchase of all items required for a complete installation.

3.7 PAINTING

A. Painting of mechanical systems, equipment, and components is specified in Division 09.

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.8 CONCRETE BASES

A. Concrete housekeeping pads for floor mounted mechanical equipment shall be provided by Architectural Trades.

B. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions.
   1. Construct concrete bases as shown on Drawings or specified, but not less than 4 inches larger in both directions than supported unit.
   2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
   3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete

base, and anchor into structural concrete floor.

4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section.

3.9 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

C. Where pipe and/or equipment support members must be welded to structural building framing, Contractor shall seek prior approval from Architect and structural engineer. Scrape, brush clean, and apply one coat of zinc rich primer after welding.

D. Field Welding: Comply with AWS D1.1.

3.10 EPOXY BONDING TO EXISTING MATERIALS

A. Use epoxy bonding compound to set sleeves or pipes in existing concrete to bond new concrete and/or grout to existing materials or to bond dissimilar materials.

B. The compound, when applied in accordance with the manufacturer's instructions, shall be capable of initial curing within 48 hours at temperatures as low as 40 deg Fand shall be capable of bonding any combination of the following properly prepared materials: Wet or dry, cured, or uncured concrete or mortar; vitrified clay; cast iron and carbon steel.

3.11 JACKING OF PIPE

A. Do not jack pipe in place except upon prior approval of proposed materials and complete details of methods.

3.12 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor mechanical materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.13 GROUTING

A. Mix and install grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

3.14 CUTTING, CORING AND PATCHING

A. Refer to Division 01 Specification Sections for requirements for cutting, coring, patching and refinishing work necessary for the installation of mechanical work.

B. All cutting, coring, patching and repair work shall be performed by the Contractor through approved, qualified subcontractors. Contractor shall include full cost of same in bid.

3.15 EXCAVATION AND BACKFILLING

A. Refer to Division 31 Specification Sections.

B. Provide all excavation, trenching, tunneling, and backfilling required for the mechanical work.

C. Provide all pumping and/or well pointing required for the mechanical work.

D. Provide foundations if required to support underground piping.

E. Backfill all excavations with well-tamped granular material. Backfill all excavations under wall footings with lean mix concrete up to underside of footings and extend concrete within excavation a minimum of four (4) feet each side of footing. Granular backfill shall be placed in layers not more than 8 inches in thickness, 95 percent compaction throughout with approved compaction equipment. Tamp, roll as required. Excavated material shall not be used.

3.16 FLASHING

A. Provide all flashing required for mechanical work. Refer to Division 07 Specification Sections.

3.17 LUBRICATION

A. Provide all lubrication for the operation of the equipment until acceptance by the Owner. Contractor is responsible for all damage to bearings up to the date of acceptance of the equipment. Protect all bearings and shafts during installation. Thoroughly grease steel shafts to prevent corrosion. Provide covers as required for proper protection of all motors and other equipment during construction.

3.18 FILTERS

A. Provide and maintain filters in air handling systems throughout the construction period and prior to final acceptance of the building. Do not run air handling equipment, without all prefilters and final filters as specified.Immediately prior to final building acceptance by the Owner, Contractor shall:
   1. Replace all disposable type air filters with new units.

3.19 CLEANING

A. Each Mechanical Trade shall be responsible for removing all debris daily as required to maintain the work area in a neat, orderly condition.

B. After equipment, steam, condensate and HVAC water piping systems have been completed and tested, each entire system shall be cleaned and flushed. Refer to Division 23 Section "Piping Systems Flushing and Chemical Cleaning" for requirements. Provide temporary bypass piping and fittings, temporary valves and strainers, temporary water make-up piping with approved means of backflow prevention, and temporary pumps as needed to perform specified flushing and cleaning requirements.

C. Prior to connection of new HVAC piping to existing HVAC piping systems, all new piping shall be subject to initial flushing, cleaning and final flushing. Refer to Division 23 Section "Piping Systems Flushing and Chemical Cleaning" for requirements. Provide temporary bypass piping and fittings, temporary valves and strainers, temporary water make-up piping with approved means of backflow prevention, and temporary pumps as needed to perform specified flushing and cleaning requirements.

D. Flushing, cleaning, and disinfection of domestic water piping is specified in Division 22 Section “Domestic Water Piping.”

E. Exterior surfaces of all piping, ductwork and equipment shall be wiped down to remove excess dirt and debris prior to concealment by Architectural Trades work.

F. Upon completion of work in each respective area, clean and protect work. Just prior to final acceptance, perform additional cleaning as necessary to provide clean equipment and areas to the Owner.

END OF SECTION 20 05 10

SECTION 20 05 13
MOTORS

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections include the following:
1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section "Mechanical Vibration Controls" for mounting motors and vibration isolation devices.
3. Division 20 Section “Variable Frequency Controllers”.
4. Division 21, 22, and 23 Sections for application of motors and reference to specific motor requirements for motor-driven equipment.
5. Division 26 Section “Enclosed Switches and Circuit Breakers”.
6. Division 26 Section “Enclosed Controllers”.
7. Division 26 Section “Fuses”.

1.2 SUMMARY

A. This Section includes basic requirements for factory installed.

1.3 DEFINITIONS

A. ABMA: American Bearing Manufacturers Association. (Formerly AFBMA: Anti-Friction Bearing Manufacturers Association.)

B. Factory-Installed Motor: A motor installed by motorized-equipment manufacturer as a component of equipment.

C. Field-Installed Motor: A motor installed at Project site and not factory installed as an integral component of motorized equipment.

D. Packaged Self-Contained Equipment: Equipment which includes component mechanical and electrical equipment mounted on common bases, skids or frames or in common enclosures with internal control and power wiring factory installed and ready to accept a single electrical service connection. Provide the equipment complete with enclosed controllers, main disconnect switches, control transformers, control devices, wiring and accessories as required.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: A Nationally Recognized Testing Laboratory (NRTL), acceptable to authorities having jurisdiction, with the experience and capability to conduct the testing indicated.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.6 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices. Provide motors that are:
   1. Compatible with the following:
      a. Magnetic controllers.
      b. Multispeed controllers.
      c. Reduced-voltage controllers.
      d. Solid-state controllers.
      e. Variable frequency controllers.
   2. Designed and labeled for use with variable frequency controllers, and suitable for use throughout speed range without overheating.
   3. Matched to torque and horsepower requirements of the load.
   4. Matched to ratings and characteristics of supply circuit and required control sequence.

B. Coordinate electrical scope of work to be provided by Division 20, 21, 22, and 23 with this Section, related Division 20, 21, 22, and 23 Specifications, Division 26 Specifications and the Drawings.

C. Electrical work provided under Division 20, 21, 22, and 23: Furnish UL Listed components in accordance with this section, Division 26, and applicable NEMA and NEC (ANSI C 1) requirements. Provide wiring, external to electrical enclosures, in conduit.

D. Furnished, installed and wired under Division 20, 21, 22, and 23 unless otherwise indicated:
   1. Disconnected components in packaged self-contained equipment that are so constructed that components of wiring must be disconnected for shipment and reconnected after installation.

E. Furnished and installed under Division 20, 21, 22, and 23 and wired under Division 26 unless otherwise indicated:
   1. Motors required for mechanical equipment.
   2. Packaged Self-Contained Equipment:
      a. Provide equipment ready to accept a single electrical service connection.
      b. For equipment with remote mounted control panels, provide mounting of the control panel and external wiring from the control panel to the package self-contained equipment.
   3. Variable frequency controllers.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: Quantity equal to 10 percent of each fuse type and size, but no fewer than 3 of each type and size.
   2. Spare Indicating Lights: Six of each type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following:
   1. Dayton.
   2. Toshiba Intl.
   3. Baldor Electric/Reliance.
   4. Rockwell Automation/Allen-Bradley.
   5. Nidec Motor Corporation; U.S. Electrical Motors.
   6. Regal Beloit/GE Commercial Motors.
   7. Regal Beloit/Leeson.
   8. Regal Beloit/Marathon.
   9. Siemens.

2.2 MOTOR REQUIREMENTS

A. Motor requirements apply to factory-installed motors except as follows:
   1. Different ratings, performance, or characteristics for a motor are specified in another Section.
   2. Manufacturer for a factory-installed motor requires ratings, performance, or characteristics, other than those specified in this Section, to meet performance specified.
   3. Submersible motors integral to pumps and excluded from NEMA and EISA standards.

B. Electrical Power Supply Characteristics: Coordinate electrical system requirements with Division 26.

C. Electrical Power System Characteristics: As scheduled on the Drawings.

D. Electrical Connection: Conduit connection boxes, threaded for conduit. For fractional horsepower motors where connection is made directly, provide screwed conduit connection in end frame.

2.3 MOTOR CHARACTERISTICS

A. Motors 1/2 HP and Larger: Three phase, unless otherwise indicated.

B. Motors Smaller Than 1/2 HP: Single phase, unless otherwise indicated.

C. Frequency Rating: 60 Hz.

D. Voltage Rating: NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected.

E. Service Factor: 1.15 for open dripproof motors; 1.0 for totally enclosed motors.

F. Duty: Continuous duty at ambient temperature of 105 deg F and at altitude of 3300 feet above sea level.

G. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

H. Brake Horsepower Input: Shall not exceed 90 percent of the rated motor horsepower.

I. Enclosure: Open dripproof (ODP) for motors installed indoors and out of the airstream. Totally-enclosed fan-cooled (TEFC) for motors installed outdoors or within the airstream.

2.4 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Fire pump motors, C-face motors, JP and JM frame motors, and motors over 200 horsepower shall be energy efficient motors. Efficiency of the motor shall be determined based on the NEMA MG1. The minimum efficiencies, nominal efficiencies and shall meet or exceed Table 12-11.

	1800 RPM OPEN DRIP-PROOF MOTORS 4 POLE		1800 RPM ENCLOSED MOTORS 4 POLE	
HP	NOMINAL EFF	MINIMUM EFF	NOMINAL EFF	MINIMUM EFF
1	82.5	81.5	82.5	81.5
1.5	84	82.5	84	82.5

	1800 RPM OPEN DRIP-PROOF MOTORS 4 POLE		1800 RPM ENCLOSED MOTORS 4 POLE	
HP	NOMINAL EFF	MINIMUM EFF	NOMINAL EFF	MINIMUM EFF
2	84	82.5	84	82.5
3	86.5	85.5	87.5	86.5
5	87.5	86.5	87.5	86.5
7.5	88.5	87.5	89.5	88.5
10	89.5	88.5	89.5	88.5
15	91	90.2	91	90.2
20	91	90.2	91	90.2
25	91.7	91	92.4	91.7
30	92.4	91.7	92.4	91.7
40	93	92.4	93	92.4
50	93	92.4	93	93
60	93.6	93	93.6	93
75	94.1	93.6	94.1	93.6
100	94.1	93.6	94.5	94.1
125	94.5	94.1	94.5	94.1
150	95	94.5	95	94.5
200	95	94.5	95	94.5

	1200 RPM OPEN DRIP-PROOF MOTORS 6 POLE		3600 RPM OPEN DRIPPROOF MOTORS 2 POLE	
HP	NOMINAL EFF	MINIMUM EFF	NOMINAL EFF	MINIMUM EFF
1	80	78.5	--	--
1.5	84	82.5	82.5	81.5
2	85.5	84	84	82.5
3	86.5	85.5	84	82.5
5	87.5	86.5	85.5	84
7.5	88.5	87.5	85.5	86.5
10	90.2	89.5	88.5	87.5
15	90.2	89.5	89.5	88.5
20	91	90.2	90.2	89.5
25	91.7	91	91	90.2
30	92.4	91.7	91	90.2
40	93	92.4	91.7	91
50	93	93	92.4	91.7
60	93.6	93	93	92.4
75	93.6	93	93	92.4
100	94.1	93.6	93	92.4
125	94.1	93.6	93.6	93

	1200 RPM OPEN DRIP-PROOF MOTORS 6 POLE		3600 RPM OPEN DRIPPROOF MOTORS 2 POLE	
HP	NOMINAL EFF	MINIMUM EFF	NOMINAL EFF	MINIMUM EFF
150	94.5	94.1	93.6	93
200	94.5	94.1	94.5	94.1

C. Efficiency: Motors 1 horsepower to 200 horsepower shall be premium efficient motors meeting requirements of NEMA Premium Efficiency Motor Program. Efficiency of the motor shall be determined based on the NEMA MG1. The nominal efficiencies shall meet or exceed Table 12-12.

Nominal Efficiencies For "NEMA Premium™" Induction Motors
Rated 600 Volts or Less (Random Wound)

	Open Drip-Proof			Totally Enclosed Fan-Cooled		
HP	6-pole	4-pole	2-pole	6-pole	4-pole	2-pole
1	82.5	85.5	77.0	82.5	85.5	77.0
1.5	86.5	86.5	84.0	87.5	86.5	84.0
2	87.5	86.5	85.5	88.5	86.5	85.5
3	88.5	89.5	85.5	89.5	89.5	86.5
5	89.5	89.5	86.5	89.5	89.5	88.5
7.5	90.2	91.0	88.5	91.0	91.7	89.5
10	91.7	91.7	89.5	91.0	91.7	90.2
15	91.7	93.0	90.2	91.7	92.4	91.0
20	92.4	93.0	91.0	91.7	93.0	91.0
25	93.0	93.6	91.7	93.0	93.6	91.7
30	93.6	94.1	91.7	93.0	93.6	91.7
40	94.1	94.1	92.4	94.1	94.1	92.4
50	94.1	94.5	93.0	94.1	94.5	93.0
60	94.5	95.0	93.6	94.5	95.0	93.6
75	94.5	95.0	93.6	94.5	95.4	93.6
100	95.0	95.4	93.6	95.0	95.4	94.1
125	95.0	95.4	94.1	95.0	95.4	95.0
150	95.4	95.8	94.1	95.8	95.8	95.0
200	95.4	95.8	95.0	95.8	96.2	95.4

Nominal Efficiencies For "NEMA Premium™" Induction Motors
Rated Medium Volts for 5kV or Less (Form Wound)

	Open Drip-Proof			Totally Enclosed Fan-Cooled		
HP	6-pole	4-pole	2-pole	6-pole	4-pole	2-pole
250	95.0	95.0	94.5	95.0	95.0	95.0
300	95.0	95.0	94.5	95.0	95.0	95.0
350	95.0	95.0	94.5	95.0	95.0	95.0

Nominal Efficiencies For "NEMA Premium™" Induction Motors
Rated Medium Volts for 5kV or Less (Form Wound)

	Open Drip-Proof			Totally Enclosed Fan-Cooled		
HP	6-pole	4-pole	2-pole	6-pole	4-pole	2-pole
400	95.0	95.0	94.5	95.0	95.0	95.0
450	95.0	95.0	94.5	95.0	95.0	95.0
500	95.0	95.0	94.5	95.0	95.0	95.0

D. Stator: Copper windings, unless otherwise indicated.
   1. Multispeed motors shall have separate winding for each speed.

E. Rotor: Squirrel cage, unless otherwise indicated.

F. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA 9, L-10 life of 120,000 hours. Calculate bearing load with NEMA minimum V- belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

G. Temperature Rise: Match insulation rating, unless otherwise indicated.

H. Insulation: Class F, unless otherwise indicated.

I. Code Letter Designation:
   1. Motors 10 HP and Larger: NEMA starting Code (KVA Code) F or G.
   2. Motors Smaller Than 10 HP: Manufacturer's standard starting characteristic.
   3. Fire Pump Motors: NEMA starting Code (KVA Code) B.

J. Enclosure: Cast iron for motors 7.5 hp and larger; rolled steel for motors smaller than 7.5 hp.
   1. Finish: Gray enamel.

K. Sound Level: Not to exceed NEMA MG-1 12.54.

2.5 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Inrush Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Shaft Grounding: Provide a means to protect motor from common mode currents.
   1. Required for:
      a. Motors used with variable frequency controllers.
      b. Motors 100 HP and larger.
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Electrostatic Technology, Inc.; Aegis SGR Conductive Microfiber.

C. Severe-Duty Motors: Totally enclosed, with 1.25 minimum service factor, greased bearings, integral condensate drains, and capped relief vents. Windings insulated with nonhygroscopic material.
   1. Finish: Chemical-resistant paint over corrosion-resistant primer.

D. Source Quality Control: Perform the following tests on each motor according to NEMA MG 1:
   1. Measure winding resistance.
   2. Read no-load current and speed at rated voltage and frequency.
   3. Measure locked rotor current at rated frequency.
   4. Perform high-potential test.

2.6 SINGLE-PHASE MOTORS

A. Type: One of the following, to suit starting torque and requirements of specific motor application:
   1. Permanent-split capacitor.
   2. Split-phase start, capacitor run.
   3. Capacitor start, capacitor run.

B. Shaded-Pole Motors: For motors 1/20 hp and smaller only.

C. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

D. Bearings: Ball type for belt-connected motors and other motors with high radial forces on motor shaft; sealed, prelubricated-sleeve type for other single-phase motors.

2.7 ENCLOSED CONTROLLERS

A. Provide enclosed controllers in accordance with requirements specified in Division 26 Section “Enclosed Controllers”.

2.8 ENCLOSED SWITCHES AND CIRCUIT BREAKERS

A. Provide enclosed switches and circuit breakers in accordance with requirements specified in Division 26 Section “Enclosed Switches and Circuit Breakers”.

2.9 FUSES

A. Provide fuses in accordance with requirements specified in Division 26 Section “Fuses”.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. All three phase motors 1/2 HP and above shall be tested by the Testing Agency.

B. Prepare for acceptance tests as follows:
   1. Check motor nameplates for horsepower, speed, phase and voltage.
   2. Check coupling alignment and shaft end play.
   3. Run each motor with its controller. Demonstrate correct rotation, alignment, and speed at motor design load.
   4. Test interlocks and control features for proper operation.
   5. Verify that current in each phase is within nameplate rating.

C. Testing: Engage a qualified testing agency to perform the following field quality-control testing:

D. Testing: Perform the following field quality-control testing:
   1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.15.1. Certify compliance with test parameters.
   2. Jog motor as required to verify proper phase and shaft rotation. Immediately after start-up, check bearing temperature and smooth operation. Take current reading at full load using a clamp-on ammeter. If ammeter reading is over the rated full load current, determine reason for discrepancy and take necessary corrective actions. Record all readings, motor nameplate data and overload heater data.
   3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.2 ADJUSTING

A. Align motors, bases, shafts, pulleys and belts. Tension belts according to manufacturer's written instructions.

3.3 CLEANING

A. After completing equipment installation, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean motors, on completion of installation, according to manufacturer's written instructions.

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SECTION 20 05 29
HANGERS AND SUPPORTS

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections include the following:
1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Division 20 Section “Mechanical General Requirements.”
3. Division 20 Section “Basic Mechanical Materials and Methods.”
4. Division 20 Section "Mechanical Vibration Controls" for vibration isolation devices.
5. Division 20 Section "Pipe Flexible Connectors, Expansion Fittings and Loops" for pipe guides and anchors.
6. Division 21 Section "Fire-Suppression System" for pipe hangers for fire-protection piping.

1.2 DEFINITIONS

A. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry Inc.

B. MFMA: Metal Framing Manufacturers Association.

1.3 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:
   1. Steel pipe hangers and supports.
   2. Thermal-hanger shield inserts.

1.5 INFORMATIONAL SUBMITTALS

A. Shop Drawings: Show fabrication and installation details and include calculations for the following: Trapeze pipe hangers. Include Product Data for components.
   1. Metal framing systems. Include Product Data for components.
   2. Pipe stands. Include Product Data for components.
   3. Equipment supports.

1.6 QUALITY ASSURANCE

A. MSS Standards: Pipe hangers, supports, and accessories shall comply with the following:
   1. MSS SP-58, Pipe Hangers and Supports – Materials, Design and Manufacture, Selection, Application, and Installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 HANGER ROD MATERIAL

A. Threaded, hot rolled, steel rod conforming to ASTM A 36 or A575.
   1. Rod continuously threaded.
   2. Use of rod couplings is prohibited.

2.3 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3

"Hanger and Support Applications" Article, and schedules and details on the Drawings for where to use specific hanger and support types.

1. Hangers and Supports for Fire Protection Piping: UL listed or FMG approved.

B. Manufacturers:
   1. Anvil; ASC Engineered Solutions.
   2. B-Line by Eaton.
   3. Carpenter & Paterson, Inc.
   4. Hilti USA.
   5. nVent Electric plc; CADDY.
   6. PHD Manufacturing, Inc.

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.4 TRAPEZE PIPE HANGERS

A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.5 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Manufacturers:
   1. Anvil; Anvil-Strut; ASC Engineered Solutions.
   2. B-Line by Eaton.
   3. nVent Electrical plc; ERISTRUT Div.
   4. Power-Strut; a part of Atkore International.
   5. Unistrut; a part of Atkore International.
   6. Hilti USA.

C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.

D. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

E. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.6 METAL INSULATION SHIELDS

A. Manufacturers:
   1. Anvil; ASC Engineered Solutions.
   2. B-Line by Eaton.
   3. Carpenter & Paterson, Inc.
   4. nVent Electric plc; CADDY.
   5. PHD Manufacturing, Inc.

B. Description: MSS SP-58, Type 40, protective shields. Shields shall span an arc of 180 degrees.

C. Shield Dimensions for Pipe: Not less than the following:
1. NPS 1/4 to NPS 2: 12 inches long and 0.048 inch thick.

2.7 PIPE COVERING PROTECTION SADDLES

A. Manufacturers:
1. Anvil; ASC Engineered Solutions.
2. B-Line by Eaton.
3. Carpenter & Paterson, Inc.
4. nVent Electric plc; CADDY.
5. PHD Manufacturing, Inc.

B. Description: MSS SP-58, Type 39A and Type 39B, for suspension of insulated hot pipe where heat losses are to be kept to a minimum.
1. Saddles shall match insulation thickness.
2. Saddle length: 12 inches.
3. Furnish with center rib for pipe sized NPS 12 and larger.

2.8 PLASTIC INSULATION SHIELDS

A. Manufacturers:
1. Anvil; ASC Engineered Solutions.
2. Armacell LLC; Insuguard.
3. B-Line by Eaton; Snap'N Shield.
4. Hydra-Zorb Company; Bronco.

B. Description: Polypropylene copolymer protective shields with modular elements designed to snap directly onto strut channel, clevis hangers, or structural members. Shields shall span an arc of 180 degrees.
1. Operating Temperature Range: Minus 40 deg F to plus 178 deg F .

C. Certifications:
1. UL Classified for USA: UL-723 (ASTM E 84).
2. UL listed for Canada: ULC-S102.2.
3. Meets UL94 HB flammability standards.

D. Shield Dimensions for Pipe: Not less than the following:
1. NPS 1/4 to NPS 4: 12 inches long.

2.9 THERMAL-HANGER SHIELDS

A. Manufacturers:
1. American Mechanical Insulation Sales Inc. (AMIS).
2. B-Line by Eaton.
3. nVent Electric plc; CADDY.
4. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
5. Rilco Manufacturing Company, Inc.
6. Value Engineered Products, Inc.

B. Description: Manufactured assembly consisting of insulation insert encased in 360 degree sheet

metal shield.
1. Minimum Compressive Strength of Insert Material:
    a. 100-psig- for sizes smaller than NPS 6.
    b. 600-psig- for sizes NPS 6 and larger.

C. Insulation-Insert Material for Cold Piping: Full 360 degree, water-repellent treated, ASTM C 533, Type I calcium silicate with vapor barrier.

D. Insulation-Insert Material for Hot Piping: Full 360 degree, water-repellent treated, ASTM C 533, Type I calcium silicate.

E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

F. Include carbon steel ASTM A36 load distribution plates as required by load, pipe movement, hanger style, and hanger spacing.

G. Thermal-Hanger Shields for Flexible Foamed Elastomeric Insulated Piping:
1. Manufacturer:
    a. B-Line by Eaton/Armacell; Armafix IPH.
    b. Aeroflex USA, Inc, Aerofix-U.
    c. ZSi-Foster, Inc.; Cush-A-Therm.
2. Insulation-Insert Material for Copper Piping with Flexible Foamed Elastomeric Insulation: Use the following:
    a. Flexible foamed elastomeric, ASTM 534, Type I-Tubular Grade 1 with PUR/PIP support inserts.

H. Thermal-Hanger Shields for Small Diameter Piping:
1. Manufacturer:
    a. Hydra-Zorb Company; Klo-Shure Insulation Couplings.
2. Insulation-Insert Material for Small Diameter Piping with Flexible Foamed Elastomeric or Glass Fiber Insulation: Use the following:
    a. Rigid Hytrel thermoplastic insulation coupling designed for use with pipe or tube NPS 4 and smaller, and insulation from 3/8 inch to 1-1/2 inch thick.

2.10 FASTENER SYSTEMS

A. Post-Installed Anchors:
1. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
    a. Manufacturers:
        1) B-Line by Eaton.
        2) DeWalt Engineered by Powers.
        3) Hilti, Inc.
        4) ITW Ramset/Red Head.
        5) MKT Fastening, LLC.
2. Internally Threaded Screw Anchors: Internally threaded, self-tapping screw anchor designed for performance in cracked and uncracked concrete. Suitable base materials include normal-weight concrete, sand-lightweight concrete and concrete over steel deck.
    a. UL Listed or FMG approved for fire sprinkler piping.

b. Available Sizes: For1/4-inch, 3/8-inch, and 1/2-inch diameter rod sizes
c. Manufacturers:
1) B-Line by Eaton; Rapid Rod Hangers.
2) DeWalt Engineered by Powers; Snake+.

3. Chemical Fasteners: Insert-type-stud bonding system anchor for use with hardened portland cement concrete, and tension and shear capacities appropriate for application. Exception: Do not use chemical fasteners to support hanger systems for fire protection piping.
a. Manufacturers:
1) DeWalt Engineered by Powers.
2) Hilti, Inc.
3) ITW Ramset/Red Head.
4) MKT Fastening, LLC.
b. Bonding Material: ASTM C 881, Type IV, Grade 3, 2-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
c. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
d. Washer and Nut: Zinc-coated steel.

2.11 ROOF MOUNTED EQUIPMENT SUPPORTS

A. Equipment Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted equipment.

2.12 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.13 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Refer to application schedules on the Drawings.

B. For insulated pipe, oversize hanger elements to accommodate insulation thickness.

C. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

D. Comply with MSS SP-58 for pipe hanger selections and applications that are not specified in

piping system Sections.

E. Use hangers and supports with galvanized, metallic coatings for outdoor applications or where exposed to outdoor conditions.

F. Use hangers and supports with plastic coating, or galvanized metallic coatings for applications in corrosive atmospheres.

G. Use metal framing, with plastic coating, or galvanized metallic coatings for metal framing in corrosive atmospheres.

H. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

I. Use padded hangers for piping that is subject to scratching.

J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. MSS Type 8 or spring type to meet system requirements.

K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
   2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
   3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
   4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
   5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

L. Concrete Structure Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Anchor Devices, Concrete and Masonry: in accordance with Group I, Group II, Type 2, Class 2, Style 1 and Style 2, Group III and Group VIII or FS FF-S-325A. Furnish cast-in floor type equipment anchor devices with adjustable positions. Furnish built in anchor devices for masonry, unless otherwise approved by the Architect. Powder actuated anchoring devices shall not be used to support any mechanical systems components.
   2. Inserts, Concrete: TYPE 18 or 19. When applied to loads equivalent to piping in sizes NPS 2 and larger, and where otherwise required by imposed loads, a one foot length of 1/2 inchreinforcing rod shall be inserted and wired through wing slots. Proprietary type continuous inserts may be proposed and shall be submitted for approval.
   3. Use mechanical-expansion anchors where required in concrete construction.
   4. Use chemical fasteners where required in concrete construction.

M. Steel Frame Structure Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Beam Clamps:
      a. Center Loading: TYPE 21, 28, 29 and 30, unless otherwise indicated. Type 27 shall be allowed to support single pipes NPS 6 size or smaller only.
      b. "C" Clamps: Type 19, 20 or 23, for supporting single pipes NPS 2-1/2 size or smaller only. Use of "C" clamps, or beam clamps of "C" pattern, or any modification thereof, is prohibited for supporting multiple pipes or pipes larger than NPS 2-1/2.

N. Hanger-Rod Attachments for Wood Construction: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. All Steel Ceiling Plates: UL listed and suitable for attachment to wood beams. For pipe sizes NPS 1/2 to NPS 2. Install in accordance with manufacturer's instructions to maintain listing.
   2. Threaded Side Beam Brackets: UL listed and FMG approved, suitable for attachment to wood beams. For pipe sizes NPS 2 to NPS 4. Install in accordance with manufacturer's instructions to maintain listing.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Use spring supports and sway braces TYPES 48, 49, 50, 51, 52, 53, 54, 55 or 56. For specific points:
      a. Provide spring supports at point of support where vertical movement will occur.
      b. For light loads and vertical movement less than 1/4 inch, TYPES 48 or 49 spring cushion supports.
      c. For vertical movements in excess of 1/4 inch but less than 1/2 inch, TYPES 51, 52 or 53 variable spring supports shall be used, loaded to not more than 75 percent of published load rating.
      d. For vertical movements of 1/2 inch and more, TYPES 54, 55 and 56 constant support spring hangers.
      e. Sway braces; TYPE 50.
      f. Variable spring hangers in accordance with referenced MSS Standards with "medium" allowable load change.

P. Comply with MSS SP-58 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

Q. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

3.2 HANGER AND SUPPORT INSTALLATION

A. Steel Pipe Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structural frame.

B. Provide necessary piping and equipment supporting elements including: building structure attachments, supplementary steel, hanger rods, stanchions and fixtures, vertical pipe attachments, horizontal pipe attachments, anchors, guides, spring supports in accordance with the referenced codes, standards, and requirements specified. Support piping and equipment from building structure, not from roof deck, floor slab, other pipe, duct or equipment.

C. At connections between piping systems, hangers and equipment of dissimilar metals, insulate, using dielectric insulating material, nonferrous piping against direct contact with the building steel by insulating the contact point of the hanger and pipe or the hanger and building steel. Test each point of dielectric insulation with an ohm meter to ensure proper isolation of dissimilar materials. Test shall be observed by the Owner's Representative and/or Architect.

D. Use copper plated or plastic coated supporting element in contact with copper tubing or glass piping.

E. File and paint cut ends and shop or field prime paint supporting element components.

F. Secure Type 40 shields to support elements in a manner that prevents movement and damage to insulation and jacket materials.

G. Hang piping parallel with the lines of the building, unless otherwise indicated. Route piping in an orderly manner and maintain gradient. Space piping and components so a threaded pipe fitting may be removed between adjacent pipes and so there will be not less than 1/2 inch of clear space between finished surfaces and piping. Arrange hangers on adjacent parallel service lines in line with each other.

H. Flange loads on connected equipment shall not exceed 75 percent of maximum allowed by equipment manufacturer. Flange loads in liquid containing systems shall be checked in the presence of the Architect when piping is full of liquid. No flange load is allowed on pumps, vibration isolated equipment or flexible connectors.

I. Spring supports, within specified limitations: Constant support type, where necessary to avoid transfer of load from support to support or onto connected equipment; otherwise, variable support type located at points subject to vertical movement.

J. Incorporate pipe anchors into piping systems to maintain permanent pipe positions. Install alignment guides for the piping adjacent to and on each side of pipe expansion loops and expansion joints to maintain alignment.

K. Where necessary, brace piping and supports against reaction, sway and vibration.

L. Do not hang piping from joist pans, floor decks, roof decks, equipment, ductwork, or other piping.

M. Install turnbuckles, swing eyes and clevises to accommodate temperature changes, pipe accessibility, and adjustment for load pitch. Rod couplings are not acceptable.

N. Install hangers and supports for piping at intervals specified, at locations not more than 3 feet from the ends of each runout, not more than 3 feet from connections to equipment, and not over 25 percent of specified interval from each change in direction of piping and for concentrated loads such as valves, etc.

O. Base the load rating for pipe support elements on loads imposed by insulated weight of pipe filled with water. The span deflection shall not exceed slope gradient of pipe.

P. If structural steel, roofs, or tunnels will allow support spacing greater than that shown above, Contractor shall submit proposed support system along with structural calculations documenting the allowance of such spacing, in accordance with ANSI, B31.1, and MSS Guidelines.

Q. Support vertical risers independently of connected horizontal piping whenever practical, with supports at the base and at intervals to accommodate system range of load with thermal conditions. Support vertical risers at each floor penetration for piping in shafts or chases. Guide for lateral stability. Fit horizontal piping connected to moving risers with two spring supports connected adjacent to riser, spaced according to required hanger spacing.

R. For risers at temperatures of 100 deg F or less place riser clamps under fittings. Support carbon steel pipe at each operating level or floor and at not more than 15-foot intervals for pipe 2 inches and smaller, and at not more than 20 foot intervals for pipe 2-1/2 inches and larger.

S. After the piping systems have been installed, tested and placed in satisfactory operation, firmly

tighten hanger rod nut and jam nut and upset threads to prevent movement of fasteners.

T. Attach pipe anchors and pipe alignment guides to the building structure where indicated. If not indicated, the method used is optional to the Contractor, subject to approval by the Architect. In the case of structural steel, make attachment by clamping in accordance with the American Institute of Steel Construction Specification for the Design, Fabrication and Erection of Structural Steel for Building.

U. Attach supporting elements connected to structural steel columns to preclude vertical slippage and cascading failure.

V. Attach pipe hangers and other supporting elements to roof purlins and trusses at panel points.

W. Where eccentric loading beam clamps are approved and where other work is supported by similar eccentric loading support element from the same structural member, locate eccentric loading support elements to minimize structural member torsion load.

X. Limit the location of supporting elements for piping and equipment, when supported from roof, to panel points of the bar joists.

Y. Building structure shall not be reinforced except as approved by the Architect in writing.

Z. Use approved cast-in-place inserts or built-in anchors for attachment to concrete structure. Size inserts and anchors for the total applied load with a safety factor in accordance with applicable codes but in no case less than 5. Coordinate installation of all imbedded items in accordance with manufacturer's instructions. Position anchorage and imbedded items as indicated and/or where required and support against displacement during placing of concrete. Cutting or repositioning of concrete beam or girder or reinforcing steel to accommodate inserts will not be allowed. Provide removable closures in imbedded device openings to prevent entry of concrete.

AA. Support piping and equipment from concrete building frame, not from roof or floor slabs unless otherwise indicated.

BB. Use cast-in-place inserts in concrete beams and girders. Drilled anchors/wedge type inserts shall be used on vertical surfaces only. Coordinate with structural engineer.

CC. Attach piping supports to the side of concrete beams and concrete joist. Provide supplementary support steel as required. Cast-in-place or drilled anchors will not be permitted in the bottom of concrete beams and concrete joist.

DD. Attach piping supports to the side of concrete beams or concrete joist. Where intermediate hangers are required to meet the hanger spacing schedule, the Contractor may propose attachment of intermediate pipe supports to the bottom of the concrete slab pending submittal of a satisfactory pull out test. The Contractor shall submit pull out test criteria, pull out test results, proposed hanger detail and hanger point loads to the Architect for written approval.

EE. Trapeze Pipe Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported.

Weld steel according to AWS D1.1.

FF. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

GG. Fastener System Installation:
1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

HH. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

II. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

JJ. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

KK. Install lateral bracing with pipe hangers and supports to prevent swaying.

LL. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

MM. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

NN. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.

OO. Refer to individual piping sections for hanger spacing and hanger rod sizes.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 20 05 29

SECTION 20 05 33
ELECTRIC HEAT TRACING

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections:
1. Division 20 Section “Mechanical General Requirements.”

1.2 SUMMARY

A. Section includes electric heat tracing for piping freeze prevention and flow control.

1.3 PERFORMANCE REQUIREMENTS

A. Pipe Heat Tracing: Select electric heat tracing cable capable of providing freeze protection and flow control with outside temperature at minus 10 deg F.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Include rated capacities, operating characteristics, and furnished specialties and accessories.

1.5 INFORMATIONAL SUBMITTALS

A. Delegated-Design Submittal:

1. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.

B. Shop Drawings: For electric heating cable.
1. Include plans, elevations, sections, and attachment details.
2. Accurately record actual locations of heating cable, thermostats, and branch circuit connections.
3. Include diagrams for power, signal, and control wiring.

1.6 CLOSEOUT SUBMITTALS

A. Field quality-control reports.

B. Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.
1. Include description of operating controls.
2. Include repair methods and parts list of components.

1.7 COORDINATION

A. Coordinate with installation of piping insulation.

PART 2 - PRODUCTS

2.1 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Thermon Americas Inc.; FLX Self-Regulating Heating Cable.
2. Raychem; nVent Electric plc; XLTrace.
3. Delta-Therm Corporation; IN Series.
4. Chromalox Advanced Thermal Technologies; a business of Spirax-Sarco Engineering PLC.

B. Comply with IEEE 515.1.

C. Heating Element: Pair of No. 16 AWG, parallel, nickel-coated copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled, non-heating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.

D. Electrical Insulating Jacket: Flame-retardant polyolefin.

E. Cable Cover: Tinned-copper braid and polyolefin outer jacket.

F. Maximum Operating Temperature (Power On): 150 deg F.

G. Maximum Exposure Temperature (Power Off): 185 deg F.

H. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL acceptable to authorities having jurisdiction, and marked for intended location and

application.

I. Capacities and Characteristics:
   1. Maximum Heat Output: 3 W/ft.as recommended by manufacturer.
   2. Piping Diameter: As indicated on the Drawings.
   3. Number of Parallel Cables: As recommended by manufacturer.
   4. Electrical Characteristics for Single-Circuit Connection: Coordinate electrical system requirements with Division 26.

J. Electrical Power System Characteristics: As scheduled on the Drawings.

2.2 CONTROLS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Thermon Americas Inc.
   2. Raychem; nVent Electric plc.
   3. Delta-Therm Corporation.
   4. Chromalox Advanced Thermal Technologies; a business of Spirax-Sarco Engineering PLC.

B. Pipe-Mounted Thermostats for Freeze Protection:
   1. Remote bulb unit with adjustable temperature range from 30 to 50 deg F.
   2. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.
   3. Remote bulb on capillary, resistance temperature device, or thermistor for directly sensing pipe-wall temperature.
   4. Corrosion-resistant, waterproof control enclosure.

2.3 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.

B. Warning Labels: Self-adhesive labels with legend “ELECTRIC HEAT TRACING.” Refer to Division 20 Section "Mechanical Identification" for additional requirements

C. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.
   1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.
   1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install electric heating cable across expansion, construction, and control joints according to manufacturer's written instructions; use cable-protection conduit and slack cable to allow movement without damage to cable.

B. Electric Heating-Cable Installation for Freeze Protection for Piping:
   1. Install electric heating cables after piping has been tested and before insulation is installed.
   2. Install electric heating cables according to IEEE 515.1.
   3. Install insulation over piping with electric cables according to Division 20 Section "Mechanical Insulation."
   4. Install warning labels at 10 foot intervals or install continuous warning tape on piping insulation where piping is equipped with electric heating cables.

C. Set field-adjustable switches and circuit-breaker trip ranges.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding."

B. Connect wiring according to Division 26 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
   1. Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.
   2. Test cables for electrical continuity and insulation integrity before energizing using 2500 Vdc megohmmeter (megger).
   3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

B. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.

C. Cables will be considered defective if they do not pass tests and inspections.

D. Remove and replace damaged heat-tracing cables.

E. Prepare test and inspection reports.

3.5 PROTECTION

A. Protect installed heating cables, including non-heating leads, from damage during construction.

END OF SECTION 20 05 33

SECTION 20 05 53
MECHANICAL IDENTIFICATION

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.3 INFORMATIONAL SUBMITTALS

A. Samples: For color, letter style, and graphic representation required for each identification material and device.

B. Valve numbering scheme.

1.4 CLOSEOUT SUBMITTALS

A. Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted copies) to include in Maintenance Manuals.

1.5 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME (ANSI) A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.6 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with location of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified:
1. Seton.
2. Brady.
3. EMED.
4. Craftmark.
5. Brimar Industries, Inc.
6. Marking Services Inc. (MSI).
7. Kolbi Pipe Marker Co.

2.2 EQUIPMENT IDENTIFICATION DEVICES

A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.
1. Data:
    a. Manufacturer, product name, model number, and serial number.
    b. Capacity, operating and power characteristics, and essential data.
    c. Labels of tested compliances.
2. Location: Accessible and visible.
3. Fasteners: As required to mount on equipment.

B. Equipment Markers: Engraved, color-coded laminated plastic. Include contact-type, permanent adhesive.
1. Terminology: Match schedules as closely as possible.
2. Data:

a. Name and plan number.
b. Equipment service.
c. Design capacity.
d. Other design parameters such as pressure drop, entering and leaving conditions, and speed.

3. Size: 2-1/2 by 4 inches for control devices, dampers, and valves; 4-1/2 by 6 inches for equipment.

C. Equipment Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.
1. Data: Instructions for operation of equipment and for safety procedures.
2. Engraving: Manufacturer's standard letter style, of sizes and with terms to match equipment identification.
3. Thickness: Minimum 1/16 inch, unless otherwise indicated.
4. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

2.3 PIPING IDENTIFICATION DEVICES

A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.
1. Colors: Comply with ASME (ANSI) A13.1, unless otherwise indicated.
2. Type and Size of Letters: Comply with ANSI A13.1, unless otherwise indicated.
3. Legends: Spelled out in full or commonly used and accepted abbreviations.
4. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.
5. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
6. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.

B. Pretensioned Pipe Markers: Precoiled semirigid plastic formed to cover full circumference of pipe and to attach to pipe without adhesive.

C. Shaped Pipe Markers: Preformed semirigid plastic formed to partially cover circumference of pipe and to attach to pipe with mechanical fasteners that do not penetrate insulation vapor barrier.

2.4 HAZARDOUS MATERIAL IDENTIFICATION DEVICES

A. Standard: NFPA 704.

B. Material: Engraved, color-coded laminated plastic. Include contact-type, permanent adhesive; or mounting screws.

C. Size: Minimum 7-1/2 inches by 7-1/2 inches with 3-inch character height.

D. Content: Appropriate for refrigerant.

2.5 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-

inch numbers, with numbering scheme to match existing numbering scheme. Provide 5/32-inch hole for fastener.
1. Material: 0.032-inch- thick brass.
2. Valve-Tag Fasteners: Brass wire-link chain or beaded chain.

2.6 VALVE SCHEDULES

A. Valve Schedules: For each piping system, on standard-size bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
1. Valve-Schedule Frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include mounting screws.
2. Frame: Finished hardwood or extruded aluminum.
3. Glazing: ASTM C 1036, Type I, Class 1, Glazing Quality B, 2.5-mm, single-thickness glass.

2.7 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags; of plasticized card stock with matte finish suitable for writing.
1. Size: 3 by 5-1/4 inches minimum.
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.
4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

A. Products specified are for applications referenced in other Division 20, 21, 22, and 23 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 EQUIPMENT IDENTIFICATION

A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:
1. Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.
2. Pumps, compressors, chillers, condensers, and similar motor-driven units.
3. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
4. Fans, blowers, primary balancing dampers, and mixing boxes.
5. Packaged HVAC central-station and zone-type units.

B. Install equipment markers with permanent adhesive on or near each major item of mechanical equipment. Data required for markers may be included on signs, and markers may be omitted if both are indicated.

1. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
2. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
3. Locate markers where accessible and visible. Include markers for the following general categories of equipment:
    a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
    b. Fire department hose valves and hose stations.
    c. Meters, gages, thermometers, and similar units.
    d. Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.
    e. Pumps, compressors, chillers, condensers, and similar motor-driven units.
    f. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
    g. Fans, blowers, primary balancing dampers, and mixing boxes.
    h. Packaged HVAC central-station and zone-type units.
    i. Tanks and pressure vessels.
    j. Strainers, filters, humidifiers, water-treatment systems, and similar equipment.

C. Install equipment signs with screws or permanent adhesive on or near each major item of mechanical equipment. Locate signs where accessible and visible.
1. Identify mechanical equipment with equipment markers in the following color codes:
    a. Green: For cooling equipment and components.
    b. Yellow: For heating equipment and components.
    c. Orange: For combination cooling and heating equipment and components.
    d. Brown: For energy-reclamation equipment and components.
2. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
3. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
4. Include signs for the following general categories of equipment:
    a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
    b. Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.
    c. Pumps, compressors, chillers, condensers, and similar motor-driven units.
    d. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
    e. Fans, blowers, primary balancing dampers, and mixing boxes.
    f. Packaged HVAC central-station and zone-type units.
    g. Tanks and pressure vessels.
    h. Strainers, filters, humidifiers, water-treatment systems, and similar equipment.

D. Area Served: Equipment serving different areas of a building other than where the equipment is installed shall be permanently marked in a manner that, in addition to identifying the equipment as specified in this Section, also identifies the area it serves.

3.3 PIPING IDENTIFICATION

A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.
   1. Pipes with OD, Including Insulation, Less Than 6 Inches: Pretensioned pipe markers. Use size to ensure a tight fit.
   2. Pipes with OD, Including Insulation, 6 Inches and Larger: Shaped pipe markers. Use size to match pipe and secure with fasteners.

B. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior nonconcealed locations as follows:
   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations through walls, floors, ceilings, and nonaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
   7. On piping above removable acoustical ceilings. Omit intermediately spaced markers.

C. Underground Pipe Markers: Install 6 to 8 inches below finished grade, directly above buried pipe.

3.4 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; plumbing fixture supply stops; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following:
   1. Valve-Tag Size and Shape:
      a. Cold Water: Minimum 1-1/2 inches, round or square.
      b. Hot Water: Minimum 1-1/2 inches, round or square.
      c. Fire Protection: Minimum 1-1/2 inches, round or square.

3.5 VALVE-SCHEDULE INSTALLATION

A. Mount valve schedule on wall in accessible location in each major equipment room.

3.6 HAZARDOUS MATERIAL IDENTIFICATION DEVICES

A. Mount to wall or door of room containing hazard. Indicate classification of refrigerant or other hazard.

3.7 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

3.8 ADJUSTING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.9 CLEANING

A. Clean faces of mechanical identification devices and glass frames of valve schedules.

3.10 SCHEDULES

A. Paint colors are listed here for reference only. Painting is specified under Division 9.

PIPE LABELING AND COLOR CODING

Pipe System Label	Drawing Abbrev.	Labels	Piping
Sanitary Sewer	SAN	White on Green	Dark Brown
Sanitary Vent	V	White on Green	Dark Brown
Domestic Cold Water	CW	White on Green	Light Green
Domestic Hot Water	HW	Black on Yellow	Dark Green
Refrigerant Liquid	RL	Black on Yellow	
Refrigerant Suction	RS	Black on Yellow	
Fire Protection	FP	White on Red	Bright Red

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SECTION 20 07 00
MECHANICAL INSULATION

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections include the following:
1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”
3. Division 20 Section “Hanger and Supports” for thermal hanger shield inserts.

4. Division 22 Section “Plumbing Fixtures: for protective shielding guards.
5. Division 22 Section “Healthcare Plumbing Fixtures” for protective shielding guards.
6. Division 23 Section "Metal Ducts" for duct liners.

1.2 SUMMARY

A. This Section includes mechanical insulation for pipe, duct, and equipment.

1.3 DEFINITIONS

A. ASJ: All-service jacket.

B. FSK: Foil, scrim, kraft paper.

C. PSK: Polypropylene, scrim, kraft paper.

D. PVC: Polyvinyl Chloride.

E. SSL: Self-sealing lap.

1.4 INDOOR PIPING INSULATION SYSTEMS DESCRIPTION

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are scheduled on the Drawings, or identified for each piping system and pipe size range.

1.5 OUTDOOR, ABOVEGROUND PIPING INSULATION SYSTEMS DESCRIPTION

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are scheduled on the Drawings, or identified for each piping system and pipe size range.

1.6 FIELD-APPLIED JACKETING SYSTEMS DESCRIPTION

A. Acceptable field-applied jacketing materials and thicknesses are scheduled on the Drawings, or identified for each piping system and pipe specialty.

1.7 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, identify thermal conductivity, thickness, and jackets (both factory and field applied, if any).
   1. ESR Report: For fire-rated grease duct insulation.

1.8 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

B. Ductwork Maximum Temperature Limits: Based on ASTM C 411 test procedures.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Prior to installation, protect insulation from exposure to water and from physical damage. Prior to installation, store insulation in manufacturer's original packaging.

1.10 COORDINATION

A. Coordinate size and location of supports, hangers, and pre-insulated pipe shields/supports specified in Division 20 Section "Hangers and Supports."

B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.11 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS, GENERAL REQUIREMENTS

A. Products shall not contain asbestos, lead, mercury, or mercury compounds.

B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

E. Adhesives used shall be fire resistant in their dry states and UL listed.

2.2 PIPE INSULATION MATERIALS

A. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
   1. Products: Subject to compliance with requirements, provide one of the products specified.
      a. Aeroflex USA, Inc.; Aerocel Tube and Sheet.

b. Armacell LLC; AP Armaflex.
c. IK Insulation Group; K-Flex USA LLC; Insul-Tube and Insul-Sheet.

B. Glass-Fiber, Preformed Pipe Insulation, Type I:
1. Products: Subject to compliance with requirements, provide one of the products specified.
a. Johns Manville; Micro-Lok.
b. Knauf Insulation; 1000 Pipe Insulation.
c. Manson Insulation Inc.; Alley-K.
d. Owens Corning; Fiberglas Pipe Insulation.
2. Type I, 850 deg F Materials: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ or ASJ-SSL. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.

2.3 INSULATING CEMENTS

A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.
1. Products: Subject to compliance with requirements, provide one of the products specified.
a. Insulco, Division of MFS, Inc.; SmoothKote.
b. P. K. Insulation Mfg. Co., Inc.; PK No. 127, and Quik-Cote.
c. Rock Wool Manufacturing Company; Delta One Shot.

2.4 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to it and to surfaces to be insulated, unless otherwise indicated.

B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
1. Products: Subject to compliance with requirements, provide one of the products specified.
a. Aeroflex USA, Inc.; Aeroseal and Aeroseal LVOC.
b. Armacell LCC; 520 Adhesive.
c. Foster Products Corporation, H. B. Fuller Company; 85-75.

C. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
1. Products: Subject to compliance with requirements, provide one of the products specified.
a. Childers Products, H.B. Fuller Company; CP-82.
b. Foster Products Corporation, H. B. Fuller Company; 85-20.
c. Johns Manville Industrial Insulation; S-90/80.
d. Marathon Industries, Inc.; 225.
e. Mon-Eco Industries, Inc.; 22-25.

D. PVC Jacket Adhesive: Compatible with PVC jacket.
1. Products: Subject to compliance with requirements, provide one of the products specified.
a. Dow Chemical Company (The); 739, Dow Silicone.
b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
c. P.I.C. Plastics, Inc.; Welding Adhesive.
d. Red Devil, Inc.; Celulon Ultra Clear.
e. Speedline Corporation; Speedline Vinyl Adhesive.

2.5 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
   1. Products: Subject to compliance with requirements, provide one of the products specified.
      a. Childers Products, H.B. Fuller Company; CP-35.
      b. Foster Products Corporation, H. B. Fuller Company; 30-90.
      c. Johns Manville Industrial Insulation; CB-50.
      d. Marathon Industries, Inc.; 590.
      e. Mon-Eco Industries, Inc.; 55-40.
      f. Vimasco Corporation; 749.
   2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
   3. Service Temperature Range: Minus 20 to plus 180 deg F.
   4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
   5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
   1. Products: Subject to compliance with requirements, provide one of the products specified.
      a. Childers Products, H.B. Fuller Company; CP-10.
      b. Foster Products Corporation, H. B. Fuller Company; 35-00.
      c. Johns Manville Industrial Insulation; CB-05/15.
      d. Marathon Industries, Inc.; 550.
      e. Mon-Eco Industries, Inc.; 55-50.
      f. Vimasco Corporation; WC-1/WC-5.
   2. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
   3. Service Temperature Range: Minus 20 to plus 200 deg F.
   4. Solids Content: 63 percent by volume and 73 percent by weight.
   5. Color: White.

2.6 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:
   1. Products: Subject to compliance with requirements, provide one of the products specified.
      a. Childers Products, H.B. Fuller Company; CP-76-8.
      b. Foster Products Corporation, H. B. Fuller Company; 95-44.
      c. Marathon Industries, Inc.; 405.
      d. Mon-Eco Industries, Inc.; 44-05.
      e. Vimasco Corporation; 750.
   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Fire- and water-resistant, flexible, elastomeric sealant.
   4. Service Temperature Range: Minus 40 to plus 250 deg F.
   5. Color: Aluminum.

B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
   1. Products: Subject to compliance with requirements, provide one of the products specified.
      a. Childers Products, H.B. Fuller Company; CP-76.
   2. Materials shall be compatible with insulation materials, jackets, and substrates.

3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.

2.7 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as specified; roll stock ready for shop or field cutting and forming.
1. Products: Subject to compliance with requirements, provide one of the products specified.
    a. Airex Manufacturing, Inc.; E-Flex Guard.
    b. Johns Manville; Zeston and Ceel-Co.
    c. P.I.C. Plastics, Inc.; FG Series.
    d. Proto PVC Corporation; LoSmoke.
    e. Speedline Corporation; SmokeSafe.
2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.
4. Factory-fabricated tank heads and tank side panels.

C. PVC Fitting Covers: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C, and including flexible glass fiber insulation inserts.
1. Products: Subject to compliance with requirements, provide one of the products specified.
    a. Airex Manufacturing, Inc.
    b. Johns Manville; Zeston and Ceel-Co.
    c. P.I.C. Plastics, Inc.; FG Series.
    d. Proto PVC Corporation; LoSmoke.
    e. Speedline Corporation; SmokeSafe.
2. Adhesive: As recommended by manufacturer.
3. Color: White.
4. Factory-fabricated fitting covers:
    a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, and mechanical joints.

D. Metal Jacket:
1. Products: Subject to compliance with requirements, provide one of the products specified.
    a. PABCO-Childers Metals; Johns Manville Industrial Insulation; Metal Jacketing Systems.
    b. RPR Products, Inc.; Insul-Mate.
2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.
    a. Sheet and roll stock ready for shop or field sizing or factory cut and rolled to size.
    b. Finish and thickness are indicated in field-applied jacket schedules.
    c. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper.
    d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper or 2.5-mil- thick Polysurlyn.
    e. Factory-Fabricated Fitting Covers:
        1) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
        2) Provide factory fabricated PVC tee covers, flange and union covers, beveled collars and valve covers.

3) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

E. Self-Adhesive Outdoor Jacket for Piping: Laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a fabric reinforced insulation cladding with natural aluminum white stucco embossed facing.
1. Products: Subject to compliance with requirements, provide one of the products specified.
a. 3M VentureClad; 1579GCW-E.
b. Polyguard; Alumaguard.

F. Self-Adhesive Outdoor Jacket for Ductwork: Laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with aluminum-foil **[white] [almond]** facing.
1. Products: Subject to compliance with requirements, provide one of the products specified.
a. MFM Building Products Corp.; FlexClad-400.
b. Polyguard; Alumaguard.
c. 3M VentureClad.

2.8 REMOVABLE AND REUSABLE INSULATION COVERS

A. Flexible Style: Custom fabricated composite jackets for valves, flanges, and expansion joints consisting of 4 inches of high temperature fiberglass insulation compressed between Teflon impregnated fiberglass inner and outer facing stitched with fiberglass core Teflon thread and secured with Velcro fasteners and double D-ring cinching. Service temperature range of minus 40 deg F to 500 deg F.
1. Fabricators:
a. Apex Energy & Environmental Products Inc.
b. 3i Supply Co.; K-Tex.
c. Valley Group of Companies.

B. Rigid Style: Custom fabricated composite jackets for valves, flanges, and expansion joints consisting of rigid foam insulation with silicone impregnated fiberglass outer facing stitched with fiberglass thread and secured with Velcro fasteners and double D-ring cinching. Service temperature range of minus 40 deg F to 500 deg F.
1. Fabricators:
a. Valley Group of Companies.

2.9 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136 and UL listed.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Ideal Tape Co., Inc., an American Biltrite company; 728 Cold Seal ASJ or comparable products by one of the following:
a. Avery Dennison Corporation, Specialty Tapes Division.
b. 3M Venture Tape.
2. Width: 3 inches.
3. Thickness: 9 mils.
4. Adhesion: 70 ounces force/inch in width.
5. Elongation: 3 percent.

6. Tensile Strength: 45 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with rubber or acrylic adhesive; complying with ASTM C 1136 and UL listed.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Ideal Tape Co., Inc., an American Biltrite company; 491 FSK or 791 Cold Seal Acrylic FSK, or comparable products by one of the following:
   a. Avery Dennison Corporation, Specialty Tapes Division.
   b. 3M Venture Tape.
2. Width: 3 inches.
3. Thickness: 6 mils.
4. Adhesion (Rubber Adhesive): 100 ounces force/inch in width.
5. Adhesion (Acrylic Adhesive): 90 ounces force/inch in width.
6. Elongation: 3 percent.
7. Tensile Strength: 35 lbf/inch in width.
8. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Ideal Tape Co., Inc., an American Biltrite company; 370 White PVC tape, or comparable products by one of the following:
   a. Avery Dennison Corporation, Specialty Tapes Division.
   b. 3M Venture Tape.
2. Width: 2 inches.
3. Thickness: 5 mils.
4. Adhesion: 20 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 15 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive and UL listed.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Ideal Tape Co., Inc., an American Biltrite company; 488 AWF rubber adhesive or 788 Cold Seal acrylic adhesive, or comparable products by one of the following:
   a. Avery Dennison Corporation, Specialty Tapes Division.
   b. 3M Venture Tape.
2. Width: 3 inches.
3. Thickness: 3.0 to 4.0 mils.
4. Adhesion (Rubber Adhesive): 90 ounces force/inch in width.
5. Adhesion (Acrylic Adhesive): 50 ounces force/inch in width.
6. Elongation: 3 percent.
7. Tensile Strength: 14 to 20 lbf/inch in width.

2.10 SECUREMENTS

A. Bands:
1. Products: Subject to compliance with requirements, provide one of the products specified.
   a. PABCO-Childers Metals; Johns Manville Industrial Insulation; Pab-Bands and Fabstraps.
   b. RPR Products, Inc.; Bands.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing or closed seal.
3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing or closed seal.
4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:
1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
   a. Products: Subject to compliance with requirements, provide one of the products specified.
      1) AGM Industries, Inc.; CWP-1.
      2) GEMCO; CD.
      3) Midwest Fasteners, Inc.; CD.
      4) Nelson Stud Welding; TPA, TPC, and TPS.
2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
   a. Products: Subject to compliance with requirements, provide one of the products specified.
      1) AGM Industries, Inc.; CWP-1.
      2) GEMCO; Cupped Head Weld Pin.
      3) Midwest Fasteners, Inc.; Cupped Head.
      4) Nelson Stud Welding; CHP.
3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. Products: Subject to compliance with requirements, provide one of the products specified.
      1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.
      2) GEMCO; Perforated Base.
      3) Midwest Fasteners, Inc.; Spindle.
   b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
   d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. Products: Subject to compliance with requirements, provide one of the products specified.
      1) GEMCO; Nylon Hangers.
      2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.
   b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.

c. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. Products: Subject to compliance with requirements, provide one of the products specified.
      1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series TSA.
      2) GEMCO; Press and Peel.
      3) Midwest Fasteners, Inc.; Self Stick.
   b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
   d. Adhesive-backed base with a peel-off protective cover.
6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
   a. Products: Subject to compliance with requirements, provide one of the products specified.
      1) AGM Industries, Inc.; RC-150.
      2) GEMCO; R-150.
      3) Midwest Fasteners, Inc.; WA-150.
      4) Nelson Stud Welding; Speed Clips.
   b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
   a. Manufacturers:
      1) GEMCO.
      2) Midwest Fasteners, Inc.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

D. Wire: 0.062-inch soft-annealed, stainless steel.
1. Manufacturers:
   a. ACS Industries, Inc.
   b. C & F Wire.
   c. PABCO-Childers Metals; Johns Manville Industrial Insulation.
   d. RPR Products, Inc.

2.11 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

C. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or 316.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
   1. Verify that systems and equipment to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.
   3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that applies to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 COMMON INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at the 4 o’clock or 8 o’clock position on horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive as recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. For services with surface temperatures below ambient, install a continuous unbroken vapor

barrier. Seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install thermal hanger insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover thermal hanger inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at the 4 o'clock or 8 o'clock position on the pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
   a. For below ambient services, apply vapor-barrier mastic over staples.
4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness. Where compression of insulation is possible, fabricate/install insulation per manufacturer's recommendations.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above ambient services, do not install insulation to the following:
1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
   4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Below-Grade Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
   4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations that Are Not Fire Rated: Install insulation through walls and partitions as detailed.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations:
   1. Terminate ductwork insulation at angle closure of fire damper sleeves.
   2. Install pipe insulation continuously through penetrations of fire-rated walls and partitions.
      a. Firestopping is specified in Division 07 Section “Through-Penetration Firestop Systems.”

F. Insulation Installation at Floor Penetrations:
   1. Duct: Install insulation through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at angle closure of fire damper sleeves.
   2. Pipe: Install insulation continuously through floor penetrations.
      a. Seal penetrations through fire-rated assemblies according to Division 07 Section "Through-Penetration Firestop Systems."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this Article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
   1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
   2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same

material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible Elastomeric, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on

each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

E. Install removable and reusable insulation covers in accordance with fabricator's instructions, and at the following locations:
   1. At steam valves.
   2. At valves, flanges, and expansion joints. Expansion joints shall have jacket installed in a manner to allow for replacing of joints without removing insulation cover.

3.6 FLEXIBLE ELASTOMERIC PIPE INSULATION INSTALLATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:
   1. Install pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
   4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install mitered sections of pipe insulation.
   2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed valve covers manufactured of same material as pipe insulation when available.
   2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.
   4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 GLASS-FIBER AND MINERAL WOOL PIPE INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with

outward clinched staples at 6 inches o.c.

4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
   1. Install PVC fitting covers when available.
   2. When PVC fitting covers are not available, install preformed pipe insulation to outer diameter of pipe flange:
      a. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
      b. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with fiberglass or mineral wool blanket insulation as specified for system.
   3. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install PVC fitting covers when available.
   2. When PVC fitting covers are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install PVC fitting covers when available.
   2. When PVC fitting covers are not available, install mitered sections of pipe insulation to valve body.
   3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   4. Install insulation to flanges as specified for flange insulation application.

3.8 FIELD-APPLIED JACKET INSTALLATION

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
   1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
   2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
   3. Completely encapsulate insulation with coating, leaving no exposed insulation.

C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
   1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

E. Where self-adhesive jackets are indicated, install according to manufacturer’s instructions and details on the drawings. Overlap seams arranged to shed water.

F. Where sound barrier jackets are indicated, install in accordance with manufacturer’s instructions.

3.9 FINISHES

A. Duct, Equipment, and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system specified in Division 09 painting Sections.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

END OF SECTION 20 07 00

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SECTION 22 05 23
GENERAL-DUTY VALVES FOR PLUMBING

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections include the following:
1. Division 20 Section "Mechanical Identification" for valve tags and charts.
2. Division 21 Fire-Suppression Piping and Fire Pump Sections for fire-protection valves.
3. Division 22 Piping Sections for specialty valves applicable to those Sections only.
4. Division 23 Section “General-Duty Valves for HVAC” for HVAC.
5. Division 23 Section "Temperature Controls" for control valves and actuators.

1.2 SUMMARY

A. This Section includes valves for general plumbing applications. Refer to piping Sections for specialty valve applications.

1.3 DEFINITIONS

A. The following are standard abbreviations for valves:
1. CWP: Cold working pressure.
2. EPDM: Ethylene-propylene-diene terpolymer rubber.

3. NBR: Acrylonitrile-butadiene rubber.
4. NRS: Nonrising stem.
5. OS&Y: Outside screw and yoke.
6. PTFE: Polytetrafluoroethylene plastic.
7. RPTFE: Reinforced polytetrafluoroethylene plastic.
8. SWP: Steam working pressure.
9. TFE: Tetrafluoroethylene plastic.
10. WOG: Water, oil, and gas.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.
   1. Certification that products for use in potable water systems comply with NSF 61 and NSF 372.

1.5 QUALITY ASSURANCE

A. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.

B. Regulatory Requirements: Comply with requirements in Public Law 111-380, "Reduction of Lead in Drinking Water Act," about lead content in materials that will be in contact with potable water for human consumption.

C. NSF Compliance: NSF 61 and NSF 372 for valve materials for potable-water service.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, grooves, and weld ends.
   3. Set angle, gate, and globe valves closed to prevent rattling.
   4. Set ball and plug valves open to minimize exposure of functional surfaces.
   5. Set butterfly valves closed or slightly open.
   6. Block check valves in either closed or open position.

B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 VALVES, GENERAL

A. Isolation valves are scheduled on the Drawings. For other general plumbing valve applications, use the following:
   1. Shutoff Service: Ball, butterfly valves. Throttling Service: Angle, ball, butterfly, or globe valves.
   3. Pump Discharge: Spring-loaded, lift-disc check valves; and bronze lift check valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.

D. For valves not indicated in the Application Schedules, select valves with the following end connections:
   1. For Copper Tubing, NPS 2 and Smaller: Solder-joint or threaded ends, except provide valves with threaded ends for condenser water, heating hot water, steam, and steam condensate services.
   2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged, solder-joint, or threaded ends.

E. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted unless otherwise noted.

F. Wetted surfaces of valves contacted by consumable water shall contain not more than 0.25 percent weighted average lead content.
   1. Exceptions:
      a. Valves in pumped sanitary systems.
      b. Valves in pumped storm systems.
      c. Drain valves.
      d. Valves in general air or vacuum systems.
      e. Valves in irrigation systems.
      f. Valves in non-potable water systems.
      g. Valves in other plumbing systems not intended for human consumption.

G. Valve Sizes: Same as upstream pipe, unless otherwise indicated.

H. Valve Actuators:
   1. Chainwheel: For attachment to valves, of size and mounting height, as indicated in the "Valve Installation" Article in Part 3.
   2. Gear Drive Operator: For quarter-turn valves NPS 8 and larger.
   3. Handwheel: For valves other than quarter-turn types.
   4. Lever Handle: For quarter-turn valves NPS 6 and smaller.

I. Extended Valve Stems: On insulated valves.

J. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.

K. Valve Grooved Ends: AWWA C606.

L. Solder Joint: With sockets according to ASME B16.18.
1. Caution: Disassemble valves when soldering, as recommended by the manufacturer, to prevent damage to internal parts.

M. Threaded: With threads according to ASME B1.20.1.

N. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE BALL VALVES

A. Bronze Ball Valves, General: MSS SP-110 and have bronze body complying with ASTM B 584, except for Class 250 which shall comply with ASTM B 61, full-depth ASME B1.20.1 threaded or solder ends, and blowout-proof stems.

B. Two-Piece, Regular Port Bronze Ball Valves with Stainless-Steel Trim: Type 316 stainless-steel ball and stem, reinforced TFE seats, blow-out-proof stem, with adjustable stem packing, soldered or threaded ends; and 150 psig SWP and 600-psig CWP ratings.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Apollo Valves; by Conbraco Industries, Inc.; Series 70LF-140/240.
b. Hammond Valve.
c. Kitz Corporation; Kitz Valves.
d. Milwaukee Valve Company; Model UPBA100S/150S.
e. NIBCO INC.; Models S-580-70-66-LF/T-580-70-66-LF.
f. Watts Water Technologies, Inc.

2.3 GENERAL SERVICE BUTTERFLY VALVES

A. General: MSS SP-67, for bubble-tight shutoff, extended-neck for insulation, disc and lining suitable for potable water, unless otherwise indicated, and with the following features:
1. Full lug, and grooved valves shall be suitable for bi-directional dead-end service at full rated pressure without the use or need of a downstream flange.
2. Valve sizes NPS 2 through NPS 6 shall have lever lock operator; valve sizes NPS 8 and larger shall have weatherproof gear operator.

B. Lug-Style (Single-Flange) Size NPS 2-1/2 through NPS 12, 200-psig CWP Rating, Aluminum-Bronze Disc, EPDM Seat, Ferrous-Alloy Butterfly Valves: Full-lug type with ductile-iron body, Type 416 stainless-steel stem, copper bushing, aluminum-bronze disc, and molded-in EPDM seat (liner).
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Apollo Valves; by Conbraco Industries, Inc.; Series 143 and Series LD145.
b. Bray International, Inc.
c. DeZurik.
d. Emerson Automation Solutions; Keystone.
e. Forum Energy Technologies; ABZ Valve.
f. Hammond Valve.
g. Milwaukee Valve Company.
h. NIBCO INC.; LD-2000-3/5.
i. Tyco Flow Control; Grinnell Flow Control.

j. Watts Water Technologies.

2.4 BRONZE CHECK VALVES

A. Bronze Check Valves, General: MSS SP-80.

B. Class 125, Bronze, Swing Check Valves with Bronze Disc: ASTM B-62 bronze body and seat with regrinding-type bronze disc, Y-pattern design, soldered or threaded end connections, and having 200 psig CWP rating.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Apollo Valves; by Conbraco Industries, Inc.; Model 162T-LF and 163T-LF (61YLF Series).
      b. Milwaukee Valve Company; Model UP509/UP1509.
      c. NIBCO INC.; Models S-413-B-LF or T-413-B-LF.
      d. Watts Water Technologies; LFCVY/LFCVYS.

2.5 LIFT CHECK VALVES

A. Class 125, Lift Check Valves with Nonmetallic Disc:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Apollo Valves; by Conbraco Industries, Inc.; Model CBV-LF (61LF Series).
      b. Bonomi USA, Inc.; Series 100002 and 100003.
      c. Hammond Valve; UP943 and UP947.
      d. Milwaukee Valve Company; UP548T and UP1548T.
      e. NIBCO INC.; Model S-480-Y-LF and T-480-Y-LF.
      f. Watts Water Technologies; LF600.
   2. Description:
      a. Standard: MSS SP-80, Type 2.
      b. CWP Rating: 250 psig.
      c. Body Design: Vertical flow.
      d. Body Material: Lead free brass or bronze.
      e. Ends: Threaded or Solder.
      f. Disc: PTFE, TFE, or Polyethermide.

2.6 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:
   1. Bronze ball valve as specified in this Section. Lead free construction is not required.
   2. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.7 CHAINWHEEL ACTUATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Babbitt Steam Specialty Co.
   2. Roto Hammer Industries, Inc.

B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
   1. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for

valve.Brackets: Type, number, size, and fasteners required to mount actuator on valve.
2. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

2.8 SOURCE QUALITY CONTROL

A. Identification: Factory label or color coding to identify lead free valves.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.
1. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

D. Examine threads on valve and mating pipe for form and cleanliness.

E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

F. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Piping installation requirements are specified in other Division 20 and 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

C. Locate valves for easy access and provide separate support where necessary.

D. Install valves in horizontal piping with stem at or above center of pipe. Butterfly valves shall be installed with stem horizontal to allow support for the disc and the cleaning action of the disc.

E. Install valves in position to allow full stem movement.

F. Install chainwheel operators on valves NPS 4 and larger and more than 84 inches above floor. Extend chains to 60 inches above finished floor elevation.

G. Install check valves for proper direction of flow and as follows:
1. Swing Check Valves: In horizontal position with hinge pin level.
2. Lift Check Valves: With stem upright and plumb.

3.3 JOINT CONSTRUCTION

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.

3.4 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION 22 05 23

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SECTION 22 13 16
SANITARY WASTE AND VENT PIPING

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections include the following:
1. Division 20 Section “Mechanical General Requirements”.
2. Division 20 Section “Basic Mechanical Materials and Methods”.
3. Division 22 Section “Drainage Piping Specialties”.
4. Division 22 Section "Chemical-Waste Piping" for chemical-waste and vent piping systems.
5. Division 22 Section "Sewage Pumps."
6. Division 22 Section “Sanitary Waste and Vent Piping” for piping outside building.

1.2 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

C. LLDPE: Linear, low-density polyethylene plastic.

D. NBR: Acrylonitrile-butadiene rubber.

E. PE: Polyethylene plastic.

F. PVC: Polyvinyl chloride plastic.

G. TPE: Thermoplastic elastomer.

1.3 SYSTEMS DESCRIPTIONS

A. Sanitary waste and vent piping system materials are scheduled on the Drawing.

1.4 ACTION SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

1.5 CLOSEOUT SUBMITTALS

A. Field quality-control inspection and test reports.

1.6 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Cast-iron soil pipe shall be marked with the collective trademark of Cast Iron Soil Pipe Institute (CISPI).

C. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
   1. Notify Owner no fewer than two days in advance of proposed interruption of sanitary waste service.
   2. Do not proceed with interruption of sanitary waste service without Owner's written permission.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 GALVANIZED STEEL PIPE AND FITTINGS

A. Galvanized Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade A or B, Schedule 40, galvanized. Include ends matching joining method.

B. Drainage Fittings: ASME B16.12, galvanized, threaded, cast-iron drainage pattern.

C. Pressure Fittings:
   1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, galvanized, seamless steel pipe. Include ends matching joining method.
   2. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
   3. Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, galvanized, standard pattern.
   4. Cast-Iron Flanges: ASME B16.1, Class 125.
   5. Cast-Iron, Flanged Fittings: ASME B16.1, Class 125, galvanized.

2.3 COPPER TUBE AND FITTINGS

A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.
   1. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

B. Hard Copper Tube: ASTM B 88, Types L, water tube, drawn temper.
   1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
   2. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
   3. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.4 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: Schedule 40, ASTM D 2665, drain, waste, and vent.
   1. PVC Socket Fittings: ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

2.5 SPECIALTY PIPE FITTINGS

A. Flexible, Nonpressure Pipe Couplings: Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.
   1. Manufacturers:
      a. Dallas Specialty & Mfg. Co.
      b. Fernco, Inc.
      c. Logan Clay Products Company (The).
      d. Mission Rubber Co.
      e. NDS, Inc.
      f. Plastic Oddities, Inc.
   2. Sleeve Materials:
      a. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
      b. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
      c. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

B. Shielded Nonpressure Pipe Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
   1. Manufacturers:
      a. Cascade Waterworks Mfg. Co.
      b. Mission Rubber Co.

C. Rigid, Unshielded, Nonpressure Pipe Couplings: ASTM C 1461, sleeve-type reducing- or transition-type mechanical coupling molded from ASTM C 1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.
   1. Manufacturers:
      a. ANACO.

D. Pressure Pipe Couplings: AWWA C219 metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
   1. Manufacturers:
      a. Cascade Waterworks Mfg. Co.
      b. Dresser, Inc.; DMD Div.
      c. Ford Meter Box Company, Inc. (The); Pipe Products Div.
      d. JCM Industries, Inc.
      e. Smith-Blair, Inc.
      f. Viking Johnson.
   2. Center-Sleeve Material: Manufacturer's standard.
   3. Gasket Material: Natural or synthetic rubber.
   4. Metal Component Finish: Corrosion-resistant coating or material.

E. Wall-Penetration Fittings: Compound, ductile-iron coupling fitting with sleeve and flexing sections for up to 20-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
   1. Manufacturers:
      a. SIGMA Corp.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Comply with requirements in Division 31 Section “Earth Moving” for excavating, trenching, and backfilling.

3.2 PIPING SYSTEM INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Sanitary sewer piping outside the building is specified in Division 22 Section "Sanitary Sewerage."

C. Basic piping installation requirements are specified in Division 20 Section "Basic Mechanical

Materials and Methods."

D. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.

E. Install cleanout fitting with closure plug inside the building in sanitary force-main piping.

F. Install underground, ductile-iron, force-main piping according to AWWA C600. Install buried piping inside the building between wall and floor penetrations and connection to sanitary sewer piping outside the building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.

G. Install underground, ductile-iron, special pipe fittings according to AWWA C600.

H. Install underground, copper, force-main tubing according to Copper Development Association's "Copper Tube Handbook."

I. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 20 Section "Basic Mechanical Materials and Methods."

J. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

K. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

L. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

M. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
   1. Building Sanitary Drain: 1/8-inch per foot downward in direction of flow, unless otherwise noted.
   2. Horizontal Sanitary Drainage Piping: 1/8-inch per foot downward in direction of flow, unless otherwise noted.
   3. Vent Piping: 1/8-inch per foot down toward vertical fixture vent or toward vent stack.

N. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

O. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.3 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:
   1. Install transition couplings at joints of piping with small differences in OD's.
   2. In Drainage Piping: Shielded, nonpressure transition couplings.
   3. In Aboveground Force Main Piping: Fitting-type transition couplings.
   4. In Underground Force Main Piping:
      a. NPS 1-1/2 and Smaller: Fitting-type transition couplings.
      b. NPS 2 and Larger: Pressure transition couplings.

3.5 VALVE INSTALLATION

A. General valve installation requirements are specified in Division 20 Section "Valves."

B. Shutoff Valves: Install shutoff valve on each sewage pump discharge.
   1. Install gate or full-port ball valve for piping NPS 2 and smaller.
   2. Install gate valve or butterfly valve for piping NPS 2-1/2 and larger.

C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

3.6 HANGER AND SUPPORT INSTALLATION

A. Pipe hangers and supports are specified in Division 20 Section "Hangers and Supports." Install the following:
   1. Vertical Piping: MSS Type 8 or Type 42, clamps.
   2. Install individual, straight, horizontal piping runs according to the following:
      a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
      c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
   3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Install supports according to Division 20 Section "Hangers and Supports."

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/4: 72 inches with 3/8-inch rod.
   2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
   3. NPS 2-1/2: 108 inches with 1/2-inch rod.

F. Install supports for vertical copper tubing every 10 feet.

G. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:
1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

D. Connect force-main piping to the following:
1. Sanitary Sewer: To exterior force main or sanitary manhole.
2. Sewage Pumps: To sewage pump discharge.

3.8 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Division 20 Section "Mechanical Identification."

3.9 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
2. Cap and subject piping to static-water pressure of 150 psig, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

3.10 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION 22 13 16

SECTION 22 13 19
DRAINAGE PIPING SPECIALTIES

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections include the following:
1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”
3. Division 22 Section "Plumbing Fixtures" for hair interceptors.
4. Division 22 Section "Healthcare Plumbing Fixtures" for plaster sink interceptors.

1.2 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. FRP: Fiberglass-reinforced plastic.

C. HDPE: High-density polyethylene plastic.

D. PE: Polyethylene plastic.

E. PP: Polypropylene plastic.

F. PVC: Polyvinyl chloride plastic.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating

characteristics, and accessories.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For drainage piping specialties to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary and storm piping specialty components.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 OIL SEPARATORS

A. Oil Interceptors:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Highland Tank & Manufacturing Co., Inc.
      b. Josam Company; Josam Div.
      c. MIFAB, Inc.
      d. Rockford Sanitary Systems, Inc.
      e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
      f. Striem.
      g. Tyler Pipe; Wade Div.
      h. Watts Drainage Products Inc.
      i. Zurn Plumbing Products Group; Specification Drainage Operation.
   2. Type: Factory-fabricated interceptor for separating and removing light oil from wastewater.
   3. Body Material: Cast iron, steel, or polypropylene.
   4. Interior Lining: Corrosion-resistant enamel for cast iron or steel bodies. Not required for polypropylene bodies.
   5. Exterior Coating: Corrosion-resistant enamel for cast iron or steel bodies. Not required for polypropylene bodies.
   6. Size and Capacities: As indicated on the drawings.
   7. Cleanout: Integral or field installed on outlet.
   8. Mounting: Above floor.
   9. Oil Storage Tank: Coordinate with Division 33 Section "Fuel Oil Distribution."

2.2 LEVEL MONITORING PROBE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Josam Company; Josam Div.

B. Description: Electronic monitor complete with controller, powered by a UL listed 9 vDC transformer, and including LED indication and audible alarm with permanent memory.

C. Probe: Telescoping stainless steel assembly designed for suspension from top of outdoor grease or oil interceptor.

PART 3 - EXECUTION

3.1 CONCRETE BASES

A. General
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 19-inch centers around full perimeter of base.
   2. For installed equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be imbedded.
   4. Install anchor bolts to elevations required for proper attachment to supported equipment.
   5. Concrete base construction requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."
   6. Cast-in-place concrete materials and placement requirements are specified in Division 03.

3.2 INSTALLATION

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for piping joining materials, joint construction, and basic installation requirements.

B. Install oil interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing. Coordinate oil-interceptor storage tank and gravity drain with Division 33 Section "Fuel Oil Distribution."

C. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

D. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

E. Install through-penetration firestop assemblies for penetrations of fire- and smoke-rated assemblies.
   1. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 20 and 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Oil Interceptors: Connect inlet, outlet, vent, and gravity drawoff piping to unit; flow-control fitting and vent to unit inlet piping; and gravity drawoff and suction piping to oil storage tank.

3.4 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
   1. Oil interceptors.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 20 Section "Mechanical Identification."

3.5 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 13 19

SECTION 22 14 13
STORM DRAINAGE PIPING

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections include the following:
1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”
3. Division 22 Section “Drainage Piping Specialties.”
4. Division 22 Section "Sump Pumps."
5. Division 33 Section “Storm Utility Drainage Piping” for piping outside building.

1.2 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. LLDPE: Linear, low-density polyethylene plastic.

C. PE: Polyethylene plastic.

D. PVC: Polyvinyl chloride plastic.

E. TPE: Thermoplastic elastomer.

1.3 SYSTEMS DESCRIPTIONS

A. Storm drainage piping system materials are scheduled on the Drawing.

1.4 ACTION SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

1.5 CLOSEOUT SUBMITTALS

A. Field quality-control inspection and test reports.

1.6 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Cast-iron soil pipe shall be marked with the collective trademark of Cast Iron Soil Pipe Institute (CISPI).

C. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with “NSF-dwv” for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping and "NSF-sewer" for plastic sewer piping.

D. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be as recommended by the manufacturer of the grooved components.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 COPPER TUBE AND FITTINGS

A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.
   1. Copper Drainage Fittings: ASME B16.23, cast-copper or ASME B16.29, wrought-copper, solder-joint fittings.

B. Hard Copper Tube: ASTM B 88, Type L, water tube, drawn temper.
   1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
   2. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
   3. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.3 SPECIAL PIPE FITTINGS

A. Flexible, Nonpressure Pipe Couplings: Comply with ASTM C 1173, elastomeric, sleeve-type,

reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Manufacturers:
    a. Dallas Specialty & Mfg. Co.
    b. Fernco, Inc.
    c. Logan Clay Products Company (The).
    d. Mission Rubber Co.
    e. NDS, Inc.
    f. Plastic Oddities, Inc.
2. Sleeve Materials:
    a. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
    b. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
    c. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

B. Shielded Nonpressure Pipe Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Manufacturers:
    a. Cascade Waterworks Mfg. Co.
    b. Mission Rubber Co.

C. Pressure Pipe Couplings: AWWA C219 metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.

1. Manufacturers:
    a. Cascade Waterworks Mfg. Co.
    b. Dresser, Inc.; DMD Div.
    c. EBAA Iron Sales, Inc.
    d. Ford Meter Box Company, Inc. (The); Pipe Products Div.
    e. JCM Industries, Inc.
    f. Romac Industries, Inc.
    g. Smith-Blair, Inc.
    h. Viking Johnson.
2. Center-Sleeve Material: Manufacturer's standard.
3. Gasket Material: Natural or synthetic rubber.
4. Metal Component Finish: Corrosion-resistant coating or material.

D. Wall-Penetration Fittings: Compound, ductile-iron coupling fitting with sleeve and flexing sections for up to 20-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

1. Manufacturers:
    a. SIGMA Corp.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Refer to Division 31 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING SYSTEM INSTALLATION

A. Storm sewer and drainage piping outside the building are specified in Division 33 Section "Storm Drainage."

B. Basic piping installation requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."

C. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers. Cleanouts are specified in Division 22 Section "Drainage Piping Specialties."

D. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.

E. Install underground, ductile-iron, force-main piping according to AWWA C600. Install buried piping inside building between wall and floor penetrations and connection to storm sewer piping outside building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
   1. Install encasement on piping according to ASTM A 674 or AWWA C105.

F. Install underground, ductile-iron, special pipe fittings according to AWWA C600.
   1. Install encasement on piping according to ASTM A 674 or AWWA C105.

G. Install underground, copper, force-main tubing according to Copper Development Association’s "Copper Tube Handbook."

H. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 20 Section "Basic Mechanical Materials and Methods."

I. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

J. Make changes in direction for storm piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

K. Lay buried building drain piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

L. Install storm drainage piping at the following minimum slopes, unless otherwise indicated:
   1. Building Storm Drain: 1/8-inch per foot downward in direction of flow, unless otherwise noted.
   2. Horizontal Storm-Drainage Piping: 1/8-inch per foot downward in direction of flow, unless otherwise noted.

M. Install force mains at elevations indicated.

N. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

O. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.3 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."

B. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

C. Hub-and-Spigot, Cast-Iron Soil Piping Calked Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.

D. Hubless Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

E. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.4 VALVE INSTALLATION

A. General valve installation requirements are specified in Division 20 Section "Valves."

B. Shutoff Valves: Install shutoff valve on each sump pump discharge.
   1. Install gate or full-port ball valve for piping NPS 2 and smaller.
   2. Install gate valve or butterfly valve for piping NPS 2-1/2 and larger.

C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sump pump discharge.

D. Backwater Valves: Install backwater valves in piping subject to backflow.
   1. Horizontal Piping: Horizontal backwater valves.
   2. Install backwater valves in accessible locations.
   3. Backwater valves are specified in Division 22 Section "Drainage Piping Specialties."

3.5 HANGER AND SUPPORT INSTALLATION

A. Pipe hangers and supports are specified in Division 20 Section "Hangers and Supports." Install the following:
   1. Vertical Piping: MSS Type 8 or Type 42, clamps.
   2. Individual, Straight, Horizontal Piping Runs: According to the following:
      a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
      c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
   3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Install supports according to Division 20 Section "Hangers and Supports."

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/4: 72 inches with 3/8-inch rod.
   2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
   3. NPS 2-1/2: 108 inches with 1/2-inch rod.

F. Install supports for vertical copper tubing every 10 feet.

G. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

C. Connect storm drainage piping to roof drains and storm drainage specialties.

D. Connect force-main piping to the following:
   1. Storm Sewer: To exterior force main or storm manhole.
   2. Sump Pumps: To sump pump discharge.

3.7 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
   1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
   2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
   2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

3. Test Procedure: Test storm drainage piping on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
2. Cap and subject piping to static-water pressure of 150 psig, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

3.8 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

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SECTION 22 14 29
SUMP PUMPS

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections include the following:
1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”
3. Division 22 Section “Sewage Pumps” for applications in sanitary drainage systems.

1.2 SUMMARY

A. This Section includes sump pumps and accessories, inside the building, for building storm drainage systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type and size of sump pump specified, include certified performance curves with operating points plotted on curves, rated capacities of selected models, furnished specialties, and accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Shop Drawings: Diagram power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each sump pump to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of sump pumps and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written rigging instructions for handling.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SUBMERSIBLE SUMP PUMPS

A. Manufacturers:
   1. ABS Pumps, Inc.
   2. Bell & Gossett; Xylem Inc.
   3. Crane Pumps and Systems; Barnes.
   4. EBARA International Corporation; Standard Pump Division.
   5. Goulds Pumps; Xylem Inc.
   6. Gorman-Rupp Company (The).
   7. Grundfos Pumps Corporation.
   8. Hydromatic.
   9. Little Giant Pump Co.
   10. Metropolitan Industries, Inc.
   11. Weil Pump Company, Inc.
   12. Zoeller Company.

B. Description: Factory-assembled and -tested, simplex, single-stage, centrifugal, end-suction, submersible, direct-connected sump pumps complying with UL 778 and Hydraulic Institute HI 1.1-1.2 and HI 1.3 for submersible sump pumps.

C. Casing: Cast iron; with cast-iron inlet strainer, legs that elevate pump to permit flow into impeller, and vertical discharge with companion flange for piping connection.

D. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, semi-open non-clog design, overhung, single suction, keyed and secured to shaft.

E. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings and double-mechanical seals.

F. Motor: Hermetically sealed, capacitor-start type, with built-in overload protection; three-conductor waterproof power cable of length required, and with grounding plug and cable-sealing assembly for connection at pump. Comply with requirements in Division 20 Section "Motors."
   1. Moisture-Sensing Probe: Internal moisture sensor with moisture alarm.

G. Pump Discharge Piping: Factory or field fabricated. Refer to Division 22 Section “Storm Drainage Piping.”

H. Pit Cover: Cast iron or steel with bituminous coating and strong enough to support controls. See Part 2 "Sump Pump Pits" Article for other requirements.

I. Controls:
   1. Mount controls in NEMA 250, Type 4X enclosure. Controls shall include: Fused disconnect switches and combination magnetic starters with overload protection for each phase to protect against single phasing. Three phase units shall include control transformer and control circuit fuse.
      a. Minimum SCCR according to UL 508 shall be as indicated on the Drawings or 5,000 A, whichever is greater.
   2. Mount three position, hand-off-auto, selector switches and magnetic starter manual reset pushbuttons on the control panel door for manual operation and resetting of the magnetic starters.
   3. Station shall be furnished with three, single pole, normally open NON-mercury mechanical float switches with 20 ft. cords, clamps, cord grips, and fasteners for pump off/pump on/high-water-alarm operation. The high-water-alarm switch shall be mounted as indicated on the Drawings. System shall be complete with cover mounting bracket. (1-inch diameter support pole by Contractor.)
   4. Provide high water alarm switch, complete with actuating mechanism for operation on an electric circuit other than the motor circuit. The switch shall be designed to operate indicated alarm device(s) and one set of spare contacts whenever a predetermined high-water level is reached in the sump. Provide alarm pilot light and alarm bell with silence switch. Mount controls on pedestal on the sump cover plate.

2.3 SUBMERSIBLE ELEVATOR SUMP PIT PUMPS

A. Manufacturers:
   1. ABS Pumps, Inc.
   2. Bell & Gossett; Xylem Inc.
   3. Crane Pumps and Systems; Barnes.
   4. EBARA International Corporation; Standard Pump Division.
   5. Goulds Pumps; Xylem Inc.
   6. Gorman-Rupp Company (The).
   7. Grundfos Pumps Corporation.

8. Hydromatic.
9. Little Giant Pump Co.
10. Metropolitan Industries, Inc.
11. Stancor, Inc.
12. Weil Pump Company, Inc.
13. Zoeller Company.

B. Description: Factory-assembled and -tested, simplex, single-stage, centrifugal, end-suction, submersible, direct-connected sump pumps complying with UL 778 and Hydraulic Institute HI 1.1-1.2 and HI 1.3 for submersible sump pumps.

C. Casing: Cast iron; with cast-iron inlet strainer, or stainless steel; with stainless-steel inlet strainer; legs that elevate pump to permit flow into impeller, and vertical discharge connection suitable for piping.

D. Impeller: Hardened 17-4ph stainless steel, or ASTM A 532/A 532M, abrasion-resistant cast iron; statically and dynamically balanced, semi-open non-clog design, overhung, single suction, keyed and secured to shaft.

E. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings and mechanical seals constructed of silicon carbide.

F. Motor: Hermetically sealed, capacitor-start type, with built-in overload protection; three-conductor waterproof power cable of length required, and with grounding plug and cable-sealing assembly for connection at pump. Comply with requirements in Division 20 Section "Motors."
1. Moisture-Sensing Probe: Internal moisture sensor with moisture alarm.

G. Pump Discharge Piping: Factory or field fabricated. Refer to Division 22 Section “Sanitary Waste and Vent Piping.”

H. Basin or Pit Cover: Fiberglass grating or cast iron or steel grating with bituminous coating.

I. Oil Separator: Refer to Division 22 Section “Drainage Piping Specialties.”

J. Oil Separator:
1. Manufacturers:
   a. Highland Tank & Manufacturing Co., Inc.; HTM-ESP-INT Series.
   b. Striem; OS-75.
2. Type: Factory-fabricated single wall interceptor for separating and removing hydraulic elevator oil from wastewater. Unit shall be furnished with legs to raise tank bottom 6 inches off floor.
3. Body Material: Carbon steel or polyethylene plastic.
4. Interior Lining: Corrosion-resistant polyurethane (not required on polyethylene tank).
5. Exterior Coating: Corrosion-resistant polyurethane (not required on polyethylene tank).
6. Flow Rate: Minimum 50 gpm per elevator.
7. Inlet and Outlet Size: As indicated on the Drawings.
8. End Connections: Threaded or flanged.
9. Upper Flow-Control Baffle: Required.
10. Filtration System: Designed to remove mechanically emulsified oil.
11. Oil Discharge Levels: Less than 100 mg/L.

K. Controls:

1. Electrical Characteristics: 115 volts, single phase.
2. Controls housed in NEMA 250, Type 4X enclosure having high decibel warning horn with silencing switch. Controls include:
    a. Alarm and separate LED lights for:
        1) Power.
        2) Overload.
        3) Pump run.
        4) Interceptor high oil level.
        5) Interceptor high liquid level.
        6) General alarm.
3. Furnish additional dry contact for remote alarm.
4. Pump Controllers:
    a. Three-float system for pump off/pump on/ operation, and high-level alarm.

2.4 SUMP PUMP BASINS

A. Sump: Existing to remain.

B. Cover: Fabricate with openings having gaskets, seals, and bushings, for access to pumps, pump shafts, control rods, discharge piping, vent connections, and power cables.
1. Material: Cast iron or steel.
2. Reinforcement: Steel or cast iron, capable of supporting foot traffic for basins installed in foot-traffic areas.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of plumbing piping to verify actual locations of storm drainage piping connections before sump pump installation.

3.2 CONCRETE

A. Install concrete bases of dimensions indicated for pumps and controllers. Refer to Division 20 Section "Basic Mechanical Materials and Methods."

B. Cast-in-place concrete materials and placement requirements are specified in Division 03.

3.3 SUMP PUMP INSTALLATION

A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earthwork."

B. Install sump pumps according to applicable requirements in Hydraulic Institute HI 1.4.

C. Install pumps and arrange to provide access for maintenance including removal of motors, impellers, couplings, and accessories.

D. Set submersible sump pumps on basin or pit floor. Make direct connections to storm drainage piping.

E. Support piping so weight of piping is not supported by pumps.

3.4 CONNECTIONS

A. Piping installation requirements are specified in Division 22 Section "Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to sump pumps to allow service and maintenance.

C. Connect storm drainage piping to pumps. Install discharge piping equal to pump discharge connection size. If pump discharge connection size is different from storm drainage piping size, provide transition from pump discharge piping size to storm drainage piping size. Refer to Division 22 Section “Storm Drainage Piping.”
   1. Install check and shutoff valves on discharge piping from each pump. Install unions on pumps having threaded pipe connections. Install valves same size as connected piping. Refer to Division 20 Section "Valves" for general-duty valves for drainage piping.

D. Ground equipment according to Division 26 Section "Grounding and Bonding."

E. Connect wiring according to Division 26 Section "Conductors and Cables."

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. Verify bearing lubrication.
   3. Disconnect couplings and check motors for proper direction of rotation.
   4. Verify that each pump is free to rotate by hand. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.

B. Start pumps without exceeding safe motor power:
   1. Start motors.
   2. Open discharge valves slowly.
   3. Check general mechanical operation of pumps and motors.

C. Test and adjust controls and safeties.

D. Remove and replace damaged and malfunctioning components.
   1. Pump Controls: Set pump controls for automatic start, stop, and alarm operation as required for system application.
   2. Set field-adjustable switches and circuit-breaker trip ranges as indicated, or if not indicated, for normal operation.

E. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project outside normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps. Refer to Division 20 Section "Mechanical General Requirements."

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SECTION 23 09 33
TEMPERATURE CONTROLS

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section.

B. Related Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 20 Section “Basic Mechanical Materials and Methods.”
   3. Division 23 Section “Testing, Adjusting, and Balancing.”

1.2 SUMMARY

A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

1.3 DEFINITIONS

A. BACnet: Communications open protocol for building automation system networks and control (developed by ASHRAE and documented per ANSI/ASHRAE Standard 135-2012.

B. BAS: Building Automation System

C. CAD: Computer Aided Design.

D. DDC: Direct-digital controls.

E. LonWorks (aka LonTalk): Communications open protocol as developed by Echelon Corporation that is utilized with building automation system networks and control.

F. TC: Temperature Control.

1.4 SYSTEM DESCRIPTION

A. Temperature control building automation system consisting of direct digital control system controllers, sensors, transducers, relays, switches, data communication network, etc. and all associated control wiring and raceway systems.

B. BAS/DDC system programming, database generation. Graphic display generation accessible through Building Network Supervisory Controller or at the remote operator workstation (when applicable for project).

C. Electric thermostats, control valves, dampers, operators, control wiring, etc.

D. Gauges, indicating devices, electric and electronic control accessories, and other control system devices.

1.5 SEQUENCE OF OPERATION

A. Control sequences for HVAC systems, subsystems, and equipment are indicated on project drawings.

1.6 SUBMITTALS

A. Submit under Division 20 and 23 provisions of respective project and as supplemented in this section.

B. All control submittal requirements shall be submitted at one time with exception to control valves, automated dampers, and initial phases of work associated with fast-track projects (when required). Early submittals of control valves and automated dampers shall be incorporated with the complete temperature controls submittal.

C. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for

materials, and installation and startup instructions for each type of product indicated.
1. Each control device labeled with setting or adjustable range of control.

D. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

E. Shop Drawings:
1. Shop drawings shall be done on CAD. Minimum size 11" x 17".
2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
3. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
4. Details of control enclosure including panel faces and interior, including controls, instruments, terminations blocks and component labeling.
5. Written sequence of operation for each controlled system.
6. Schedule of dampers including size, leakage, and flow characteristics (Refer to Design Data).
7. Schedule of valves including leakage and flow characteristics (Refer to Design Data).
8. Complete bill of materials to identify and quantify all control components.

F. Design Data: Provide indicated component selection and sizing criteria for the following component categories:
1. Dampers:
   a. Component tag.
   b. Equipment served/function.
   c. Overall damper size (inch width x inch height).
   d. Quantity of damper sections with respective size(s):
   e. Material and gauge of thickness.
   f. Mounting orientation (horizontal or vertical).
   g. Blade configuration (parallel or opposed)
   h. Pressure drop (in. WG).
   i. Shut-off rating/differential pressure rating (in. wg).
   j. Leakage rating (CFM/sq.ft. at 4 in. wg).
   k. Normal position (normally open, normally closed, floating).
   l. Actuator spring range (where applicable).
   m. Actuator power requirement.
   n. Actuator torque requirement.
   o. Actuator quantity.
   p. Damper manufacturer/model number.
   q. Actuator manufacturer/model number.

G. Wall mounted temperature sensor, thermostat and/or other temperature control device cover color shall be coordinated to match color of wall mounted electrical device components and cover plates – coordinate with electrical contractor. Provide samples of available temperature control device cover colors to Architect upon request or if available temperature control device colors do not match electrical device colors so a desired color selection may be determined. Provide sample of temperature sensor / thermostat guard upon request of Architect, Engineer or Owner.

H. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

I. Submit field reports indicating operating conditions after detailed check out of systems at Date of

Substantial Completion.

J. Project Record Documents: Include the following:
   1. Revise Shop Drawings to reflect actual installation and operating sequences.
   2. Record actual locations of control components, including control units, thermostats, and sensors.
   3. Submit the electronic files for all as-built shop drawings in pdf format on USB Flash Drives (3 Total).

K. Maintenance Manuals: Include the following:
   1. Product data with installation details, maintenance instructions and lists of spare parts for each type of control device.
   2. Keypad illustrations and step-by-step procedures indexed for each operator function, where applicable.
   3. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
   4. Calibration records and list of set points.

1.7 REFERENCES

A. AMCA 500 - Test Methods for Louvers, Dampers and Shutters.

B. ANSI/ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure fittings.

C. ANSI/ASTM B32 - Solder Metal.

D. ANSI/NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

E. ASTM B280 - Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.

F. ASTM B75 - Seamless Copper Tube for General Engineering Purposes.

G. ASTM D1693 - Environmental Stress - Cracking of Ethylene Plastics.

H. ASTM E1 - Specification for ASTM Thermometers.

I. MMC – Michigan Mechanical Code, version applicable for project.

J. NEMA DC 3 - Low-Voltage Room Thermostats.

K. UL 1820 - Fire Test of Pneumatic Tubing for Flame and Smoke Characteristics Only.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who is a certified installer of the automatic control system manufacturer for both installation and maintenance of units required for this Project.

B. Manufacturer Qualifications: A firm experienced in manufacturing automatic temperature-control systems similar to those indicated for this Project and with a record of successful in-service performance.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70,

Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with all applicable code requirements for project.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated or optional to be factory mounted on equipment, arrange for shipping of control devices to unit manufacturer.

1.10 COORDINATION

A. Coordinate work under Division 20 and 23 provisions and as supplemented in this section.

B. Coordinate location of space temperature sensors, space humidity sensor, thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

C. Coordinate installation of system components with installation of mechanical systems and equipment to achieve compatibility.

D. Ensure installation of components is complementary to installation of similar components in other systems.

E. Coordinate control wiring requirements, including actual terminal block numbers, with mechanical equipment manufacturers or suppliers.

F. Coordinate equipment with Division 28 Section "Fire Alarm" to achieve compatibility with equipment that interfaces with that system.

G. Ensure control system installation is complete, checked, tested and functioning properly prior to system balancing and Owner/Engineer system checkout.

H. Cooperate fully with the Test and Balance Contractor and provide labor to operate the temperature control system as required to meet the scope of work defined in Division 23 Section "Testing, Adjusting and Balancing."

1.11 WARRANTY

A. Provide warranty per Division 20 Section "Mechanical General Requirements" and as supplemented in this section.

B. Provide 24 hour per day emergency service during warranty period, with maximum response period of four (4) hours. Provide phone number(s) for quick assistance by a Service Engineer regarding hardware or software problems.

C. Provide scheduled maintenance service during warranty period to inspect, calibrate, and adjust controls. Make a minimum of one eight hour service call every three months. Notify Owner prior to each scheduled inspection trip. Submit written reports upon completion of service.

1.12 SPECIAL TOOLS

A. Deliver two sets of any special tools required for operation, adjustment, resetting or maintenance,

excluding PC laptop.

1.13 PROTECTION OF PROPRIETARY INFORMATION

A. Non-disclosure agreement(s) that may be subject to proprietary manuals and software shall be submitted by the proprietary equipment manufacturer to the Owner for approval and signature during the warranty period.

PART 2 - PRODUCTS

2.1 CONTROL AND INSTRUMENTATION TUBING

A. Copper Tubing: ASTM B280 or ASTM B75, seamless, hard drawn or annealed.
   1. Fittings: ANSI/ASME B16.22, wrought copper.
   2. Joints: ANSI/ASTM B32, 95-5 tin antimony.

B. Copper Tubing: ASTM B280 or ASTM B75, seamless, hard drawn or annealed.
   1. Fittings: UL approved rod or forged brass rated to 200 psig at 100 degrees F.
   2. Joints: Ball Sleeve compression type.

C. Polyethylene Tubing: Black, UL 1820 flame and smoke retardant where exposed in an air plenum, virgin polyethylene, conforming to modified ASTM D1693 test. All non-metallic tubing shall be minimum 1/4" O.D.; micro-sleeve is not acceptable.
   1. Fittings: UL approved rod or forged brass rated to 200 psig at 100 degrees F.
   2. Joints: Compression or barbed type.

2.2 DAMPERS - AUTOMATED

A. Performance: Test in accordance with AMCA 500.

B. Frames: Galvanized steel, minimum 16 gauge, minimum 2 inches in width, welded or riveted with corner reinforcement for 12 gage structural equivalence.

C. Blades: Galvanized steel, minimum 14 gauge, maximum blade size 8 inches wide, 60 inches long, attached to minimum 1/2 inch shafts. Dampers which are required to have a static pressure rating over 4 inch W.G. shall have minimum 3/4 inch solid shafts.

D. Blade Seals: Synthetic elastomeric or Neoprene, mechanically attached, field replaceable.

E. Jackshafts (where required): Minimum 1/2 inch galvanized steel.

F. Jamb Seals: Stainless steel.

G. Bearings: Oil impregnated sintered bronze or lubricant free, solid stainless steel. Provide thrust washers at bearings for all dampers which are to be mounted with blades in the vertical position.

H. Linkages: Accessible for maintenance. Linkages may be located in airstream. Linkages located in damper frame shall be external to the duct, accessible for maintenance. Linkages located in the airstream shall be zinc-plated.

I. Leakage: Less than 8 CFM per square foot based on 4 inches W.G. pressure differential.

J. Static Pressure Rating: As scheduled on the drawings, or if not scheduled, minimum 4" W.G.

K. Maximum Velocity: As scheduled on the drawings, or design for maximum velocity to be encountered in location where installed.

L. Temperature Limits: -40 to 200 deg F.

M. Manufacturers:
1. American Warming & Ventilating.
2. Arrow United Industries.
3. Greenheck.
4. Honeywell.
5. Johnson Controls.
6. Louvers & Dampers, Inc.
7. Ruskin.
8. Tamco.
9. Vent Products.

2.3 DAMPERS, INSULATED OUTDOOR AIR / RELIEF AIR / EXHAUST AIR - AUTOMATED

A. Performance: AMCA certified for Air Performance and Air Leakage.

B. Frames: Extruded aluminum, .080-inch thickness minimum, 4 inches deep minimum, thermally broken, and insulated with polystyrene or polyurethane foam insulation.

C. Blades: Extruded aluminum, internally insulated, and thermally broken. Maximum blade size 8 inches wide, 60 inches long.

D. Shafts: Minimum 7/16 inch hexagonal or square corrosion resistant zinc plated steel.

E. Blade Seals: Extruded EPDM, silicone, or synthetic elastomeric, mechanically attached.

F. Jamb Seals: Silicone, or synthetic elastomeric, mechanically attached.

G. Bearings: Dual bearing assembly of durable synthetic polymer resulting in no metal-to-metal contact. Provide thrust washers at bearings for all dampers which are to be mounted with blades in the vertical position.

H. Linkage: Linkage shall be installed in the frame side and shall be constructed of aluminum and/or corrosion resistant zinc plated steel.

I. Leakage: Less than 3 CFM per square foot at 1 inch W.G. pressure differential at minus 40 deg F.

J. Static Pressure Rating: As scheduled on the drawings, or if not scheduled, minimum 4 inches W.G.

K. Maximum Velocity: As scheduled on the drawings, or design for maximum velocity to be encountered in location where installed.

L. Temperature Limits: Minus 40 to 155 deg F.

M. Manufacturers:
1. Greenheck ICD-45.
2. Ruskin TED50 Series.
3. Tamco Series 9000 BF.

2.4 DAMPER OPERATORS - ELECTRIC

A. Electric damper motor shall be 24 or 120 volt two-position or modulating as required with spring return type and sized to operate the damper with sufficient reserve power for smooth operation from full close to full open and tight shut-off. Damper motor shall have "O ring" gaskets for weatherproof operation.

B. Number: Sufficient to achieve unrestricted movement throughout damper range. Provide sufficient number of operators such that one operator does not operate more than the maximum square footage of damper area as recommended in standard catalog of manufacturer.

C. Manufacturers:
1. Belimo.
2. Delta Control Products.
3. Honeywell.
4. Schneider Electric Controls.
5. Johnson Controls.
6. Siemens.

2.5 ELECTRICAL REQUIREMENTS FOR CONTROLS WORK

A. Electrical accessories such as relays, switches, contactors and control transformers shall meet the requirements of the Division 26 Specifications of respective project.

B. Electrical wiring and conduit shall meet the requirements of the Division 26 Specifications.

C. All control wiring in mechanical rooms and any other exposed areas shall be run in conduit. Low voltage temperature control wiring in concealed accessible locations (i.e. above lay-in ceilings), as well as low voltage temperature control wiring within partitions, may be run using plenum rated cable, neatly tie-wrapped and fastened to the building structure (not to ceiling or ceiling support wires).

D. Conduits carrying control wiring shall be sized for a maximum fill of 40% of capacity.

E. Where raceway is required, two separate raceway systems shall be provided; one for A.C. wiring and the other for D.C. wiring.

F. Data transmission cabling and equipment grounding procedures shall meet the latest FCC guidelines for electromagnetic field generation.

G. All control wiring sizes and types shall meet or exceed the equipment manufacturer's recommendations.

H. TC Contractor shall provide 24V power supply transformers for TC Contractor provided controllers. Maximum Transformer circuit for controls shall be 100VA serving controllers within mechanical room control panels or for remote terminal unit controllers served from common 24V power supply circuit. Transformers shall be located within enclosures provided by TC

Contractor.

2.6 LIMIT SWITCHES

A. Oil tight type with operator as required providing required function. Limit switches used on dampers should be set at approximately 75% of full stroke.

B. Manufacturers:
1. Allen-Bradley.
2. General Electric.
3. Square D.
4. Westinghouse.
5. Micro-switch.

2.7 GAS DETECTION MONITORING SYSTEM (CO & NO2)

A. UL approved Control Panel shall be capable of monitoring carbon monoxide and nitrogen oxide sensors via communication bus. The control panel shall indicate exact gas concentrations and location for each sensor with information displayed on LCD display. Controller shall be capable of handling 32 sensor inputs. Two alarm levels shall be displayed for each sensing point. Normal and failure indications shall be provided for each sensing point.

B. Setpoint adjustments shall be capable from a local keypad.

C. Control panel shall have two internal DPDT relays that can be programmed for alarm levels. A local strobe shall be provided and connected to 2nd level general alarm. Specific sensor in alarm shall be indicated on LCD display.

D. Control panel shall be capable of controlling 2 remote alarm relay modules based on adjustable setpoints.

E. Control Panel shall include audible alarm, 65 dBA at 3 ft.

F. Control Panel shall be equipped with power supply module to supply power to all connected sensor/transmitters associated with panel.

G. Wall mounting brackets shall be provided.

H. Control Panel Manufacturer: Vulcain, model VA-201C control panel with VA-201TA power supply transformer. Alternate systems subject to approval by engineer.

I. UL approved carbon monoxide sensor/transmitter shall be capable of detecting carbon monoxide (CO) at a radius of 50 ft. Detection Range shall be 0-500ppm at 3% accuracy. Sensor must compensate for variations in humidity and temperature to maintain a high level of accuracy. Local audible alarm (65 dBA at 3 ft) shall be provided on sensor/transmitter, activated upon 2nd high alarm level which shall be adjustable at control panel. Sensor shall be capable of operating in environmental conditions of 5-90% relative humidity and 32 to 100 degF temperatures. Sensor Manufacturer: Vulcain, model VA-201T-Q1-CO. Alternate systems subject to approval by engineer.

J. UL approved nitrogen dioxide sensor/transmitter shall be capable of detecting nitrogen dioxide (NO2) at a radius of 50 ft. Detection Range shall be 0-10ppm at 3% accuracy. Sensor must

compensate for variations in humidity and temperature to maintain a high level of accuracy. Local audible alarm (65 dBA at 3 ft) shall be provided on sensor/transmitter, activated upon 2nd high alarm level which shall be adjustable at control panel. Sensor shall be capable of operating in environmental conditions of 5-90% relative humidity and 32 to 100 degF temperatures. Sensor Manufacturer: Vulcain, model VA-201T-Q1-NO2. Alternate systems subject to approval by engineer.

K. Calibration Kit with carrying case shall be provided for carbon monoxide sensors. Two 100 liter tanks shall be provided. Manufacturer: Vulcain, model SKCOQ1. Alternate systems subject to approval by engineer.

L. Calibration Kit with carrying case shall be provided for nitrogen oxide sensors. Two 50 liter tanks shall be provided. Manufacturer: Vulcain, model SKNO2Q1. Alternate systems subject to approval by engineer

M. Sensor/transmitter guards: Provide wire guards for all CO and NO2 sensor locations.

2.8 LOCAL AND AUXILIARY CONTROL COMPONENT ENCLOSURE PANELS

A. Unitized cabinet type for each system under automatic control with relays and controls mounted in cabinet and temperature indicators, pressure gauges, pilot lights, pushbuttons and switches flush on cabinet panel face, or as detailed on drawings. Provide panel with locking door.

B. ANSI/NEMA 250, general purpose utility enclosures with enameled finished face panel, or as indicated on the drawings.

C. Panels shall be sized for a maximum fill of 50% capacity and shall not be smaller than 24" X 24".

PART 3 - EXECUTION

3.1 INSTALLATION - CONTROL SYSTEMS

A. Install in accordance with manufacturer's instructions.

B. Check and verify location of temperature sensors, thermostats and other exposed control sensors with plans and room details before installation. Locate room temperature sensors and thermostats 48 inches above floor unless noted otherwise.

C. The location of all control-related items to be mounted on the exterior of the building must be approved by the Architect prior to installation. Indicate proposed locations on the shop drawings.

D. Caulk both sides of damper frames to duct walls to prevent leakage between damper frame and duct.

E. Mount control panels adjacent to associated equipment on vibration free walls or free-standing angle iron supports. Sensors used for closed loop control must be connected to the same DDC controller as the associated output signal.

F. Provide conduit and electrical wiring where required.

G. All wiring in altered and unaltered areas shall be run concealed. "Wiremold" in finished areas shall be allowed when wiring cannot be run concealed in walls or partitions. Minimize

"wiremold" routing.

H. Splicing of DDC sensor cabling at junction boxes shall not be acceptable.

I. All equipment which has moving parts and is remotely started by the control system shall be provided with warning labels no less than 2 inches in height, and in bright warning color, stating that the equipment is remotely started by automatic controls. Such labels shall be posted clearly in the area of any moving parts, such as belts, fans, pumps, etc.

J. Coil and conceal excess capillary on remote element instruments.

K. Install thermometers in air duct systems on flanges.

L. Install all gauges and thermometers in locations where they are easily read from normal floor level. Provide tubing or wiring as required.

M. Locate all control components and accessories such that they are easily accessible for adjustment, service and replacement.

N. Locate, size and support sensing elements in airstreams so that they properly sense the representative condition. Controlling, transmitting and indicating elements shall be located to sense the average condition. Safety elements shall be located to sense the extreme condition.

O. Locate and size sensing elements in liquid lines so that they are in moving liquid and not in stagnant or turbulent locations. Wells shall not obstruct the flow of the liquid being measured. Pipes one inch and smaller shall be increased at least one pipe size at the point of insertion.

P. Locate pressure sensing taps in liquid lines in straight runs of pipe with at least 10 pipe diameters of straight pipe both upstream and downstream of pressure tap. Provide a shut-off cock in sensing line at each pressure tap.

Q. Install pressure sensing elements in ducts and casings with clean, sharp taps to accurately read true static pressure, avoiding velocity influence and turbulence.

R. Locate, support and install all control components and accessories so that they will not be subject to vibration, excessive temperatures, dirt, moisture or other harmful conditions beyond their rated limitations.

S. Where insulation is penetrated due to the installation of sensing elements or tubing, reseal the openings air and vapor tight. Provide brackets for devices to be located on insulated surfaces so as to clear the finished surface of the insulation and to avoid puncturing the vapor seal.

T. Provide all necessary relays, switches, linkages, control devices, accessories and connections as required for a complete and operational control system as specified herein and shown.

U. All electric valve and damper operators shall be capable of moving from full closed to full open, or vice versa, within 120 seconds.

3.2 TC CONTRACTOR DESIGN & INSTALLATION COORDINATION MEETINGS

A. Temperature Controls Shop Drawing Pre-submittal Meeting: TC Contractor's option to schedule a meeting at the Engineer's Office to review project design documentation for clarification purposes to aide in the TC Contractor development of TC/BAS shop drawings. For simple

clarification items, TC Contractor may contact Engineer via telephone to discuss. For project scope questioning items, TC Contractor shall utilize the formal Request of Information (RFI) process.

B. Temperature Controls Shop Drawing Submittal Meeting: Project Design Engineer's option to schedule a meeting at the Engineer's Office to review the TC Contractor's formally submitted drawings to address Engineer's comments and concerns that indicate TC Contractor's shop drawings vary from project design intent. This meeting can be avoided if TC Contractor's shop drawing submittal is complete and Engineer is confident that documents are going to lead to an installation that meets project design intent.

C. Temperature Controls Installation Technician Meeting: Project Design Engineer's option to schedule a meeting at the project site to meet and discuss project expectations with the TC Contractor's field installation technician and/or project manager. Discussion may include:
   1. Shop drawing review comments to ensure installation technician has the most up-to-date TC submittal.
   2. Graphics generation requirements including special Owner requirements and schedule for completion.
   3. Owner training agenda and scheduling.
   4. TC/BAS system acceptance procedures.

3.3 IDENTIFICATION AND MARKING

A. All sensors, relays, switches, etc. shall be marked with the same identification number as used on the as-built shop drawings. Use Brother P-touch label maker or similar with black text on clear or white super adhesive tape. If label applied in wet environment, spray label with clear enamel for waterproofing.

B. Wire shall be color coded according to functional use. Identify color coding format on record drawings.

C. Identify each wire as to ID number at each controller termination, field device termination or on the field device.

D. All control panels and auxiliary enclosures shall be supplied with engraved phenolic nameplate permanently attached on the front exterior with panel identification to match details of temperature control submittals and include system(s) served and area(s) served on the labeling. Include labeling near 120VAC terminations within panel identifying power source panel ID and specific circuit breaker used.

E. Temperature control conduit and junction box covers shall be painted green to signify that it is used for temperature controls. All junction box covers shall be painted green and the conduit shall be painted with a green mark (approximately 6 inches long) every 36" to 48", and on both sides of all penetrations.

3.4 OWNER INSTRUCTION AND TRAINING

A. Provide a minimum of eight (8) hours of combined on-site and classroom instruction and training to the Owner on the operation of the control systems for the initial installation.

B. Instruction and training shall be performed by a competent Contractor representative familiar with the control systems operation, maintenance and calibration.

C. Training shall take place after check, test, start-up of temperature controls system at a time mutually agreed upon by the Owner and Contractor.

D. Provide computer training & tutorial material on USB Flash Drives 5 total describing operator's BAS graphical interface capabilities and functions.

E. Provide 5 sets of literature pertaining to the operation and maintenance of the DDC system components provided.

3.5 CALIBRATION AND START-UP

A. After installation and connection of control components, test, adjust and re-adjust as required all control components in terms of function, design, systems balance and performance. Make systems ready for environmental equipment acceptance tests.

B. After environmental equipment has been accepted and after the systems have operated in normal service for two weeks, check the adjustment on control components and recalibrate where required. Components not in calibration shall be recalibrated to function as required or shall be replaced. Control devices, linkages, and other control components shall be calibrated and adjusted for stable and accurate operation in accordance with the design intent and to obtain optimum performance from the equipment controlled. Cause every device to automatically operate as intended to ensure its proper functionality.

3.6 ACCEPTANCE PROCEDURE

A. Upon successful completion of start-up and recalibration as indicated in this section, the Architect shall be requested in writing to inspect the satisfactory operation of the control systems.

B. Demonstrate operation of all control systems, including each individual component, to the Owner and Architect.

C. After correcting all items appearing on the punch list, make a second written request to the Owner and Architect for inspection and approval.

D. After all items on the punch list are corrected and formal approval of the control systems is provided by the Architect, the Contractor shall indicate to the Owner in writing the commencement of the warranty period.

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SECTION 23 11 23
FUEL GAS PIPING

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”

1.2 SUMMARY

A. This Section includes facility fuel gas piping.

B. Service meter assemblies will be furnished and installed by utility company.

1.3 DEFINITIONS

A. Gas Main: Utility's natural gas piping.

B. Gas Distribution: Piping from gas main to individual service-meter assemblies.

C. Service-Meter Assembly: Piping, valves, service regulator, service meter, and specialties.

D. Point of Delivery: Piping outlet from service-meter assembly.

E. Fuel Gas Piping: Piping that conveys fuel gas from point of delivery to fuel gas utilization devices.

F. PE: Polyethylene.

1.4 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:
1. Piping and Valves: Performance requirements are scheduled on the Drawings.

1.5 SYSTEMS DESCRIPTIONS

A. Fuel gas piping system materials are scheduled on the Drawing.

1.6 ACTION SUBMITTALS

A. Product Data: For the following:
1. Specialty valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
2. Pressure regulators. Include pressure rating, capacity, and settings of selected models.

1.7 INFORMATIONAL SUBMITTALS

A. Shop Drawings: For fuel gas piping. Include plans and attachments to other work.
1. Wiring Diagrams: Power, signal, and control wiring.

B. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.

1.8 CLOSEOUT SUBMITTALS

A. Field quality-control test reports.

B. Operation and Maintenance Data: For natural gas specialties and accessories to include in

operation and maintenance manuals.
1. Lubricated Plug Valves: Installation, operation, lubrication, and leak testing procedures.

1.9 QUALITY ASSURANCE

A. Electrical Components and Devices: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

B. NFPA Standard: Comply with NFPA 54, "National Fuel Gas Code."

1.10 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and legally dispose of liquids from drips in existing gas piping. Handle cautiously to avoid spillage and ignition. Notify fuel gas supplier. Handle flammable liquids used by Installer with proper precautions and do not leave on premises from end of one day to beginning of next day.

B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

D. Protect stored PE pipes and valves from direct sunlight.

1.11 PROJECT CONDITIONS

A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

B. Gas System Pressure: Not more than 5.0 psig.

C. Design values of fuel gas supplied for these systems are as follows:
1. Nominal Heating Value: 1000 Btu/cu. ft.
2. Nominal Specific Gravity: 0.6.

1.12 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the

manufacturers specified.

2.2 BLACK STEEL PIPE AND FITTINGS

A. Black Steel Pipe: ASTM A 53/A 53M or ASTM A 106; Type E or S; Grade B; Schedule 40. Wall thickness of wrought-steel pipe shall comply with ASME B36.10M.
   1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern, with threaded ends according to ASME B1.20.1.
   2. Steel Threaded Fittings: ASME B16.11, forged steel with threaded ends according to ASME B1.20.1.
   3. Steel Welding Fittings: ASME B16.9, wrought steel or ASME B16.11, forged steel.
   4. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends according to ASME B1.20.1.
   5. Cast-Iron Flanges and Flanged Fittings: ASME B16.1, Class 125.
   6. Joint Compound and Tape: Suitable for natural gas.
   7. Steel Flanges and Flanged Fittings: ASME B16.5.
   8. Gasket Material: Thickness, material, and type suitable for natural gas.

2.3 PE PIPE AND FITTINGS

A. Manufacturers:
   1. Chevron Phillips Chemical Company LLC; Performance Pipe Division; Driscopipe and Driscoflex.
   2. Endot Industries, Inc.
   3. Mexichem Datacom & Infrastructure; DuraLine; PolyPipe.
   4. Oil Creek Plastics.

B. PE Pipe: ASTM D 2513, PE2708 or PE4710, SDR 11.
   1. PE Fittings: ASTM D 2683, socket type or ASTM D 3261, butt type with dimensions matching ASTM D 2513, SDR 11, PE pipe.

C. Transition Fittings: Manufactured pipe fitting with one PE pipe end for heat-fusion connection to PE pipe and with one ASTM A 53/A 53M, Schedule 40, steel pipe end for threaded connection to steel pipe.

D. Service-Line Risers: Manufactured PE pipe fitting with PE pipe inlet for heat-fusion connection to underground PE pipe; PE pipe riser section with protective-coated, anodeless, steel casing and threaded outlet for threaded connection to aboveground steel piping.

2.4 PIPING SPECIALTIES

A. Flexible Connectors: ANSI Z21.24, copper alloy.

B. Quick-Disconnect Devices: ANSI Z21.41, convenience outlets and matching plug connector.

C. Y-Pattern Strainers:
   1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
   2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
   3. Strainer Screen: 40-mesh startup strainer and perforated stainless-steel basket with 50 percent free area.
   4. CWP Rating: 125 psig.

D. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.5 JOINING MATERIALS

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods."

2.6 SPECIALTY VALVES

A. Valves, NPS 3 and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.

B. Natural Gas Valves, NPS 3 and Smaller: Use the following:
   1. Ball Valves: Bronze or brass body with AGA or CSA stamp, UL listed or FM approved for service, with chrome-plated brass ball and lever handle; 125-psig minimum pressure rating.
      a. Manufacturers:
         1) Apollo Valve; Conbraco Industries, Inc.
         2) Jomar International Ltd.
         3) Legend Valve and Fitting, Inc.
         4) Milwaukee Valve Company.
         5) NIBCO INC.
         6) Watts Water Technologies, Inc.; Watts Regulator Co.
      b. Tamperproof Feature: Include design for locking.

2.7 PRESSURE REGULATORS

A. Description: Single stage and suitable for fuel gas service. Include steel jacket and corrosion-resistant components, elevation compensator, and atmospheric vent.
   1. Manufacturers:
      a. Line Pressure Regulators:
         1) Elster Gas North America; Elster American Meter.
         2) Fisher Controls International, Inc.; Division of Emerson Process Management.
         3) Itron Gas.
   2. NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel flanges.
   3. Service Pressure Regulators: ANSI Z21.80. Include 100-psig- minimum inlet pressure rating.
   4. Line Pressure Regulators: ANSI Z21.80/GCA 6.22 or ANSI B109.4/CGA 6.18, with inlet pressure rating as scheduled on the Drawings.
      a. Regulators for Generator Sets: Direct operated, fast acting type.

B. Pressure Regulator Vents: Factory- or field-installed, corrosion-resistant screen in opening if not connected to vent piping.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Refer to Division 31 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 EXAMINATION

A. Examine roughing-in for fuel gas piping system to verify actual locations of piping connections before equipment installation.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 PREPARATION

A. Close equipment shutoff valves before turning off natural gas to premises or piping section.

B. Inspect natural-gas piping according to NFPA 54 and the International Fuel Gas Code [**NFPA 58**] to determine that natural-gas utilization devices are turned off in piping section affected.

C. Comply with NFPA 54 and the International Fuel Gas Code [**NFPA 58**] requirements for prevention of accidental ignition.

3.4 SERVICE-METER ASSEMBLY INSTALLATION

A. Service meter assembly will be installed by the fuel gas utility company.

B. Install gas valve or plug valve and strainer upstream from each service pressure regulator.

C. Install service pressure regulators with vent outlet turned down and with corrosion-resistant-metal insect screen.

D. Install pressure gage upstream and downstream from each service pressure regulator. Pressure gages are specified in Division 20 Section "Meters and Gages."

E. Install service meters downstream from service pressure regulators.
   1. Service meters with connections larger than NPS 1 supported from piping or set on concrete bases.

3.5 SERVICE ENTRANCE PIPING

A. Extend fuel gas piping and connect to fuel gas distribution for service entrance to building.
   1. Exterior fuel gas distribution system piping, service pressure regulator, and service meter will be provided by gas utility.
   2. Refer to Article entitled “Codes, Permits and Fees” in Division 20 Section “Mechanical General Requirements” for additional requirements.

B. Install dielectric fitting downstream from and adjacent to each service meter unless meter is supported from service-meter bar with integral dielectric fitting. Install shutoff valve downstream from and adjacent to dielectric fitting. Dielectric fittings are specified in Division 20 Section "Basic Mechanical Materials and Methods."

3.6 PIPING SYSTEM INSTALLATION

A. Comply with NFPA 54 and the International Fuel Gas Code for installation and purging of natural-gas piping.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout

are approved on Coordination Drawings.

C. Basic piping installation requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."

D. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels, unless indicated to be exposed to view.

E. Concealed Locations:
   1. Above Inaccessible Ceiling Locations: Gas piping with welded joints may be installed in inaccessible spaces, subject to approval of authorities having jurisdiction, whether or not such spaces are used as plenums. Do not locate valves or unions above inaccessible ceilings.
   2. Above Accessible Ceiling Locations: Gas piping with welded joints may be installed in accessible ceiling spaces, subject to approval of authorities having jurisdiction, whether or not such spaces are used as plenums. Do not locate valves or unions above ceilings used as plenums.
   3. In Floor Channels: Gas piping may be installed in floor channels, subject to approval of authorities having jurisdiction. Channels must have cover and be open to space above cover for ventilation.
   4. Underground Beneath Building: Gas piping may be installed in protective conduit in accordance with Chapter “Gas Piping Installations” in the International Fuel Gas Code.
   5. In Partitions: Do not install concealed piping in solid partitions, unless installed in a chase or casing.
      a. Exception: Piping passing through partitions or walls.
   6. In Walls: Gas piping with welded joints and protective wrapping specified in Part 2 "Protective Coating" Article may be installed in masonry walls, subject to approval of authorities having jurisdiction.
   7. Prohibited Locations: Do not install gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.

F. Drips and Sediment Traps: Install drips at points where condensate may collect. Include outlets of service meters. Locate where readily accessible for cleaning and emptying. Do not install where condensate would be subject to freezing.
   1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use minimum-length nipple of 3 pipe diameters, but not less than 3 inches long, and same size as connected pipe. Install with space between bottom of drip and floor for removal of plug or cap.

G. Install fuel gas piping at uniform grade of 0.1 percent slope upward toward risers.

H. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

I. Connect branch piping from top or side of horizontal piping.

J. Install strainer on inlet of each automatic and electrically operated valve.

K. Install pressure gage upstream and downstream from each line pressure regulator. Pressure gages are specified in Division 20 Section "Meters and Gages."

L. Locate valves for easy access.

M. Install flanges when connecting to valves, specialties, and equipment having NPS 2-1/2 and larger connections.

N. Install gas valve or plug valve and strainer upstream from each line pressure regulator or appliance pressure regulator.

O. Install vent piping for gas pressure regulators and gas trains, extend outside building, and vent to atmosphere. Terminate vents with turned-down, reducing-elbow fittings with corrosion-resistant insect screens in large end.

P. Install containment conduits for gas piping below slabs, within building, in gastight conduits extending minimum of 4 inches outside building and vented to atmosphere. Terminate vents with turned-down, reducing-elbow fittings with corrosion-resistant insect screens in large end. Prepare and paint outside of conduits with coal-tar, epoxy-polyamide paint according to SSPC-Paint 16.

3.7 JOINT CONSTRUCTION

A. Basic piping joint construction is specified in Division 20 Section "Basic Mechanical Materials and Methods."

B. Use materials suitable for fuel gas.

C. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

3.8 POLYETHYLENE PIPE INSTALLATION

A. Install underground, PE, natural gas distribution piping according to ASTM D 2774.

B. Install underground, PE, natural gas distribution piping at entrance to and under part of building in steel piping protective conduit that is vented to outside.

3.9 HANGER AND SUPPORT INSTALLATION

A. Pipe hanger and support and equipment support materials and installation requirements are specified in Division 20 Section "Hangers and Supports."

B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
   1. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.

C. Support vertical steel pipe at each floor and at spacing not greater than 15 feet.

3.10 CONNECTIONS

A. Drawings indicate general arrangement of fuel gas piping, fittings, and specialties.

B. Install piping adjacent to appliances to allow service and maintenance.

C. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance using gas.

3.11 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each service meter, pressure regulator, and specialty valve.
   1. Text: In addition to name of identified unit, distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
   2. Nameplates, pipe identification, and signs are specified in Division 20 Section "Mechanical Identification."
   3. Trace Wire: Yellow insulated, minimum 18 AWG wire, having copper or other approved conductor, with insulation suitable for direct burial, installed adjacent to underground nonmetallic piping, with aboveground access to tracer wire at each end of pipe.

3.12 PAINTING

A. Use materials and procedures in Division 09 painting Sections.

B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
   1. Alkyd System: MPI EXT 5.1D.
      a. Prime Coat: Alkyd anticorrosive metal primer.
      b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
      c. Topcoat: Exterior alkyd enamel (semigloss) **[(flat)]** **[(gloss)]**.
      d. Color: Gray.

C. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.13 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base.
   1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
   2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
   3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
   4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   5. Install anchor bolts to elevations required for proper attachment to supported equipment.
   6. Use 3000-psig, 28-day, compressive-strength concrete and reinforcement as specified in Division 03.

3.14 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
   1. Test, inspect, and purge natural gas according to NFPA 54 and the International Fuel Gas Code and authorities having jurisdiction.

C. Additional Testing: Subject welded fuel gas piping installed within ceiling spaces used as plenums to test pressure of 150 psig for a minimum of 2 hours.

D. Natural-gas piping will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.15 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate, and maintain lubricated plug valves.

END OF SECTION 23 11 23

SECTION 23 81 26
SPLIT-SYSTEM AIR-CONDITIONING UNITS

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 20 Section “Basic Mechanical Materials and Methods.”

1.2 SUMMARY

A. This Section includes ductless split-system air-conditioning and heat pump units consisting of separate evaporator-fan and compressor-condenser components.

B. Products supplied but not installed under this Section:
   1. Roof curbs and equipment rails.

1.3 ACTION SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

1.4 INFORMATIONAL SUBMITTALS

A. Shop Drawings: Diagram power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

A. Field quality-control test reports.

B. Operation and Maintenance Data: For split-system air-conditioning units to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of split-system units and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

C. ASHRAE Compliance:
   1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."

D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

E. Seasonal Energy-Efficiency Ratio (SEER): Minimum 13.

1.7 COORDINATION

A. Coordinate size and location of concrete or plastic pads for units.

B. Coordinate delivery and placement of roof curbs, and equipment supports. Installation of roof curbs, equipment supports, and roof penetrations is specified in Division 07 Section “Roof Accessories.” Pipe Roof Penetration Enclosures are specified in Division 20 Section “Basic Mechanical Materials and Methods.”

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Filters: One set of filters for each unit.
   2. Infrared remotes where applicable.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Single-Zone Split-System Air-Conditioning Units:
      a. Airedale North America, Inc.
      b. Carrier Corp.; United Technologies Corporation.
      c. Daikin Applied; a member of Daikin Industries, Ltd.; Daikin AC.
      d. Johnson Controls-Hitachi.

e. LG Electronics, HVAC Division.
f. Mitsubishi Electric & Electronics America, Inc.; HVAC Advanced Products Division.
g. Samsung Electronics.

2. Roof Curbs and Equipment Rails:
a. Pate Company (The).
b. Roof Products and Systems Corp.
c. ThyCurb; a division of THYBAR Corporation.

2.2 SINGLE-ZONE DUCTLESS SPLIT SYSTEM AIR CONDITIONER

A. Complete packaged air conditioning unit factory fabricated and tested.

B. Indoor Evaporator Section: Complete with fan section, motor, washable filter, condensate drain pan, built in factory installed condensate pump, and direct expansion evaporator section. Include factory-installed float switch to detect high condensate water level and disable fan operation.

C. Air Cooled Condensing Section: Completely factory piped for single point connection of refrigerant lines. Condensing unit with propeller fan shall be matched to evaporator section to provide cooling capacity as scheduled on drawings.

D. Controls: Unit furnished with factory installed microprocessor controls. Provide wireless remote or unit mounted control or wall thermostat, which shall provide selection of all functions and control of room temperature set points. Furnish and install one mounting bracket for each wireless remote control.

E. Provide complete refrigerant piping circuit (including all piping specialties) sized in accordance with manufacturer's requirements to interconnect evaporator and condenser sections.

F. Wall-Mounting, Evaporator-Fan Components:
1. Cabinet: With removable panels for servicing, and discharge drain pans with drain connection.
2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with AHRI 210/240, and with thermal-expansion valve.
3. Fan: Direct drive, centrifugal fan.
4. Fan Motors: Comply with requirements in Division 20 Section "Motors."
a. Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.
5. Filters: Permanent, cleanable.

G. Air-Cooled, Compressor-Condenser Components:
1. Casing: Steel, finished with baked enamel, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
a. Compressor Type: Reciprocating or Scroll.
b. Include refrigerant charge.
c. Refrigerant: R-410A.
3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with

AHRI 210/240, and with liquid subcooler.
4. Fan: Aluminum-propeller type, directly connected to motor.
5. Motor: Permanently lubricated, with integral thermal-overload protection.
6. Low Ambient Kit: Permits operation down to 0 deg F. Include wind manufacturer's wind baffle accessory.

H. Control equipment is specified in Division 23 Section "Temperature Controls," and sequence of operation is indicated on the Drawings.

I. Thermostat: Wall-mounted low voltage type to control compressor and evaporator fan.

J. Automatic-reset timer to prevent rapid/short cycling of compressor.

2.3 ACCESSORIES

A. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized with nitrogen, and sealed; factory-insulated suction line with flared fittings at both ends.

B. Roof Curbs and Equipment Rails:
1. Minimum 18 gage welded galvanized steel construction.
2. Integral base flange or plate.

C. Automatic Condensate Pump Units (Field Installed)
1. Manufacturers:
a. Little Giant Pump Co.; Subsidiary of Tecumseh Products Co.
b. Beckett Corporation.
c. Hartell Pumps Div.; Milton Roy Co.
d. Hydromatic Pump Company; Division of Pentair Pump Group.
2. Description: Packaged units with corrosion-resistant pump, plastic tank with cover, and automatic controls.

D. Wall Sleeve-Seal Systems:
1. Manufacturers:
a. Airex Manufacturing, Inc.; Pro-System Kit.
2. Description: Exterior wall seal system for HVAC refrigerant line set piping penetrations through the building envelope.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Deliver roof curbs and equipment support to site for installation under Division 07. Install roof-mounting compressor-condenser components on equipment supports specified. Anchor units to supports with removable, cadmium-plated fasteners. Install wind baffle according to manufacturer's installation instructions.

D. Install and connect refrigerant tubing to components. Install tubing to allow access to unit. Evacuate and charge with refrigerant in accordance with manufacturer's instructions.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 20 and 23 Sections.

B. Install piping adjacent to unit to allow service and maintenance.

C. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning units and retest as specified above.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 23 81 26

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SECTION 23 82 39
ELECTRIC WALL AND CEILING HEATERS

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 20 Section “Basic Mechanical Materials and Methods.”

1.2 SUMMARY

A. This Section includes wall and ceiling heaters with propeller fans and electric heating elements.

1.3 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Plans, elevations, sections, and details.
   2. Wiring Diagrams: Power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

A. Field quality-control test reports.

B. Operation and Maintenance Data: For wall and ceiling heaters to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Berko Electric Heating; a division of Marley Engineered Products.
2. Brasch Manufacturing Company, Inc.
3. Chromalox Advanced Thermal Technologies; Spirax-Sarco Engineering plc.
4. Indeeco Heating Solutions; ASPEQ Heating Group.
5. Markel Products; a division of TPI Corporation.
6. QMark Electric Heating; a division of Marley Engineered Products.

B. Description: An assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.

C. Cabinet:
1. Front Panel: Stamped-steel louver, with removable panels fastened with tamperproof fasteners.
2. Finish: Baked enamel over baked-on primer with manufacturer's standard color selected by Architect, applied to factory-assembled and -tested wall and ceiling heaters before shipping.

D. Surface-Mounting Cabinet Enclosure: Steel with finish to match cabinet.

E. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and hum, embedded in magnesium oxide refractory and sealed in corrosion-resistant metallic sheath. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware, and limit controls for high temperature protection. Provide integral circuit breaker for overcurrent protection.

F. Fan: Aluminum propeller directly connected to motor.
1. Motor: Permanently lubricated. Comply with requirements in Division 20 Section "Motors."

G. Controls: Unit-mounted thermostat.

H. Electrical Connection: Factory wired motors and controls for a single field connection including factory wired disconnect switch and starter.

I. Capacities and Characteristics: Refer to schedule on Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive wall and ceiling heaters for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for electrical connections to verify actual locations before wall and ceiling heater installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall boxes in finished wall assembly.

B. Install wall and ceiling heaters to comply with NFPA 90A.

C. Suspend wall and ceiling heaters from structure with threaded rod.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding."

B. Connect wiring according to Division 26 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   2. Operate electric heating elements to verify proper operation and electrical connections.
   3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning units and retest as specified above.

3.5 ADJUSTING

A. Adjust initial temperature set points.

END OF SECTION 23 82 39

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SECTION 26 00 10
ELECTRICAL GENERAL REQUIREMENTS

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

1.2 SUMMARY

A. This Section includes electrical general administrative and procedural requirements. The following requirements are included in this Section to supplement the requirements specified in

Division 1 Specification Sections.

1.3 REFERENCES

A. All materials shall be new. The electrical and physical properties of all materials, and the design, performance characteristics, and methods of construction of all items of equipment, shall be in accordance with the latest issue of the various, applicable Standard Specifications of the following recognized authorities:
   1. ANSI - American National Standards Institute; www.ansi.org.
   2. ASTM - ASTM International; www.astm.org.
   3. CSI - Construction Specifications Institute (The); www.csiresources.org.
   4. ICEA - Insulated Cable Engineers Association, Inc.; www.icea.net.
   5. IEEE - Institute of Electrical and Electronics Engineers, Inc. (The); www.ieee.org.
   6. NEC - National Electrical Code
   7. NECA - National Electrical Contractors Association; www.necanet.org.
      a. NECA 1-2000, "Practices for Good Workmanship in Electrical Contracting (ANSI)."
   8. NEMA - National Electrical Manufacturers Association; www.nema.org.
   9. NETA - InterNational Electrical Testing Association; www.netaworld.org.
   10. UL - Underwriters Laboratories Inc.; www.ul.com.

1.4 QUALITY ASSURANCE

A. Scope of Work: Furnish all labor, material, equipment, technical supervision, and incidental services required to complete, test, and leave ready for operation the electrical systems as specified in the Division 26 Sections and as indicated on Drawings.
   1. Contract Documents are complementary, and what is required by one shall be as binding as if required by all. In the event of inconsistencies or disagreements within the Construction Documents bids shall be based on the most expensive combination of quality and quantity of the work indicated.
   2. The Contractor understands that the work herein described shall be complete in every detail.

B. Ordinances and Codes: Perform all Work in accordance with applicable Federal, State, and local ordinances and regulations, the Rules and Regulations of NFPA, NECA, and UL, unless otherwise indicated.
   1. Notify the Architect/Engineer if revisions to the Drawings or Specifications are required to conform to applicable ordinances, codes, or regulations. Identify the cost associated with these revisions in the bid.

C. Source Limitations: All equipment of the same or similar systems shall be by the same manufacturer.

D. Tests and Inspections: Perform all tests required by state, city, county, and/or other agencies having jurisdiction. Provide all materials, equipment, etc., and labor required for tests.

E. Performance Requirements: Perform all work in a first class and workmanlike manner, in accordance with the latest accepted standards and practices for the trades involved.

F. Sequence and Schedule: Avoid interference with the work of other trades. Remove and relocate any work which in the opinion of the Owner's Representatives causes interference.

1.5 CODES, PERMITS AND FEES

A. Unless otherwise indicated, all required permits, licenses, inspections, approvals, and fees for electrical work shall be secured and paid for by the Contractor. All work shall conform to all applicable codes, rules, and regulations.

B. Comply with rules of local utility companies. Coordinate with the utility company supplying service to the installation and determine all devices including, but not limited to, all current and potential transformers, meter boxes, C.T. cabinets, and meters which will be required and include the cost of all such items and all utilities costs in proposal.

C. All work shall be executed in accordance with the rules and regulations outlined in local and state codes. Prepare any detailed Drawings or diagrams which may be required by the governing authorities. Where the Drawings and/or Specifications indicate materials or construction that exceed code requirements, the Drawings and/or Specifications shall govern.

1.6 DRAWINGS

A. The Drawings show the location and general arrangement of equipment, electrical systems, and related items. They shall be followed as closely as elements of the construction will permit.

B. Examine the Drawings of other trades and verify the conditions governing the work on the job site. Arrange work accordingly, providing such fittings, conduit, junction boxes, and accessories as may be required to meet such conditions.

C. Deviations from the Drawings, apart from minor changes in routing and other such incidental changes that do not affect the functioning or serviceability of the systems, shall not be made without the written approval of the Architect/Engineer.

D. The architectural and structural Drawings take precedence in all matters pertaining to the building structure, mechanical Drawings in all matters pertaining to mechanical trades, and electrical Drawings in all matters pertaining to electrical trades. Where there are conflicts or differences between the Drawings for the various trades, report such conflicts or differences to the Architect/Engineer for resolution.

E. Drawings are not intended to be scaled for rough-in or to serve as shop drawings. Take all field measurements required to complete the Work.

1.7 MATERIAL AND EQUIPMENT MANUFACTURERS

A. All items of equipment shall be furnished complete with all accessories normally supplied with the catalog items listed and all other accessories necessary for a complete and satisfactory operating system. All equipment and materials shall be new, be standard products of manufacturers regularly engaged in the production of electrical equipment and be of the manufacturer's latest design.

B. If an approved manufacturer is other than the manufacturer used as the basis for design, the equipment or product provided shall be equal in size, quality, durability, appearance, capacity, and efficiency through all ranges of operation, shall conform with arrangements and space limitations of the equipment shown on the plans and/or specified, shall be compatible with the other components of the system and shall comply with the requirements for Items Requiring Prior Approval specified in this section of the Specifications. All costs to make these items of

equipment comply with these requirements including, but not limited to, electrical work, and building alterations shall be included in the original Bid. Similar equipment shall be by one manufacturer.

C. Where existing equipment is modified to include new switches, circuit breakers, metering, or other components, the new components shall be by the original equipment manufacturer and shall be listed for installation in the existing equipment. Where original equipment manufacturer components are not available, third-party aftermarket components shall be listed for the application and submitted to the engineer for approval. Reconditioned or salvaged components shall not be used unless specifically indicated on the drawings.

1.8 INSPECTION OF SITE

A. Visit the site, examine, and verify the conditions under which the Work must be conducted before submitting Proposal. The submitting of a Proposal implies that the Contractor has visited the site and understands the conditions under which the Work must be conducted. No additional charges will be allowed because of failure to make this examination or to include all materials and labor to complete the Work.

1.9 ITEMS REQUIRING PRIOR APPROVAL

A. Bids shall be based upon manufactured equipment specified. All items that the Contractor proposes to use in the Work that are not specifically named in the Contract Documents must be submitted for review prior to bids. Such items must be submitted in compliance with Division 1 specifications. Requests for prior approval must be accompanied by complete catalog information, including but not limited to, model, size, accessories, complete electrical information, and performance data in the form given in the equipment schedule on the drawings at stated design conditions. Where items are referred to by symbolic designations on the drawings, all requests for prior approval shall bear the same designations.
   1. Equipment to be considered for prior approval shall be equal in quality, durability, appearance, capacity, and efficiency through all ranges of operation, shall fulfill the requirements of equipment arrangement and space limitations of the equipment shown on the plans and/or specified and shall be compatible with the other components of the system.
   2. All costs incurred to make equipment comply with other requirements, including providing maintenance, clearance, electrical, replacement of other components, and building alterations shall be included in the original bid.

B. Voluntary alternates may be submitted for consideration, with listed addition or deduction to the bid.

1.10 SHOP DRAWINGS/SUBMITTALS

A. Submit project-specific submittals for review in compliance with Division 1.

B. All shop Drawings shall be submitted in groupings of similar and/or related items (lighting fixtures, switchgear, etc.). Incomplete submittal groupings will be returned unchecked.

C. If deviations (not substitutions) from the Contract Documents are deemed necessary by the Contractor, the details of such deviations, the reason for the deviation, and the resulting changes shall be included with the submittal for approval.

D. Submit for approval shop drawings for electrical systems or equipment indicated in other sections

of electrical specs. Where items are referred to by symbolic designation on the Drawings and Specifications, all submittals shall bear the same designation (light fixtures).

1.11 COORDINATION DRAWINGS

A. Submit project specific coordination drawings for review in compliance with Division 1 Specification Sections.

1.12 OPERATION AND MAINTENANCE INSTRUCTIONAL MANUALS

A. Submit project specific Operation and Maintenance Instructional Manuals for review in compliance with Division 01 Specification Sections.

B. Provide complete operation and maintenance instructional manuals covering all electrical equipment herein specified, together with parts lists. Maintenance and operating instructional manuals shall be job specific to this project. Generic manuals are not acceptable. Manual shall be provided on electronic media. All literature shall be combined in one document and shall be properly bookmarked with all applicable sections. Maintenance and operating instructional manuals shall be provided when construction is approximately 75% complete.

C. The operating and maintenance instructions shall include a brief, general description for all electrical systems including, but not limited to:
1. Routine maintenance procedures.
2. Trouble-shooting procedures.
3. Contractor's telephone numbers for warranty repair service.
4. Submittals.
5. Recommended spare parts list.
6. Names and telephone numbers of major material suppliers and subcontractors.
7. System schematic drawings on 8-1/2" x 11" sheets.

1.13 RECORD DRAWINGS

A. Submit record drawings in compliance with Division 01.

B. Contractor shall submit to the Architect/Engineer, record drawings on electronic media which have been neatly marked to represent as-built conditions for all new electrical work. Modifications to original drawings shall be marked with a contrasting color so the marks are readily apparent.

C. The Contractor shall keep accurate note of all deviations from the construction documents and discrepancies in the underground concealed conditions and other items of construction on field drawings as they occur. The marked up field documents shall be available for review by the Architect, Engineer, and Owner at their request during construction.

1.14 INSTRUCTION OF OWNER PERSONNEL

A. Before final inspection, instruct Owner's designated personnel in operation, adjustment, and maintenance of electrical equipment and systems at agreed upon times. A minimum of 8 hours of formal instruction to Owner's personnel shall be provided for each building. Additional hours are specified in individual specification sections.

B. Use operation and maintenance manuals as basis for instruction. Review contents of manual with

personnel in detail to explain all aspects of operation and maintenance.

C. In addition to individual equipment training provide overview of each electrical system. Utilize the as-built documents for this overview.

D. Prepare and insert additional data in operation and maintenance manual when need for such data becomes apparent during instruction, or as requested by Owner.

1.15 WARRANTY

A. Warranty: Comply with the requirements in Division 01 Specification Sections. Contractor shall warranty that the electrical installation is free from defects and agrees to replace or repair, to the Owner’s satisfaction, any part of this electrical installation which becomes defective within a period of one year (unless specified otherwise in other Division 26 sections) from the date of substantial completion following final acceptance, provided that such failure is due to defects in the equipment, material, workmanship, or failure to follow the contract documents.

B. Contractor shall be responsible for any temporary services including equipment and installation required to maintain operation as a result of any equipment failure or defect during warranty period.

C. File with the Owner all warranties from the equipment manufacturers including the operating conditions and performance capacities they are based on.

1.16 USE OF EQUIPMENT

A. The use of any equipment, or any part thereof for purposes other than testing even with the Owner's consent, shall not be construed to be an acceptance of the work on the part of the Owner, nor be construed to obligate the Owner in any way to accept improper work or defective materials.

B. Do not use Owner's lamps for temporary lighting except as allowed and directed by the Owner. Equip lighting fixtures with new lamps when the project is turned over to the Owner.

1.17 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:
   1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
   2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
   3. To allow right of way for piping and conduit installed at required slope.
   4. To ensure that connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions; and to maintain the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 8 Section "Access Doors and Frames."

D. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and

systems that are functionally interdependent are tested to demonstrate successful interoperability.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange, and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to raceways and piping systems installed at a required slope.

3.2 DEMOLITION WORK

A. All demolition of existing electrical equipment and materials will be done by this Contractor unless otherwise indicated. Include all items related to the existing systems that are being removed such as, but not limited to, electrical equipment, cabinets, devices, lighting fixtures, conduit, fittings, boxes, wiring, and supports. No abandoned components of the electrical systems indicated to be removed shall remain.
   1. Where electrically powered equipment is included in the demolition scope of other trades, disconnect electrical wiring connections and remove circuit wiring complete.

B. In general, demolition work is indicated on the Drawings. However, the Contractor shall visit the job site to determine the full extent and character of this work.

C. Unless specifically noted otherwise, removed materials shall not be reused in the work.
   1. Materials indicated to be salvaged shall be carefully removed, stored, and protected from damage.
   2. Salvaged materials intended to be re-used shall be thoroughly cleaned, refurbished if necessary, and determined to be fully functional prior to placing back into service.
   3. Salvaged materials of value that are not to be reused shall remain the property of the Owner unless such ownership is waived. Items that the Owner has waived ownership shall become the property of the Contractor, who shall remove and legally dispose of same, away from the premises.

D. Where equipment or fixtures are removed, outlet boxes that remain recessed in walls shall be properly blanked off, and conduits capped. After alterations are complete, the entire installation shall present a "finished" look, as approved by the Architect/Engineer. The original function of the present electrical systems remaining in service shall not be changed unless specifically

indicated as part of the project scope.

E. Reroute signal wires, lighting, and power wiring as required to maintain services that are to remain and/or unaffected by the renovations. Where walls and ceilings are to be removed as shown on the Drawings, the conduit is to be cut off by the Electrical Trades so that the abandoned conduit in these walls and ceilings may be removed with the walls and ceilings by the Architectural Trades. All dead-end conduit runs shall be plugged at the remaining line outlet boxes or the panels.

F. Where new walls and/or floors are installed which interfere with existing outlets, devices, etc., the Electrical Trades shall adjust, extend and reconnect such items as required to maintain continuity of same.

G. All electrical work in altered and unaltered areas shall be run concealed wherever possible. Use of surface raceway or exposed conduits will be permitted only where specifically indicated on the drawings or approved by the Architect/Engineer.

H. Existing lighting shall be reused where indicated on plans. Reused fixtures shall be detergent cleaned, re-lamped, and reconditioned suitable for satisfactory operation and appearance.

3.3 INSTALLATION OF EQUIPMENT

A. Install all equipment in strict accordance with all directions and recommendations furnished by the manufacturer. Where such directions conflict with the Drawings and Specifications, report such conflicts to the Architect/Engineer for resolution.

B. Device Location:
   1. Allow for wiring devices, control devices, and fire alarm devices to be relocated within a 10’ radius to accommodate final coordination with furnishings and other finish elements. Devices relocated prior to installation shall be done without additional cost to the project.

3.4 WORK IN EXISTING BUILDINGS

A. The Owner will provide access to existing buildings as required. Access requirements to occupied buildings shall be identified on the project schedule. The Contractor, once Work is started in the existing building, shall complete same without interruption to return work areas as soon as possible to Owner.

B. Adequately protect and preserve all existing and newly installed Work. Promptly repair any damage to same at Contractor's expense.

C. Consult with the Owner’s Representative as to the methods of carrying on the Work so as not to interfere with the Owner's operation any more than necessary. Accordingly, all service lines shall be kept in operation as long as possible and the services shall only be interrupted at such time as will be designated by the Owner's Representative.

3.5 TEMPORARY SERVICES

A. Provide and remove upon completion of the project, following the general conditions and as described in Division 01, a complete temporary electrical and telephone service during construction.

3.6 DISPOSAL

A. Fluorescent Lamps
   1. Fluorescent lamps are known to contain mercury and are classified as hazardous material. All fluorescent lamps shall be assumed to contain mercury unless tested and confirmed otherwise with a toxicity characteristic leaching procedure (TCLP).
   2. Hazardous materials (fluorescent lamps), shall be sent to a lamp recycling facility. The materials shall be properly packaged with labels that meet the Department of Transportation Regulations and stored in a secure location before transportation.
   3. The Contractor shall identify the costs of the lamp disposal process including, but not limited to, the lamp packaging, storage, transportation, disposal, and any profile fees.
   4. Upon completion of the project, provide documentation to verify that the lamps have been properly disposed of in accordance with all local, state, and federal guidelines.

B. Ballasts
   1. Lighting ballasts manufactured prior to 1979 have been known to contain polychlorinated biphenyls (PCBs). Unless specifically noted on the ballast as containing "No PCBs," the ballast shall be assumed to contain components with PCB materials.
   2. Hazardous materials (ballasts with PCBs), shall be disposed of at a hazardous waste incineration facility, or at a recycling facility in accordance with the Code of Federal Regulations as administered by the EPA in regards to this issue. The ballasts shall be packaged/stored in fifty-five gallon steel drums with labels that meet the Department of Transportation Regulations.
   3. The Contractor shall identify the costs of the ballast disposal process including, but not limited to, the packaging, storage, transportation, disposal, and any profile fees.
   4. Provide at completion of the project documentation (manifests) to verify that the ballasts have properly been disposed of in accordance with all local, state, and federal guidelines.

3.7 CHASES AND RECESSES

A. Provided by the architectural trades, but the Contractor shall be responsible for their accurate location and size.

3.8 CUTTING, PATCHING AND DAMAGE TO OTHER WORK

A. Refer to General Conditions for requirements.

B. All cutting, patching, and repair work shall be performed by the Contractor through approved, qualified subcontractors. Contractor shall include full cost of same in bid.

3.9 EXCAVATION AND BACKFILLING

A. Provide all excavation, trenching, tunneling, dewatering, and backfilling required for the electrical work. Coordinate the work with other excavating and backfilling in the same area.

B. Where conduit is installed less than 2'6" below the surface of pavement, provide concrete encasement, 4" minimum coverage, all around or as shown on the electrical Drawings.

C. Backfill all excavations with well-tamped granular material. Backfill all excavations under wall footings with lean mix concrete up to underside of footings and extend concrete within excavation a minimum of four (4) feet each side of footing. Granular backfill shall be placed in layers not more than 8 inches in thickness, 95 percent compaction throughout with approved compaction

equipment. Tamp, roll as required. Excavated material shall not be used.

D. Backfill all excavations inside building, under drives, and parking areas with well-tamped granular material. Granular backfill shall be placed in layers not more than 8 inches in thickness, 95 percent compaction throughout with approved compaction equipment. Tamp, roll as required. Excavated material shall not be used.

E. Backfill outside building with granular material to a height 12 inches over top of pipe compacted to 95 percent compaction as specified above. Backfill remainder of excavation with unfrozen excavated material in such a way as to prevent settling.

3.10 EQUIPMENT CONNECTIONS

A. Make connections to equipment and other items included in the work in accordance with the approved shop Drawings and rough-in measurements furnished by the manufacturers of the particular equipment furnished. All additional connections not shown on the Drawings, but called out by the equipment manufacturer's shop Drawings shall be provided.

3.11 CLEANING

A. All debris shall be removed daily as required to maintain the work area in a neat, orderly condition.

B. Final cleanup shall include, but not be limited to, washing of fixture lenses or louvers, switchboards, substations, motor control centers, panels, etc. Fixture reflectors and lenses or louvers shall be left with no water marks or cleaning streaks.

3.12 PROTECTION AND HANDLING OF EQUIPMENT AND MATERIALS

A. Equipment and materials shall be protected from theft, injury, or damage.

B. Protect conduit openings with temporary plugs or caps.

C. Provide adequate storage for all equipment and materials delivered to the job site. Location of the space will be designated by the Owner's representative or Architect/Engineer. Equipment set in place in unprotected areas must be provided with temporary protection.

3.13 EXTRA WORK

A. For additional electrical work which may be proposed or requested, furnish an itemized cost breakdown of material and labor required to complete the work. Proceed only after receiving a written authorization.

B. Before providing an itemized break-down for additional electrical work, submit unit prices for the following items: 1/2", 3/4", 1", 1-1/2" EMT conduit; #12, #10, #8, #6, #2 building wire; duplex receptacles, GFCI receptacles, data box and raceway, V4000 wiremold, and fittings, fire alarm audible/visual notification appliance and visual notification appliance, and other common electrical work which may be anticipated for any future revisions. These unit costs, once agreed to, shall be applied to additions and deducts for all project change orders.

3.14 DRAWINGS AND MEASUREMENTS

A. The Drawings are not intended to be scaled for rough-in measurements nor to serve as Shop Drawings. Field measurements necessary for ordering materials and fitting the installation to the building construction and arrangement are the Contractor's responsibility. The Contractor shall check latest Architectural Drawings and locate light switches from same where door swings are different from Electrical Drawings.

END OF SECTION 26 00 10

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SECTION 26 05 19
CONDUCTORS AND CABLES

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes:
   1. Building wires and cables rated 600V and less.
   2. Connectors, splices, and terminations rated 600 V and less.

1.3 SUBMITTALS

A. Field Quality-Control Test Reports

B. Submit letter of compliance (intent) for general building wire and cable. Provide product data for the following:
   1. Metal-Clad Cable, Type MC
   2. Mineral Insulated Cable, Type MI
   3. Power Cable for Variable Frequency Controlled Motors

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. Standards:
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

C. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

D. Conductor Insulation:
1. Type THHN/THWN-2: Comply with UL 83.
2. Type THW/THW-2: Comply with NEMA WC-70/ICEA S-95-658 and UL 83.
3. Type XHHW-2: Comply with UL 44.

2.2 METAL-CLAD CABLE, TYPE MC

A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.

B. Manufacturers:
1. AFC Cable Systems
2. Alpha Wire Company
3. American Bare Conductor
4. Belden
5. Encore
6. General Cable
7. Okonite
8. Service Wire Co.
9. Southwire Company

C. Standards:
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. Comply with UL 1569.
3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Circuits:
1. Single circuit and multi-circuit with color-coded conductors for branch circuit distribution.
2. Power-Limited Fire-Alarm Circuits: Comply with UL 1424.

E. Conductors:
1. Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

F. Conductor Insulation:
1. Type TFN/THHN/THWN-2: Comply with UL 83.
2. Type XHHW-2: Comply with UL 44.

G. Armor: Steel, interlocked.

H. Jacket: PVC applied over armor.

2.3 2-HOUR FIRE RATED MINERAL INSULATED CABLE, TYPE MI

A. Description: Solid copper conductors encased in compressed metal oxide with an outer metallic sheath, rated 600 V.

B. Manufacturers:
1. KME America
2. Pentair
3. Watlow Electric Manufacturing

C. Standards:
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. UL 2196 for fire resistance.
3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Circuits:
1. Single circuit.

E. Conductors: Copper, complying with ASTM B 3 for bare annealed copper.

F. Insulation: Compressed magnesium oxide.

G. Sheath: Copper.

2.4 2-HOUR FIRE RATED MC POWER CABLE

A. Description: MC Power cable listed by UL as a 2 hour Fire Rated when installed in accordance with installation procedures complying with the product listing.

B. Manufacturers:
1. OMNI Cable – Vita Link
2. Prysmian GroupDraka – Lifeline MC.

C. Standards:
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for

intended location and use.
2. UL 1569
3. UL 2196 for fire resistance.
4. Electrical Circuit Integrity Systems (FHIT) – System No. 120 or System No. 50, of the UL Fire Resistance Directory
5. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide," and NFPA 70, Article 728.120 and Article 310.120.

D. Conductors: Annealed Copper, Class B strand complying with ASTM B-3 and B-8.

E. Insulation: Thermoset, low smoke zero halogen silicone rubber.

F. Armor: Continuously welded and corrugated copper exceeding the NEC requirement for equipment grounding conductor

G. Outer Jacket (if required): Black low smoke zero halogen polyolefin.

2.5 POWER CABLE FOR VARIABLE FREQUENCY CONTROLLED MOTORS

A. Description: A factory assembly of three conductor cable with three symmetrical ground conductors, a continuous shield, an overall PVC jacket and a product specific connector and termination kit.

B. Manufacturers:
1. Service Wire Co.

C. Standards:
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. Comply with UL 1277
3. Comply with ICEA S-95-658/NEMA WC 70 for Type TC-ER Power Cable (for VFD application)
4. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Circuits:
1. Single circuit feeder.

E. Phase Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

F. Ground Conductor: Bare copper.

G. Phase Conductor Insulation: Moisture resistant, flame retardant, cross linked polyethylene (2KV RHW-2) suitable for 90 deg C conductor temperature operation inf dry, damp and wet locations

H. Shield: Helically applied minimum 5 mils thick bare copper with minimum 50% overlap.

I. Armor: Steel, interlocked.

J. Jacket: Oil resistant PVC

K. Connector: Water-tight and UL listed for installation on supplied TC cable (tray cable) assembly.
   1. Body material: nickel clad aluminum
   2. Connector shall provide a 360-degree electrical bonding of the copper tape shield to the connector body.
   3. Connection of the copper tape shield to the connector body shall be accomplished by an integral and self-retaining grounding collar that automatically provides a 360-degree connection as the connector is tightened.
   4. The connector assembly shall be designed to ensure against loosening of threads due to vibration.
   5. A UL listed chrome plated grounding and bonding locknut with a 360-degree knurled teeth connection shall be provided with each connector to secure and bond the connector to the inverter cabinet / motor termination box.
   6. Tinned copper braids (minimum ¾ inches wide) with installation hardware to connect the copper tape shield to the inverter enclosure / back-panel and to the motor frame shall be provided as part of the cable system.

L. Termination Kit: Tinned copper braids (minimum ¾ inches wide) with installation hardware to connect the copper tape shield to cable core, to the inverter enclosure/back-panel, and to the motor frame shall be provided as part of the cable system.
   1. Braid width shall be determined by cable core diameter size and shall be placed at a separation of 180 degrees.

2.6 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Refer to application schedule on the drawings

B. Feeders and Branch Circuits: Solid or stranded for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.

C. Each feeder shall be of the same conductor and insulation material (phase, neutral, and parallel).

D. Use conductor not smaller than 14 AWG for control circuits,

E. Where equipment is listed for use with copper conductors only, use copper conductors for the entire length of feeder.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Refer to application schedule on the drawings

B. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel wire-mesh strain relief device at terminations to suit application.

C. Fire Alarm Circuits: Type THHN/THWN-2, in raceway.

D. Class 1 Control Circuits: Type THHN/THWN-2, in raceway.

E. Class 2 Control Circuits: Type THHN/THWN-2, in raceway.

F. Connection between Variable Frequency Controllers and Motors: Use power cable for variable frequency- controlled motors. Install and terminate according to cable manufacturer's recommendations.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Complete raceway installation between conductor and cable termination points according to Section 26 05 33 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

G. Complete cable tray systems installation according to Section 26 05 36 "Cable Trays for Electrical Systems" prior to installing conductors and cables.

H. Support communication cables above accessible ceiling, using spring metal clips or plastic cable ties to support cables from structure. Do not rest cable on ceiling panels.

I. Neatly train and lace wiring inside boxes, equipment, and panelboards.

J. Provide a separate neutral conductor for each circuit unless multi-wire branch circuits are specifically indicated on the drawings.

K. Electrical Contractor shall be responsible for de-rating of conductors as required by N.E.C. when more than three current carrying conductors are installed in a single raceway or cable. Neutral conductors shall be considered current carrying conductors.

L. Type MC cable shall be supported and secured at intervals not exceeding 4'-0" in new construction

M. AC/MC cable shall not be used for home runs to receptacle or distribution panels.

N. Where AC/MC cable is permitted by the specifications, AC/MC cable shall not be bundled.

O. Between support, hangers and termination no more than 3" deflection from the bottom of the cable to a horizontal line between the support/hanger or termination.

P. Do not route conductors across roof without prior approval from engineer.

Q. Install and terminate power cable for variable frequency- controlled motors according to cable manufacturer's recommendations.

R. Install fire resistive cable assemblies (Type MI cable and/or fire rated MC cable) in accordance with the manufacturer's instructions and the product UL listing.
   1. Do not paint fire resistive cable assemblies.

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than un-spliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

D. Clean conductor surfaces before installing lugs and connectors.

E. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.

F. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and larger.

G. Use piercing connector with insulating covers for conductor splices and taps, 8 AWG and larger only for taps to existing feeders. Do not use piercing connectors in new construction.

H. Use Sta-Kon connectors to terminate stranded conductors #10 AWG and smaller to screw terminals.

I. Use insulated spring wire connectors with plastic caps (wire nuts) for copper conductor splices and taps, 10 AWG and smaller. Push-in style connectors are not permitted.

J. Provide lugs suitable for bussing and conductor material used.

3.5 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 26 05 53 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 05 33 "Raceways and Boxes."

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section "Penetration Firestopping".

3.8 FIELD QUALITY CONTROL

A. Perform the following field quality control tests in accordance with Division 26 section "Electrical Testing"
   1. Description: Test all feeders rated 100 A and above.
   2. Visual and Mechanical Inspection
      a. Inspect cables for physical damage and proper connection in accordance with the one line diagram.
      b. Test cable mechanical connections with an infrared survey.
      c. Check cable color-coding against project Specifications and N.E.C. requirements.
   3. Electrical Tests
      a. Perform insulation resistance test on each conductor with respect to ground and adjacent conductors. Applied potential to be 1000 volts dc for 1 minute.
      b. Perform continuity test to insure proper cable connection.
   4. Test Values
      a. Minimum insulation resistance values shall be not less than fifty mega-ohms.

B. Test Reports: Prepare a written report to record the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

END OF SECTION 26 05 19

SECTION 26 05 26
GROUNDING AND BONDING

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

B. Related Sections include the following:
1. Division 26 Section “Electrical General Requirements”.
2. Division 26 Section “Conductors and Cables”.

1.3 REFERENCES

A. ASTM B 3: Specification for Soft or Annealed Copper Wire.

B. ASTM B 8: Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft.

C. ASTM B 33: Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes.

D. ASTM B 187: Specification for Copper, Bus Bar, Rod, and Shapes and General Purpose Rod,

Bar, and Shapes.

E. IEEE 81: Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.

F. IEEE 142: Grounding of Industrial and Commercial Power Systems.

G. IEEE C2: National Electrical Safety Code.

H. NETA MTS – 2001: Maintenance Testing Specifications.

I. NFPA 70: National Electrical Code.

J. NFPA 70B: Recommended Practice for Electrical Equipment Maintenance.

K. TIA/EIA 607: Commercial Building Grounding and Bonding Requirements Standard.

L. UL 467: Grounding and Bonding Equipment.

M. UL 486 A: Wire Connectors and Soldering Lugs for Use with Copper Conductors.

1.4 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 26 “Electrical General Requirements”.

B. Accurately record actual locations of grounding electrodes and connections to building steel.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Refer to specification section “Electrical Testing.”

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
   1. Comply with UL 467.

C. Comply with NFPA 70; for overhead-line construction and medium-voltage underground construction, comply with IEEE C2.

D. Comply with ANSI/TIA/EIA-607 “Standard for Commercial Building Grounding and Bonding Requirements for Telecommunications”.

E. Comply with ANSI/IEEE 1100 -1992 “Powering and Grounding Sensitive Electronic Equipment”.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Grounding Conductors and Cables:

a. Refer to Division 26 Section “Conductors and Cables”.

2. Grounding Rods:
   a. American Electric-Blackburn.
   b. Apache Grounding/Erico Inc.
   c. Chance/Hubbell.
3. Mechanical Connectors:
   a. American Electric-Blackburn.
   b. Burndy.
   c. Chance/Hubbell.
4. Exothermic Connections:
   a. Cadweld.
5. Compression-type Connectors:
   a. Burndy HyGround
   b. Blackburn EZ Ground.
   c. Panduit.

2.2 GROUNDING CONDUCTORS

A. For insulated conductors, comply with Division 26 Section "Conductors and Cables."

B. Equipment Grounding Conductors: Insulated with green-colored insulation.

C. Grounding Electrode Conductors: Stranded cable.

D. Underground Conductors: Bare, stranded, copper unless otherwise indicated.

E. Bare Copper Conductors: Comply with the following:
   1. Solid Conductors: ASTM B 3.
   2. Assembly of Stranded Conductors: ASTM B 8.
   3. Tinned Conductors: ASTM B 33.

F. Copper Bonding Conductors: As follows:
   1. Bonding Conductor: Stranded copper conductor; size per the NEC.
   2. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; size per the NEC.
   3. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; size per the NEC.

G. Electrical Grounding Busbar
   1. 24” (min) x 2” x ¼” tin plated, copper busbar with two rows of ¼” x 20 tapped holes 1” on center.

H. Telecommunications Main Grounding Busbar (TMGB)
   1. 48” (min) x 4” x ¼” tin plated, copper busbar with three rows of ¼ x 20 tapped holes 1” on center.

I. Telecommunications Grounding Busbar (TGB)
   1. 12” (min) x 2” x ¼” tin plated, copper busbar with two rows of ¼ x 20 tapped holes 3” on center.

J. Telecommunications Bonding Backbone (TBB)
   1. Minimum No. 2 AWG insulated stranded copper.

K. Telecommunications Bonding Conductors
   1. Minimum No. 6 AWG insulated stranded copper.

2.3 CONNECTOR PRODUCTS

A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.

B. Bolted Connectors: Bolted-pressure-type connectors, or compression type.

C. Welded Connectors: Exothermic-welded type, in kit form, and selected for the specific application per manufacturer's written instructions.

D. Compression-Type Connectors: Pure, wrought copper, per ASTM B187.

2.4 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel.
   1. Size: 5/8 in diameter.
   2. Length: 120 inches.

PART 3 - EXECUTION

3.1 EQUIPMENT GROUNDING

A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.

B. Underground Grounding Conductors: No. 2/0 AWG minimum. Bury at least 24 inches below grade or bury 12 inches above duct bank when installed as part of the duct bank.

C. In raceways, use insulated equipment grounding conductors. Install equipment grounding conductors in all feeders and circuits. Terminate each end on suitable lugs, bus or bushing.
   1. Where existing branch circuits are using conduit as equipment grounding conductor and are extended, provide grounding bushing on existing conduit and provide new equipment grounding conductor with new branch circuit.

D. Install equipment grounding conductors in all feeders and circuits. Terminate each end on suitable lugs, bus or bushing.

E. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.

F. Air-Duct Equipment Circuits: Install an equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners and heaters. Bond conductor to each unit and to air duct.

G. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate equipment grounding conductor to each electric water heater, heat-tracing, and antifrost heating cable. Bond conductor to heater units, piping, connected equipment, and components.

H. Metal Poles Supporting Outdoor Lighting Fixtures: Provide a separate equipment grounding conductor with supply branch-circuit conductors. Bond pole and foundation reinforcing steel to equipment ground conductor.

I. Verify specific equipment grounding requirements with the manufacturer's recommendations.

3.2 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
   1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
   2. Make connections with clean, bare metal at points of contact.
   3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
   4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
   5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells. Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Equipment Grounding Conductor Terminations
   1. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and larger.
   2. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

D. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

E. Connections at Test Wells: Use compression-type connectors on conductors and make bolted- and clamped-type connections between conductors and ground rods.

F. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

G. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Connections shall be non-reversible. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

H. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and

cable.

3.3 INSTALLATION

A. Equipotential Ground: Interconnect grounding electrodes to form one, electrically continuous, equipotential grounding electrode system Grounding electrodes to be interconnected include:
   1. Ground rods.
   2. Existing counterpoise ground if available.
   3. Metal water service pipe.

B. Ground Rods: Install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes.
   1. Verify that final backfill and compaction has been complete before driving ground rods.
   2. Drive ground rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.
   3. Interconnect ground rods with grounding electrode conductors. Use exothermic welds or non-reversing compression-type connectors, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.

C. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage. Install in conduit where routed above grade.
   1. Aluminum and copper-clad aluminum conductors shall not be used in direct contact with masonry, within 18 inches of the earth, or where subject to corrosive conditions.

D. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors or non-reversing compression-type connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

E. Metal Water Service Pipes in direct contact with the earth for 10 feet: Provide insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to all metal water service entrances to building including fire protection water service entrance. Connect grounding conductors to metal water service pipes by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

F. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.

G. Bond each aboveground portion of gas piping system upstream from equipment shutoff valve.

H. Separately Derived AC Power Systems: Ground separately-derived ac power system neutrals including distribution transformers to grounding electrodes per NFPA 70.

I. Packaged Engine Generator: Solidly ground the packaged engine generator neutral to the normal power source neutral. Do not ground the generator neutral to a separate grounding electrode.

J. Grounding Bus:
   1. Install grounding bus in the locations listed below where currently missing and elsewhere

as indicated:
a. Electrical equipment rooms.
b. Telephone equipment rooms.
c. Rooms housing service equipment.

2. Use insulated spacer; space 2 inch from wall and support from wall 12 inches above finished floor, unless otherwise indicated.

K. Equipment Grounding: Provide a permanent and continuous bonding of conductor enclosures, equipment frames, power distribution equipment ground busses, cable trays, metallic raceways, and other non-current carrying metallic parts of the electrical system.

L. Bond together metal building elements not attached to grounded structure; bond to ground.

3.4 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING

A. Pad-Mounted Transformers and Switches: Install two ground rods and counterpoise circling pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with transformers/substations by connecting them to underground cable and grounding electrodes. Use not less than a No. 2 AWG conductor for counterpoise and for taps to equipment ground pad. Bury counterpoise not less than 18 inches below grade and 6 inches from the foundation.

3.5 TELECOMMUNICATIONS GROUNDING

A. Telecommunications Grounding System: The telecommunications grounding system shall consist of:
1. Telecommunications Main Grounding Busbar (TMGB) located in the main telecommunications room near the telecommunications service entrance. Bond to the main building electrical grounding electrode system via a No. 3/0 AWG copper ground conductor.
2. A Telecommunications Grounding Busbar (TGB) in each telecommunications room, cabinets, etc.
3. A Telecommunications Bonding Backbone (TBB) tying together the TMGB and each TGB.
4. Bonding of all equipment racks, raceways, non-current carrying metallic equipment and surge protection devices within the telecommunications room to the TGB's or TMGB using approved bonding conductors. Each piece of equipment shall be bonded individually directly to the ground bus.

B. All bonding connections shall be installed at an accessible location for inspection and maintenance.

C. All telecommunications bonding connections shall be of an approved mechanical type connection. Do not use exothermic welds unless specifically indicated on the Drawings.

D. The physical routing shall, in general, follow the same path as the backbone cable system.

E. Bond each TGB directly to the building steel with a No. 6 AWG conductor.

F. Do not use TGB's as a power system ground connection unless specifically noted on the Drawings.

G. All bonding connectors and conductors shall be UL listed for the purpose intended.

H. TMGB and TGB installation: Use insulated spacer; space 2 inch from wall and support from wall 12 inches above finished floor, unless otherwise indicated.

I. Individually bond each piece of non-current carrying metallic equipment in the Telecommunications Room to the TGB.

J. Install continuous cable from the TMGB to the furthest TGB. Bond all TGB's to TBB with bare No. 3/0 AWG copper ground conductor and T-tap grounding hardware.

3.6 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality control tests in accordance with Division 26 section "Electrical Testing"
   1. Inspect grounding and bonding system conductors and connections for tightness and proper installation and for compliance with the Drawings and Specifications.
   2. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.
      a. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal.
      b. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
      c. Perform tests, by the fall-of-potential method according to IEEE 81. Instrumentation utilized shall be as defined in Section 12 of IEEE 81 and shall be specifically designed for ground impedance testing. Provide sufficient spacing so that curves flatten in the 62% area of the distance between the item under test and the current electrode.
   3. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
      a. Equipment Rated 500 kVA and Less: 10 ohms.
      b. The telecommunications grounding system shall have a maximum resistance of 1 ohm as measured from the TMGB ground to earth ground.
   4. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

3.7 GRADING AND PLANTING

A. Restore surface features, including vegetation, at areas disturbed by Work of this Section. Reestablish original grades, unless otherwise indicated. If sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include application of topsoil, fertilizer, lime, seed, sod, sprig, and mulch. Comply with Division 2 Section "Landscaping." Maintain restored surfaces. Restore disturbed paving as indicated.

END OF SECTION 26 05 26

SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Hangers and supports for electrical equipment and systems.
   2. Construction requirements for concrete bases.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Allied Tube & Conduit; a part of Atkore International..
      b. B-Line, by Eaton..
      c. GS Metals Corp.
      d. Pentair Electrical & Fastening Solutions.
      e. Thomas & Betts Corporation.
      f. Unistrut; a part of Atkore International.
      g. Wesanco, Inc.
   2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
   3. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
   4. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded

body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
   1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) B-Line by Eaton.
         2) Empire Tool and Manufacturing Co., Inc.
         3) Hilti Inc.
         4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
         5) MKT Fastening, LLC.
   2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
   3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
   4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
   5. Toggle Bolts: All-steel springhead type.
   6. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

2.3 ROOF MOUNTED CONDUIT AND EQUIPMENT SUPPORTS

A. General: Shop- or field- fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted conduit and equipment.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. B-Line by Eaton; Dura-Blok.
   2. MIRO Industries.
   3. Pentair Electrical & Fastening Solutions; Caddy Pyramid.
   4. Pipe Pier Support Systems; Pipe Piers.

C. Adjustable Compact Stand: Recycled rubber base unit with integral threaded coupling capable of accepting 3/8-16 threaded rod, or 1-5/8 inch by 1-5/8 inch metal strut and various supporting elements.

D. Multiple-Conduit and Equipment Stand: Assembly of bases, vertical and horizontal members,

and conduit supports, for roof installation without membrane penetration.
1. Bases: One or more adjustable compact stand bases.
2. Vertical Members: Two or more protective-coated-steel channels.
3. Horizontal Member: Protective-coated-steel channel.
4. Supports: Standard strut clamps, hangers, and accessories.

2.4 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels specified in Division 6 Section "Rough Carpentry." Plywood sheets shall be free of all voids. Plywood shall have a minimum of two coats of fire-resistant, non-conducting paint applied to all sides of all sheets. Provide flush hardware and supports to mount plywood to wall. The provided hardware shall have sufficient strength to carry all anticipated loads including, but not limited to cabling, cable management and equipment racks.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
1. Secure raceways and cables to these supports with:
    a. Two-bolt conduit clamps
    b. Single-bolt conduit clamps
    c. Single-bolt conduit clamps using spring friction action for retention in support channel.

D. Support single runs of MC cable using spring-steel clamps from suspended ceiling hangers, hanger wire or building structure at intervals not to exceed three feet. Do not support MC cable from ceiling grid.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. To Steel:
   a. Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
   b. Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69
   c. Spring-tension clamps.
6. To Light Steel: Sheet metal screws.
7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel support systems attached to substrate.

D. Slotted support systems applications:
   1. Indoor dry and damp Locations: Painted Steel
   2. Outdoors and interior wet locations: Galvanized Steel
   3. Corrosive Environments, including pool equipment rooms: Nonmetallic

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

F. Do not fasten supports to pipes, ducts, mechanical equipment, and conduit.

G. Obtain permission from Architect/Engineer before using powder-actuated anchors.

H. Obtain permission from Architect/Engineer before drilling or cutting structural members.

I. Fabricate supports from structural steel or steel channel. Rigidly weld members or use hexagon head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.

J. Install surface-mounted cabinets and panelboards with minimum of four anchors.

K. In wet and damp locations use steel channel supports to stand cabinets and panelboards one inch off wall.

L. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.

M. The Contractor shall replace all supports and channels that sag, twist, and/or show signs of not providing proper structural support, to the equipment, it is intended for, as determined by the Owner and Architect/Engineer. All costs associated with replacing supports and steel channels shall be incurred by the Contractor.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation

to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 INSTALLATION OF ROOF MOUNTED SUPPORTS

A. Install in accordance with manufacturer's instructions.

B. If gravel top roof, gravel must be removed around and under support.

C. Consult roofing manufacturer for roof membrane compression capacities. If required, a compatible sheet of roofing material (rubber pad) may be required under rooftop support to disperse concentrated loads and add further membrane protection.

D. Utilize properly sized clamps and accessories to suit conduit sizes.

E. Provide vertical steel channel members as required for elevated conduit supports where required for clearances, coordination with other roof mounted systems or derating.

3.5 CONCRETE BASES

A. Provide concrete bases for all floor mounted electrical equipment.

B. Provide concrete bases for all exterior, grade level electrical equipment, and where indicated.

C. Base/Pad Construction:
1. Construct per manufacturer's recommendations for particular equipment, including suggested piers and dowel rods.
2. Interior concrete bases shall have a minimum depth of 4" unless other indicated or recommended by the manufacturer.
3. Exterior concrete bases shall have a minimum depth of 8" unless other indicated or recommended by the manufacturer.
4. Construct concrete bases for primary and secondary power distribution equipment per requirements of the electrical utility, where submitted for its review.

D. Anchor equipment to base per both supports and equipment manufacturer's instructions.

E. Coordinate conduit openings and sleeve locations in base with requirements of equipment to be supported.

3.6 BACKBOARDS

A. A minimum of two walls (or as indicated on drawings) shall be covered with plywood backboards to a minimum 8'-6" above finished floor in all Telecommunication Rooms and similar spaces and as indicated on Drawings.

B. Securely fasten backboard to wall using appropriate hardware and mount at all four corners, minimum. Securely fasten backboard to wall-framing members (studs).

C. Provide adequate backboard space to allow a clean and workable arrangement for telephone and data connections.

3.7 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 26 05 29

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SECTION 26 05 33
RACEWAYS AND BOXES

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Related Sections include the following:
1. Division 26 Section "Wiring Devices" for devices installed in boxes and for floor-box service fittings, and for access floor boxes and service poles.
2. Division 26 “Hangers and Supports for Electrical Systems” for concrete bases.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. ENT: Electrical nonmetallic tubing.

C. FMC: Flexible metal conduit.

D. IMC: Intermediate metal conduit.

E. LFMC: Liquidtight flexible metal conduit.

F. LFNC: Liquidtight flexible nonmetallic conduit.

G. RNC: Rigid nonmetallic conduit.

H. PVC: Polyvinyl Chloride.

I. HDPE: High Density Polyethylene.

J. RTRC: Reinforced Thermosetting Resin Conduit

1.4 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate layout and installation of raceways, boxes, enclosures, cabinets, and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AFC Cable Systems, Inc.
   2. Alflex Inc.
   3. Allied Tube Triangle Century.
   4. Anamet Electrical, Inc.; Anaconda Metal Hose.
   5. International Metal Hose.

6. Electri-Flex Co
7. Grinnell Co./Tyco International; Allied Tube and Conduit Div.
8. LTV Steel Tubular Products Company – Manhattan/CDT/Cole-Flex.
9. Maverick.
10. O-Z Gedney; unit of General Signal.
11. Wheatland.

B. Rigid Steel Conduit: ANSI C80.1.

C. IMC: ANSI C80.6.

D. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch, minimum.

E. EMT: ANSI C80.3.

F. FMC: Zinc-coated steel.

G. LFMC: Flexible steel conduit with PVC jacket.

H. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
2. Fittings for EMT: Steel, set screw type.
3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch, with overlapping sleeves protecting threaded joints.

2.2 NONMETALLIC CONDUIT AND TUBING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. American International.
2. Anamet Electrical, Inc.; Anaconda Metal Hose.
3. Arnco Corp.
4. Cantex Inc.
5. Certainteed Corp.; Pipe and Plastics Group.
6. Condux International.
7. ElecSys, Inc.
8. Electri-Flex Co.
9. Integral.
10. Kor-Kap.
11. Lamson and Sessions: Carlon Electrical Products.
12. Manhattan/CDT/Cole-Flex.
13. RACO; Division of Hubbell, Inc.
14. Scepter.
15. Spiralduct, Inc./AFC Cable Systems, Inc.
16. Thomas & Betts Corporation.

B. ENT: NEMA TC 13.

C. RNC: NEMA TC 2, Schedule 40 and Schedule 80 PVC.

D. ENT and RNC Fittings: NEMA TC 3; match to conduit or tubing type and material.

E. LFNC: UL 1660.

F. HDPE: UL 651, ASTM D 3350, ASTM D 1248 Schedule 40.

G. RTRC: Comply with UL 2515A and NEMA TC 14.

2.3 METAL WIREWAYS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Hoffman.
2. Square D.

B. Material and Construction: Sheet metal sized and shaped as indicated, NEMA 1 or 3R as required for environment.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.

E. Wireway Covers: Screw-cover type.

F. Finish: Manufacturer's standard enamel finish.

2.4 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers. Finish with manufacturer's standard prime coating.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Airey-Thompson Sentinel Lighting: Wiremold Company (The).
   b. Thomas & Betts Corporation.
   c. Walker Systems, Inc.; Wiremold Company (The).
   d. Wiremold Company (The); Electrical Sales Division.
   e. Mono-Systems, Inc.

B. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.

2.5 BOXES, ENCLOSURES, AND CABINETS

A. Sheet Metal Outlet and Device Boxes: NEMA OS 1. Shall be used within walls or ceiling.

B. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover. Shall be used in all exposed, non-recessed, locations.

C. Floor Boxes: Cast metal, fully adjustable, rectangular.

D. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

E. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover. Shall be used in areas exposed to water.

F. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.
   1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

G. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.

2.6 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. Description: Comply with ANSI/SCTE 77.
   1. Color of Frame and Cover: Gray in concrete areas; Green in grassy areas.
   2. Configuration: Units shall be designed for flush burial and have integral closed bottom, unless otherwise indicated.
   3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
   4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
   5. Cover Legend: Molded lettering, "ELECTRIC", “COMMUNICATIONS” or as indicated for each system service.
   6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
   7. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or a combination of the two.
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Hubbell: Quazite
      b. Armorcast Products Company.
      c. Carson Industries LLC.
      d. CDR Systems Corporation.
      e. NewBasis.
      f. Christy Concrete Products.

2.7 SLEEVES FOR RACEWAYS

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Through-Penetration Firestop Systems."

2.8 SLEEVE SEALS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex Co.
4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.
1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
2. Pressure Plates: Plastic. Include two for each sealing element.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.9 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.10 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
1. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
2. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Provide raceways in interior and exterior locations in accordance with the “Raceway Application Matrix” included on the drawings.

B. Boxes and Enclosures, Exterior Aboveground: NEMA 250, Type 3R.

C. Boxes, Enclosures, and Handholes:
   1. Handholes and Pull Boxes in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Non-deliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 15 structural load rating.
   2. Handholes and Pull Boxes in Sidewalk and Similar Applications with a Safety Factor for Non-deliberate Loading by Vehicles: Polymer-concrete units, SCTE 77, Tier 8 structural load rating.

D. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, nonmetallic in damp or wet locations.

E. Minimum Raceway Size: 3/4-inch trade size.

F. Raceway Fittings: Compatible with raceways and suitable for use and location.
   1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
   2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.
   3. EMT: Use compression or set-screw, cast-metal fittings. Comply with NEMA FB 2.10.
   4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

G. Do not install aluminum conduits in contact with concrete.

H. Install surface raceways only where indicated on Drawings.

I. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

E. Install temporary closures to prevent foreign matter from entering raceways.

F. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.

G. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.

H. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.

I. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
   1. Install concealed raceways with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.

J. Support conduit within 12 inches of enclosures to which attached.

K. Raceways Embedded in Slabs:
   1. Raceways embedded in slabs shall be limited to above grade concrete decks. Embedded conduit shall be limited to servicing floor boxes and equipment located in open spaces away from accessible walls.
   2. Install in middle 1/3 of slab thickness where practical and leave at least 2 inches of concrete cover.
   3. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
   4. Space raceways laterally to prevent voids in concrete.
   5. Run conduit larger than 1-inch trade size parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
   6. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
   7. Conduits shall run flat. Do not allow conduits to cross.
   8. Change from non-metallic raceway to rigid steel before turning up out of the concrete and rising above the floor.

L. Install exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible.
   1. Run parallel or banked raceways together on common supports.
   2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.

M. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

N. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

O. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

Q. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

R. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

S. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.

T. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.

U. Communications and Signal Cabling Systems Raceways: In addition to above requirements, install raceways in maximum lengths of 150 feet and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.
   1. Electrical condulet (LB's) are not permitted.
   2. Conduits shall have no more than two 90 degree bends between pull points or pull boxes.
   3. Conduits shall contain no continuous sections longer than 150 ft. without a pull point/box.
   4. Conduit for fiber cabling shall have a bend radius of at least 10 times the internal diameter.
   5. Conduit for copper cabling less than 2" shall have a bend radius of at least 6 times the internal diameter. Conduit for copper cabling 2" and larger shall have a bend radius of at least 10 times the internal diameter.
   6. All conduit ends shall have an insulated bushing.

V. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
   1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
   2. Where conduits route through, to, or from a hazardous classified space (Class I or II), provide proper seal offs when exiting or entering the hazardous classified space.
   3. Where conduits pass between spaces that are maintained at two different vapor pressures.
   4. Where otherwise required by NFPA 70.

W. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.

X. Expansion-Joint Fittings:
   1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
   2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
      a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
      b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
      c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
      d. Attics: 135 deg F temperature change.
   3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot

of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.

4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

Y. Flexible Conduit Connections: Comply with NEMA RV3. Use maximum of 72 inches of flexible conduit for recessed and semirecessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use LFMC in damp or wet locations. Install separate ground conductor across flexible connections.

Z. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying raceways to receptacle or fixture ground terminals. Provide cover clips to cover space between connecting pieces.

AA. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block and install box flush with surface of wall.

BB. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

CC. Locate boxes so that cover or plate will not span different building finishes.

DD. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

EE. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

FF. Set floor boxes level and flush with finished floor surface. Trim non-metallic boxes after installation to fit flush with finished floor surface.

GG. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

HH. Do not route feeders across roof unless approved in writing by Engineer.

II. Provide a pull box (a handhole for outdoor applications) for each conduit run that exceeds 250 feet. Provide two pull boxes (handholes for outdoor applications) for runs that exceed 500 feet.

JJ. Outlet boxes within hazardous locations shall be of the proper class and division as noted in the N.E.C.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:
1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 2 Section "Earthwork" for pipe less than 6 inches in nominal diameter.
2. Install backfill as specified in Division 2 Section "Earthwork."

3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 2 Section "Earthwork."
4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
    a. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches of concrete.
    b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
5. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits, placing them 24 inches o.c. Align planks along the width and along the centerline of conduit.

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

D. Install handholes and boxes with bottom below the frost line, 42” below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 SLEEVE INSTALLATION FOR ELECTRICAL AND COMMUNICATIONS PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Through-Penetration Firestop Systems."

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Rectangular Sleeve Minimum Metal Thickness:
    1. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16

inches, thickness shall be 0.052 inch.

2. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 0.138 inch.

E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

F. Cut sleeves to length for mounting flush with both surfaces of walls.

G. Extend sleeves installed in floors 2 inches above finished floor level.

H. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway unless sleeve seal is to be installed.

I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 7 Section "Joint Sealants" for materials and installation.

K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials. Comply with Division 7 Section "Through-Penetration Firestop Systems."

L. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.

M. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

N. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between raceway and sleeve for installing mechanical sleeve seals.

3.6 SLEEVE-SEAL INSTALLATION

A. Install to seal underground, exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Through-Penetration Firestop Systems."

3.8 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.9 CLEANING

A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

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SECTION 26 05 53
ELECTRICAL IDENTIFICATION

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
1. Identification for raceway and metal-clad cable.
2. Identification for conductors and communication and control cable.
3. Underground-line warning tape.
4. Warning labels and signs.
5. Equipment identification labels.
6. Miscellaneous identification products.

1.3 QUALITY ASSURANCE

A. Comply with ANSI A13.1 and ANSI C2.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.145.

1.4 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and

Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 RACEWAY AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Color for Printed Legend:
1. Power Circuits: Black letters on an orange field.
2. Legend: Indicate system or service and voltage, if applicable.

C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.2 CONDUCTOR, COMMUNICATION AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

2.3 UNDERGROUND-LINE WARNING TAPE

A. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.
1. Not less than 6 inches wide by 4 mils thick.
2. Compounded for permanent direct-burial service.
3. Embedded continuous metallic strip or core.
4. Printed legend shall indicate type of underground line.

2.4 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.

C. Warning label and sign shall include, but are not limited to, the following legends:
1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD -

EQUIPMENT HAS MULTIPLE POWER SOURCES."

2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.5 EQUIPMENT IDENTIFICATION LABELS

A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. Black letters on a white background. Minimum letter height shall be 3/8 inch.

B. Outdoor Equipment Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.6 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.
   1. Minimum Width: 3/16 inch.
   2. Tensile Strength: 50 lb, minimum.
   3. Temperature Range: Minus 40 to plus 185 deg F.
   4. Color: Black, except where used for color-coding.

B. Paint: Paint materials and application requirements are specified in Division 9 painting Sections.

C. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

2.7 WIRING DEVICE IDENTIFICATION

A. Description: Self-adhesive label with black upper case letters on clear polyester label, font size 7.

PART 3 - EXECUTION

3.1 APPLICATION

A. Accessible Raceways and Metal-Clad Cables More Than 600 V: Identify with "DANGER-HIGH VOLTAGE" in black letters at least 2 inches high, with self-adhesive vinyl labels. Repeat legend at 10-foot maximum intervals.

B. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service and Feeders More Than 400 A: Identify with orange self-adhesive vinyl label.

C. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded, self-adhesive vinyl tape applied in bands:
   1. Fire Alarm System: Red.
   2. Security System: Blue and yellow.
   3. Telecommunication System: Green and yellow.
   4. Control Wiring: Green and red.

D. Power-Circuit Conductor Identification: For conductors No. 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and handholes use color-coding conductor tape and marker tape. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.

E. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use marker tape. Identify each ungrounded conductor according to source and circuit number as indicated on Drawings. Identify control circuits by control wire number as indicated on shop drawings.

F. Branch-Circuit Conductor Identification: Mark junction box covers in indelible ink with the panel and breaker numbers of other circuits contained within.

G. Conductor Identification: Locate at each conductor at panelboard gutters, pull boxes, outlet and junction boxes, and each load connection or termination point.

H. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections.
   1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
   2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
   3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.

I. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable. Install underground-line warning tape for both direct-buried cables and cables in raceway.

J. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply self-adhesive warning labels. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.
   1. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:
      a. Power transfer switches.
      b. Controls with external control power connections.
   2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.

K. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
   1. Labeling Instructions:
      a. Indoor Equipment: Engraved, laminated acrylic or melamine label mechanically secured.
      b. Outdoor Equipment: Stenciled.
      c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
   2. Equipment to Be Labeled: If included on project. All items may not be on project.
      a. Panelboards, electrical cabinets, and enclosures.
      b. Access doors and panels for concealed electrical items.
      c. Electrical switchgear and switchboards.

d. Transformers.
e. Emergency system boxes and enclosures.
f. Disconnect switches.
g. Enclosed circuit breakers.
h. Motor starters.
i. Push-button stations.
j. Power transfer equipment.
k. Contactors.
l. Remote-controlled switches, dimmer modules, and control devices.
m. Power-generating units.
n. Fire-alarm control panel and annunciators.
o. Monitoring and control equipment.
p. Breakers or switches at distribution panels.

3.2 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location:
1. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
2. Conduit Markers: Provide identification for each power conduit containing conductors rated 400A or greater.

C. Apply identification devices to surfaces after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach nonadhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.

F. System Identification Color Banding for Raceways and Cables: Each color band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

G. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.
1. Color shall be factory applied or, for sizes larger than No. 10 AWG if authorities having jurisdiction permit, field applied.
2. Colors for 208/120-V Circuits:
   a. Phase A: Black.
   b. Phase B: Red.
   c. Phase C: Blue.
   d. Grounded Conductor (Neutral): White.
3. Colors for 480/277-V Circuits:
   a. Phase A: Brown.
   b. Phase B: Orange.
   c. Phase C: Yellow.
   d. Ground Conductor (Neutral): Grey.

4. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

H. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

I. Label information arrangement for 3 lines of text.
1. Line one shall describe the panel or equipment. Line one example: “DP-XX,” RP-XX,” “T-XX,” “EF-XX,” etc.
2. Line two shall describe the first disconnecting means feeding this panel or equipment. Line two example: “Fed from DP-XX,” “Fed from RP-XX,” etc.
3. Line three indicates that location of the disconnecting means as identified in line two. Line three example: “First Floor Elect. Rm #XXX.”
4. Line four shall include “Via T-XX” when panel or equipment is fed from a transformer.

J. Examples:

RP-1A FED FROM DP-1A ELECTRICAL ROOM A100 VIA T-1A	EF-1 FED FROM MCC-1A MECHANICAL ROOM F101	LP-1A LOCATED IN ELECTRICAL ROOM A100

K. Fusible Enclosed Switches and Distribution Equipment: Install self-adhesive vinyl label indicating fuse rating and type on the outside of door on each fused switch.

L. Painted Identification: Prepare surface and apply paint according to Division 9 painting Sections.

M. Degrease and clean surface to receive nameplates.

N. Install nameplate and labels parallel to equipment lines.

O. Secure nameplate to equipment front using screws.

P. Secure nameplate to inside surface of door on panelboard that is recessed in finished locations.

Q. Identify conduit using field painting where required.

R. Paint red colored band on each fire alarm conduit and junction box.

S. Paint bands 10 feet on center, and 4 inches minimum in width.

END OF SECTION 26 05 53

SECTION 26 05 73
OVERCURRENT DEVICE COORDINATION STUDY/ARC FLASH HAZARD ANALYSIS

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 SCOPE

A. The contractor shall furnish short-circuit and protective device coordination studies as prepared by the electrical equipment manufacturer.

B. The contractor shall furnish an Arc Flash Hazard Analysis Study per the requirements set forth in NFPA 70E -Standard for Electrical Safety in the Workplace. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2018, Annex D prepared by the electrical equipment manufacturer.

C. The scope of the studies shall include all new distribution equipment supplied by the equipment Manufacturer under this contract.

1.3 REFERENCES

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
1. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems
2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems

3. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis
4. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings
5. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.
6. IEEE 1584 -Guide for Performing Arc-Flash Hazard Calculations

B. American National Standards Institute (ANSI):
1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
2. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures
3. ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis
4. ANSI C 37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories.

C. The National Fire Protection Association (NFPA)
1. NFPA 70 -National Electrical Code, latest edition
2. NFPA 70E – Standard for Electrical Safety in the Workplace, latest edition.

1.4 ACTION SUBMITTALS

A. The short-circuit and protective device coordination studies shall be submitted to the design engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the engineer may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory.

1.5 INFORMATIONAL SUBMITTALS

A. The results of the short-circuit, protective device coordination, and arc flash hazard analysis studies shall be summarized in a final report. Report shall be provided on electronic media. All literature shall be combined in one document and shall be properly bookmarked with all applicable sections.

B. The report shall include the following sections:
1. Executive Summary.
2. Descriptions, purpose, basis and scope of the study.
3. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties.
4. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip unit settings, fuse selection.
5. Fault current calculations including a definition of terms and guide for interpretation of the computer printout.
6. Details of the incident energy and flash protection boundary calculations.
7. Recommendations for system improvements, where needed.
8. One-line diagram.

C. Arc flash labels shall be provided in full size representation in PDF format and submitted with the study.

D. The report shall be signed and sealed by the Professional Engineer supervising the study.

1.6 QUALIFICATIONS

A. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the supervision and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies.

B. The Registered Professional Electrical Engineer shall be a full-time employee of the equipment manufacturer.

C. The Registered Professional Electrical Engineer shall have a minimum of five (5) years of experience in performing power system studies and registered in the state where the project is located.

D. The equipment manufacturer shall demonstrate experience with Arc Flash Hazard Analysis by submitting names of at least ten actual arc flash hazard analysis it has performed in the past year.

1.7 COMPUTER SOFTWARE PROGRAMS

A. Computer Software Programs: Subject to compliance with requirements, provide products by one of the following:
   1. EDSA Micro Corporation.
   2. SKM Systems Analysis, Inc.
   3. ESA Inc.
   4. CGI CYME.
   5. Operation Technology, Inc.

PART 2 - PRODUCTS

2.1 STUDIES

A. Contractor to furnish short-circuit and protective device coordination studies as prepared by equipment manufacturer.

B. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E -Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D prepared by the equipment manufacturer.

2.2 DATA COLLECTION

A. Contractor shall furnish all data as required by the power system studies. The Engineer performing the short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.

B. Source combination may include present and future motors and generators.

C. Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner.

D. If applicable, include fault contribution of existing motors in the study. The Contractor shall

obtain required existing equipment data to satisfy the study requirements.

2.3 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY

A. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standard 141-1993.

B. Transformer design impedances shall be used when test impedances are not available.

C. Provide the following:
   1. Calculation methods and assumptions
   2. Selected base per unit quantities
   3. One-line diagram of the system being evaluated
   4. Source impedance data, including electric utility system and motor fault contribution characteristics
   5. Tabulations of calculated quantities
   6. Results, conclusions, and recommendations.

D. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:
   1. Electric utility's supply termination point
   2. Incoming switchgear
   3. Unit substation primary and secondary terminals
   4. Low voltage switchgear
   5. Motor control centers
   6. Standby generators and automatic transfer switches
   7. Branch circuit panelboards
   8. Other significant locations throughout the system.

E. For grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short-circuit study.

F. Protective Device Evaluation:
   1. Evaluate equipment and protective devices and compare to short circuit ratings.
   2. Adequacy of switchgear, motor control centers, and panelboard bus bars to withstand short-circuit stresses.
   3. Notify design engineer in writing, of existing, circuit protective devices improperly rated for the calculated available fault current.

2.4 PROTECTIVE DEVICE COORDINATION STUDY

A. Proposed protective device coordination time-current curves (TCC) shall be displayed on log-log scale graphs.

B. Include on each TCC graph, a complete title and one-line diagram with legend identifying the specific portion of the system covered.

C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.

D. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

E. Plot the following characteristics on the TCC graphs, where applicable:
   1. Electric utility's overcurrent protective device
   2. Medium voltage equipment overcurrent relays
   3. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands
   4. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands
   5. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves
   6. Conductor damage curves
   7. Ground fault protective devices, as applicable
   8. Pertinent motor starting characteristics and motor damage points, where applicable
   9. Pertinent generator short-circuit decrement curve and generator damage point
   10. The largest feeder circuit breaker in each motor control center and applicable panelboard.

F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

G. For emergency and standby distribution paths, provide selective coordination tables to demonstrate tested upstream/downstream breaker pairs selectively coordinate across the full range of over currents, from overload to the maximum available fault current, and for the full range of overcurrent protective device opening times associate with those fault currents.

2.5 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2018, Annex D.

B. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.

C. The Arc-Flash Hazard Analysis shall include all significant locations in 240 volt and 208 volt systems fed from transformers equal to or greater than 125 kVA where work could be performed on energized parts.

D. Safe working distances shall be based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm2.

E. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations

F. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation

of synchronous generators with the electric utility, where applicable.

G. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:
   1. Fault contribution from induction motors should not be considered beyond 3-5 cycles.
   2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g. contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).

H. For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.

I. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.

J. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.

K. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

2.6 REPORT SECTIONS

A. Input data shall include, but not be limited to the following:
   1. Feeder input data including feeder type (cable or bus), size, length, number per phase, conduit type (magnetic or non-magnetic) and conductor material (copper or aluminum).
   2. Transformer input data, including winding connections, secondary neutral-ground connection, primary and secondary voltage ratings, kVA rating, impedance, % taps and phase shift.
   3. Generation contribution data, (synchronous generators and Utility), including short-circuit reactance (X”d), rated MVA, rated voltage, three-phase and single line-ground contribution (for Utility sources) and X/R ratio.
   4. Motor contribution data (induction motors and synchronous motors), including short-circuit reactance, rated horsepower or kVA, rated voltage, and X/R ratio.

B. Short-Circuit Output Data shall include, but not be limited to the following reports:
   1. Low Voltage Fault Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
      a. Voltage
      b. Calculated fault current magnitude and angle
      c. Fault point X/R ratio
      d. Equivalent impedance
   2. Momentary Duty Report shall include a section for three-phase and unbalanced fault

calculations and shall show the following information for each applicable location:
a. Voltage
b. Calculated symmetrical fault current magnitude and angle
c. Fault point X/R ratio
d. Calculated asymmetrical fault currents
1) Based on fault point X/R ratio
2) Based on calculated symmetrical value multiplied by 1.6
3) Based on calculated symmetrical value multiplied by 2.7
e. Equivalent impedance

3. Interrupting Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
a. Voltage
b. Calculated symmetrical fault current magnitude and angle
c. Fault point X/R ratio
d. No AC Decrement (NACD) Ratio
e. Equivalent impedance
f. Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a symmetrical basis
g. Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a total basis

C. Recommended Protective Device Settings:
1. Phase and Ground Relays:
a. Current transformer ratio
b. Current setting
c. Time setting
d. Instantaneous setting
e. Recommendations on improved relaying systems, if applicable.
2. Circuit Breakers:
a. Adjustable pickups and time delays (long time, short time, ground)
b. Adjustable time-current characteristic
c. Adjustable instantaneous pickup
d. Recommendations on improved trip systems, if applicable.

D. Incident energy and flash protection boundary calculations
1. Arcing fault magnitude
2. Protective device clearing time
3. Duration of arc
4. Arc flash boundary
5. Working distance
6. Incident energy
7. Hazard Risk Category
8. Recommendations for arc flash energy reduction

PART 3 - EXECUTION

3.1 FIELD ADJUSTMENT

A. The contractor shall adjust relay and protective device settings according to the recommended settings table provided by the coordination study.

B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

C. Notify design engineer in writing of any required major equipment modifications.

3.2 ARC FLASH WARNING LABELS

A. The contractor shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.

B. All labels will be based on recommended overcurrent device settings and will be provided after the results of the analysis have been presented to the owner and after any system changes, upgrades or modifications have been incorporated in the system.

C. The label for equipment where arc incident energy is calculated shall include the following, at a minimum:
1. Location designation
2. Nominal system voltage
3. Arc flash boundary
4. Incident energy
5. Working distance
6. Engineering report number, revision number and issue date.

D. The label for equipment where arc incident energy is not calculated shall include the following, at a minimum:
1. Location designation
2. Nominal system voltage
3. Arc flash boundary from NFPA 70E 2018 Table 130.7(C) 15(a)
4. Arc flash PPE category from NFPA 70E 2018 Table 130.7(C) 15(a)
5. Engineering report number, revision number and issue date.

E. Labels shall be machine printed, with no field markings.

F. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.
1. For each 480 and 208 volt panelboard, one arc flash label shall be provided.
2. For each motor control center, one arc flash label shall be provided.
3. For each low voltage switchboard, one arc flash label shall be provided.
4. For each switchgear, one flash label shall be provided.
5. For medium voltage switches one arc flash label shall be provided

G. Labels shall be field installed by the contractor.

END OF SECTION 26 05 73

SECTION 26 09 23
LIGHTING CONTROL DEVICES

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following lighting control devices:
   1. Time controllers.
   2. Outdoor and indoor photoelectric control.
   3. Occupancy sensors.
   4. Outdoor motion sensors.
   5. Lighting contactors.
   6. Wall digital time switches.

B. Related Sections include the following:
   1. Division 26 Section “Electrical General Requirements”.
   2. Division 26 Section "Wiring Devices" for wall-box dimmers and manual light switches.

3. Division 26 Section "Lighting Control Systems" for programmable lighting systems.

1.3 REFERENCES

A. IEEE C62.41: Guide for Surge Voltages in Low-Voltage AC Power Circuits.

B. IEEE C136.10: Standard for Roadway Lighting Equipment Locking-Type Photocontrol Devices and Mating Receptacle Physical and Electrical Interchangeability and Testing.

C. NEMA ICS 2: Industrial Control and Systems Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC Part 8: Disconnect Devices for Use in Industrial Control Equipment.

D. NFPA 70: National Electrical Code.

E. UL 486A: Wire Connectors and Soldering Lugs for Use with Copper Conductors.

F. UL 773: Plug-in, Locking Photocontrols for Use with Area Lighting.

G. UL 773A: Nonindustrial Photoelectric Switches for Lighting Control.

H. UL 917: Clock Operated Switches.

I. UL 1449: Surge Protective Devices.

J. UL 1598: Luminaires.

K. NECA 130-2010: Installing and Maintaining Wiring Devices.

1.4 DEFINITIONS

A. LED: Light-emitting diode.

B. PIR: Passive infrared.

C. ULTRASONIC: Active emission of at least 35 kHz sound waves, using Doppler reflectance to detect motion.

D. MICROPHONIC: Passive reception to listen for continued occupancy, with circuitry to filter out white noise.

E. MULTI-Tech: Using PIR and ultrasonic or microphonic technologies in one sensor.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated including physical data and electrical performance.

B. Shop Drawings: Show installation details for occupancy and light-level sensors.
   1. Lighting plan showing location, orientation, and coverage area of each sensor.
   2. Interconnection diagrams showing field-installed wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. Include the following:
   1. Description of operation and servicing procedures.
   2. List of major components.
   3. Recommended spare parts.
   4. Programming instructions and system operation procedures.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.7 COORDINATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

B. Coordinate interface of lighting control devices with temperature controls specified in Division 23.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the site under provisions of Division 26 Section “Electrical General Requirements”.

B. Store and protect products under provisions of Division 26 Section “Electrical General Requirements”.

PART 2 - PRODUCTS

2.1 GENERAL LIGHTING CONTROL DEVICE REQUIREMENTS

A. Line-Voltage Surge Protection: An integral part of the devices for 120- and 277-V solid-state equipment. For devices without integral line-voltage surge protection, field-mounting surge protection shall comply with IEEE C62.41 and with UL 1449.

2.2 TIME CONTROLLERS

A. Manufacturers:
   1. Intermatic, Inc.
   2. TORK.

B. General
   1. Provide NEMA Type 1-general purpose steel enclosure with corrosion-resistant primer and baked enamel finish in manufacturer’s standard color.
   2. Provide enclosure suitable for surface mounting with hinged front; padlock hasp; and side, bottom, and back knockouts for conduit connections.
   3. Provide heavy-duty pressure terminals suitable for wire sizes up to no. 8 AWG.

C. Digital Time Controller: Electronic, solid-state programmable units with alphanumeric display

complying with UL 917.

1. Contact Configuration: SPDT.
2. Contact Rating Normally Open: (20-A inductive or resistive, 120-277-V ac, 20-A ballast load, 120-277 V ac.) (10-A inductive or resistive, 120-277-V ac, 10-A ballast load, 120 277 V ac.)
3. Contact Rating Normally Closed: 10-A inductive or resistive, 120-277-V ac, 10-A ballast load, 120-277 V ac.
4. Input Voltage:120 volts.
5. Programs: 2-channels.
    a. For each channel, 7 day or full year load control, minimum 1,000 on/off operations with one-minute programming resolution; minimum 99 holiday event scheduling; automatic adjustment for daylight savings (with disable); automatic leap year compensation; manual override ON and OFF to the next scheduled event; LCD display.
6. Circuitry: Allow connection of a photoelectric relay as substitute for on and off function of a program on selected channels.
7. Astronomical Time: Provide astronomic feature adjustable from 10° to 60° Northern and Southern latitudes with 1-99 minute adjustable offset from sunrise to sunset for Selected channels.
8. Battery Backup: Field replaceable lithium battery with minimum 8 year life for schedules and time clock.

2.3 OUTDOOR PHOTOELECTRIC CONTROL

A. Manufacturers:
1. Intermatic, Inc.
2. Square D.
3. TORK.

B. General
1. Provide fully-gasketed, weathertight enclosure constructed of die cast zinc, with one-half inch conduit nipple for mounting purposes, and with positioning lug to permit full 360-degree adjustable orientation of photocell.
2. Provide hermetically-sealed, one-inch-diameter, cadmium sulphide photoelectric cell with manual, light level selector.
3. Provide photoelectric control suitable for an operating temperature range of minus 40 degrees F to plus 140 degrees F.

C. Description: Solid state, with SPST dry contacts rated for 2000 W tungsten or 1800 VA ballasted load, to operate connected load, relay, contactor coils, or microprocessor input, and complying with UL 773A.
1. Light-Level Monitoring Range: Adjustable turn-on range of 1 to 5 footcandle and adjustable turn-off range of 3 to 15 footcandle, and a directional lens in front of photocell to prevent fixed light sources from causing turn-off.
2. Time Delay: Adjustable delay up to two minutes to prevent false operation.
3. Contacts: Normally closed, fail on.
4. Electrical: Provide photocell with operating voltage rated to switch the load directly unless otherwise indicated.
5. Surge Protection: Metal-oxide varistor type, complying with IEEE C62.41 for Category A1 locations.
6. Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or

stem-and-swivel mounting accessories as required to direct sensor to the North sky exposure.

7. Provide hermatically-sealed, one inch diameter, cadmium sulphide photoelectric cell with manual, 2 to 50 footcandle, light level selector.

2.4 INDOOR PHOTOELECTRIC CONTROL

A. Manufacturers:
   1. Wattstopper LS-101.
   2. Sensorswitch CM-PC.

B. Photoelectric Sensor: Solid-state, light-level sensor unit utilizing an internal photoconductive cell to detect changes in lighting levels and capable of controlling any lighting source.
   1. Housing: White, thermoplastic, tamper resistant, ceiling mount.
   2. Sensor shall operate on 24V DC power through a control unit which supplies DC power to the sensor and provides relay contacts to control the lighting load and auxiliary contacts.
   3. Light-Level Monitoring Range: 10 to 200 footcandle, with an adjustment for turn-on and turn-off levels within that range.
   4. Deadband: Adjustable range of 10 to 300%.
   5. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling, with deadband adjustment.
   6. Indicator: Two LEDs to indicate the beginning of on and off cycles.
   7. Manual override function.
   8. Provide indoor photoelectric switches and control units from single manufacturer.
   9. Provide indoor photoelectric switches from same manufacturer as occupancy sensors.
   10. Provide all control units and relays required to interface with occupancy sensors as required.

C. Indoor Photoelectric Sensor Control Units:
   1. Description: Transformer and relay combined in single unit to provide 24DC power to sensors and provide 20A contact(s) for control of lighting loads at 120 or 277V. Control unit input power shall be from unswitched leg of lighting circuit it is controlling.
      a. Control units shall be provided as required to power indoor photoelectric sensor, control lighting loads and provide a minimum of one auxiliary contact.
      b. Sensor control units shall mount external to 4” sq junction box in the ceiling space. Wiring between control unit and photoelectric switch shall be plenum rated.
      c. Locate control unit in accessible location in gyp-board ceilings, adjacent to return air grilles, or provide access panel.
      d. Additional auxiliary relay modules shall be provided as required to provide control of all lighting circuits and additional auxiliary contacts as required.
      e. It is acceptable to provide controls and auxiliary contacts as required integral to the sensor, provided all required contacts are provided.
      f. Maximum of 3 sensors per power pack. Verify exact quantities required with manufacturer.

2.5 OCCUPANCY SENSORS

A. General
   1. Coordinate occupancy sensor locations, coverages and required quantities with manufacturer’s recommendations. Coverage areas indicated on the Drawings are for minor motion (6 to 8 inches of hand movement). Provide additional occupancy sensors and

control units as required to achieve complete minor motion coverage of the space indicated.

2. Adjust occupancy sensors and test that complete minor motion coverage is obtained in accordance with Part 3. Provide written confirmation of testing to owner, architect and engineer.
3. Provide occupancy sensors with a bypass switch to override the "ON" function in the event of sensor failure.
4. Provide occupancy sensors with an LED indicator indicating when motion is being detected during testing and normal operation of the sensor.
5. Provide occupancy sensors and occupancy sensor control units from single manufacturer.

B. Wall Switch Passive Infrared Occupancy Sensor
   1. Manufacturers:
      a. Perfect Sense – PS-PWS
      b. Wattstopper PW-100.
      c. Hubbell Building Automation SOM 101.
      d. Greengate OSW-P-0451-W.
      e. Sensorswitch WSD.
      f. Philips LRS2210.
      g. Leviton ODS10-IDW.
   2. Description: Wall mounted, 180° coverage, passive infrared sensing occupancy sensor.
      a. Electrical Characteristics: Capable of switching up to 800W fluorescent or incandescent lighting loads at 120V and 1200 watts fluorescent loads at 277V.
      b. Functions: Automatic ON/Automatic OFF, or Manual ON/Automatic OFF operation, field selectable. Integral manual override pushbutton switch.
      c. Adjustments: User adjustable sensitivity and time delay. Time delay shall be adjustable from 30 seconds to 30 minutes. Ambient light sensing shall be adjustable from 20 footcandle to 300 footcandle, with override.
      d. Ambient Light Sensor: Integral ambient light sensor to switch off lights when sufficient daylight is present.
      e. Device Body: White plastic with momentary on/off override pushbutton designed to mount in a standard switch box with "decora" style switch plate.
   3. Dual Level Switching: Provide occupancy sensor capable of controlling two switch legs independently where dual level switching is indicated.
      a. Manufacturers:
         1) Perfect Sense PWD.
         2) Wattstopper PW-200.
         3) Hubbell Building Automation SOM-102.
         4) Greengate OSW-P-0451-DMV.
         5) Sensorswitch WSD-2P.
         6) Philips LRS2215.
         7) Leviton ODSOD-IDW.

C. 360° Ceiling Mounted Dual Technology Occupancy Sensor
   1. Manufacturers:
      a. Perfect Sense CDS.
      b. Wattstopper DT 300
      c. Hubbell Building Automation "OMNI-DT" Series.
      d. Greengate OMC-DT-2000-R.
      e. Sensorswitch CM-PDT-R.
      f. Philips LRM2255.
      g. Leviton OSC10-M0W.

2. Description: Ceiling mounted, 360° coverage, multi-tech sensing occupancy sensor.
    a. Housing: White, thermoplastic, tamper resistant ceiling mount.
    b. Functions: Automatic ON must sense motion from both ultrasonic and infrared sensing elements. Either technology shall maintain ON, with adjustable time delays.
    c. Adjustments: User adjustable sensitivity adjustment shall be provided for each sensing technology. Time delay shall be adjustable from 30 seconds to 30 minutes.
    d. Sensor shall operate on 24V DC power through control unit which supplies DC power to the sensor and provides relay contacts to control the lighting load and auxiliary contacts.
    e. Manual override function.

D. 110° Wall Mounted Dual Technology Occupancy Sensor
1. Manufacturers:
    a. Perfect Sense DTC.
    b. Wattstopper DT-200
    c. Hubbell Building Automation “LO-DT” Series.
    d. Sensorswitch WV-PDT-R/WV-BR.
    e. Philips LRM2265.
    f. Leviton OSW12-M0W.
2. Description: Wall mounted, 110° coverage, multi-tech occupancy sensor.
    a. Housing: White, thermoplastic, tamper resistant with swivel bracket for wall or ceiling mounting.
    b. Functions: Automatic ON must sense motion from both sensing elements. Either technology shall maintain ON, with adjustable time delays.
    c. Adjustments: User adjustable sensitivity adjustment shall be provided for each sensing technology. Time delay shall be adjustable from 30 seconds to 15 minutes.
    d. Sensor Orientation: Orient sensor in room such that sensor will not detect motion through open door which could cause false activation.
    e. Sensor shall operate on 24V DC power through control unit which supplies DC power to the sensor and provides relay contacts to control the lighting load and auxiliary contacts.
    f. Manual override function.

E. 360° Ceiling Mounted Ultrasonic Occupancy Sensors
1. Manufacturers:
    a. Perfect Sense WDS.
    b. Wattstopper “WT” Series.
    c. Hubbell Building Automation “OMNI-US” Series.
    d. Greengate OPC-U-2000.
    e. Sensorswitch CM MPT-10.
    f. Philips LRM2255.
    g. Leviton OSC20-U0W.
2. Description: Ceiling mounted, 360° coverage, ultrasonic or microphonics sensing occupancy sensor.
    a. Housing: White, thermoplastic, tamper resistant.
    b. Adjustments: Adjustments: User adjustable sensitivity and time delay. Time delay shall be adjustable from 30 seconds to 15 minutes.
    c. Sensor shall operate on 24V DC power through control unit which supplies DC power to the sensor and provides relay contacts to control the lighting load and auxiliary contacts.
    d. Manual override function.

F. 360° Ceiling Mounted Passive Infrared Occupancy Sensor.
   1. Manufacturers:
      a. Perfect Sense CPS.
      b. Wattstopper CI-200.
      c. Hubbell Building Automation OMNI-IR.
      d. Greengate OMC-P-04500-R.
      e. Sensorswitch CM-9.
      f. Philips LRM2250.
      g. Leviton OSC04-I0W.
   2. Description: Ceiling mounted, 360° coverage, infrared sensing occupancy sensor.
      a. Housing: White, thermoplastic, tamper resistant ceiling mount.
      b. Adjustments: User adjustable sensitivity adjustment shall be provided for each sensing technology. Time delay shall be adjustable from 30 seconds to 30 minutes.
      c. Sensor shall operate on 24V DC power through control unit which supplies DC power to the sensor and provides relay contacts to control the lighting load and auxiliary contacts.
      d. Manual override function.

G. Occupancy Sensor Control Units:
   1. Description: Transformer and relay combined in single unit to provide 24DC power to sensors and provide 20A contact(s) for control of lighting loads at 120 or 277V. Control unit input power shall be from unswitched leg of lighting circuit it is controlling.
      a. Control units shall be provided as required to power ceiling mounted occupancy sensors, control lighting loads and provide a minimum of one auxiliary contact.
      b. Occupancy sensor control units shall mount external to 4” sq junction box in the ceiling space. Wiring between control unit and occupancy sensor shall be plenum rated.
      c. Locate control unit in accessible location in gyp-board ceilings, adjacent to return air grilles, or provide access panel.
      d. Additional auxiliary relay modules shall be provided as required to provide control of all lighting circuits and additional auxiliary contacts as required.
      e. It is acceptable to provide controls and auxiliary contacts as required integral to the ceiling sensor, provided all required contacts are provided.
      f. Maximum of 3 sensors per power pack. Verify exact quantities required with manufacturer.

2.6 LIGHTING CONTACTORS

A. Manufacturers:
   1. Cutler-Hammer; Eaton Corporation.
   2. Square D Co.
   3. General Electric.
   4. Siemens.
   5. Square D Co; class 8903.

B. Contactor
   1. Electrically-operated mechanically-held contactor per NEMA ICS2, with 120 volt, 60 hertz coil and 600 volt, 60 hertz, 20 ampere contacts with size and number of poles as required and indicated.
   2. Provide contacts to be 100 percent, continuously rated for all types of ballast and tungsten lighting and resistance loads without the need for in-rush current derating.

3. Provide NEMA type 1 enclosure unless otherwise indicated.
4. Provide corrosion-resistant primer treatment with light gray baked acrylic enamel finish.
5. Provide the following control and indicating devices:
    a. Auxiliary contacts: One field convertible.
    b. Auxiliary relay to convert maintained-contact type control circuit to momentary-contact type control circuit necessary for contactor control.
    c. Hand-off-auto selector switch, of the heavy-duty "oil-tight", maintained-contact type, mounted on the front cover with legend plate.
    d. Control transformer with primary voltage as indicated and 120-volt, single phase, 60 hertz secondary including fuse and fuseholder.
    e. Green pilot light to indicate "power on" condition. Mount on front cover with legend plate.

PART 3 - EXECUTION

3.1 LIGHTING CONTACTOR INSTALLATION

A. Install lighting contactors as indicated on plan. Install at accessible locations. Switch controls where provided shall be no higher than 54" or lower than 48".

B. Demonstrate proper operation of all lighting control functions to the Owner and Engineer.

3.2 OUTDOOR PHOTOELECTRIC CONTROL INSTALLATION

A. Mount photocell on roof or parapet to ½" GRS conduit, supported to building structure below. Coordinate roof penetration with roofing contractor.

B. Install photoelectric control oriented in the northeast direction and not within any potential shadows.

C. Adjust photocell sensitivity and delay to meet owner's requirements. Multiple adjustments may be required, as needed.

3.3 TIME CONTROLLER INSTALLATION

A. Install time controller, near contactor control equipment or as indicated on plan. Install at accessible location.

B. Program time controller as directed by the owner. Train owner in time clock programming.

3.4 OCCUPANCY SENSOR INSTALLATION

A. Install wall mounted occupancy sensors as noted on plan. Arrange occupancy sensors with adjacent switch devices so that device plates line-up and are equally spaced.

B. Install ceiling mounted sensors at approximate locations as indicated on plan. Sensor manufacturer shall provide quantity of sensors as required to provide complete coverage for rooms.

C. Locate sensors such that motion through open doors will not falsely activate sensors.

D. Do not locate ultrasonic sensors within six feet of supply air diffusers.

E. Locate infrared sensors to avoid obstructions.

F. Provide the services of a manufacturer’s representative for commissioning of occupancy sensor installation. This shall include consultation on layout and location prior to installing sensors, testing of each sensor for compliance with Contract Documents and field adjustment and fine tuning after installation is complete. Provide written confirmation of testing to the Owner, Architect and Engineer.

G. Field adjustments shall take place in the presence of the owner and the engineer. This shall include owner training on adjustment techniques for the occupancy sensors.

3.5 WIRING INSTALLATION

A. Wiring Method: Comply with Division 26 Section "Conductors and Cables".

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

E. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.6 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section "Electrical Identification."

B. Label time switches and contactors with a unique designation.

3.7 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
   2. Operational Test: Verify actuation of each sensor and adjust time delays.

B. Remove and replace lighting control devices where test results indicate that they do not comply with specified requirements.

C. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.8 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose.

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SECTION 26 09 43
LIGHTING CONTROL SYSTEMS

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the design and installation programmable automatic lighting controls with all input and control devices necessary to meet the performance indicated on the contract drawings and this specification.

B. Related Sections include the following:
1. Division 26 Section "Lighting Control Devices" for time switches, photoelectric switches, occupancy sensors, and multi-pole contactors.

2. Division 26 Section “LED Interior Lighting” for luminaire specifications and accessories.

1.3 DEFINITIONS

A. BACnet: A networking communication protocol that complies with ASHRAE 135.

B. Lon Works: A control network technology platform for designing and implementing interoperable control devices and networks.

C. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling and power-limited circuits.

D. RS-485: A serial network protocol, like RS-232, complying with TIA/EIA-485-A.

1.4 SUBMITTALS

A. Product Data: Indicating general device descriptions, dimensions, electrical specifications, wiring details, and nomenclature for all sensors, relays, dimming modules, control stations and other devices necessary for complete operation of the system

B. Shop Drawings: Detail assemblies of standard components, custom assembled for specific application on this Project.
   1. Outline Drawings: Indicate dimensions, weights, arrangement of components, and clearance and access requirements for all system components requiring field installation.
   2. Riser Diagram: Show interconnection between all system components.
      a. Identify complete data communication backbone and interconnection between sensors, relays, dimming modules control stations and other components.
      b. Identify typical room/area type configurations.
      c. Indicate interconnections with emergency egress lighting relays and transfer devices required.
   3. Information Technology (IT) connection: Provide information pertaining to interconnection with facility IT networking equipment and third-party systems.
   4. Other Diagrams and Operational Descriptions – as needed to indicate system operation or interaction with other system(s).
   5. Contractor startup and commissioning worksheet.

C. Software and Firmware Operational Documentation:
   1. Software operating and upgrade manuals.
   2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
   3. Device address list.
   4. Printout of software application and graphic screens.

D. Submit qualifications of commissioning agent and draft functional test plans for review and approval.

E. Field quality-control test reports and commissioning reports at project closeout.

F. Software licenses and upgrades required by and installed for operation and programming of digital devices.

G. Operation and Maintenance Data: For lighting controls to include in emergency, operation, and maintenance manuals. Include the following:

1. Software manuals.
2. Operation of adjustable zone controls.
3. Description of operation and servicing procedures.
4. List of major components and recommended parts.
5. System operation and integration instructions.

H. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain lighting control module and power distribution components through one source from a single manufacturer with total responsibility for compatibility of lighting control system components specified in this Section.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with 47 CFR, Subparts A and B, for Class A digital devices.

D. Comply with NFPA 70.

E. Listed as qualified under Design Lights Consortium (DLC) Networked Lighting Control System Specification V2.0.

F. System luminaires and controls are certified by manufacturer to have been designed, manufactured and tested for interoperability.

G. Comply with ASHRAE 90.1 – 2013.

1.6 COORDINATION

A. Coordinate lighting control components specified in this Section and with systems and components specified in other Sections to form an integrated interconnection of compatible components.

B. Match components and interconnections for optimum performance of lighting control functions.

C. Coordinate lighting controls with devices specified in Division 26 Section “Lighting Control Devices”.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of lighting controls that fail in materials or workmanship within specified warranty period.
1. Warranty Period: Five years from date of Substantial Completion.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Batteries for all sensors and switches: Quantity equal to 10% percent of each type and size,

but no fewer than 3 of each type and size.

1.9 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for five years.

B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revise licenses for use of the software.
   1. Provide 30-day notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment, if necessary.

1.10 SYSTEM COMMISSIONING

A. Provide the services of a third party, independent agent to perform functional testing and verification of the lighting control system to comply with the requirements of ASHRAE 90.1 – 2013.

B. Perform functional testing of all lighting control system operations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Acuity nLight Air
   2. Lutron Vive
   3. WaveLinx – Cooper Lighting

2.2 SYSTEM PERFORMANCE REQUIREMENTS

A. System Architecture
   1. System shall have an architecture that is based upon three main concepts: (a) networkable intelligent lighting control devices, (b) standalone lighting control zones using distributed intelligence, (c) system backbone for remote, time based and global operation between control zones.
      a. Intelligent lighting control devices shall have individually addressable network communication capability and consist of one or more basic lighting control components: occupancy sensor, photocell sensor, relay, dimming output, contact closure input, analog 0-10V input, and manual wall station capable of indicating switching, dimming, and/or scene control. Combining one or more of these components into a single device enclosure shall be permissible to minimize overall device count of system.
      b. Lighting control zones consisting of one or more networked luminaires and intelligent lighting control devices and shall be capable of providing automatic control from sensors (occupancy and/or photocell) and manual control from local wall stations without requiring connection to a higher-level system backbone; this capability is referred to as “distributed intelligence.”

c. System must be capable of interfacing directly with networked luminaires such that either low voltage network cabling or wireless RF communication is used to interconnect networked luminaires with control components such as sensors, switches and system backbone.

2. The system shall provide individually addressable switching and dimming control of the following: networked luminaires, control zones to include multiple switch legs or circuits, and relay and dimming outputs from centralized panels to provide design flexibility appropriate with sequence of operations required in each project area or typical space type. A single platform shall be used for both indoor and outdoor lighting controls.
3. Lighting control zones shall be networked with a higher-level system backbone to provide time-based control, remote control from inputs and/or systems external to the control zone, and remote configuration and monitoring through a software.
4. All system devices shall support remote firmware update, such that physical access to each device is not necessary, for purposes of upgrading functionality later.
5. System shall be capable of "out of box" sequence of operation for each control zone. Standard sequence is:
   a. All switches control all fixtures in a zone.
   b. All occupancy sensors automatically control all fixtures in the control zone with a default timeout.

B. Wireless Networked Control Zone Characteristics
1. All wireless networked devices paired, meshed or grouped together shall automatically follow the "out of box" default sequence of operations.
2. Wireless network communication shall support uniform and instant response such that all luminaires in a lighting control zone respond immediately and synchronously in response to a sensor or wall station signal.
3. To support the system architecture requirement for distributed intelligence, wireless network communication shall support communication of control signals from sensors and wall stations to networked luminaires and wireless load control devices, without requiring any communication, interpretation, or translation of information through a backbone device such as a wireless access point, communication bridge or gateway.
4. All wireless communication shall be encrypted using at least 128-bit Advanced Encryption Standard (AES).
5. The following types of wired networked control devices shall be provided for egress and/or emergency light fixtures:
   a. UL924 Listed Line-Voltage power sensing: These devices shall be listed as emergency relays under the UL924 standard and shall automatically close the load control relay(s) and provide 100% light output upon detection of loss or interruption of power sensed via line voltage connections.

C. System Integration Capabilities
1. The system shall be capable of interface with third party building management systems (BMS) to support two-way communication using the industry standard BACnet/IP or BACnet/MSTP protocols.
   a. Systems utilizing a third-party converter or systems that require a dedicated server to achieve integration are not acceptable.

2.3 SYSTEM SOFTWARE INTERFACES

A. Management Interface
1. System shall provide a web-based management interface that provides remote system

control, live status monitoring, and configuration capabilities of lighting control settings and schedules.

2. Management interface must be compatible with industry-standard web browser clients, including, but not limited to, Microsoft Internet Explorer®, Apple Safari®, Google Chrome®, Mozilla Firefox®.
3. All system software updates must be available for automatic download and installation via the internet.

B. Historical Database and Analytics Interface
1. System shall provide a browser-based trending and monitoring interface that stores historical data for all occupancy/daylight sensors and lighting loads. Additionally, the system shall optionally upload that data to a cloud-based server.

C. Visualization Interfaces
1. System shall provide an optional web-based visualization interface that displays a graphical floorplan. System data, to include status of occupancy sensors, daylight sensors and light output shall be overlaid to the floorplan to provide a graphical status page.

D. Portable Programming Interface for Standalone Control Zones
1. Portable handheld application interface for standalone control zones shall be provided for systems that allows configuration of lighting control settings.
2. Programming capabilities through the application shall include, but not be limited to, the following:
   a. Switch, occupancy and photo sensor group configuration
   b. Manual/automatic on modes
   c. Turn-on dim level
   d. Occupancy sensor time delays
   e. Dual technology occupancy sensors sensitivity
   f. Photo-sensor calibration adjustment and auto-setpoint
   g. Trim level settings

2.4 SYSTEM BACKBONE AND SYSTEM INTEGRATION EQUIPMENT

A. System Controller
1. System Controller shall be a multi-tasking, real-time digital control processor consisting of modular hardware with plug-in enclosed processors, communication controllers, and power supplies.
2. System Controller shall perform the following functions:
   a. Facilitation of global network communication between different areas and control zones.
   b. Time-based control of downstream wireless network devices.
   c. Linking into an Ethernet network.
   d. Connection to various software interfaces, including management interface, historical database and analytics interface, visualization interface, and personal control applications.
3. System Controller shall not require a dedicated PC or a dedicated cloud connection.
4. Device shall automatically detect all networked devices connected to it, including those connected to wireless communication bridges.
5. Device shall have a standard and astronomical internal time clock.
6. Shall be capable of connecting to the customers Local Area Network (LAN) via IEEE 802.11.x Wireless and IEEE 802.3 Wired connection.

2.5 WIRELESS NETWORKED DEVICES

A. Wireless Networked Sensor Interface
   1. The device shall be capable of broadcasting the following manual wall control commands: on, off, and adjust dim level.

B. Wireless Networked Light Controllers (No Sensor)
   1. The wireless light controller shall be capable of providing continuous dimming and on/off control of one commercial light fixture including fluorescent, HID, induction and LEDs.
   2. An external antenna attached to the luminaire shall not be allowed.
      a. Each wireless light controller shall provide measurement capability of the amperage, voltage, wattage, and watt-hours of its controlled lighting.

C. Wireless Networked Digital Sensors
   1. In addition to providing Wireless Networked Light Controllers functionality, also provides:
      a. Integrated digital occupancy sensing and digital photocell sensor.
      b. Sensor shall connect directly to the wireless light controller and shall be suitable for embedding into the enclosure of a luminaire.
      c. Sensor shall have software-adjustable settings
      d. Photocell shall be suitable for closed and open loop applications.

D. Wireless Network Communication Bridge
   1. A communication bridge device shall be provided that interfaces with the System Controller via Owner's LAN connection and interfaces with wireless network.
   2. Device shall be capable of communicating with a group of a minimum of 250 wireless networked devices and luminaires, to reduce the amount of communication bridges required in the system.

2.6 CONDUCTORS AND CABLES

A. General: All conductors and cables shall comply with the requirements of Division 26 Section "Conductors and Cables." Where cable is permitted to be installed exposed in ceiling space, provide plenum rated cable.

B. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG.

C. Classes 2 and 3 Control Cables: Multi-conductor cable with copper conductors not smaller than No. 22 AWG.

D. Class 1 Control Cables: Multi-conductor cable with copper conductors not smaller than No. 18 AWG.

E. Digital and Multiplexed Signal Cables: As required by system manufacturer. Provide plenum rated cables where installed exposed in ceiling space.

PART 3 - EXECUTION

3.1 WIRING INSTALLATION

A. The lighting control system shall be installed and connected as shown on the plans and as directed by the manufacturer.

B. Comply with NECA 1.

C. Wiring Method: Install wiring in raceways except where installed in accessible ceilings. Comply with Division 26 Sections "Conductors and Cables" and “Raceways and Boxes”.

D. Where cables are installed in finished areas with exposed construction, conceal cables from view. Route at top of structural systems and conceal on top of structural members where possible. Where cable is exposed to view, provide raceway. As an alternative to raceway, provide cable that is factory colored to match exposed ceiling. Submit sample to Architect for approval.

E. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions.

F. Install field-mounting transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.

G. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

H. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in terminal cabinets, equipment enclosures, and in junction, pull, and outlet boxes as per manufacturers’ recommendations.

I. Identify components and power and control wiring according to Division26 Section "Electrical Identification."

J. Label each relay with a unique designation.

3.2 INSTALLATION REQUIREMENTS

A. Review all required installation and pre-startup procedures with the manufacturer’s representative through pre-construction meetings.

B. Install and connect the networked lighting control system components according to the manufacturer’s installation instructions, wiring diagrams, the project submittals, plans and specifications.

C. Coordination with Owner’s IT Network Infrastructure to secure all required network connections to the owner’s IT network infrastructure. Provide the owner’s representative with all network infrastructure requirements of the networked lighting control system. Provide the manufacturer’s representative with all necessary contacts pertaining to the owner’s IT infrastructure, to ensure that the system is properly connected and started up.

D. Verify integration and interoperability scope with the Mechanical Contractor prior to submittal phase and provide all necessary schedules to the Lighting Control manufacturer.

3.3 SYSTEM STARTUP

A. Upon completion of installation by the installer, including completion of all required verification and documentation required by the manufacturer, the system shall be started up and programmed by an authorized representative of the manufacturer.
   1. Low voltage network cable testing shall be performed prior to system startup at the discretion of the manufacturer.

B. System start-up and programming shall include:
   1. Verifying operational communication to all system devices.
   2. Programming the network devices into functional control zones to meet the required sequence of operation.
   3. Programming and verifying all sequence of operations.
   4. Customization of owner's software interfaces and applications.

C. Initial start-up and programming are to occur on-site. Additional programming may occur on-site or remotely over the Internet as necessary.

3.4 DOCUMENTATION

A. Submit software database file with desired device labels and notes completed.

B. Document the installed location of all networked devices, including networked luminaires. Provide as-built plan drawing showing device addresses corresponding to locations of installed equipment.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components and equipment installation, including connections and assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:
   1. Test for circuit continuity.
   2. Verify that the control module features are operational.
   3. Check operation of local override controls.
   4. Test system diagnostics by simulating improper operation of several components selected by Architect.

3.6 SYSTEM COMMISSIONING

A. Facilitate the functional testing and verification of the lighting control system by an independent, third party commissioning agent.

B. Perform commissioning in the presence of the Owner's representative.

C. Submit functional test plan checklist signed by the commissioning agent.

3.7 SOFTWARE INSTALLATION

A. Install and program software with initial settings of adjustable values. Make backup copies of software and user-supplied values. Provide current licenses for software.

3.8 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting programming functions and other system parameters and to assist Owner's personnel in making program changes to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to program, adjust, operate, and maintain lighting controls.

B. Demonstration shall be done only after initial system start-up setup has occurred and system is functioning properly.

C. Demonstration shall consist of a four-hour minimum session.

3.10 MANUFACTURER SUPPORT

A. Manufacturer telephone support shall be available at no cost to the Owner during the warranty period and shall include the following:
   1. Assistance in solving programming or other application issues pertaining to the control equipment.
   2. The manufacturer shall provide a toll-free number for direct technical support available 7 days a week, 24 hours a day.
   3. A factory authorized technician shall be located within a 100-mile radius of the project site.

END OF SECTION 26 09 43

SECTION 26 0999
ELECTRICAL TESTING

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

B. Related Sections include the following:
1. Division 26 Section “Electrical General Requirements.”
2. Division 26 Section “Conductors and Cables.”
3. Division 26 Section “Grounding and Bonding.”
4. Division 26 Section “Packaged Engine Generators.”
5. Division 26 Section “Enclosed Switches.”
6. Division 26 Section “Transfer Switch.”
7. Division 26 Section “Enclosed Controllers.”
8. Division 26 Section “Surge Protective Devices”
9. Division 26 Section “Switchboards.”
10. Division 26 Section “Panelboards.”
11. Division 26 Section “Dry Type Transformers (600V and Less).”
12. Division 26 Section “Enclosed Bus Assemblies.”
13. Division 26 Section “Fuses.”

1.2 SECTION INCLUDES

A. Engage the services of a recognized corporately independent N.E.T.A. certified testing firm to perform inspections and tests as specified herein.

B. The testing firm shall provide all material, equipment, labor, and technical supervision to perform such tests and inspections.

C. It is the intent of these tests to assure that all tested electrical equipment is operational and within industry and manufacturer's tolerances and is installed in accordance with design Specifications.

D. The test and inspections shall determine suitability for energization.

E. Equipment to be tested and inspected shall be the equipment shown on the one-line diagram and schedules as required by part three of each individual Specification Section. In addition, all equipment that is part of an emergency distribution system shall be tested.

1.3 REFERENCES

A. All inspections and tests shall be in accordance with the latest version of the following codes and standards except as provided otherwise herein.
   1. National Electrical Manufacturer's Association - NEMA
   2. American Society for Testing and Materials - ASTM
   3. Institute of Electrical and Electronic Engineers - IEEE
   4. InterNational Electrical Testing Association - NETA Acceptance Testing Specifications - ATS-2017
   5. InterNational Electrical Testing Association - NETA Maintenance Testing Specifications-MTS-2015
   6. American National Standards Institute - ANSI C2: National Electrical Safety Code
   7. State and Local Codes and Ordinances
   8. Insulated Cable Engineers Association - ICEA
   9. Association of Edison Illuminating Companies - AEIC
   10. Occupational Safety and Health Administration
   11. National Fire Protection Association - NFPA
      a. ANSI/NFPA 70: National Electrical Code
      b. ANSI/NFPA 70B: Electrical Equipment Maintenance
      c. NFPA 70E: Electrical Safety Requirements for Employee Workplaces
      d. ANSI/NFPA 101: Life Safety Code

1.4 QUALIFICATIONS

A. The testing firm shall be corporately independent and function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems evaluated by the testing firm.

B. The testing firm shall be regularly engaged in the testing of electrical equipment devices, installations, and systems.

C. The lead, on site, technical person and at least 50% of the onsite crew shall be currently certified by the InterNational Electrical Testing Association (NETA) or National Institute for Certification in Engineering Technologies in Electrical Power Distribution System Testing.

D. The testing firm shall only utilize technicians who are regularly employed by the firm on a full-time basis for testing services.

E. The Contractor shall submit proof of the above qualifications with bid proposal.

F. The terms test agency, test contractor, testing laboratory, test organization, or contractor test company, shall be construed to mean the testing firm.

G. Acceptable Testing Firms:
   1. Potomac Testing; Phone (248) 689-8980.
   2. Utilities Instrumentation Services; Phone (734) 424-1200.
   3. High Voltage Maintenance Corporation; Phone (248) 305-5596.
   4. Powertech Services, Inc.; Phone (810) 720-2280.

5. Power Plus Engineering, Inc.; Phone (800) 765-3120.
6. Premier Power Maintenance, Inc.; (517) 230-6629

1.5 PERFORMANCE REQUIREMENTS

A. The Electrical Contractor shall supply a suitable and stable source of electrical power to each test site. The testing firm shall specify the power requirements.

B. The Electrical Contractor shall notify the testing firm when equipment becomes available for acceptance tests. Work shall be coordinated to expedite project scheduling.

C. The testing firm shall notify the Owner's Representative prior to commencement of any testing.

D. Any system, material or workmanship, which is found defective on the basis of acceptance tests, shall be reported to the Engineer. The Electrical Contractor shall correct all defects.

E. The testing firm shall maintain a written record of all tests and shall assemble and certify a final test report.

F. Safety and Precautions
1. Safety practices shall include, but are not limited to, the following requirements:
   a. Occupational Safety and Health Act.
   b. Accident Prevention Manual for Industrial Operations, National Safety Council.
   c. Applicable state and local safety operating procedures.
   d. NETA Safety/Accident Prevention Program.
   e. Owner's safety practices.
   f. National Fire Protection Association - NFPA 70E.
   g. American National Standards for Personnel Protection.
2. All tests shall be performed with apparatus de-energized except where otherwise specifically required.
3. The testing firm shall have a designated safety representative on the project to supervise operations with respect to safety.

1.6 TEST INSTRUMENT CALIBRATION

A. Test Instrument Calibration
1. The testing firm shall have a calibration program, which assures that all applicable test instruments are maintained within rated accuracy.
2. The accuracy shall be directly traceable to the National Institute of Standards and Technology.
3. Instruments shall be calibrated in accordance with the following frequency schedule:
   a. Field instruments: Analog - 6 months maximum Digital - 12 months maximum
   b. Laboratory instruments: 12 months
   c. Leased specialty equipment: 12 months (Where accuracy is guaranteed by Lessor)
4. Dated calibration labels shall be visible on all test equipment.
5. Records must be kept up-to-date which show date and results of instruments calibrated or tested.
6. An up-to-date instrument calibration instruction and procedures shall be maintained for each test instrument.
7. Calibrating standard shall be of higher accuracy than that of the instrument tested.

B. Field Test Instrument Standards

1. All equipment used for testing and calibration procedures shall exhibit the following characteristics:
   a. Maintained in good visual and mechanical condition.
   b. Maintained in safe, operating condition.

C. Suitability of Test Equipment
1. All test equipment shall be in good mechanical and electrical condition.
2. Selection of metering equipment should be based on knowledge of the waveform of the variable being measured. Digital multi-meters may be average of RMS sensing and may include or exclude the dc component. When the variable contains harmonics of dc offset and, in general, any deviation from a pure sine wave, average sensing, average measuring RMS scaled meters may be misleading. Use of RMS measuring meters is recommended.
3. Field test metering used to check power system meter calibration must have any accuracy higher than that of the instrument being checked.
4. Accuracy of metering in test equipment shall be appropriate for the test being performed.
5. Waveshape and frequency of test equipment output waveforms shall be appropriate for the test and tested equipment.

1.7 TEST REPORTS

A. A test report shall be generated for each piece of major equipment or groups of equipment and shall include the following:
1. A list of visual and mechanical inspections required by Division 26 Specification Sections in a checklist or similar format.
2. Test reports, including test values where applicable, for all required electrical tests. Clearly indicate where test values fall outside of the limits of recommended values.
3. Summary and interpretation of test results detailing problems located and recommended corrective measures.
4. Record of infrared scan and photos showing potential problem locations.
5. Signed and dated by the testing firm field superintendent stating that all required tests have been completed.

B. Test reports shall be furnished to the Architect/Engineer within 14 days of the completion each test on an ongoing basis. Original copies of the reports shall be furnished directly to the Architect/Engineer by the testing company prior to formal submittal via the Contractors.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 THERMOGRAPHIC SURVEY

A. Visual and Mechanical Inspection
1. Remove all necessary covers prior to scanning.
2. Inspect for physical, electrical, and mechanical condition.

B. Equipment to be Scanned
1. All components of the distribution system down to and including branch circuit panelboards and motor control centers. Return 3 months after equipment has been energized and loaded to do a final scan of all equipment.

C. Provide report indicating the following:
   1. Problem area (location of "hot spot").
   2. Temperature rise between "hot spot" and normal or reference area.
   3. Cause of heat rise.
   4. Phase unbalance, if present.
   5. Areas scanned.

D. Test Parameters
   1. Scanning distribution system with ability to detect 1°C between subject area and reference at 30°C.
   2. Equipment shall detect emitted radiation and convert detected radiation to visual signal.
   3. Infrared surveys should be performed during periods of maximum possible loading but not less than twenty percent (20%) of rated load of the electrical equipment being inspected.

E. Test Results
   1. Interpretation of temperature gradients requires an experienced technician. Some general guidelines are:
      a. Temperature gradients of 37°F to 44.6°F indicate possible deficiency and warrant investigation.
      b. Temperature gradients of 44.6°f to 59°F indicate deficiency; repair as time permits.
      c. Temperature gradients of 61°F and above indicate major deficiency; repair immediately.

END OF SECTION 26 0999

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SECTION 26 22 00
DRY-TYPE TRANSFORMERS (600 V AND LESS)

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 750 kVA:
   1. Distribution transformers.
   2. Control and signal transformers.

B. Related Section includes the following:
   1. Division 26 Section “Electrical General Requirements.”
   2. Division 26 Section “Grounding and Bonding.”
   3. Division 26 Section “Conductors and Cables.”
   4. Division 26 Section “Raceways and Boxes.”
   5. Division 26 “Hangers and Supports for Electrical Systems” for concrete bases.

1.3 REFERENCES

A. ANSI/IEEE C57.12.9: Test Code for Dry-Type Distribution and Power Transformers

B. NEMA 250: Enclosures for Electrical Equipment (1000 Volts Maximum)

C. NEMA ST 1: Specialty Transformers

D. NEMA ST 20: Dry Type Transformers for General Applications

E. NEMA TP 1: Guide for Determining Energy Efficiency for Distribution Transformers

F. NEMA TP 2: Standard Test Method for Measuring the Energy Consumption of Distribution Transformers

G. NETA ATS: Acceptable Testing Specifications for Electrical Power Distribution Equipment and Systems

H. NFPA 70: National Electrical Code

I. UL 486A: Wire Connectors and Soldering Lugs for Use with Copper Conductors

J. UL 506: Specialty Transformers

K. UL 1561: Dry-Type General Purpose and Power Transformers

1.4 SUBMITTALS

A. Product Data Include rated nameplate data, capacities, weights, dimensions, utility or manufacturer's anchorage and base recommendations, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.
   1. Transformer Inrush: Provide time-current coordination curves demonstrating transformer inrush and ANSI damage curves with primary overcurrent device selections to clear inrush yet still protecting damage curve.

B. Shop Drawings: Wiring and connection diagrams.

C. Qualification Data: Testing agency.

D. Source quality-control test reports. Include loss data, efficiency at 25, 50, 75 and 100 percent rated load, and sound level.

E. Output Settings Reports: Record of tap adjustments specified in Part 3.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined in OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
   1. Transformer Inrush: Provide time-current coordination curves demonstrating transformer inrush and ANSI damage curves with primary overcurrent device selections to clear inrush yet still protecting damage curve.
   2. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise onsite testing specified in Part 3.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with IEEE C 57.12.91.

D. Comply with NFPA 70.

E. Energy-Efficient Transformers Rated 15 kVA and Larger: Certified as meeting doe 2016 efficiency levels when tested according to NEMA TP2.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

B. Store, protect, and handle products to site under provisions of Division 26 section “Electrical General Requirements.”

C. Deliver transformers individually wrapped for protection and mounted on shipping skids.

D. Accept transformers on site. Inspect for damage.

E. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

F. Handle in accordance with manufacturer’s written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork shall meet load requirements. Requirements for concrete bases for electrical equipment are specified in Division 26 “Hangers and Supports for Electrical Systems.”

B. Coordinate installation of wall-mounting and structure-hanging supports.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Acme.
2. Cutler-Hammer.
3. GE Electrical Distribution & Control.
4. Siemens Industries, Inc.
5. Square D/Groupe Schneider NA.
6. Sola/Hevi-Duty Electric.

2.2 MATERIALS

A. Cores: Grain-oriented, non-aging silicon steel.

B. Coils: Continuous windings without splices, except for taps.
   1. Internal Coil Connections: Brazed or pressure type.
   2. Coil Material: Aluminum.

C. Vibration Isolation: Isolate core and coil from enclosure using vibration-absorbing mounts.

D. Grounding: Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

2.3 DISTRIBUTION TRANSFORMERS

A. Description: Factory-assembled and tested, air cooled, dry-type transformer rated for 60 Hz operation. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Indoor Enclosure: Ventilated, NEMA 250, Type 2. Provide lifting eyes or brackets.

C. Indoor Transformer Enclosure Finish: Comply with NEMA 250 for "Indoor Corrosion Protection."
   1. Finish Color: Gray.

D. Enclosure Finish for Indoor Units: Manufacturer's standard gray finish over rust-inhibiting primer on phosphatizing-treated metal surfaces.

E. Insulation Class (15 kVA and larger): 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature TP-1 compliant.

F. Insulation Class (less than 15 kVA): 185 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.

G. Basic Impulse Level: 10 kV.

H. Taps for Transformers Smaller Than 3 kVA: None.

I. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

J. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

K. Case Temperature: Do not exceed 35 degrees C rise above ambient at warmest point.

L. Mounting: Suitable for mounting as indicated.

M. Wall Brackets: Manufacturer's standard brackets.

N. Nameplate: Include transformer connection data and overload capacity based on rated allowable temperature rise.

2.4 CONTROL AND SIGNAL TRANSFORMERS

A. Description: Factory-assembled and tested, self-cooled, two-winding dry type, rated for continuous duty, and 60 Hz operation, complying with NEMA ST 1, and listed and labeled as complying with UL 506.

B. Ratings: Continuous duty. If rating is not indicated, provide at least 50 percent spare capacity above connected peak load.

2.5 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.91.

B. Provide the following factory tests on each unit provided in accordance with NEMA ST 20:
   1. Voltage ratio.
   2. Polarity and phase relation.
   3. No load losses.
   4. Impedance (501 kVA and larger).
   5. Applied and induced potential.

C. Provide the factory tests on the actual transformers provided or on similar units identical to those provided in accordance with NEMA ST 20:
   1. Impedance (less than 501 kVA).
   2. Temperature rise.
   3. Audible sound level.
   4. Full load losses.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls and floors for suitable mounting conditions where transformers will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install Products in accordance with manufacturer’s instructions.

B. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
   1. Mount transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure.

C. Install floor mounted transformers on and anchor to concrete bases according to manufacturer’s recommendations.

1. Mount transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure.

D. Identification: Engraved metal or laminated-plastic nameplate mounted with corrosion resistant screws. Provide nameplate according to Division 26 Section “Electrical Identification” indicating the following:
   1. Transformer designation (e.g. “T-1”).
   2. Primary power characteristics (e.g. “480V, 3PH, 3W”).
   3. Secondary power characteristics (e.g. “208Y/120V, 3PH, 4W”).
   4. Power rating (e.g. “75 kVA”).
   5. Power source (e.g. “Fed from DP-1).

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding."

B. Connect wiring according to Division 26 Section "Conductors and Cables."

C. Provide conduit according to Division 26 Section “Raceways and Boxes” for connections to transformer case. Make conduit connections to side panel of enclosure.

D. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

E. Check for damage and tighten connections prior to energizing transformer.

3.4 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality control tests in accordance with Division 26 section “Electrical Testing” for transformers 75KVA and above:
   1. Visual and Mechanical Inspection
      a. Inspect for physical damage, cracked insulators, tightness of connections, defective wiring and general mechanical and electrical conditions.
      b. Verify proper core grounding.
      c. Verify proper equipment grounding.
      d. Compare equipment nameplate with single line diagram and report discrepancies.
   2. Electrical Tests
      a. Perform insulation resistance tests, winding-to-winding and windings-to-ground, utilizing a meg-ohmmeter with test voltage output in accordance with N.E.T.A. Acceptance Testing Specifications, Table 10.5. Test duration shall be for 10 minutes with resistance values tabulated at 30 seconds, 1 minute, and 10 minutes. Calculate Polarization index.
      b. Perform a turns ratio test between windings at every tap position. The final tap setting is to be set at the secondary system rated voltage at full load or as directed by the Architect/Engineer.
      c. Verify proper secondary voltage phase-to-phase and phase-to-neutral after energization and prior to loading.

3. Test Values
   a. Perform insulation resistance tests in accordance with N.E.T.A. Acceptance Testing Specifications, Table 10.5. Results to be temperature corrected in accordance with Table 10.14.
   b. The polarization index should be above 1.2 unless an extremely high value is obtained initially, such that when doubled will not yield a meaningful value.
   c. Turns ratio test results shall not deviate more than one half percent (0.5%) from either the adjacent coils or the calculated ratio.

3.5 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 5 percent. Submit recording and tap settings as test results.

B. Adjust buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.

C. Output Settings Report: Prepare a written report that records output voltages and tap settings.

END OF SECTION 26 22 00

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SECTION 26 24 16
PANELBOARDS

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Distribution panelboards.
   2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. GFEP: Ground-fault equipment protection.

D. AFCI: Arc-fault circuit interrupter.

E. RFI: Radio-frequency interference.

F. RMS: Root mean square.

G. SPDT: Single pole, double throw.

1.4 SUBMITTALS

A. Product Data: For each type of panelboard, overcurrent protective device, surge protective device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Related Submittals:
   1. Provide overcurrent device coordination study to demonstrate proper overcurrent device ratings, adjustments, and settings.

C. Shop Drawings: For each panelboard and related equipment.
   1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:
      a. Enclosure types and details for types other than NEMA 250, Type 1.
      b. Bus configuration, current, and voltage ratings.
      c. Short-circuit current rating of panelboards and overcurrent protective devices.
      d. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
   2. Wiring Diagrams: Power, signal, and control wiring.

D. Field quality-control test reports including the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

F. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1, include the following:
   1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
   2. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association and that is acceptable to authorities having jurisdiction.
   1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories through one source from a single manufacturer.

C. Product Options: Drawings indicate size, profiles, and dimensional requirements of panelboards and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with NEMA PB 1.

F. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
   1. Ambient Temperature: Not exceeding 104 deg F.
   2. Altitude: Not exceeding 6600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
   1. Ambient temperatures within limits specified.
   2. Altitude not exceeding 6600 feet.

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
   1. Notify Construction Manager no fewer than seven days in advance of proposed interruption of electrical service.
   2. Do not proceed with interruption of electrical service without Construction Manager's written permission.

1.7 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Keys: Six spares for each type of panelboard cabinet lock.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Panelboards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:

a. Eaton Corporation; Cutler-Hammer Products.
b. GE by ABB.
c. Siemens Industries, Inc.
d. Square D.

2.2 MANUFACTURED UNITS

A. Enclosures: Mounting as noted on panel schedules. NEMA PB 1, Type 1.
1. Rated for environmental conditions at installed location.
a. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
2. Cabinet Front: Flush or surface cabinet as noted on the Drawings.
a. Eaton LTDD (Piano hinge trim)
b. GE – FGB (front hinge to box).
c. Square D – Continuous piano hinge trim.
d. Siemens – Figure 4 hinge to box w/piano hinge.
3. Finishes:
a. Panels and Trim: galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
b. Back Boxes: Same finish as panels and trim.
4. Directory Card: With transparent protective cover, mounted in metal frame, inside panelboard door.

B. Phase and Ground Buses:
1. Material: Hard-drawn copper, 98 percent conductivity
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.

C. Conductor Connectors: Suitable for use with conductor material.
1. Main and Neutral Lugs: Mechanical type.
2. Ground Lugs and Bus Configured Terminators: Compression type.
3. Feed-Through Lugs: Mechanical type suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
4. Double Lugs: Mechanical type mounted at location of main incoming lugs.

D. Service Equipment Label: UL labeled for use as service equipment for panelboards with main service disconnect switches.

E. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.

F. Surge Protective Devices: Where indicated, provide manufactured units with direct bus connected type as specified in Division 26 Section "Surge Protective Devices."
1. Provide Surge Protective Device for all Distribution and Branch Circuit Panelboards that are part of the Emergency Distribution System.
2. Provide Surge Protective Devices elsewhere where indicated on the drawings.

2.3 PANELBOARD SHORT-CIRCUIT RATING

A. Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.4 DISTRIBUTION PANELBOARDS

A. Main bus bars, neutral and ground, shall be copper and sized in accordance with U.L. Standards to limit temperature rise on any current carrying part to the maximums as indicated in UL67.

B. Doors: Secured with vault-type latch with tumbler lock; keyed alike. Omit for fused-switch panelboards.

C. Main Overcurrent Protective Devices: Circuit breaker.

D. Branch Overcurrent Protective Devices:
   1. For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
   2. For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.5 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Main bus bars, neutral and ground, shall be sized in accordance with U.L. Standards to limit temperature rise on any current carrying part to the maximums as indicated in UL67.

B. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

2.6 OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker: NEMA AB 3, with interrupting capacity to meet available fault currents.
   1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits.
      a. Circuit Breakers 250A and Larger: Magnetic trip element with front-mounted, field-adjustable trip setting with restricted access cover.
   2. Electronic trip-unit circuit breakers shall have RMS sensing; field-replaceable rating plug; and with the following field-adjustable settings with restricted access cover:
      a. Instantaneous trip.
      b. Long- and short-time pickup levels.
      c. Long- and short-time time adjustments.
      d. Ground-fault pickup level, time delay, and I^2t response.
   3. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
   4. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
   5. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
   6. AFCI Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.

B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.
   1. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
   2. Application Listing: Appropriate for application; Type HACR for heating, air-conditioning, and refrigerating equipment.
   3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

4. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."
5. Shunt Trip: 120-V trip coil energized from separate circuit.
6. Do not use tandem circuit breakers.
7. Provide lock on devices for circuit breakers when called out on panel schedules with “LOD” designation.
8. Provide type GFEP circuit breakers for all self- regulating heating (snow melting and heat trace) cables branch circuits and where noted on panel schedules with “GFEP” designation
9. Provide GFCI circuit breaker when called out on panel schedules with “GFCI” designation.
10. Provide Arc-Fault Circuit Interrupters where indicated on panel schedule with “AFCI” designation.
11. Provide shunt trip breakers when called out on panel schedules with “STB” designation.
12. Provide smart controllable circuit breakers when called out on panel schedules with “SMT” designation.
13. Provide permanent padlockable handle for circuit breakers when called out on panel schedules with “PL” designation.

C. Circuit Breaker Selection for Transformer Primary Protection:
1. Circuit Breaker Selection for Transformer Primary Protection: Provide circuit breakers with time-current characteristics to clear transformer inrush currents while still providing protection for the ANSI through-fault protection curve. Provide circuit breakers with adjustable magnetic trip or electronic trip units as necessary to provide time-current curve shaping to achieve long time trip indicated on drawings, inrush coordination and damage protection.

2.7 ACCESSORY COMPONENTS AND FEATURES

A. Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Provide permanent provisions for padlocking all overcurrent devices in Distribution Panelboards. Provisions shall remain in place whether or not lock is installed.

C. Provide permanent provisions for padlocking overcurrent devices in Branch Circuit Panelboards that serve equipment not provided with a local, lockable disconnecting means. Provisions shall remain in place whether or not lock is installed

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Comply with mounting and anchoring requirements specified in Division 26 Section “Hangers and Supports for Electrical Systems.”

C. Mount top of trim 74 inches above finished floor, unless otherwise indicated.

D. Mount plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.

E. Install overcurrent protective devices and controllers.
   1. Set field-adjustable switches and circuit-breaker trip ranges.

F. Install filler plates in unused spaces.

G. Stub four 1-inch empty conduits from recessed panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.

H. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

3.2 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Electrical Identification."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads or created by retrofitting. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable. Coordinate final directory room names and numbers with Facility Engineer.

C. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding."

B. Connect wiring according to Division 26 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:
   1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

B. Testing: Perform the following field quality control tests in accordance with Division 26 section “Electrical Testing”
   1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters. Perform electrical tests on all breakers and switches 200A and above or that constitute a component of an emergency distribution system. Main circuit breakers in branch circuit panelboards 225A and below are not required to be tested.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
   1. Measure as directed during period of normal system loading.
   2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
   3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
   4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

D. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scanning of each panelboard. Remove panel fronts so joints and connections are accessible to portable scanner.
   1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   2. Record of Infrared Scanning: Prepare a certified report that identifies panelboards checked and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 CLEANING

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

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SECTION 26 27 26
WIRING DEVICES

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. General
   1. Single and duplex receptacles
   2. Ground-fault circuit interrupter receptacles
   3. Surge protective receptacles
   4. Single- and double-pole snap switches.
   5. Device wall plates.
   6. Pin and sleeve connectors and receptacles.
   7. Floor service fittings
   8. Poke-through assemblies
   9. Access floor boxes
   10. Service/power poles.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. AFCI: Arc-fault circuit interrupter.

D. PVC: Polyvinyl chloride.

E. RFI: Radio-frequency interference.

F. SPD: Surge protective devices.

G. UTP: Unshielded twisted pair.

H. USB: Universal serial bus.

1.4 REFERENCES

A. DSCC W-C-596G: Federal Specification Connector, Electrical, Power, General Specification.

B. DSCC W-C-896F: Federal Specification Switches, Toggle (Toggle and Lock), Flush Mounted (General Specification).

C. IEC 309-1, Part 1: General Requirements: Plugs, Socket-Outlets and Couplers for Industrial Purposes

D. NEMA FB 11: Plugs, Receptacles, and Connectors of the Pin and Sleeve Type for Hazardous Locations.

E. NEMA WD 1: General Requirements for Wiring Devices.

F. NEMA WD 6: Wiring Device – Dimensional Requirements.

G. UL 20: General-Use Snap Switches.

H. UL 486A: Wire Connectors and Soldering Lugs for Use with Copper Conductors.

I. UL 498: Electrical Attachment Plugs and Receptacles.

J. UL 943: Ground Fault Circuit Interrupters.

K. NECA 130-2010:Installing and Maintaining Wiring Devices.

1.5 SUBMITTALS

A. Product Data: Provide manufacturer’s catalog information showing dimensions, colors, and configurations for each type of product indicated.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and source.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70,

Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

1.7 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Surge Protective Receptacles: One for every 10 of each type installed, but no fewer than two of each type.

PART 2 - PRODUCTS

2.1 GENERAL WIRING DEVICE REQUIREMENTS

A. Comply with NFPA 70, NEMA WD 1, NEMA WD 6, and UL498.

B. Devices for Owner-Furnished Equipment:
   1. Receptacles: Match plug configurations.
   2. Cord and Plug Sets: Match equipment requirements.

C. Device Color:
   1. Wiring Devices Connected to Normal Power System: As selected by Architect, unless otherwise indicated or required by NFPA 70 or device listing.
   2. Wiring Devices Connected to Emergency Power System: Red.
   3. Surge Protective Devices: Blue.
   4. Wall Switches: As selected by Architect, unless otherwise indicated.

2.2 STANDARD GRADE RECEPTACLES

A. Duplex Receptacle, NEMA 5-20R:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Hubbell Wire Device-Kellems: 5352
      b. Eaton/Arrow Hart Wiring Devices: 5362
      c. Leviton: 5362
      d. Legrand, Pass & Seymour: 5362

B. Tamper-Resistant Duplex Receptacle, NEMA 5-20R:
   1. Safety mechanism to energize contacts only when both openings are simultaneously engaged.
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Hubbell Wiring Device-Kellems: 5362TR
      b. Eaton/Arrow Hart Wiring Devices: AHTR5362
      c. Leviton: 5362-SG

d. Legrand, Pass & Seymour: TR5362

C. Weather-Resistant Duplex Receptacle, NEMA 5-20R:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Hubbell Wire Device-Kellems: BR20WR
b. Eaton/Arrow Hart Wiring Devices: WRBR20
c. Leviton: WBR20
d. Legrand, Pass & Seymour: WR20TR

D. Weather- and Tamper-Resistant Duplex Receptacle, NEMA 5-20R:
1. Safety mechanism to energize contacts only when both openings are simultaneously engaged.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Hubbell Wire Device-Kellems: BR20WRTR
b. Eaton/Arrow Hart Wiring Devices: TWRBR20
c. Leviton: TWR20
d. Legrand, Pass & Seymour: WR5352TR

2.3 GFCI RECEPTACLES

A. General:
1. Comply with UL 943

B. Duplex GFCI Receptacle, NEMA 5-20R:
1. Manufacturers: Subject to compliance with requirements, provide one of the following:
a. Hubbell Wiring Device-Kellems: GFRST20
b. Eaton/Arrow Hart Wiring Devices: SGF20
c. Leviton: GFNT2
d. Legrand, Pass & Seymour: 2097

C. Tamper-Resistant Duplex GFCI Receptacle, NEMA 5-20R:
1. Safety mechanism to energize contacts only when both openings are simultaneously engaged.
2. Manufacturers: Subject to compliance with requirements, provide one of the following:
a. Hubbell Wiring Device-Kellems: GFTRST20
b. Eaton/Arrow Hart Wiring Devices: TRSGF20
c. Leviton: GFTR2
d. Legrand, Pass & Seymour: 2097TR

D. Tamper- and Weather-Resistant Duplex GFCI Receptacle, NEMA 5-20R:
1. Safety mechanism to energize contacts only when both openings are simultaneously engaged.
2. Manufacturers: Subject to compliance with requirements, provide one of the following:
a. Hubbell Wiring Device-Kellems: GFTWRST20
b. Eaton/Arrow Hart Wiring Devices: TWRSGF20
c. Leviton: GFWT2
d. Legrand, Pass & Seymour: 2097TRWR

E. Weather-Resistant Duplex GFCI Receptacle, NEMA 5-20R:

1. Manufacturers: Subject to compliance with requirements, provide one of the following:
   a. Eaton/Arrow Hart Wiring Devices WRSGF20
   b. Leviton: GFWR2
   c. Legrand, Pass & Seymour: 2097TRWR

F. Dead Front GFCI, 20A:
1. Manufacturers: Subject to compliance with requirements, provide one of the following:
   a. Hubbell Wiring Device-Kellems: GFBFST20
   b. Eaton/Arrow Hart Wiring Devices: SGF20
   c. Leviton: GFRBF
   d. Legrand, Pass & Seymour: 2087

2.4 SURGE PROTECTION DEVICE RECEPTACLES

A. Duplex Surge Protective Receptacle, NEMA 5-20R:
1. Integral surge protection in line to ground, line to neutral, and neutral to ground.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Hubbell Wiring Device-Kellems: HBL 5360S
   b. Eaton/Arrow Hart Wiring Devices: 5350_S
   c. Leviton: 5380
   d. Legrand, Pass & Seymour: 8300SP

2.5 WALL SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Hubbell Wiring Device-Kellems: 1220 Series
2. Eaton/Arrow Hart Wiring Devices: AH1220 Series
3. Leviton: 1220 Series
4. Legrand, Pass & Seymour: PS20AC Series Office Areas
5. Hubbell Wiring Device-Kellems: 2100 Series
6. Eaton/Arrow Hart Wiring Devices: 7630
7. Leviton: 5621 Series
8. Legrand, Pass & Seymour: 2624

B. Device body: Plastic handle.

C. Single- and Double-Pole Switches: Comply with DSCC W-C-896F and UL 20.

D. Snap Switches: Heavy Duty specification grade, quiet type; rated 20A., 120-277 V AC.

E. Provide single-pole, two-pole, three-way and four-way switches as indicated.

F. Provide pilot light where indicated. Switch shall be illuminated when the switch is off.

G. Provide key type where indicated. Furnish four keys to Owner.

H. Combination Switch and Receptacle: Both devices in a single gang unit with plaster ears and removable tab connector that permit separate or common feed connection.
1. Switch: 20 A, 120/277-V ac.
2. Receptacle: NEMA WD 6, Configuration 5-20R.

2.6 WALL PLATES

A. Manufacturers:
   1. Provide wall plates and corresponding wiring devices from same manufacturer.

B. Single and combination types to match corresponding wiring devices.
   1. Plate-Securing Screws: Metal with head color to match plate finish.
   2. Material for Finished Spaces:
      a. 0.035-inch- thick, satin-finished stainless steel
   3. Material for Unfinished Spaces:
      a. Galvanized steel
   4. Material for Wet Locations: Gasketed Cast aluminum with hinged cover and listed and labeled as Extra Duty Weatherproof While-In-Use.
      a. Manufacturers:
         1) Hubbell: MX3200
         2) Red Dot Model: CKLSVU, Thomas & Betts
         3) Intermatic: WP3110MXD
         4) Leviton: IUM1V
   5. Material for Damp Locations: Gasketed Cast aluminum with hinged cover and listed and labeled as Weatherproof.
      a. Manufacturers:
         1) Red Dot Model CCGV, ABB Installation Products
         2) Eaton/Arrow Hart WLRD1
         3) Legrand, Pass & Seymour
         4) Intermatic: WP3110MXD

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Prior to installation of devices, verify wall openings are neatly cut and will be completely covered by wall plates, clean debris from outlet boxes and provide extension rings to bring outlet boxes flush with finished surface.

C. Install devices and assemblies level, plumb, and square with building lines.

D. Arrangement of Devices:
   1. Coordinate locations of outlet boxes provided under Division 26 Section "Raceways and Boxes" to obtain mounting heights indicated on Drawings.
   2. Unless otherwise indicated, mount flush, with long dimension vertical, and with grounding terminal of receptacles on top.
   3. Where multiple switches, dimmers, and/or occupancy sensors are adjacent to each other, provide a single cover plate. Custom fabricate, if required, for all combinations. Provide separate boxes or barriers as required for the application.
   4. Install horizontally mounted receptacles with grounding pole on the left.
   5. Install GFCI receptacles so that the "Push To Test" and "Reset" designations can be read correctly. If printed in both directions, install with ground pole on top.
   6. Install switches with OFF position down.

E. Install cover plates on switch, receptacle, and blank outlets in finished areas.

F. Install weather-resistant type receptacles in all damp and wet locations.

G. Install weatherproof cover plates on receptacles in damp locations.

H. Install weatherproof While-In-Use cover plates on receptacles in wet locations.

I. Install tamper-resistant type receptacles in all locations as required by the NEC (406.12) and as indicated on plan.

J. Use oversized plates for outlets installed in masonry walls.

K. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.

L. Remove wall plates and protect devices and assemblies during painting.

M. Adjust devices and wall plates to be flush and level. Three corners of wall plates must be in contact with wall surfaces. Devices shall be solidly mounted against the box.

3.2 IDENTIFICATION

A. Comply with Division 26 Section "Electrical Identification."
   1. Receptacles: Identify panelboard and circuit number from which served. Use adhesive label as specified in Division 26 Section “Electrical Identification” with black-filled lettering on back side of wall plate, and durable wire markers or tags inside outlet boxes.
   2. Wall Switches: Identify panelboard and circuit number from which served. Use adhesive label as specified in Division 26 Section “Electrical Identification” with black-filled lettering on back side of wall plate, and durable wire markers or tags inside outlet boxes.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding." Connect wiring device grounding terminal to outlet box with bonding jumper. Use of quick ground strap or screw is not acceptable.

B. Connect wiring according to Division 26 Section "Conductors and Cables." Connect wiring devices by wrapping conductor around screw terminal or by using back wiring and tightening the screw securely.

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. Inspect each wiring device for defects.
   2. Operate each wall switch with circuit energized and verify proper operation.
   3. After installing wiring devices and after electrical circuitry has been energized, test each receptacle for proper polarity, ground continuity, and compliance with requirements.
   4. Test each GFCI receptacle for proper operation with both local and remote fault simulations according to manufacturer's written instructions.

B. Remove malfunctioning units, replace with new units, and retest as specified above.

END OF SECTION 26 27 26

SECTION 26 28 13
FUSES

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Cartridge fuses rated 600 V and less for use in switches, controllers.
   2. Spare-fuse cabinets.

1.3 SUBMITTALS

A. Product Data: Include the following for each fuse type indicated:
   1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
   2. Let-through current curves for fuses with current-limiting characteristics.
   3. Time-current curves, coordination charts and tables, and related data.
   4. Fuse size for elevator feeders and elevator disconnect switches.

B. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
   1. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
   2. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.

C. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals.
   1. In addition to items specified in Division 1 Section "Closeout Procedures" and "Operation and Maintenance Data" include the following:
      a. Let-through current curves for fuses with current-limiting characteristics.
      b. Time-current curves, coordination charts and tables, and related data.
      c. Ambient temperature adjustment information.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with:
   1. NEMA FU 1 – Low Voltage Cartridge Fuses.
   2. NFPA 70 – National Electrical Code.
   3. UL 198C – High-Interrupting-Capacity Fuses, Current-Limiting Types.
   4. UL 198E – Class R Fuses.
   5. UL 512 – Fuseholders.

1.5 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.6 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: Quantity equal to 10% percent of each fuse type and size, but no fewer than 3 of each type and size.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper Bussmann, Inc.
   2. Eagle Electric Mfg. Co., Inc.; Cooper Industries, Inc.
   3. Ferraz Shawmut, Inc.
   4. Tracor, Inc.; Littelfuse, Inc. Subsidiary.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage.
   1. Feeders: Class RK1, time delay
   2. Motor Branch Circuits: Class RK5, time delay.
   3. Other Branch Circuits: Class RK1, time delay.

2.3 SPARE-FUSE CABINET

A. Cabinet: Wall-mounted, 0.05-inch- thick steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
   1. Size: 30 inches high by 24 inches wide by 12 inches deep.
   2. Finish: Gray, baked enamel.
   3. Identification: "SPARE FUSES" in 1-1/2-inch- high letters on exterior of door.
   4. Fuse Pullers: For each size of fuse.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

B. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Fuses shall be shipped separately. Any fuses shipped installed in equipment, shall be replaced by the Electrical Contractor with new fuses as specified above prior to energization at no additional expense to Owner. All fuses shall be stored in moisture free packaging at job site and shall be installed immediately prior to energization of the circuit in which it is applied.

B. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

C. Install spare-fuse cabinet(s).

3.3 IDENTIFICATION

A. Install labels indicating fuse rating and type on outside of the door on each fused switch.

END OF SECTION 26 28 13

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SECTION 26 28 16
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

B. Related Sections include the following:
   1. Division 26 Section “Fuses”.

1.2 SUMMARY

A. This Section includes the following individually mounted, enclosed switches and circuit breakers:
   1. Fusible switches.
   2. Nonfusible switches.
   3. Molded-case circuit breakers.
   4. Molded-case switches.

B. Related Sections:
   1. Division 26 “Hangers and Supports for Electrical Systems” for concrete bases.

C. GD: General duty.

D. GFCI: Ground-fault circuit interrupter.

E. HD: Heavy duty.

F. RMS: Root mean square.

G. SPDT: Single pole, double throw.

1.3 REFERENCES

A. NECA 1: Practices for Good Workmanship in Electrical Contracting.

B. NETA ATS: Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

C. NEMA 250: Enclosures for Electrical Equipment (1000 Volts Maximum).

D. NEMA AB 1: Molded Case Circuit Breakers and Molded Case Switches.

E. NEMA FU 1: Low Voltage Cartridge Fuses.

F. NEMA KS 1: Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

G. NEMA PB1.1: General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less.

H. NEMA PB2.1: General Instructions for Proper Installation, Operation, and Maintenance of Deadfront Switchboards Rated 600 Volts or Less.

I. NFPA 70: National Electrical Code.

1.4 SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
   1. Enclosure types and details for types other than NEMA 250, Type 1.
   2. Current and voltage ratings.
   3. Short-circuit current rating.
   4. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Qualification Data: For testing agency.

D. Field quality-control test reports including the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Closeout Procedures" and "Operation and Maintenance Data" include the following:
   1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
   2. Time-current curves, including selectable ranges for each type of circuit breaker.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
   1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
   2. Altitude: Not exceeding 6600 feet.

1.7 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Spares: For the following:
      a. Potential Transformer Fuses: 2 of each size and type.
      b. Control-Power Fuses: 2 of each size and type
      c. Fuses for Fusible Switches: Equal to 10 percent of amount installed for each size and type, but no fewer than 3 of each size and type.
   2. Spare Indicating Lights: Six of each type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FUSIBLE AND NONFUSIBLE SWITCHES

A. Manufacturers:
1. Eaton Corporation; Cutler-Hammer Products.
2. General Electric Co.; Electrical Distribution & Control Division.
3. Siemens Industries, Inc.
4. Square D/Group Schneider.

B. Fusible Switch: NEMA KS 1, quick make, quick-break load interrupter enclosed knife switch Type HD, with clips or bolt pads to accommodate specified fuses, externally operable lockable handle with capability to accept two padlocks and interlocked with cover in closed position.

C. Nonfusible Switch: NEMA KS 1, quick make, quick-break load interrupter enclosed knife switch Type HD, externally operable lockable handle with capability to accept two padlocks and interlocked with cover in closed position.

D. Accessories:
1. Provide early break auxiliary contacts in motor disconnect switches for motors that are fed from variable frequency controllers.
2. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
3. Neutral Kit: Internally mounted; insulated, capable of being grounded, and bonded; and labeled for copper and aluminum neutral conductors.
4. Auxiliary Contact Kit: Auxiliary set of contacts arranged to open before switch blades open.

2.3 TOGGLE DISCONNECT SWITCH

A. Manufacturers:
1. Double Pole:
   a. Hubbell 1372.
   b. Leviton 3032-2W.
   c. Pass & Seymour 7812.
   d. Bryant 30102.
2. Three Pole:
   a. Hubbell 1379.
   b. Leviton MS303-DSW.
   c. Pass & Seymour 7813.
   d. Bryant 30103.

B. Description: Heavy duty, 30A, 600 volt, double or three pole as required, single throw, motor rated switch without overload protection. Provide NEMA 1 enclosure and padlock attachment.

2.4 MOLDED-CASE CIRCUIT BREAKERS AND SWITCHES

A. Manufacturers:
1. Eaton Corporation; Cutler-Hammer Products.
2. General Electric Co.; Electrical Distribution & Control Division.
3. Siemens Industries, Inc.
4. Square D/Group Schneider.

B. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault

currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic Trip-Unit Circuit Breakers: RMS sensing; field-replaceable rating plug; with the following field-adjustable settings:
    a. Instantaneous trip.
    b. Long- and short-time pickup levels.
    c. Long- and short-time time adjustments.
    d. Ground-fault pickup level, time delay, and I^2t response.
4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller and let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and two-pole configurations with 5 or 30-mA trip sensitivity as required.

C. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.

1. Lugs: Mechanical style suitable for number, size, trip ratings, and conductor material.
2. Application Listing: Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
3. Enclosure: Provide handle capable of being locked in the open position with padlock.
4. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
5. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."
6. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
7. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
8. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
9. Circuit breaker selection for primary

D. Circuit Breaker Selection for Transformer Primary Protection: Provide circuit breakers with time-current characteristics to clear transformer inrush currents while still providing protection for the ANSI through-fault protection curve. Provide circuit breakers with adjustable magnetic trip or electronic trip units as necessary to provide time-current curve shaping to achieve long time trip indicated on drawings, inrush coordination and damage protection.

2.5 ENCLOSURES

A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.

1. Indoor Dry Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 3R.
3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONCRETE BASES

A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.

B. Concrete base is specified in Division 26 Section "Hangers and Supports for Electrical Systems," and concrete materials and installation requirements are specified in Division 3.

3.3 INSTALLATION

A. Comply with applicable portions of NECA 1, NEMA PB 1.1, and NEMA PB 2.1 for installation of enclosed switches and circuit breakers.

B. Mount individual wall-mounting switches and circuit breakers with tops at uniform height, unless otherwise indicated. Anchor floor-mounting switches to concrete base.

C. Install switches with off position down.

D. Install NEMA KS 1 enclosed switch where indicated for motor loads ½ HP and larger and equipment loads greater than 30A.

E. Install toggle disconnect switch, surface mounted, where indicated for motor loads less than ½ HP and equipment loads 30A. and less.

F. Install fuses in fusible disconnect switches.

G. Install flexible liquid tight conduit from toggle disconnect switch to portable equipment. Leave a 6’-0” whip.

H. Install flexible liquid tight conduit from toggle disconnect switch to stationary equipment.

I. Install control wiring from early break contacts in motor disconnect switch to variable frequency controllers to shut down controller when switch is open.

J. Install equipment on exterior foundation walls at least one inch from wall to permit vertical flow of air behind breaker and switch enclosures.

K. Support enclosures independent of connecting conduit or raceway system.

L. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Electrical Identification."

B. Enclosure Nameplates: Label each enclosure with engraved metal or laminated-plastic nameplate as specified in Division 26 Section "Electrical Identification."

C. Provide adhesive label as specified in Division 26 Section "Electrical Identification" on inside door of each switch indicating UL fuse class and size for replacement.

3.5 FIELD QUALITY CONTROL

A. Prepare for acceptance testing as follows:
   1. Inspect mechanical and electrical connections.
   2. Verify switch and relay type and labeling verification.
   3. Verify rating of installed fuses.

B. Perform the following field tests and inspections and prepare test reports:
   1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches. Certify compliance with test parameters.
   2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.6 for molded-case circuit breakers. Test all NEMA AB1, molded case circuit breakers with thermal magnetic trip or auxiliary, solid-state trip units 100A and larger. Certify compliance with test parameters.
      a. Visual and Mechanical Inspection
         1) Circuit breaker shall be checked for proper mounting and compare nameplate data to Drawings and Specifications.
         2) Operate circuit breaker to ensure smooth operation.
         3) Inspect case for cracks or other defects.
         4) Check internals on unsealed units.
      b. Electrical Tests
         1) Perform a contact resistance test.
         2) Perform an insulation resistance test at 1000 volts dc from pole-to-pole and from each pole-to-ground with breaker closed and across open contacts of each phase.
         3) Perform long time delay time-current characteristic tests by passing three hundred percent (300%) rated current through each pole separately. Record trip time. Make external adjustments as required to meet time current curves.
         4) Determine short time pickup and delay by primary current injection.
         5) Determine ground fault pickup and time delay by primary current injection.
         6) Determine instantaneous pickup current by primary injection using run-up or pulse method.
         7) Perform adjustments for final settings in accordance with coordination study.
         8) For circuit breakers 800A and larger, verify all functions of trip unit by means of secondary injection in lieu of primary injection.
      c. Test Values
         1) Compare contact resistance or millivolt drop values to adjacent poles and similar breakers. Investigate deviations of more than fifty percent (50%). Investigate any value exceeding manufacturer's recommendations.
         2) Insulation resistance shall not be less than 100 megohms.

3) Trip characteristic of breakers shall fall within manufacturer's published time-current characteristic tolerance band, including adjustment factors.
4) All trip times shall fall within N.E.T.A. Acceptance Testing Specifications, Table 10.7 Circuit breakers exceeding specified trip time at three hundred percent (300%) of pickup shall be tagged defective.
5) Instantaneous pickup values shall be within values shown on N.E.T.A. Acceptance Testing Specifications, Table 10.8 or manufacturer's recommendations.

3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.6 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip and time delay settings to values as determined by the protective device coordination study.

3.7 CLEANING

A. On completion of installation, vacuum dirt and debris from interiors; do not use compressed air to assist in cleaning.

B. Inspect exposed surfaces and repair damaged finishes.

END OF SECTION 26 28 16

SECTION 26 29 13
ENCLOSED CONTROLLERS

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes ac, enclosed controllers rated 600 V and less, of the following types:
   1. Across-the-line, manual and magnetic controllers.
   2. Reduced-voltage controllers.
   3. Multispeed controllers.

B. Related Sections include the following:
   1. Division 20 Section "Variable Frequency Controllers" for general-purpose, ac, adjustable-frequency, pulse-width-modulated controllers for use on constant torque loads in ranges up to 200 hp.
   2. Division 26 “Hangers and Supports for Electrical Systems” for concrete bases.

1.3 SUBMITTALS

A. Product Data: For each type of enclosed controller. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each enclosed controller.
   1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
      a. Each installed unit's type and details.
      b. Nameplate legends.
      c. Short-circuit current rating of integrated unit.
      d. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices in combination controllers.
   2. Wiring Diagrams: Power, signal, and control wiring.

C. Qualification Data: For manufacturer.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Closeout Procedures” and “Operation and Maintenance Data" include the following:
   1. Routine maintenance requirements for enclosed controllers and all installed components.

F. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

1.4 REFERENCES

A. ANSI/NEMA ICS 6 - Enclosures for Industrial Controls and Systems.

B. ANSI/UL 198C - High-Intensity Capacity Fuses; Current-Limiting Types.

C. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service.

D. FS W-F-870 - Fuseholders (For Plug and Enclosed Cartridge Fuses).

E. FS W-S-865 - Switch, Box, (Enclosed), Surface-Mounted.

F. NEMA AB 1 - Molded Case Circuit Breakers.

G. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies.

H. NEMA KS 1 - Enclosed Switches.

I. ANSI/NFPA 70 - National Electrical Code.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
   1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Source Limitations: Obtain enclosed controllers of a single type through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with NFPA 70.

F. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed controllers, minimum clearances between enclosed controllers, and for adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prior to beginning work on any system, verify all existing conditions that affect the work and coordinate with all other trade Contractors. Determine that the work can be installed as indicated or immediately report to the Architect/Engineer errors, inconsistencies or ambiguities.

B. Deliver products to site under provisions of Section 26 00 10. Store and protect products under provisions of Section 26 00 10.

C. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

D. Handle in accordance with manufacturer's written instructions. Lift large equipment only with lugs provided for the purpose. Handle carefully to avoid damage to motor control center components, enclosure, and finish.

E. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

1.7 PROJECT RECORD DOCUMENTS

A. Accurately record actual locations of each contactor and indicate circuits controlled. Submit under provisions of 26 00 10.

1.8 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
   1. Notify Construction Manager no fewer than seven days in advance of proposed interruption of electrical service.
   2. Indicate method of providing temporary utilities.
   3. Do not proceed with interruption of electrical service without Construction Manager's written permission.

1.9 COORDINATION

A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3 Section "Cast-in-Place Concrete."

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

D. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.

E. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.10 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Spare Fuses: Furnish one spare for every five installed, but no fewer than one set of three of each type and rating.
   2. Indicating Lights: Two of each type installed.
   3. Keys: Furnish 2 of each to Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. ABB Power Distribution, Inc.; ABB Control, Inc. Subsidiary.
   2. Danfoss Inc.; Danfoss Electronic Drives Div.
   3. Eaton Corporation; Cutler-Hammer Products.
   4. General Electrical Company; GE Industrial Systems.
   5. Rockwell Automation; Allen-Bradley Co.; Industrial Control Group.

6. Siemens/Furnas Controls.
7. Square D.

2.2 ACROSS-THE-LINE ENCLOSED CONTROLLERS

A. Manual Controller: NEMA ICS 2, general purpose, Class A, with "quick-make, quick-break" toggle or pushbutton action, and marked to show whether unit is "OFF," "ON," or "TRIPPED."
   1. Overload Relay: Ambient-compensated type with inverse-time-current characteristics and NEMA ICS 2, Class 10 tripping characteristics. Relays shall have heaters and sensors in each phase, matched to nameplate, full-load current of specific motor to which they connect and shall have appropriate adjustment for duty cycle.

B. Magnetic Controller: NEMA ICS 2, Class A, full voltage, nonreversing, across the line, unless otherwise indicated.
   1. Control Circuit: 120 V; obtained from integral control power transformer with sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.
   2. Adjustable Overload Relay: Dip switch selectable for motor running overload protection with NEMA ICS 2, Class 20 tripping characteristic, and selected to protect motor against voltage and current unbalance and single phasing. Provide relay with Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.

C. Combination Magnetic Controller: Factory-assembled combination controller and disconnect switch.
   1. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by an NRTL.

2.3 REDUCED-VOLTAGE ENCLOSED CONTROLLERS

A. Star-Delta Controller: NEMA ICS 2, closed transition with adjustable time delay.

B. Part-Winding Controller: NEMA ICS 2, closed transition with separate overload relays for starting and running sequences.

C. Autotransformer Reduced-Voltage Controller: NEMA ICS 2, closed transition.

D. Solid-State, Reduced-Voltage Controller: NEMA ICS 2, suitable for use with NEMA MG 1, Design B, polyphase, medium induction motors.
   1. Adjustable acceleration rate control utilizing voltage or current ramp, and adjustable starting torque control with up to 500 percent current limitation for 20 seconds.
   2. Surge suppressor in solid-state power circuits providing 3-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
   3. LED indicators showing motor and control status, including the following conditions:
      a. Control power available.
      b. Controller on.
      c. Overload trip.
      d. Loss of phase.
      e. Shorted silicon-controlled rectifier.
   4. Coil operating voltage: 120 volts secondary, 60 hertz.

2.4 MULTISPEED ENCLOSED CONTROLLERS

A. Multispeed Enclosed Controller: Match controller to motor type, application, and number of speeds; include the following accessories:
   1. Compelling relay to ensure that motor will start only at low speed.
   2. Accelerating relay to ensure properly timed acceleration through speeds lower than that selected.
   3. Decelerating relay to ensure automatically timed deceleration through each speed.

2.5 VARIABLE FREQUENCY CONTROLLERS

A. Refer to Division 20 “Variable Frequency Controllers.”

B. Equipment furnished by mechanical trades and installed by electrical trades.

2.6 ENCLOSURES

A. Description: Flush- or surface-mounting cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.
   1. Outdoor Locations: NEMA 250, Type 3R.
   2. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

2.7 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.

B. Push-Button Stations, Pilot Lights: NEMA ICS 2, heavy-duty type.

C. Indicating Lights: Run (Red), off or ready (Green).

D. Auxiliary Contacts: Provide two normally open (N.O.) and two normally closed (N.C.) contacts.

E. Selector Switch: NEMA ISC 2, mounted in front cover to read “hand/off/auto,” provide auxiliary contact for auto position monitoring.

F. Control Relays: Auxiliary and adjustable time-delay relays.

G. Manufacturer provided nameplate shall be provided on controller enclosure. Nameplate shall contain the following information:
   1. Manufacturer’s name or identification.
   2. Voltage rating.
   3. Current and/or horsepower rating.
   4. Short-circuit current rating.

2.8 FACTORY FINISHES

A. Enclosure Finish: The enclosure shall be finished with gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive enclosed controllers for compliance with requirements, installation tolerances, and other conditions affecting performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Select features of each enclosed controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, controller, and load; and configuration of pilot device and control circuit affecting controller functions.

B. Select horsepower rating of controllers to suit motor controlled.

3.3 INSTALLATION

A. For control equipment at walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

B. Install freestanding equipment on concrete bases.

C. Comply with mounting and anchoring requirements specified in Division 26 Section "Hangers and Supports for Electrical Systems."

D. Enclosed Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 26 Section "Fuses."

E. Install motor control equipment and contactors in accordance with manufacturer’s instructions.

F. Select and install heater elements in motor starters to match installed motor characteristics.

G. Motor Data: Provide neatly typed label inside each motor starter enclosure door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.

3.4 CONCRETE BASES

A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.

B. Concrete base is specified in Division 26 Section "Hangers and Supports for Electrical Systems," and concrete materials and installation requirements are specified in Division 3.

3.5 IDENTIFICATION

A. Identify enclosed controller, components, and control wiring according to Division 26 Section "Electrical Identification."

3.6 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers according to Division 26 Section "Conductors and Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic-control devices where applicable.
   1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
   2. Connect selector switches with enclosed controller circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.7 CONNECTIONS

A. Conduit installation requirements are specified in other Division 26 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.

B. Ground equipment according to Division 26 Section "Grounding and Bonding."

3.8 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:
   1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:
   1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
   2. Assist in field testing of equipment including pretesting and adjusting of solid-state controllers.
   3. Report results in writing.

C. Testing: Perform the following field quality control tests in accordance with Division 26 section “Electrical Testing”
   1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS, "**Motor Control - Motor Starters** and **Motor Control - Adjustable Speed Drive Systems**." Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.9 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers. Refer to Division 1 Sections "Closeout Procedures" and "Demonstration and Training".

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SECTION 26 32 13
PACKAGED ENGINE GENERATORS

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

1.2 SUMMARY

A. This Section includes packaged engine generator sets for emergency power supply with the following features:
   1. Gas engine.
   2. Unit-mounted control and monitoring.
   3. Outdoor enclosure.
   4. Temporary Generator Docking Station

B. Related Sections include the following:
   1. Division 26 Section "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.
   2. Division 26 “Hangers and Supports for Electrical Systems” for concrete bases.

1.3 DEFINITIONS

A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

B. Steady-State Voltage Modulation: The uniform cyclical variation of voltage within the operational bandwidth, expressed in Hertz or cycles per second.

1.4 SUBMITTALS

A. Product Data: Submit product data under provisions of Section 26 00 10. Include the following:
   1. Data on features, components, accessories ratings, and performance.
   2. Thermal damage curve for generator.
   3. Time-current characteristic curves for generator protective device.
   4. Manufacturer’s anchorage and base recommendations.

B. Shop Drawings: Submit shop drawings under provisions of Section 26 01 00. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Submit shop drawings showing plan and elevation views with overall interconnection point dimensions, fuel consumption rate curves at various loads, ventilation and combustion air requirements, and electrical diagrams including schematic and interconnection diagrams.
   2. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
   3. Internal Wiring Diagrams: For engine, generator, control panel, battery, battery rack, battery charger, exhaust silencer, vibration isolators, day tank, remote radiator, and remote annunciator.

C. Qualification Data: For manufacturer.

D. Source quality-control test reports.
   1. Certified summary of prototype-unit test report.
   2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
   3. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
   4. Report of sound generation.
   5. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1, include the following:
   1. List of tools and replacement items recommended to be stored at the Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.

2. Include instructions for normal operation, routine maintenance requirements, service manuals for engine and day tank, oil sampling and analysis for engine wear, and emergency maintenance procedures.

G. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
1. Maintenance Proximity: Not more than four hours' normal travel time from Installer's place of business to Project site.
2. Engineering Responsibility: Preparation of data for vibration isolators and seismic restraints of engine skid mounts, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 200 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

C. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

D. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

E. Product Options: Drawings indicate size, profiles, and dimensional requirements of packaged generator sets and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

G. Comply with NFPA 30.

H. Comply with NFPA 37.

I. Comply with NFPA 70.

J. UL2200 Listed and labeled

K. Comply with NFPA 110 requirements for Level 1 emergency power supply system.

L. Comply with NECA/EGSA 404-2000 – Recommended Practice for Installing Generator Sets.

M. Engine Exhaust Emissions: Comply with applicable state and local government requirements.
1. Provide engines used for standby applications that carry certification of compliance with current EPA emissions requirements or provide engines which comply with EPA emissions requirements and provide the necessary field testing to certify EPA emissions compliance.

N. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork shall meet load requirements. Requirements for concrete bases for electrical equipment are specified in Division 26 “Hangers and Supports for Electrical Systems.”

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.
1. Warranty Period: Five years from date of Substantial Completion.
2. If the engine-generator is not functional for a period longer than 24 hours during the warranty period, provide a portable generator to serve all loads connected to the generator until the existing, on site, generator is repaired.

1.8 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Maintenance agreements shall include parts and supplies as used in manufacture and installation of original equipment.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Fuses: One for every 10 of each type and rating, but not less than one of each.
2. Indicator Lamps: Two for every six of each type used, but not less than two of each.
3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
1. Caterpillar; Engine Div.
2. Kohler Co; Generator Division.

3. Onan Corp./Cummins Power Generation; Industrial Business Group.
4. MTU/Onsite Energy.
5. Generac.

2.2 ENGINE-GENERATOR SET

A. Packaged engine-generator set shall be a coordinated assembly of compatible components.

B. Safety Standard: Comply with ASME B15.1 and UL 2200.

C. Mounting Frame: Adequate strength and rigidity to maintain alignment of mounted components without depending on concrete foundation. Mounting frame shall be free from sharp edges and corners and shall have lifting attachments arranged for lifting with slings without damaging components.

D. Capacities and Characteristics:
1. Power Output Ratings: Nominal ratings as indicated
2. Output Connections: Three-phase, four wire.
3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

E. Generator set performance:
1. Steady-State Voltage Operational Bandwidth: 4 percent of rated output voltage from no load to full load.
2. Steady-State Voltage Modulation Frequency: Less than 1 Hz.
3. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
4. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
5. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
6. Transient Frequency Performance: Less than 5 percent variation for a 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
7. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. The telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
8. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, the system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.

F. Provide guards for all external rotating parts to prevent accidental injury. Guards shall be securely bolted to the generator but removable for maintenance. Guards shall be painted with a rust inhibiting primer and an epoxy based gloss topcoat. Guards shall comply with OSHA requirements.

G. Service Conditions:
1. Environmental Conditions: Engine-generator system shall withstand the following

environmental conditions without mechanical or electrical damage or degradation of performance capability:
a. Ambient Temperature: Minus 15 to plus 40 deg C.
b. Altitude: Rated for altitude at project location.

2.3 ENGINE

A. Fuel: Natural Gas

B. Rated Engine Speed: 1800 rpm.

C. Lubrication System: The following items are mounted on engine or skid:
1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

D. Engine Fuel System:
1. Natural Gas
a. Carburetor.
b. Secondary Gas Regulator.
c. Fuel-Shutoff Solenoid Valve.
d. Flexible Fuel Connectors.

E. Coolant Jacket Heater: Thermal circulation type water heater with integral thermostatic control, sized to maintain engine jacket water at 90 degrees F, and suitable for operation on 120 volts AC.

F. Governor: Adjustable Isochronous with speed sensing.

G. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.
1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.
a. Rating: 50-psig maximum working pressure with coolant at 180 deg F, and noncollapsible under vacuum.
b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

H. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
1. Minimum sound attenuation of 25 dB at 500 Hz.

2. Sound level measured at a distance of 10 feet from exhaust discharge after installation is complete shall be **85** dBA or less.

I. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

J. Starting System: 12-V electric, with negative ground.
1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
3. Cranking Cycle: As required by NFPA 110 for system level specified.
4. Battery: Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least twice without recharging.
5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in Part 1 "Project Conditions" Article. Include accessories required to support and fasten batteries in place.
7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
8. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:
    a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
    b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
    c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
    d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
    e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
    f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.4 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation:
1. When mode-selector switch on the control and monitoring panel is in the automatic position, remote control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set.
2. When mode-selector switch is switched to the on position the generator set starts.
3. When mode-selector switch is switched to the off position it initiates generator set

shutdown.

4. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms.
5. Operation of a remote emergency-stop switch also shuts down generator set.

B. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.
   1. Wall-Mounted Cabinet Construction: Rigid, self-supporting steel unit complying with NEMA ICS 6. Power bus shall be copper. Bus, bus supports, control wiring, and temperature rise shall comply with UL 891.
   2. Current and Potential Transformers: Instrument accuracy class.

C. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1 system.

D. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

E. Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data-link transmission of indications to remote data terminals. Data system connections to terminals are covered in Division 26 Section "Electrical Power Monitoring and Control."

F. Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel.

G. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

H. The integrity of the control wiring between the Generator(s) and each Emergency System Automatic Transfer Switch shall be continuously monitored per National Electrical Code Section 700.

2.5 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Circuit Breaker: Insulated-case, electronic-trip type; 100 percent rated; complying with UL 489.
   1. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
   2. Trip Settings: Matched to generator thermal damage curve as closely as possible.
   3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
   4. Mounting: Mount unit in enclosure to meet ANSI/NEMA 250, Type 1 requirements. Adjacent to or integrated with control and monitoring panel.
      a. Where multiple output circuit breakers are provided, the output circuit breaker and load wiring that serves the emergency branch and the fire pump circuit, when required, shall be physically separated from breakers serving standby branches.
   5. Circuit breakers shall be by the same manufacturer of distribution equipment provided and shall selectively provide coordination with downstream circuit breakers.

B. Generator Disconnect Switch: Molded-case type, 100 percent rated.
   1. Rating: Matched to generator output rating.

2. Shunt Trip: Connected to trip switch when signaled by generator protector or by other protective devices.

C. Generator Protector: Microprocessor-based unit that continuously monitors current level in each phase of generator output, integrates generator heating effect over time, and predicts when thermal damage of the alternator will occur. When signaled by the protector or other generator-set protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from the load circuits. Protector shall perform the following functions:
1. Initiates a generator overload alarm when the generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
2. Under single or three-phase fault conditions, regulates the generator to 300 percent of rated full-load current for up to 10 seconds.
3. As the overcurrent heating effect on the generator approaches the thermal damage point of the unit, the protector switches the excitation system off, opens the generator disconnect device, and shuts down the generator set.
4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

2.6 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with ANSI/NEMA MG 1

B. Electrical Insulation: ANSI/NEMA MG 1: Class H or Class F.

C. Temperature Rise: 130 degrees C standby.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

F. Enclosure: ANSI/NEMA MG 1, open drip proof.

G. Instrument Transformers: Mounted within generator enclosure.

H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.
1. Manual adjustment on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.

I. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

J. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

K. Subtransient Reactance: 12 percent, maximum.

2.7 OUTDOOR GENERATOR-SET ENCLOSURE

A. Description: Vandal-resistant, weatherproof steel housing, wind resistant up to 100 mph. Multiple panels shall be lockable and provide adequate access to components requiring maintenance.

Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.

1. Provide sound attenuating enclosure to meet the sound criteria specified in Part 1, "Quality Assurance"

B. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.

1. Louvers: Fixed-engine cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.

2.8 VIBRATION ISOLATION DEVICES

A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

2.9 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard enamel over corrosion-resistant pretreatment and compatible standard primer.

2.10 TEMPORARY GENERATOR DOCKING STATION

A. Description: Docking station for temporary connection of portable generator for use when permanent generator is out of service for testing or repair interlocked circuit breaker transfer controls.

1. Listed to UL 1008

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Trystar
2. ASCO
3. ESL Power Systems

C. Enclosure

1. NEMA 3R
    a. Pad-lockable front door shall include a hinged access plate at the bottom for entry of temporary cabling that prevents unauthorized tampering while in use.
    b. Enclosure Integrity shall be maintained while temporary cabling is connected during use
    c. Front and Side shall be accessible for maintenance
    d. Top, Side, and Bottom shall be accessible for permanent cabling
    e. Free standing, pad mounted
2. Powder coat painted after fabrication.

D. Phase, Neutral, and Ground Busbar

1. Material: Silver-plated Copper
2. Equipment Ground Bus: bonded to box.
3. Ground Bus: 50% of phase size.
4. Neutral Bus: Rated 100 percent of phase bus.

E. Temporary generator connectors:
   1. Series 16 male Cam-Lok style panel mounted connectors.
   2. Connected to bus bar in panel.
   3. Color code according to system voltage requirements.
   4. Protected against accidental contact while not in use
   5. Provide access door with kirk-key interlocked with permanent generator breaker to prevent access to camlok connectors unless generator breaker is open

F. Permanent Connection for line and load connections shall be factory installed, broad range set-screw mechanical type, located behind a physical barrier.

G. Short Circuit & Withstand Rating
   1. Minimum 65K unless otherwise indicated on drawings

H. Voltage & Amperage
   1. As required for the application and as indicated on the drawings.

I. Factory Installed Phase Rotation Monitor Device:
   1. Phase monitoring relay to be Siemens 3U4512-1AR20 or equal and factory installed
   2. Provide fusing for phase rotation monitor

J. Circuit Breakers
   1. UL 489 molded case circuit breakers
   2. Removable for service and maintenance
   3. Provide circuit breakers to match the distribution equipment manufacturer used throughout the facility.
   4. Provide breaker selections to achieve selective coordination where indicated on the drawings.

K. Accessories:
   1. Auto-start connections to match generator system
   2. Strip Heater & Thermostat

2.11 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
   1. Tests: Comply with NFPA 110, Level 1 energy converters and with IEEE 115.

B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
   1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
   2. Full load run.
   3. Maximum power.
   4. Voltage regulation.
   5. Transient and steady-state governing.
   6. Single-step load pickup.
   7. Safety shutdown.

C. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.

B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

D. Beginning of installation means Installer accepts existing conditions.

3.2 INSTALLATION

A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.

B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

C. Install packaged engine generator with vibration isolation devices on concrete base.
   1. Size concrete base as recommended by generator manufacturer.
   2. The top of the concrete pad shall be a minimum of 4” above finished grade or adjacent finished floor.
   3. Secure sets to anchor bolts installed in concrete bases.
   4. Concrete base construction is specified in Division 26 Section "Hangers and Supports for Electrical Systems."
   5. Install condensate drain piping to muffler drain outlet full size of drain connection with a shutoff valve, stainless-steel flexible connector, and Schedule 40, black steel pipe with welded joints. Flexible connectors and piping materials and installation requirements are specified in Division 23 Section "Hydronic Piping."

D. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Division 23 Sections. Drawings indicate general arrangement of piping and specialties.

B. Install fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.

C. Connect cooling-system water piping to engine-generator set and heat exchanger with flexible connectors.

D. Connect engine exhaust pipe to engine with flexible connector.

E. Connect fuel piping to engines with a gate valve and union and flexible connector.
   1. Natural- and LP-gas piping, valves, and specialties for gas distribution outside the building

are specified in Division 2 Section "Natural Gas Distribution."

F. Ground equipment according to Division 26 Section "Grounding and Bonding."

G. Connect wiring according to Division 26 Section "Conductors and Cables."

H. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

I. Connect control wiring between temporary generator docking station and generator controller to monitor MTS status and annunciate when permanent emergency source has been disconnected.

J. Extend start signal control wiring to temporary generator docking station.

K. Connect control wiring from emergency ATS to load bank shunt trip breaker

3.4 IDENTIFICATION

A. Identify system components according to Division 23 Section "Mechanical Identification" and Division 26 “Section Electrical Identification."

3.5 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality control tests in accordance with Division 26 section “Electrical Testing”

B. Perform tests and inspections and prepare test reports.
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Perform the following field tests and inspections and prepare test reports:
1. Provide full load test utilizing portable resistor test bank, for four hours minimum. Simulate power failure including operation of transfer switch, automatic starting cycle, and automatic shutdown, and return to normal. Coordinate with Division 26 Section "Transfer Switches”
2. During test, record the following at 20 minute intervals:
    a. Kilowatts.
    b. Amperes.
    c. Voltage.
    d. Coolant temperature.
    e. Room temperature.
    f. Frequency.
    g. Oil pressure.
3. Test alarm and shutdown circuits by simulating conditions.
4. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections 7.15.2.1 and 7.22.1 (except for vibration baseline test). Certify compliance with test parameters.
5. Perform tests recommended by manufacturer.
6. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, the following:

a. Single-step full-load pickup test.

7. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
   a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
   b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
   c. Verify acceptance of charge for each element of the battery after discharge.
   d. Verify that measurements are within manufacturer's specifications.
8. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
9. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
10. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg. Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
11. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
12. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.
13. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations on the property line and compare measured levels with required values.

D. Coordinate tests with tests for transfer switches and run them concurrently.

E. Test instruments shall have been calibrated within the last 12 months, traceable to standards of the National Institute for Standards and Technology, and adequate for making positive observation of test results. Make calibration records available for examination on request.

F. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

G. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

H. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

I. Remove and replace malfunctioning units and retest as specified above.

J. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

K. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

L. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each power wiring termination and each bus connection. Remove all access panels so terminations and connections are accessible to portable scanner.
   1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.
   2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   3. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

M. Inspect, test and adjust portable generator docking station.
   1. Commission phase rotation monitor to match site electrical distribution.
   2. Install instruction signs indicating bonding requirements to match building system.
   3. Confirm proper operation of portable generator start circuit.
   4. Confirm proper operation of MTS status and annunciation.

3.6 DEMONSTRATION

A. Provide systems demonstration for Owner, Construction Manager and Electrical Engineer.

B. Simulate power outage by interrupting normal source, and demonstrate that system operates to provide emergency power.

C. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Refer to Division 1 Section "Demonstration and Training."
   1. Provide a minimum of two 3-hour training sessions for the Owner’s personnel. One session shall be conducted at time of start-up, the other within three months of start-up.
   2. Training shall include: Review of maintenance procedures and schedule, troubleshooting procedures, demonstration of all alarm and safety functions with appropriate actions to be taken, and review of regular testing and exercising schedule including inspection and observation procedures.
   3. Coordinate with demonstration and training required in Division 26 section “Transfer Switches”.

3.7 CLEANING

A. Clean engine and generator surfaces. Replace oil and fuel filters.

END OF SECTION 26 32 13

SECTION 26 33 23
CENTRAL BATTERY INVERTERS

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Related Sections include the following:
   1. Division 26 Section “Electrical General Requirements.”

1.2 SUMMARY

A. This Section includes fast-transfer central battery inverters with the following features:
   1. Output distribution section.
   2. Internal maintenance bypass/isolation switch.
   3. Emergency-only circuits.

B. Related Sections:
   1. Division 26 “Hangers and Supports for Electrical Systems” for concrete bases.

1.3 DEFINITIONS

A. LCD: Liquid-crystal display.

B. LED: Light-emitting diode.

C. UPS: Uninterruptible power supply.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:
   1. Electrical ratings, including the following:
      a. Capacity to provide power during failure of normal ac.
      b. Inverter voltage regulation and total harmonic distortion of output current.
      c. Rectifier data.
      d. Transfer time of transfer switch.
      e. Data for specified optional features.
   2. Transfer switch.
   3. Inverter.
   4. Battery charger.
   5. Batteries.
   6. Battery monitoring.
   7. Manufacturer’s anchorage and base recommendations.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, components, and location and identification of each field connection. Show access, workspace, and clearance requirements; details of control panels; and battery arrangement.
   1. Wiring Diagrams: Detail internal and interconnecting wiring; and power, signal, and control wiring.
   2. Elevation and details of control and indication displays.
   3. Output distribution section.

1.5 INFORMATIONAL SUBMITTALS

A. Source quality-control test reports.

B. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For central battery inverter equipment to include in emergency, operation, and maintenance manuals specified in Division 1.

B. Warranties: Special warranties specified in this Section.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Central Battery Inverter System: UL 924 listed.

C. Comply with NFPA 70 and NFPA 101.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver equipment in fully enclosed vehicles.

B. Store equipment in spaces having environments controlled within manufacturers' written instructions for ambient temperature and humidity conditions for nonoperating equipment.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace batteries that fail in materials or workmanship within specified warranty period. Special warranty, applying to batteries only, applies to materials only, on a prorated basis, for period specified.

B. Warranty Period: Include the following warranty periods, from date of Substantial Completion.
   1. Premium, Valve-Regulated, Recombinant, Lead-Calcium Batteries:
      a. Full Warranty: One year.
      b. Pro Rata: 19 years.

1.10 COORDINATION

A. Coordinate size and location of concrete bases. Concrete, reinforcement, and formwork shall meet load requirements. Requirements for concrete bases for electrical equipment are specified in Division 26 “Hangers and Supports for Electrical Systems.”

1.11 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to Owner.
   1. Fuses: One for every 10 of each type and rating, but no fewer than three of each.
   2. Cabinet Ventilation Filters: One complete set.
   3. One spare circuit board for each critical circuit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Chloride Systems.

2. Controlled Power Company.
3. Cooper Industries, Inc.; Sure-Lites Division.
4. Dual-Lite.
5. Lithonia Lighting; Emergency Lighting Systems.
6. Myers Power Products, Inc.
7. Thomas & Betts Corporation; Emergi-Lite Corporation Division.

2.2 INVERTER PERFORMANCE REQUIREMENTS

A. Ratings: Provide rated KVA output, input voltage and output voltage as indicated on the drawings.

B. Fast-Transfer Central Battery Inverters: Automatically sense loss of normal ac supply and use a solid-state switch to transfer loads. Transfer in 0.004 second or less from normal supply to battery-inverter supply.
   1. Operation: Unit supplies power to output circuits from a single, external, normal supply source. Unit automatically transfers load from normal source to internal battery/inverter source. Retransfer to normal is automatic when normal power is restored.

C. Maximum Acoustical Noise: 50 dB, "A" weighting, emanating from any component under any condition of normal operation, measured 39 inches from nearest surface of component enclosure.

2.3 SERVICE CONDITIONS

A. Environmental Conditions: Inverter system shall be capable of operating continuously in the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
   1. Ambient Temperature for Electronic Components: 32 to 98 deg F.
   2. Relative Humidity: 0 to 95 percent, noncondensing.
   3. Altitude: Sea level to 4000 feet.

2.4 INVERTERS

A. Description: Solid-state type, with the following operational features:
   1. Automatically regulate output voltage to within plus or minus 5 percent.
   2. Automatically regulate output frequency to within plus or minus 1 Hz, from no load to full load at unit power factor over the operating range of battery voltage.
   3. Output Voltage Waveform of Unit: Sine wave with maximum 10 percent THD throughout battery operating-voltage range, from no load to full load.
      a. THD may not exceed 5 percent when serving a resistive load of 100 percent of unit rating.
   4. Output power rating: Rated in kVA at unity power factor and shall be able to supply the rated kW from .5 lagging to .5 leading.
   5. Output Protection: Current-limiting and short-circuit protection.
   6. Brownout Protection: Produces rated power without draining batteries when input voltage is down to 75 percent of normal.

2.5 BATTERY CHARGER

A. Description: Solid-state, automatically maintaining batteries in fully charged condition when normal power is available. With LED indicators for "float" and "high-charge" modes.

2.6 BATTERIES

A. Description: Premium, valve-regulated, recombinant, lead-calcium.

2.7 ENCLOSURES

A. NEMA 250, Type 1 steel cabinets with access to components through hinged doors with flush tumbler lock and latch.

B. Finish: Manufacturer's standard baked-enamel finish over corrosion-resistant prime treatment.

2.8 CONTROL AND INDICATION

A. Description: Group displays, indications, and basic system controls on common control panel on front of central battery inverter enclosure.

B. Minimum displays, indicating devices, and controls shall include those in lists below. Provide sensors, transducers, terminals, relays, and wiring required to support listed items. Alarms shall include an audible signal and a visual display.

C. Indications: Plain-language messages on a digital LCD or LED.
   1. Quantitative Indications:
      a. Input voltage, each phase, line to line.
      b. Input current, each phase, line to line.
      c. System output voltage, each phase, line to line.
      d. System output current, each phase.
      e. System output frequency.
      f. DC bus voltage.
      g. Battery current and direction (charge/discharge).
      h. Elapsed time-discharging battery.
   2. Basic Status Condition Indications:
      a. Normal operation.
      b. Load-on bypass.
      c. Load-on battery.
      d. Inverter off.
      e. Alarm condition exists.
   3. Alarm Indications:
      a. Battery system alarm.
      b. Control power failure.
      c. Fan failure.
      d. Overload.
      e. Battery-charging control faulty.
      f. Input overvoltage or undervoltage.
      g. Approaching end of battery operation.
      h. Battery undervoltage shutdown.
      i. Inverter fuse blown.
      j. Inverter transformer overtemperature.
      k. Inverter overtemperature.
      l. Static bypass transfer switch overtemperature.
      m. Inverter power supply fault.
      n. Inverter output overvoltage or undervoltage.

o. System overload shutdown.
p. Inverter output contactor open.
q. Inverter current limit.

4. Controls:
   a. Inverter on-off.
   b. Start.
   c. Battery test.
   d. Alarm silence/reset.
   e. Output-voltage adjustment.

D. Include the following minimum array:
1. Ready, normal-power on light.
2. Charge light.
3. Inverter supply load light.
4. Battery voltmeter.
5. AC output voltmeter with an accuracy within 2 percent of full scale.
6. Load ammeter.
7. Test switch to simulate ac failure.

E. Enclosure: Steel, with hinged lockable doors, suitable for wall or floor mounting as required. Manufacturer's standard corrosion-resistant finish.

2.9 OPTIONAL FEATURES

A. Emergency-Only Circuits: Automatically energize only when normal supply has failed. Disconnect emergency-only circuits when normal power is restored.

B. Maintenance Bypass/Isolation Switch: Switch is interlocked so it cannot be operated unless static bypass transfer switch is in bypass mode. Switch provides manual selection among the following three conditions without interrupting supply to the load during switching:
1. Full Isolation: Load is supplied, bypassing central battery inverter system. Normal ac input circuit, static bypass transfer switch, and central battery inverter load terminals are completely disconnected from external circuits.
2. Maintenance Bypass: Load is supplied, bypassing central battery inverter system. Central battery inverter ac supply terminals are energized to permit operational checking, but system load terminals are isolated from the load.
3. Normal: Normal central battery inverter ac supply terminals are energized and the load is supplied through either static bypass transfer switch and central battery inverter rectifier-charger and inverter, or battery and inverter.

2.10 OUTPUT DISTRIBUTION SECTION

A. Panelboard: Comply with Division 26 Section "Panelboards," except provide assembly integral to equipment cabinet.

2.11 SYSTEM MONITORING AND ALARMS

A. Battery Ground-Fault Detector: Initiates alarm when resistance to ground of positive or negative bus of battery is less than 5000 ohms.
1. Annunciation of Alarms: At inverter system control panel.

2.12 SOURCE QUALITY CONTROL

A. Factory test complete inverter system, including battery, before shipment. Include the following:
   1. Functional test and demonstration of all functions, controls, indicators, sensors, and protective devices.
   2. Full-load test.
   3. Transient-load response test.
   4. Overload test.
   5. Power failure test.

B. Observation of Test: Give 14 days' advance notice of tests and provide access for Owner's representative to observe tests at Owner's option.

C. Report test results. Include the following data:
   1. Description of input source and output loads used. Describe actions required to simulate source load variation and various operating conditions and malfunctions.
   2. List of indications, parameter values, and system responses considered satisfactory for each test action. Include tabulation of actual observations during test.
   3. List of instruments and equipment used in factory tests.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance.
   1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment will be installed before installation begins.

B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

3.3 CONNECTION

A. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams, unless otherwise indicated.

B. Ground equipment according to Division 26 Section "Grounding and Bonding."

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 IDENTIFICATION

A. Identify equipment and components according to Division 26 Section “Electrical Identification.”

3.5 FIELD QUALITY CONTROL

A. After central battery inverters are installed and electrical circuitry has been energized, test for compliance with requirements.

B. Testing: Perform the following field quality-control testing according to manufacturer's written instructions and as listed below, to demonstrate condition and performance of each component of central battery inverter system:
   1. Inspect interiors of enclosures for integrity of mechanical and electrical connections, component type and labeling verification, and ratings of installed components.
   2. Test manual and automatic operational features and system protective and alarm functions.
   3. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections 7.18 and 7.22.2. Certify compliance with test parameters.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove malfunctioning units, replace with new units, and retest as specified above.

D. Report results in writing.

3.6 STARTUP SERVICE

A. Verify that central battery inverter is installed and connected according to the Contract Documents.

B. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 26 Sections.

C. Complete installation and startup checks according to manufacturer's written instructions.

3.7 ADJUSTING AND CLEANING

A. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

B. Install new filters in each equipment cabinet within 14 days from date of Substantial Completion.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain central battery inverters. Refer to Division 1 Section "Closeout Procedures” and “Demonstration and Training”.

END OF SECTION 26 33 23

SECTION 26 36 00
TRANSFER SWITCHES

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 SUMMARY

A. This Section includes transfer switches rated 600 V and less, including the following:
   1. Automatic transfer switches
   2. Remote annunciation system.

B. Related Sections:
   1. Division 26 “Hangers and Supports for Electrical Systems” for concrete bases.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Dimensioned plans, sections, and elevations showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

C. Field quality-control test reports.

D. Operation and Maintenance Data: Submit under provision of Section “Electrical General

Requirements". For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Closeout Procedures" and "Operation and Maintenance Data" include the following:

1. Features and operating sequences, both automatic and manual.
2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.
3. Include instructions for operating equipment under emergency conditions.
4. Document ratings of equipment and each major component.
5. Include routine preventive maintenance and lubrication schedule.
6. List special tools, maintenance materials, and replacement parts

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.

B. Testing Agency Qualifications: Refer to specification section "Electrical Testing".

C. Source Limitations: Obtain automatic transfer switches, bypass/isolation switches, non-automatic transfer switches, remote annunciators, and remote annunciator and control panels through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, for emergency service under UL 1008, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

F. UL 1008 - Standard for Automatic Transfer Switches, unless requirements of those specifications are stricter.

G. NFPA 70 - National Electrical Code, including use in emergency and standby systems in accordance with Articles 517, 700, 701 and 702

H. NFPA 110 - Standard for Emergency and Standby Power Systems

I. IEEE Standard 446 - IEEE Recommended Practice for Emergency and Standby Power Systems (Orange Book)

J. IEEE Standard 241 - IEEE Recommended Practice for Electric Power Systems in Commercial Buildings (Gray Book)

K. NEMA Standard ICS2-447 - AC Automatic Transfer Switches

L. IEC - Standard for Automatic Transfer Switches

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of the transfer switch and associated auxiliary components that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Contactor Transfer Switches:
      a. Emerson; ASCO Power Technologies, LP
      b. Caterpillar; Engine Div.
      c. GE Zenith Controls.
      d. Kohler Co.; Generator Division.
      e. Cummins Power Generation.

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.

B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

Switch Rating	Minimum WCR with "any breaker" rating
30-200	10,000
260-400	35,000
600-800	50,000
1000-1200	65,000
1600-4000	100,000

   1. Provide fault-current and withstand ratings in accordance with UL 1008 standard's 1½ and 3 cycle long-time ratings. Transfer switches which are not tested and labeled with 1½ and 3 cycle (any breaker) ratings and have series, or specific breaker ratings only, are not acceptable.
   2. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.

C. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels have communication capability matched with remote device.

D. Solid-State Controls: Repetitive accuracy of all settings is plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

E. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge

withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

F. Electrical Operation: Accomplish by a non-fused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.

G. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
   1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
   2. Switch Action: Double throw; mechanically held in both directions.
   3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.

H. Neutral Terminal: Solid and fully rated, unless otherwise indicated.

I. Heater: Equip switches exposed to outdoor temperatures and humidity, and other units indicated, with an internal heater. Provide thermostat within enclosure to control heater.

J. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color code or by numbered or lettered wire and cable tape markers at terminations.
   1. Designated Terminals: Pressure type suitable for types and sizes of field wiring indicated.
   2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
   3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.

K. Enclosures: General-purpose NEMA 250, Type 12, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.3 AUTOMATIC TRANSFER SWITCH

A. Comply with Level 1 equipment according to NFPA 110.

B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.

C. Manual Switch Operation: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.

D. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

E. Transfer Switches Based on Molded-Case-Switch Components: Comply with NEMA AB 1, UL 489, and UL 869A.

F. In-Phase Monitor: Factory-wired, internal relay controls transfer so it occurs only when the two sources are synchronized in phase. Relay compares phase relationship and frequency difference between normal and emergency sources and initiates transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer is initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.

G. Automatic Transfer-Switch Features
1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes. Provides automatic defeat of delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
5. Test Switch: Simulates normal-source failure.
6. Switch-Position Pilot Lights: Indicate source to which load is connected.
7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.
    a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
10. Engine Shutdown Contacts:
    a. Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
11. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
    a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
    b. Push-button programming control with digital display of settings.
    c. Integral battery operation of time switch when normal control power is not available.
12. Transfer inhibit: Terminals shall be provided for a remote contact which opens to signal the ATS to transfer to emergency and for remote contacts which open to inhibit transfer to emergency and/or retransfer to normal.

2.4 REMOTE ANNUNCIATOR SYSTEM

A. Functional Description: Remote annunciator panel annunciates conditions for indicated transfer switches. Annunciation includes the following:
1. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.

2. Switch position.
3. Switch in test mode.
4. Failure of communication link.

B. Annunciator Panel: LED-lamp type with audible signal and silencing switch.
1. Indicating Lights: Grouped for each transfer switch monitored.
2. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.
3. Mounting: Flush, modular, steel cabinet, unless otherwise indicated.
4. Lamp Test: Push-to-test or lamp-test switch on front panel.

2.5 SOURCE QUALITY CONTROL

A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Annunciator and Control Panel Mounting: Flush in wall, unless otherwise indicated.

B. Identify components according to Division 26 Section “Electrical Identification”.

3.2 WIRING TO REMOTE COMPONENTS

A. Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding."

B. Connect wiring according to Division 26 Section "Conductors and Cables.”

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Testing: Perform the following field quality control tests in accordance with Division 26 section “Electrical Testing.”
1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.

2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.22.3. Certify compliance with test parameters.
3. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
    a. Check for electrical continuity of circuits and for short circuits.
    b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
    c. Verify that manual transfer warnings are properly placed.
    d. Perform manual transfer operation.
4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
    a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
    b. Simulate loss of phase-to-ground voltage for each phase of normal source.
    c. Verify time-delay settings.
    d. Verify pickup and dropout voltages by data readout or inspection of control settings.
    e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
    f. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

C. Coordinate tests with tests of generator and run them concurrently.

D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

E. Remove and replace malfunctioning units and retest as specified above.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Division 1 Section "Closeout Procedures" and "Demonstration and Training."
    1. Coordinate this training with that for generator equipment.

END OF SECTION 26 36 00

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SECTION 26 43 13
SURGE PROTECTIVE DEVICES

PART 1 - GENERAL 1
1.1 RELATED DOCUMENTS 1
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2.2 ENCLOSURES 3
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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes:
   1. Type 2 surge protective devices.
   2. Enclosures

B. Related Sections include the following:
   1. Section 26 24 16 "Panelboards" for integral Type 2 SPDs installed by panelboard manufacturer.
   2. Section 26 27 26 "Wiring Devices" for integral Type 3 SPDs installed by receptacle manufacturer.

1.3 DEFINITIONS

A. I_n: Nominal discharge current.

B. Maximum Continuous Operating Voltage (MCOV): The maximum designated RMS value of the power frequency voltage that may be continuously applied to the mode of protection of an SPD.

C. Metal-Oxide Varistor (MOV): An electronic component with a significant bidirectional, nonlinear current-voltage characteristic.

D. Mode(s), Modes of Protection, or Protection Modes: Electrical paths where the SPD offers defense against transient over-voltages. Examples include: line to neutral (L-N), line to ground (L-G), line to line (L-L), and neutral to ground (N-G).

E. SCCR: Short-circuit current rating.

F. Type 1 SPDs: Permanently connected SPDs intended for installation between the secondary of the service transformer and the line side of the service disconnect overcurrent device.

G. Type 2 SPDs: Permanently connected SPDs intended for installation on the load side of the service disconnect overcurrent device, including SPDs located at the branch panel.

H. Type 3 SPDs: Point of utilization SPDs.

I. Voltage Protection Rating (VPR): A rating selected from UL 1449 list of preferred values assigned to each mode of protection.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.
   1. For each type of product.
      a. Include electrical characteristics, specialties, and accessories for SPDs.
      b. Certification of compliance with UL 1449 by qualified electrical testing laboratory recognized by authorities having jurisdiction including the following information:
         1) Tested values for VPRs.
         2) I_n ratings.
         3) MCOV, type designations.
         4) OCPD requirements.
         5) Manufacturer's model number.
         6) System voltage.
         7) Modes of protection.

B. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For manufacturer's special warranty.

1.6 WARRANTY

A. Special Manufacturer Extended Warranty: Manufacturer warrants that SPDs perform in accordance with specified requirements and agrees to provide repair or replacement of SPDs that fail to perform as specified within extended warranty period.
   1. Initial Extended Warranty Period: Five year(s) from date of Substantial Completion, for labor, materials, and equipment.

PART 2 - PRODUCTS

2.1 TYPE 2 SURGE PROTECTIVE DEVICE (SPDS)

A. Manufacturers:
   1. Cutler-Hammer, Inc.; Eaton Corporation.
   2. General Electric Company.
   3. Siemens Industries, Inc.
   4. Square D; Schneider Electric.

B. Source Limitations: Obtain devices from single source from single manufacturer.

C. General Characteristics:
1. Reference Standards: UL 1449 (latest Edition), Type 2; UL 1283 (latest edition).
2. EMI-RFI Noise Rejection: based on MIL-STD-E220A, 50-ohm standard Insertion Loss Test:
   a. 34dB at 100 kHz.
   b. 51dB at 1 MHz.
   c. 54dB at 10 MHz.
   d. 48dB at 100 MHz.
3. MCOV: Not less than 125 percent of nominal system voltage for 208Y/120 V and 120/240 V power systems, and not less than 115 percent of nominal system voltage for 480Y/277 V power systems.
4. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than:
   a. Service Entrance Switchboard: 320kA
   b. Distribution panelboards and switchboards 800A or greater: 150KA
   c. Distribution Panelboards and Branch Circuit Panelboards 600A and less: 100kA
5. Peak surge current rating must be arithmetic sum of the ratings of individual MOVs in a given mode.
6. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits must not exceed the following:
   a. Line to Neutral: 1200 V
   b. Line to Ground: 1200 V
   c. Neutral to Ground: 1200 V
   d. Line to Line: 2000 V
7. Protection modes and UL 1449 VPR for grounded wye circuits with 208Y/120 V, three-phase, four-wire circuits must not exceed the following:
   a. Line to Neutral: 700 V.
   b. Line to Ground: 700 V.
   c. Neutral to Ground: 700 V.
   d. Line to Line: 1200 V.
8. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits must not exceed the following:
   a. Line to Neutral: 700 V.
   b. Line to Ground: 700 V.
   c. Neutral to Ground: 700 V.
9. SCCR: Equal or exceed 100 kA.
10. I_n Rating: 10 kA.

D. Options:
1. Include LED indicator lights for power and protection status.
2. Include internal thermal protection that disconnects the SPD before damaging internal suppressor components.
3. Include surge counter.

2.2 ENCLOSURES

A. Indoor Enclosures: Type 1.

B. Outdoor Enclosures: Type 3R.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Surge protective devices shall be factory installed in all new distribution equipment.

B. Provide OCPD and disconnect for installation of SPD in accordance with UL 1449 and manufacturer's instructions.

C. Install leads between disconnects and SPDs short, straight, twisted, and in accordance with manufacturer's instructions. Comply with wiring methods in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
   1. Do not splice and extend SPD leads unless specifically permitted by manufacturer.
   2. Do not exceed manufacturer's recommended lead length.
   3. Do not bond neutral and ground.

D. Use crimped connectors and splices only. Wire nuts are unacceptable.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Compare equipment nameplate data for compliance with Drawings and the Specifications.
   2. Inspect anchorage, alignment, grounding, and clearances.
   3. Verify that electrical wiring installation complies with manufacturer's installation requirements.

B. Nonconforming Work:
   1. SPDs that do not pass tests and inspections will be considered defective.
   2. Remove and replace defective units and retest.

C. Prepare test and inspection reports.

D. Manufacturer Services:
   1. Engage factory-authorized service representative to support field tests and inspections.

3.3 STARTUP SERVICE

A. Complete startup checks in accordance with manufacturer's instructions.

B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests; reconnect them immediately after the testing is over.

C. Energize SPDs after power system has been energized, stabilized, and tested.

END OF SECTION 26 43 13

Project		Catalog #	TYPE OA - ADD ALTERNATE BID
Prepared by		Notes	PROVIDE SPECIFIED FIXTURE BY APPROVED MANUFACTURER OR ENGINEER-APPROVED EQUAL BY: LITHONIA VCPG SERIES GARDCO SOFTVIEW SERIES



TopTier (D1-D6)



TopTier (D7-D10)

McGraw-Edison

TT TopTier

Parking Garage Luminaire

Product Features

Light ARchitect™

Interactive Menu

- Ordering Information page 2
- Product Specifications page 2
- Optical Configurations page 2
- Mounting Details page 3
- Energy and Performance Data page 4
- Control Options page 6

Product Certifications

Quick Facts

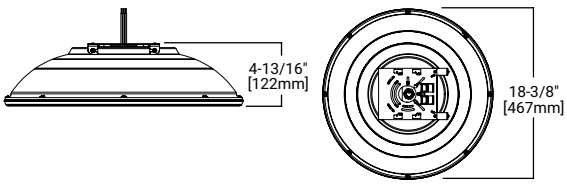
- Lumen packages range from 2,757 - 22,831
- Efficacies up to 146 lumens per watt
- Utilizes patented waveguide technology for maximum visual comfort
- Surface, pendant, trunnion, wall and direct conduit mount options

Connected Systems

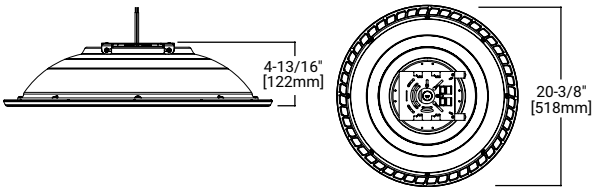
- WaveLinx Lite
- Synapse

Dimensional Details

SURFACE MOUNT
CQ, MQ, WQ and RW: D1-D6
DL: D1-D4
Base luminaire weight: 18.2 lbs (8.3 kg)



SURFACE MOUNT
CQ, MQ, WQ and RW: D7+
DL: D5+
Base luminaire weight: 20.1 lbs (9.1 kg)



NOTES:
1. Visit https://www.designlights.org/search/ to confirm qualification. Not all product variations are DLC qualified.
2. IDA Certified for 3000K CCT and warmer only.

McGraw-Edison — TT TopTier

Ordering Information

SAMPLE NUMBER: **TT-D3-740-U-WQ-STM-30L-AP**

Product Family	Configuration	Color Temperature	Voltage	Distribution	Mounting	Lead Length [7]	Finish
TT=TopTier [1] **BAA-TT**=TopTier, Buy American Act Compliant [27] **TAA-TT**=TopTier, Trade Agreements Act Compliant [27]	**D1**=4,000 Nominal Lumens **D2**=5,500 Nominal Lumens **D3**=6,500 Nominal Lumens **D4**=8,000 Nominal Lumens **D5**=10,000 Nominal Lumens **D6**=13,000 Nominal Lumens **D7**=15,000 Nominal Lumens **D8**=18,000 Nominal Lumens **D9**=20,000 Nominal Lumens **D10**=22,000 Nominal Lumens	**735**=70 CRI, 3500K CCT **740**=70 CRI, 4000K CCT **750**=70 CRI, 5000K CCT **830**=80 CRI, 3000K CCT **AMB**=Amber 590nm [29] 4000K 80CRI	**U**=120-277V **H**=347-480V [22, 26] **1**=120V **2**=208V **3**=240V **4**=277V **8**=480V **9**=347V	**CQ**=Concentrated **MQ**=Medium **WQ**=Wide **RW**=Rectangular Wide [3] **DL**=Drive Lane / Type 4 [3]	**[Blank]**=Surface Mount [16] **TMB**=Trunnion Mount with Connection Box **DPM**=Decorative Pendant Mount [4] **WM**=Wall Mount **STM**=Stem Mount to 1/2" conduit [16] 18" stem	**[Blank]**=6" **30L**=30" **36L**=36" **48L**=48" **72L**=72" **108L**=108" **120L**=120" **144L**=144"	**NW**=White **AP**=Grey **BZ**=Bronze **BK**=Black **DP**=Dark Platinum **GM**=Graphite Metallic

Options (Add as Suffix)

F=Single Fuse (120, 277 or 347V Specify Voltage)
FF=Double Fuse (208, 240 or 480V Specify Voltage)
IBP=Integral Battery Pack [5, 24]
IBP-CEC=Integral Battery Pack, CEC compliant [5]
ITS=Integral Transfer Switch [3]
924=UL924 listed luminaire [19]
CG=Clear Glass [8]
SG=Solite® Glass [9]
UPL=Uplight [6]
TR=Tamper Resistant Hardware
NAT=Natatorium finish
DALI=DALI Driver [15]
MS/DIM-L08=Dimming Occupancy Sensor (<9' Mounting) [11, 17]
MS/DIM-L20=Dimming Occupancy Sensor (9' - 20' Mounting) [11, 17]
ZW=WaveLinx-Enabled Module and 4-PIN Receptacle [23]
SPB1=Dimming Motion and Daylight Sensor, Bluetooth Programmable, < 8' Mounting [11, 21]
SPB2=Dimming Motion and Daylight Sensor, Bluetooth Programmable, 8' - 20' Mounting [11, 21]
SPB4=Dimming Motion and Daylight Sensor, Bluetooth Programmable, 20' - 40' Mounting [17, 21]
ZD=WaveLinx-Enabled Module with DALI Driver and 4-PIN Receptacle [23]
ZW-SWPD4WH=WaveLinx Control Module and Wireless Sensor – 7'-15'
ZW-SWPD5WH=WaveLinx Control Module and Wireless Sensor – 15'-40'
ZW-WOBWH=WaveLinx Control Module and LC Bluetooth Sensor – 7'-15'
ZW-WOFWH=WaveLinx Control Module and LC Bluetooth Sensor – 15'-40'
ZD-SWPD4WH=WaveLinx with DALI Driver and Wireless Sensor – 7'-15'
ZD-SWPD5WH=WaveLinx with DALI Driver and Wireless Sensor – 15'-40'
ZD-WOBWH=WaveLinx with DALI Driver and LC Bluetooth Sensor – 7'-15'
ZD-WOFWH=WaveLinx with DALI Driver and LC Bluetooth Sensor – 15 -40'
LWR-LW=Enlighted Wireless Sensor, Wide Lens 8' - 16' Mounting Height [11, 18]
LWR-LN=Enlighted Wireless Sensor, Narrow Lens 16' - 40' Mounting Height [11, 18]
DIM10-MS/DIM-L08=Synapse occupancy sensor (<8' Mounting)
DIM10-MS/DIM-L20=Synapse occupancy sensor (8'-20' Mounting)

Accessories (Order Separately) [28]

MA1252=Replacement 10kV Surge Module
TT/WG=Wire Guard [25]
TT/BG-UP-XX=Bird Guard [12, 13]
TT/HSS-XX=House Side Shield [25]
DPMS36-XX=36" Pendant Mount Stem [12, 14]
DPMS48-XX=48" Pendant Mount Stem [12, 14]
DPMS96-XX=96" Pendant Mount Stem [12, 14]
FSIR-100=Wireless Configuration Tool for Occupancy Sensor [17]
SWPD4-WH=WaveLinx Wireless Sensor, 7'–15' Mounting Height [20, 21, 22, 23]
SWPD5-WH=WaveLinx Wireless Sensor, 15'–40' Mounting Height [20, 21, 22, 23]

FOR LUMINAIRES NOTED AS EM, PROVIDE WITH INTEGRAL UL924 LISTED EMERGENCY BYPASS.

NOTES:

1. DesignLights Consortium® Qualified. Refer to www.designlights.org Qualified Products List under Family Models for details.
2. Only for use with 480V Wye systems. Per NEC, not for use with ungrounded systems, impedance grounded systems or corner grounded systems (commonly known as Three Phase Three Wire Delta, Three Phase High Leg Delta and Three Phase Corner Grounded Delta systems).
3. Not available with D7 - D10 configurations.
4. Order Pendant Mount Stem accessory.
5. IBP ambient operating temperature -20°C to 35°C (D1-D3), -20°C to 25°C (D4-D6). Not available with D7-D10 configurations, DALI, or ZD options.
6. Additional 8.0W. Provides 920 lumens. Not available with D10 configuration.
7. Choose lead length for Surface Mount and Stem Mount only. TMB, DPM and WM lengths predetermined.
8. Not available with CQ.
9. Standard with CQ, option available with WQ only.
10. U voltage only. Ambient operating temperature -20°C to 50°C (D1-D4) or -20°C to 40°C (D5-D6). UL924 listed component.
11. Includes integral photocell.
12. Specify color in place of XX.
13. Designed for use with Stem Mount and Decorative Pendant Mount only.
14. Designed for use with Decorative Pendant Mount only.
15. Not available with H voltage or IBP. Not compatible with MS/DIM or LWR sensors.
16. Specify Lead Length for wire harness length.
17. The FSIR-100 configuration tool is required to adjust parameters including high and low modes, sensitivity, time delay and more.
18. Enlighted wireless sensors are factory installed only, and require network components in appropriate quantities.
19. 924 option provides luminaire UL924 listing, used in conjunction with ITS or IBP-CEC.
20. Requires ZW or ZD receptacle.
21. Sensor configuration mobile application required for configuration. See controls page for details.
22. Cannot be used with other control options.
23. For WaveLinx applications, WAC Gateway required to enable field-configurability: Order WAC-PoE and WPOE-120 (10V to PoE injector) power supply if needed. Not required for WaveLinx Lite Commercial (LC) applications.
24. Specify 120V or 277V.
25. TT/WG and TT/HSS cannot be installed together. TT/HSS & TT/WG not available on D7-D10 configurations.
26. D4-D10 only. Not compatible with battery.
27. Only product configurations with these designated prefixes are built to be compliant with the Buy American Act of 1933 (BAA) or Trade Agreements Act of 1979 (TAA), respectively. Please refer to DOMESTIC PREFERENCES website for more information. Components shipped separately may be separately analyzed under domestic preference requirements.
28. Accessories sold separately will be separately analyzed under domestic preference requirements. Consult factory for further information.
29. Narrow-band 590nm +/- 5nm for wildlife and observatory use. Choose lumen package D1.

Product Specifications

Construction

- Low profile, die-cast aluminum housing provides a clean, symmetric aesthetic

Optics

- Five optical distributions utilizing visual comfort waveguide technology
- 10 lumen packages, ranging from 2,757 to 22,831
- Integral uplight option utilizes a dedicated, 8W light engine, producing 920 lumens for reduced visual contrast and cave effect
- IDA Certified for 3000k CCT and warmer only. Not available with uplight option.

Electrical

- D1-D6: -40C - 50C operating temperature
- D7-D10: -40C - 40C operating temperature
- Greater than 90% lumen maintenance at 50,000 hours
- IP66 rated
- 120-277V 50/60Hz, 347V 60Hz or 480V 60Hz operation
- 10kV surge module standard
- 0-10V dimming standard

Mounting

- Surface mount directly to square or octagonal 4" surface or recessed junction box using quick mount bracket
- Optional stem mount bracket with set screw for direct 1/2" NPS conduit mounting
- Trunnion, decorative pendant, and wall mount options also available

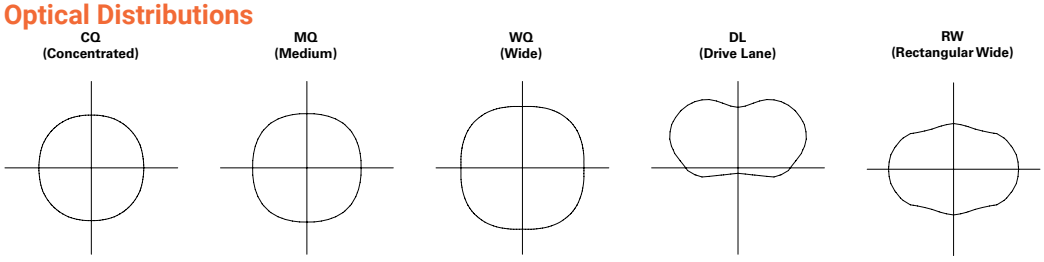
Finish

- 2.5 mil nominal TGIC powder coat thickness
- Finishes include white, black, bronze, gray, dark platinum and graphite metallic
- RAL and custom color matches available
- Natatorium option (NAT) available, providing 5,000 hour salt spray rating per ASTM B117, with a scribe rating of 9 per ASTM D1654

Warranty

- Five-year warranty

Optical Distributions

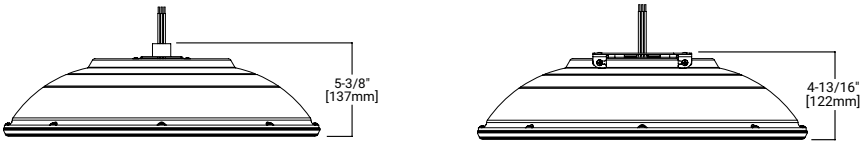


McGraw-Edison **TT TopTier**

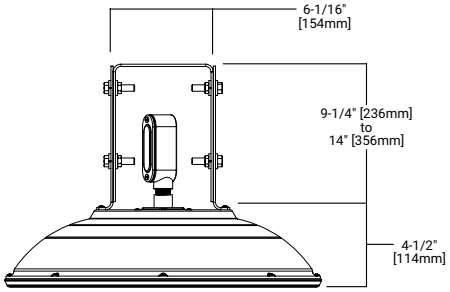
Mounting Details

***D1-D6 configuration shown (D1-D4 for DL distribution)**

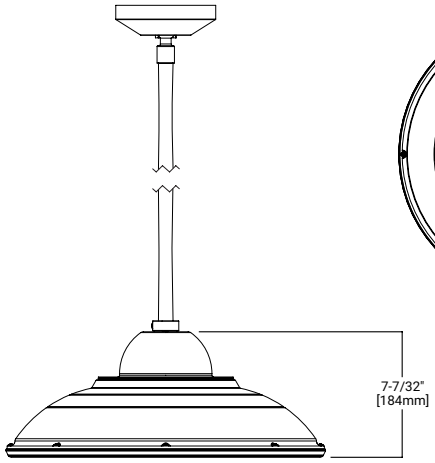
Stem Mount



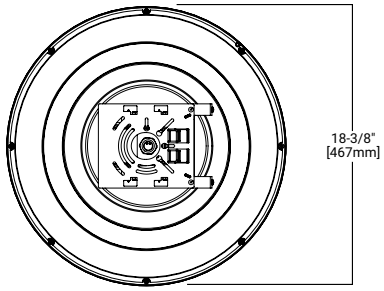
Trunnion Mount



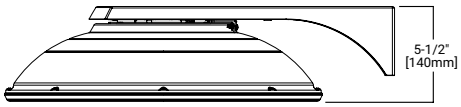
Decorative Pendant Mount



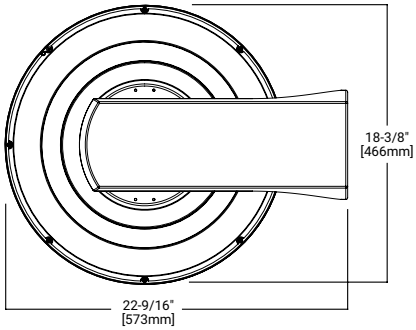
Top View



Wall Mount

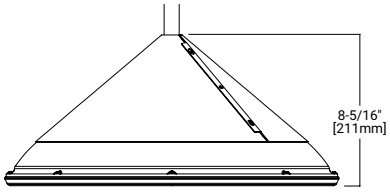


Top View - Wall Mount

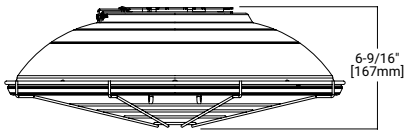


Accessories

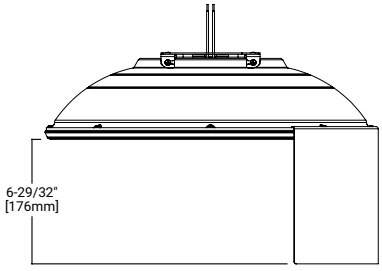
Bird Guard (TT/BG-UP-XX)



Wire Guard (TT/WG)



House Side Shield (TT/HSS-XX)



McGraw-Edison **TT TopTier**

Energy and Performance Data

View TopTier IES files

Power and Lumens (3000K/3500K/4000K/5000K)

Lumen Package			D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
Power (Wattage) CQ, MQ, WQ			28.0	39.2	47.2	57.6	74.7	105.2	124.7	148.7	173.1	193.8
Power (Wattage) RW Only			28.0	39.2	47.2	57.6	74.7	105.2	127.1	152.6	178.0	--
Power (Wattage) DL Only			28.8	40.5	48.8	59.8	62.3	97.4	127.1	152.6	178.0	--
Distribution												
3000K CCT 80 CRI	CQ Concentrated	Lumens	3,409	4,640	5,595	6,660	8,383	11,030	12,307	14,411	16,430	18,001
		BUG Rating	B1-U0-G1	B2-U0-G1	B2-U0-G1	B2-U0-G1	B3-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G2
		Lumens per Watt	122	118	119	116	112	105	99	97	95	93
	MQ Medium	Lumens	3,647	4,964	5,986	7,125	8,969	11,800	12,854	15,053	17,161	18,802
		BUG Rating	B2-U0-G1	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3
		Lumens per Watt	130	127	127	124	120	112	103	101	99	97
	WQ Wide	Lumens	3,449	4,695	5,662	6,740	8,483	11,161	12,350	14,463	16,489	18,065
		BUG Rating	B2-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3
		Lumens per Watt	123	120	120	117	114	106	99	97	95	93
	RW Rectangular Wide	Lumens	2,757	3,753	4,526	5,387	6,781	8,922	11,977	13,619	15,122	--
		BUG Rating	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	--
		Lumens per Watt	98	96	96	94	91	85	94	89	85	--
	DL Drive Lane / Type 4	Lumens	2,959	3,985	4,762	5,622	6,537	8,771	11,834	13,337	14,768	--
		BUG Rating	B1-U0-G2	B2-U0-G3	B2-U0-G3	B2-U0-G3	B1-U0-G3	B2-U0-G3	B2-U0-G4	B2-U0-G4	B2-U0-G4	--
		Lumens per Watt	103	98	98	94	105	90	93	87	83	--
3500K CCT 70 CRI	CQ Concentrated	Lumens	3,618	4,925	5,940	7,070	8,899	11,708	14,944	17,500	19,951	21,858
		BUG Rating	B1-U0-G1	B2-U0-G1	B2-U0-G1	B2-U0-G1	B3-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B4-U0-G2	B4-U0-G2
		Lumens per Watt	129	126	126	123	119	111	120	118	115	113
	MQ Medium	Lumens	3,872	5,270	6,355	7,564	9,520	12,527	15,609	18,279	20,839	22,831
		BUG Rating	B2-U0-G2	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3
		Lumens per Watt	138	134	135	131	127	119	125	123	120	118
	WQ Wide	Lumens	3,662	4,984	6,011	7,154	9,005	11,848	14,997	17,562	20,022	21,936
		BUG Rating	B2-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G4
		Lumens per Watt	131	127	127	124	121	113	120	118	116	113
	RW Rectangular Wide	Lumens	2,927	3,984	4,805	5,719	7,198	9,471	14,544	16,537	18,363	--
		BUG Rating	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	--
		Lumens per Watt	105	102	102	99	96	90	114	108	103	--
	DL Drive Lane / Type 4	Lumens	3,141	4,230	5,055	5,968	7,938	10,650	14,370	16,195	17,933	--
		BUG Rating	B1-U0-G2	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G4	B3-U0-G4	B3-U0-G5	--
		Lumens per Watt	109	104	104	100	127	109	113	106	101	--
4000K/ 5000K CCT 70 CRI	CQ Concentrated	Lumens	3,828	5,211	6,284	7,480	9,415	12,387	14,944	17,500	19,951	21,858
		BUG Rating	B1-U0-G1	B2-U0-G1	B2-U0-G1	B2-U0-G1	B3-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B4-U0-G2	B4-U0-G2
		Lumens per Watt	137	133	133	130	126	118	120	118	115	113
	MQ Medium	Lumens	4,096	5,575	6,723	8,002	10,072	13,253	15,609	18,279	20,839	22,831
		BUG Rating	B2-U0-G2	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3
		Lumens per Watt	146	142	142	139	135	126	125	123	120	118
	WQ Wide	Lumens	3,874	5,273	6,359	7,569	9,527	12,535	14,997	17,562	20,022	21,936
		BUG Rating	B2-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G4
		Lumens per Watt	138	135	135	131	128	119	120	118	116	113
	RW Rectangular Wide	Lumens	3,097	4,215	5,083	6,050	7,615	10,020	14,544	16,537	18,363	--
		BUG Rating	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	--
		Lumens per Watt	111	108	108	105	102	95	114	108	103	--
	DL Drive Lane / Type 4	Lumens	3,323	4,475	5,348	6,314	7,938	10,650	14,370	16,195	17,933	--
		BUG Rating	B1-U0-G2	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G4	B3-U0-G4	B3-U0-G5	--
		Lumens per Watt	115	110	110	106	127	109	113	106	101	--

McGraw-Edison **TT TopTier**

Energy and Performance Data

CQ, MQ and WQ Distributions

Lumen Package	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
Power (Wattage)	28.0	39.2	47.2	57.6	74.7	105.2	124.7	148.7	173.1	193.8
Input Current @ 120V (A)	0.23	0.33	0.39	0.48	0.62	0.88	1.09	1.31	1.53	1.72
Input Current @ 208V (A)	0.13	0.19	0.23	0.28	0.36	0.51	0.57	0.67	0.78	0.88
Input Current @ 240V (A)	0.12	0.16	0.20	0.24	0.31	0.44	0.56	0.66	0.76	0.85
Input Current @ 277V (A)	0.10	0.14	0.17	0.21	0.27	0.38	0.49	0.58	0.67	0.74
Input Current @ 347V (A)	0.08	0.11	0.14	0.17	0.22	0.30	0.40	0.47	0.55	0.62
Input Current @ 480V (A)	0.06	0.08	0.10	0.12	0.16	0.22	0.30	0.35	0.41	0.45

RW Distribution

Lumen Package	D1	D2	D3	D4	D5	D6	D7	D8	D9
Power (Wattage)	28.0	39.2	47.2	57.6	74.7	105.2	127.1	152.6	178.0
Input Current @ 120V (A)	0.23	0.33	0.39	0.48	0.62	0.88	1.11	1.34	1.58
Input Current @ 208V (A)	0.13	0.19	0.23	0.28	0.36	0.51	0.58	0.69	0.81
Input Current @ 240V (A)	0.12	0.16	0.20	0.24	0.31	0.44	0.56	0.67	0.78
Input Current @ 277V (A)	0.10	0.14	0.17	0.21	0.27	0.38	0.50	0.59	0.68
Input Current @ 347V (A)	0.08	0.11	0.14	0.17	0.22	0.30	0.41	0.48	0.57
Input Current @ 480V (A)	0.06	0.08	0.10	0.12	0.16	0.22	0.30	0.36	0.42

DL Distribution

Lumen Package	D1	D2	D3	D4	D5	D6	D7	D8	D9
Power (Wattage)	28.8	40.5	48.8	59.8	62.3	97.4	127.1	152.6	178.0
Input Current @ 120V (A)	0.24	0.34	0.41	0.50	0.55	0.86	1.11	1.34	1.58
Input Current @ 208V (A)	0.14	0.19	0.23	0.29	0.28	0.44	0.58	0.69	0.81
Input Current @ 240V (A)	0.12	0.17	0.20	0.25	0.28	0.43	0.56	0.67	0.78
Input Current @ 277V (A)	0.10	0.15	0.18	0.22	0.24	0.37	0.50	0.59	0.68
Input Current @ 347V (A)	0.08	0.12	0.14	0.17	0.21	0.31	0.41	0.48	0.57
Input Current @ 480V (A)	0.06	0.08	0.10	0.12	0.15	0.23	0.30	0.36	0.42

Lumen Maintenance

Lumen Package	Ambient Temperature	25,000 hours*	50,000 hours*	60,000 hours*	100,000 hours**	Theoretical L70 hours**
D1-D6 (D1 - D4 DL/T4)	25°C	98.0%	95.2%	94.1%	89.8%	> 300,000
	40°C	97.9%	94.8%	93.6%	89.0%	> 290,000
	50°C	97.7%	94.5%	93.2%	88.4%	> 270,000
D7 - D10 (D5+ DL/T4)	25°C	95.8%	93.2%	92.2%	88.2%	> 300,000
	40°C	93.9%	89.7%	88.1%	81.9%	> 180,000

* Supported by IES TM-21 standards
**Theoretical values represent estimations commonly used; however, refer to the IES position on LED Product Lifetime Prediction, IES PS-10-18, explaining proper use of IES TM-21 and LM-80.

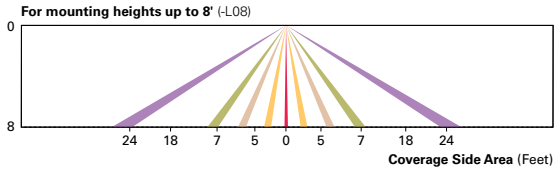
Lumen Multiplier

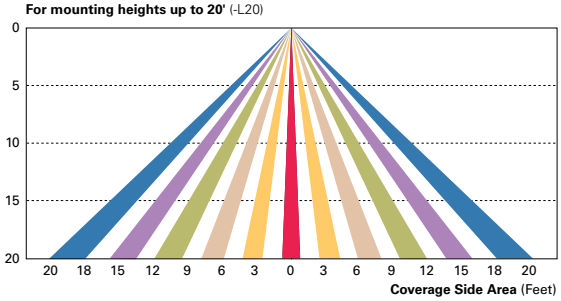
Ambient Temperature	Multiplier
0°C	1.03
10C	1.02
25°C	1.00
40°C	0.98
50°C	0.97

Control Options

0-10V (D) 0-10V dimming comes standard on all TopTier configurations for use with integrated or external lighting controls.

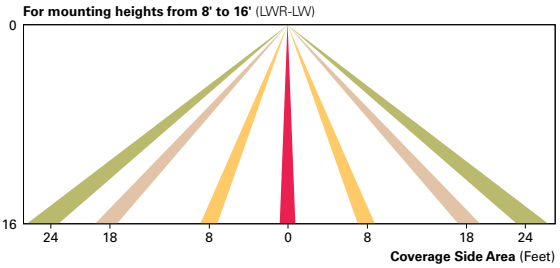
Dimming Occupancy Sensor (MS/DIM) These sensors are factory installed in the luminaire, dimming to 50% after five minutes of no motion detected. When motion is detected, the luminaire output is 100%. Includes an integral photocell that can be programmed for "dusk-to-dawn" operation. The FSIR-100 programming tool can be utilized to adjust dimming level, time delay, sensitivity and other parameters. Two lens options provide optimal coverage patterns up to 20' mounting height.

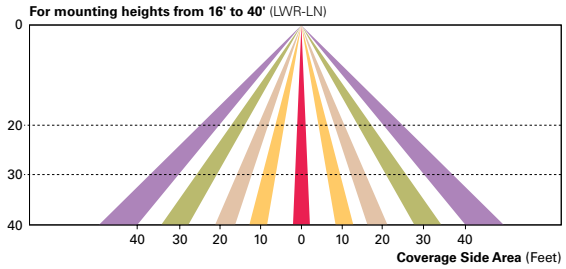




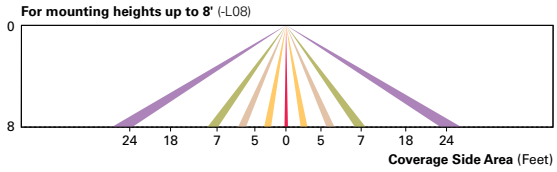
WaveLinx-Ready 4-PIN Twistlock Receptacle (ZW) Includes the WaveLinx control module, integrated 4-Pin receptacle, and standard 0-10V dimming driver, enabling the subsequent addition of a WaveLinx sensor.

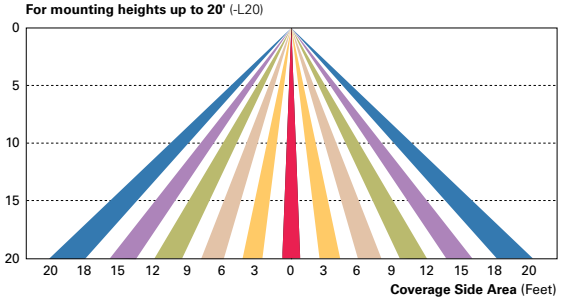
Enlighted Wireless Control and Monitoring System (LWR-LW and LWR-LN) The Enlighted control system is a connected lighting solution, combining LED luminaires with an integrated wireless sensor system. The sensor controls the lighting system in compliance with the latest energy codes while collecting valuable data about building performance and use. Software applications utilizing energy dashboards maximize data inputs to help optimize the use of other resources beyond lighting.





Synapse (DIM10) SimplySNAP integrated wireless controls system by Synapse. Includes factory installed DIM10 control module and MS/DC motion sensor; requires additional Synapse system components for operation. Contact Synapse at www.synapsewireless.com for product support, warranty, and terms and conditions.





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Specifications and dimensions
subject to change without notice.

Project		Catalog #	TYPE OB - ADD ALTERNATE BID
Prepared by		Notes	PROVIDE SPECIFIED FIXTURE BY APPROVED MANUFACTURER OR ENGINEER-APPROVED EQUAL BY: LITHONIA VCPG SERIES GARDCO SOFTVIEW SERIES



TopTier (D1-D6)



TopTier (D7-D10)

McGraw-Edison

TT TopTier

Parking Garage Luminaire

Product Features

Light ARchitect™

Interactive Menu

- Ordering Information page 2
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- Optical Configurations page 2
- Mounting Details page 3
- Energy and Performance Data page 4
- Control Options page 6

Product Certifications

Quick Facts

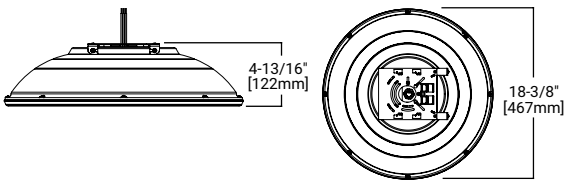
- Lumen packages range from 2,757 - 22,831
- Efficacies up to 146 lumens per watt
- Utilizes patented waveguide technology for maximum visual comfort
- Surface, pendant, trunnion, wall and direct conduit mount options

Connected Systems

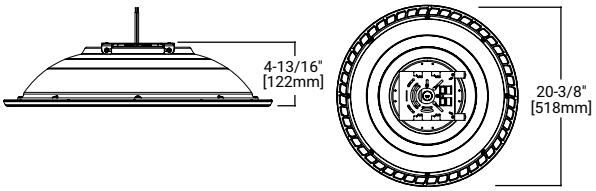
- WaveLinx Lite
- Synapse

Dimensional Details

SURFACE MOUNT
CQ, MQ, WQ and RW: D1-D6
DL: D1-D4
Base luminaire weight: 18.2 lbs (8.3 kg)



SURFACE MOUNT
CQ, MQ, WQ and RW: D7+
DL: D5+
Base luminaire weight: 20.1 lbs (9.1 kg)



NOTES:
1. Visit https://www.designlights.org/search/ to confirm qualification. Not all product variations are DLC qualified.
2. IDA Certified for 3000K CCT and warmer only.

McGraw-Edison — TT TopTier

Ordering Information

SAMPLE NUMBER: **TT-D3-740-U-WQ-STM-30L-AP**

Product Family	Configuration	Color Temperature	Voltage	Distribution	Mounting	Lead Length [7]	Finish
TT=TopTier [1] **BAA-TT**=TopTier, Buy American Act Compliant [27] **TAA-TT**=TopTier, Trade Agreements Act Compliant [27]	**D1**=4,000 Nominal Lumens **D2**=5,500 Nominal Lumens **D3**=6,500 Nominal Lumens **D4**=8,000 Nominal Lumens **D5**=10,000 Nominal Lumens **D6**=13,000 Nominal Lumens **D7**=15,000 Nominal Lumens **D8**=18,000 Nominal Lumens **D9**=20,000 Nominal Lumens **D10**=22,000 Nominal Lumens	**735**=70 CRI, 3500K CCT **740**=70 CRI, 4000K CCT **750**=70 CRI, 5000K CCT **830**=80 CRI, 3000K CCT **AMB**=Amber 590nm [29] 4000K 80CRI	**U**=120-277V **H**=347-480V [22, 26] **1**=120V **2**=208V **3**=240V **4**=277V **8**=480V **9**=347V	**CQ**=Concentrated **MQ**=Medium **WQ**=Wide **RW**=Rectangular Wide [3] **DL**=Drive Lane / Type 4 [3]	**[Blank]**=Surface Mount [16] **TMB**=Trunnion Mount with Connection Box **DPM**=Decorative Pendant Mount [4] **WM**=Wall Mount **STM**=Stem Mount to 1/2" conduit [16] 18" stem	**[Blank]**=6" **30L**=30" **36L**=36" **48L**=48" **72L**=72" **108L**=108" **120L**=120" **144L**=144"	**NW**=White **AP**=Grey **BZ**=Bronze **BK**=Black **DP**=Dark Platinum **GM**=Graphite Metallic

Options (Add as Suffix)

F=Single Fuse (120, 277 or 347V Specify Voltage)
FF=Double Fuse (208, 240 or 480V Specify Voltage)
IBP=Integral Battery Pack [5, 24]
IBP-CEC=Integral Battery Pack, CEC compliant [5]
ITS=Integral Transfer Switch [3]
924=UL924 listed luminaire [19]
CG=Clear Glass [8]
SG=Solite® Glass [9]
UPL=Uplight [6]
TR=Tamper Resistant Hardware
NAT=Natatorium finish
DALI=DALI Driver [15]
MS/DIM-L08=Dimming Occupancy Sensor (<9' Mounting) [11, 17]
MS/DIM-L20=Dimming Occupancy Sensor (9' - 20' Mounting) [11, 17]
ZW=WaveLinx-Enabled Module and 4-PIN Receptacle [23]
SPB1=Dimming Motion and Daylight Sensor, Bluetooth Programmable, < 8' Mounting [11, 21]
SPB2=Dimming Motion and Daylight Sensor, Bluetooth Programmable, 8' - 20' Mounting [11, 21]
SPB4=Dimming Motion and Daylight Sensor, Bluetooth Programmable, 20' - 40' Mounting [11, 21]
ZD=WaveLinx-Enabled Module with DALI Driver and 4-PIN Receptacle [23]
ZW-SWPD4WH=WaveLinx Control Module and Wireless Sensor – 7'-15'
ZW-SWPD5WH=WaveLinx Control Module and Wireless Sensor – 15'-40'
ZW-WOBWH=WaveLinx Control Module and LC Bluetooth Sensor – 7'-15'
ZW-WOFWH=WaveLinx Control Module and LC Bluetooth Sensor – 15'-40'
ZD-SWPD4WH=WaveLinx with DALI Driver and Wireless Sensor – 7'-15'
ZD-SWPD5WH=WaveLinx with DALI Driver and Wireless Sensor – 15'-40'
ZD-WOBWH=WaveLinx with DALI Driver and LC Bluetooth Sensor – 7'-15'
ZD-WOFWH=WaveLinx with DALI Driver and LC Bluetooth Sensor – 15 -40'
LWR-LW=Enlighted Wireless Sensor, Wide Lens 8' - 16' Mounting Height [11, 18]
LWR-LN=Enlighted Wireless Sensor, Narrow Lens 16' - 40' Mounting Height [11, 18]
DIM10-MS/DIM-L08=Synapse occupancy sensor (<8' Mounting)
DIM10-MS/DIM-L20=Synapse occupancy sensor (8'-20' Mounting)

Accessories (Order Separately) [28]

MA1252=Replacement 10kV Surge Module
TT/WG=Wire Guard [25]
TT/BG-UP-XX=Bird Guard [12, 13]
TT/HSS-XX=House Side Shield [25]
DPMS36-XX=36" Pendant Mount Stem [12, 14]
DPMS48-XX=48" Pendant Mount Stem [12, 14]
DPMS96-XX=96" Pendant Mount Stem [12, 14]
FSIR-100=Wireless Configuration Tool for Occupancy Sensor [17]
SWPD4-WH=WaveLinx Wireless Sensor, 7'–15' Mounting Height [20, 21, 22, 23]
SWPD5-WH=WaveLinx Wireless Sensor, 15'–40' Mounting Height [20, 21, 22, 23]

FOR LUMINAIRES NOTED AS EM, PROVIDE WITH INTEGRAL UL924 LISTED EMERGENCY BYPASS.

NOTES:

1. DesignLights Consortium® Qualified. Refer to www.designlights.org Qualified Products List under Family Models for details.
2. Only for use with 480V Wye systems. Per NEC, not for use with ungrounded systems, impedance grounded systems or corner grounded systems (commonly known as Three Phase Three Wire Delta, Three Phase High Leg Delta and Three Phase Corner Grounded Delta systems).
3. Not available with D7 - D10 configurations.
4. Order Pendant Mount Stem accessory.
5. IBP ambient operating temperature -20°C to 35°C (D1-D3), -20°C to 25°C (D4-D6). Not available with D7-D10 configurations, DALI, or ZD options.
6. Additional 8.0W. Provides 920 lumens. Not available with D10 configuration.
7. Choose lead length for Surface Mount and Stem Mount only. TMB, DPM and WM lengths predetermined.
8. Not available with CQ.
9. Standard with CQ, option available with WQ only.
10. U voltage only. Ambient operating temperature -20°C to 50°C (D1-D4) or -20°C to 40°C (D5-D6). UL924 listed component.
11. Includes integral photocell.
12. Specify color in place of XX.
13. Designed for use with Stem Mount and Decorative Pendant Mount only.
14. Designed for use with Decorative Pendant Mount only.
15. Not available with H voltage or IBP. Not compatible with MS/DIM or LWR sensors.
16. Specify Lead Length for wire harness length.
17. The FSIR-100 configuration tool is required to adjust parameters including high and low modes, sensitivity, time delay and more.
18. Enlighted wireless sensors are factory installed only, and require network components in appropriate quantities.
19. 924 option provides luminaire UL924 listing, used in conjunction with ITS or IBP-CEC.
20. Requires ZW or ZD receptacle.
21. Sensor configuration mobile application required for configuration. See controls page for details.
22. Cannot be used with other control options.
23. For WaveLinx applications, WAC Gateway required to enable field-configurability: Order WAC-PoE and WPOE-120 (10V to PoE injector) power supply if needed. Not required for WaveLinx Lite Commercial (LC) applications.
24. Specify 120V or 277V.
25. TT/WG and TT/HSS cannot be installed together. TT/HSS & TT/WG not available on D7-D10 configurations.
26. D4-D10 only. Not compatible with battery.
27. Only product configurations with these designated prefixes are built to be compliant with the Buy American Act of 1933 (BAA) or Trade Agreements Act of 1979 (TAA), respectively. Please refer to DOMESTIC PREFERENCES website for more information. Components shipped separately may be separately analyzed under domestic preference requirements.
28. Accessories sold separately will be separately analyzed under domestic preference requirements. Consult factory for further information.
29. Narrow-band 590nm +/- 5nm for wildlife and observatory use. Choose lumen package D1.

Product Specifications

Construction

- Low profile, die-cast aluminum housing provides a clean, symmetric aesthetic

Optics

- Five optical distributions utilizing visual comfort waveguide technology
- 10 lumen packages, ranging from 2,757 to 22,831
- Integral uplight option utilizes a dedicated, 8W light engine, producing 920 lumens for reduced visual contrast and cave effect
- IDA Certified for 3000k CCT and warmer only. Not available with uplight option.

Electrical

- D1-D6: -40C - 50C operating temperature
- D7-D10: -40C - 40C operating temperature
- Greater than 90% lumen maintenance at 50,000 hours
- IP66 rated
- 120-277V 50/60Hz, 347V 60Hz or 480V 60Hz operation
- 10kV surge module standard
- 0-10V dimming standard

Mounting

- Surface mount directly to square or octagonal 4" surface or recessed junction box using quick mount bracket
- Optional stem mount bracket with set screw for direct 1/2" NPS conduit mounting
- Trunnion, decorative pendant, and wall mount options also available

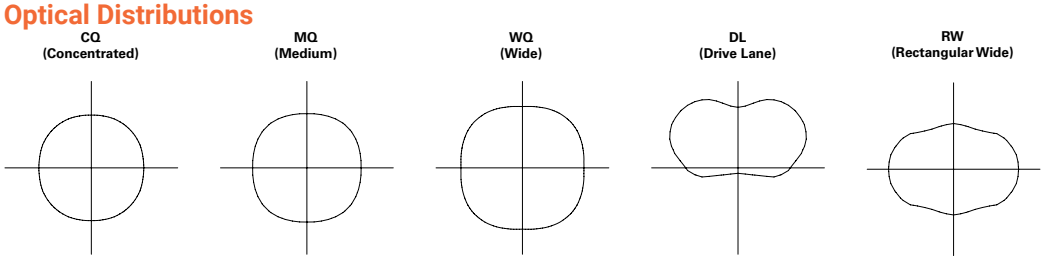
Finish

- 2.5 mil nominal TGIC powder coat thickness
- Finishes include white, black, bronze, gray, dark platinum and graphite metallic
- RAL and custom color matches available
- Natatorium option (NAT) available, providing 5,000 hour salt spray rating per ASTM B117, with a scribe rating of 9 per ASTM D1654

Warranty

- Five-year warranty

Optical Distributions

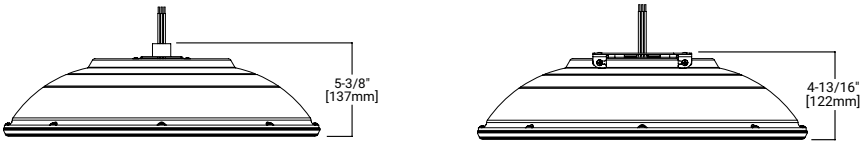


McGraw-Edison **TT TopTier**

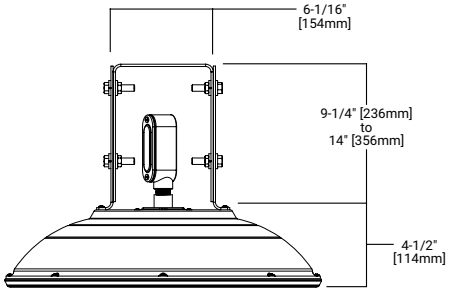
Mounting Details

***D1-D6 configuration shown (D1-D4 for DL distribution)**

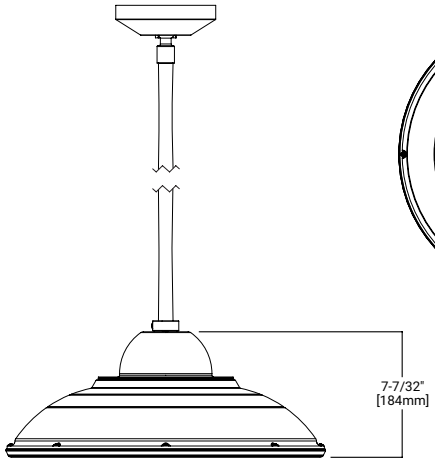
Stem Mount



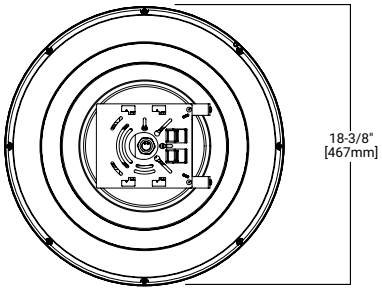
Trunnion Mount



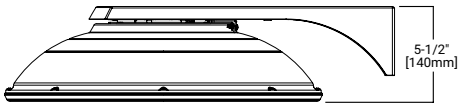
Decorative Pendant Mount



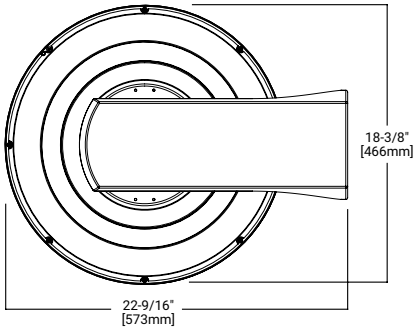
Top View



Wall Mount

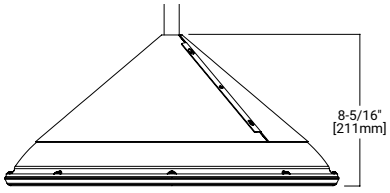


Top View - Wall Mount

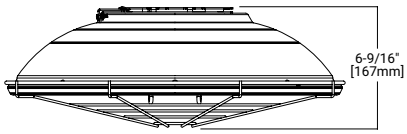


Accessories

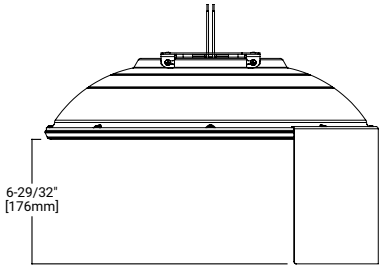
Bird Guard (TT/BG-UP-XX)



Wire Guard (TT/WG)



House Side Shield (TT/HSS-XX)



McGraw-Edison **TT TopTier**

Energy and Performance Data

View TopTier IES files

Power and Lumens (3000K/3500K/4000K/5000K)

Lumen Package			D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
Power (Wattage) CQ, MQ, WQ			28.0	39.2	47.2	57.6	74.7	105.2	124.7	148.7	173.1	193.8
Power (Wattage) RW Only			28.0	39.2	47.2	57.6	74.7	105.2	127.1	152.6	178.0	--
Power (Wattage) DL Only			28.8	40.5	48.8	59.8	62.3	97.4	127.1	152.6	178.0	--
Distribution												
3000K CCT 80 CRI	CQ Concentrated	Lumens	3,409	4,640	5,595	6,660	8,383	11,030	12,307	14,411	16,430	18,001
		BUG Rating	B1-U0-G1	B2-U0-G1	B2-U0-G1	B2-U0-G1	B3-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G2
		Lumens per Watt	122	118	119	116	112	105	99	97	95	93
	MQ Medium	Lumens	3,647	4,964	5,986	7,125	8,969	11,800	12,854	15,053	17,161	18,802
		BUG Rating	B2-U0-G1	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3
		Lumens per Watt	130	127	127	124	120	112	103	101	99	97
	WQ Wide	Lumens	3,449	4,695	5,662	6,740	8,483	11,161	12,350	14,463	16,489	18,065
		BUG Rating	B2-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3
		Lumens per Watt	123	120	120	117	114	106	99	97	95	93
	RW Rectangular Wide	Lumens	2,757	3,753	4,526	5,387	6,781	8,922	11,977	13,619	15,122	--
		BUG Rating	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	--
		Lumens per Watt	98	96	96	94	91	85	94	89	85	--
	DL Drive Lane / Type 4	Lumens	2,959	3,985	4,762	5,622	6,537	8,771	11,834	13,337	14,768	--
		BUG Rating	B1-U0-G2	B2-U0-G3	B2-U0-G3	B2-U0-G3	B1-U0-G3	B2-U0-G3	B2-U0-G4	B2-U0-G4	B2-U0-G4	--
		Lumens per Watt	103	98	98	94	105	90	93	87	83	--
3500K CCT 70 CRI	CQ Concentrated	Lumens	3,618	4,925	5,940	7,070	8,899	11,708	14,944	17,500	19,951	21,858
		BUG Rating	B1-U0-G1	B2-U0-G1	B2-U0-G1	B2-U0-G1	B3-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B4-U0-G2	B4-U0-G2
		Lumens per Watt	129	126	126	123	119	111	120	118	115	113
	MQ Medium	Lumens	3,872	5,270	6,355	7,564	9,520	12,527	15,609	18,279	20,839	22,831
		BUG Rating	B2-U0-G2	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3
		Lumens per Watt	138	134	135	131	127	119	125	123	120	118
	WQ Wide	Lumens	3,662	4,984	6,011	7,154	9,005	11,848	14,997	17,562	20,022	21,936
		BUG Rating	B2-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G4
		Lumens per Watt	131	127	127	124	121	113	120	118	116	113
	RW Rectangular Wide	Lumens	2,927	3,984	4,805	5,719	7,198	9,471	14,544	16,537	18,363	--
		BUG Rating	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	--
		Lumens per Watt	105	102	102	99	96	90	114	108	103	--
	DL Drive Lane / Type 4	Lumens	3,141	4,230	5,055	5,968	7,938	10,650	14,370	16,195	17,933	--
		BUG Rating	B1-U0-G2	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G4	B3-U0-G4	B3-U0-G5	--
		Lumens per Watt	109	104	104	100	127	109	113	106	101	--
4000K/ 5000K CCT 70 CRI	CQ Concentrated	Lumens	3,828	5,211	6,284	7,480	9,415	12,387	14,944	17,500	19,951	21,858
		BUG Rating	B1-U0-G1	B2-U0-G1	B2-U0-G1	B2-U0-G1	B3-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B4-U0-G2	B4-U0-G2
		Lumens per Watt	137	133	133	130	126	118	120	118	115	113
	MQ Medium	Lumens	4,096	5,575	6,723	8,002	10,072	13,253	15,609	18,279	20,839	22,831
		BUG Rating	B2-U0-G2	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3
		Lumens per Watt	146	142	142	139	135	126	125	123	120	118
	WQ Wide	Lumens	3,874	5,273	6,359	7,569	9,527	12,535	14,997	17,562	20,022	21,936
		BUG Rating	B2-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G4
		Lumens per Watt	138	135	135	131	128	119	120	118	116	113
	RW Rectangular Wide	Lumens	3,097	4,215	5,083	6,050	7,615	10,020	14,544	16,537	18,363	--
		BUG Rating	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	--
		Lumens per Watt	111	108	108	105	102	95	114	108	103	--
	DL Drive Lane / Type 4	Lumens	3,323	4,475	5,348	6,314	7,938	10,650	14,370	16,195	17,933	--
		BUG Rating	B1-U0-G2	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G4	B3-U0-G4	B3-U0-G5	--
		Lumens per Watt	115	110	110	106	127	109	113	106	101	--

McGraw-Edison **TT TopTier**

Energy and Performance Data

CQ, MQ and WQ Distributions

Lumen Package	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
Power (Wattage)	28.0	39.2	47.2	57.6	74.7	105.2	124.7	148.7	173.1	193.8
Input Current @ 120V (A)	0.23	0.33	0.39	0.48	0.62	0.88	1.09	1.31	1.53	1.72
Input Current @ 208V (A)	0.13	0.19	0.23	0.28	0.36	0.51	0.57	0.67	0.78	0.88
Input Current @ 240V (A)	0.12	0.16	0.20	0.24	0.31	0.44	0.56	0.66	0.76	0.85
Input Current @ 277V (A)	0.10	0.14	0.17	0.21	0.27	0.38	0.49	0.58	0.67	0.74
Input Current @ 347V (A)	0.08	0.11	0.14	0.17	0.22	0.30	0.40	0.47	0.55	0.62
Input Current @ 480V (A)	0.06	0.08	0.10	0.12	0.16	0.22	0.30	0.35	0.41	0.45

RW Distribution

Lumen Package	D1	D2	D3	D4	D5	D6	D7	D8	D9
Power (Wattage)	28.0	39.2	47.2	57.6	74.7	105.2	127.1	152.6	178.0
Input Current @ 120V (A)	0.23	0.33	0.39	0.48	0.62	0.88	1.11	1.34	1.58
Input Current @ 208V (A)	0.13	0.19	0.23	0.28	0.36	0.51	0.58	0.69	0.81
Input Current @ 240V (A)	0.12	0.16	0.20	0.24	0.31	0.44	0.56	0.67	0.78
Input Current @ 277V (A)	0.10	0.14	0.17	0.21	0.27	0.38	0.50	0.59	0.68
Input Current @ 347V (A)	0.08	0.11	0.14	0.17	0.22	0.30	0.41	0.48	0.57
Input Current @ 480V (A)	0.06	0.08	0.10	0.12	0.16	0.22	0.30	0.36	0.42

DL Distribution

Lumen Package	D1	D2	D3	D4	D5	D6	D7	D8	D9
Power (Wattage)	28.8	40.5	48.8	59.8	62.3	97.4	127.1	152.6	178.0
Input Current @ 120V (A)	0.24	0.34	0.41	0.50	0.55	0.86	1.11	1.34	1.58
Input Current @ 208V (A)	0.14	0.19	0.23	0.29	0.28	0.44	0.58	0.69	0.81
Input Current @ 240V (A)	0.12	0.17	0.20	0.25	0.28	0.43	0.56	0.67	0.78
Input Current @ 277V (A)	0.10	0.15	0.18	0.22	0.24	0.37	0.50	0.59	0.68
Input Current @ 347V (A)	0.08	0.12	0.14	0.17	0.21	0.31	0.41	0.48	0.57
Input Current @ 480V (A)	0.06	0.08	0.10	0.12	0.15	0.23	0.30	0.36	0.42

Lumen Maintenance

Lumen Package	Ambient Temperature	25,000 hours*	50,000 hours*	60,000 hours*	100,000 hours**	Theoretical L70 hours**
D1-D6 (D1 - D4 DL/T4)	25°C	98.0%	95.2%	94.1%	89.8%	> 300,000
	40°C	97.9%	94.8%	93.6%	89.0%	> 290,000
	50°C	97.7%	94.5%	93.2%	88.4%	> 270,000
D7 - D10 (D5+ DL/T4)	25°C	95.8%	93.2%	92.2%	88.2%	> 300,000
	40°C	93.9%	89.7%	88.1%	81.9%	> 180,000

* Supported by IES TM-21 standards
**Theoretical values represent estimations commonly used; however, refer to the IES position on LED Product Lifetime Prediction, IES PS-10-18, explaining proper use of IES TM-21 and LM-80.

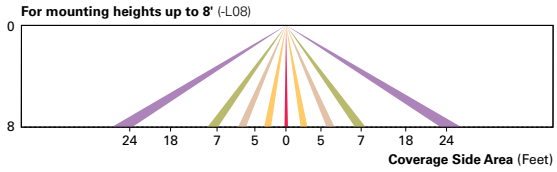
Lumen Multiplier

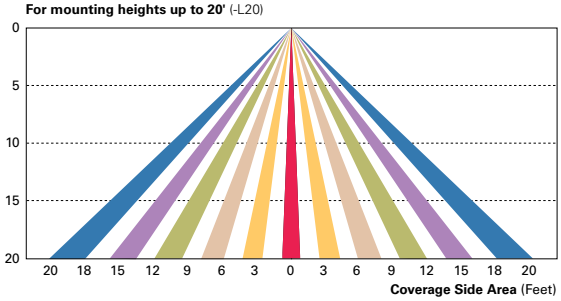
Ambient Temperature	Multiplier
0°C	1.03
10C	1.02
25°C	1.00
40°C	0.98
50°C	0.97

Control Options

0-10V (D) 0-10V dimming comes standard on all TopTier configurations for use with integrated or external lighting controls.

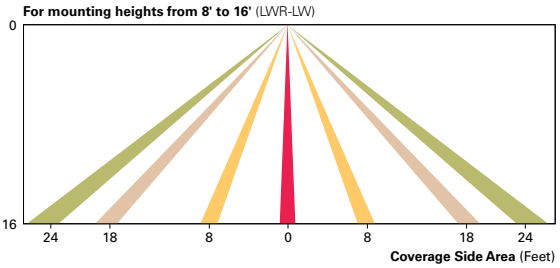
Dimming Occupancy Sensor (MS/DIM) These sensors are factory installed in the luminaire, dimming to 50% after five minutes of no motion detected. When motion is detected, the luminaire output is 100%. Includes an integral photocell that can be programmed for "dusk-to-dawn" operation. The FSIR-100 programming tool can be utilized to adjust dimming level, time delay, sensitivity and other parameters. Two lens options provide optimal coverage patterns up to 20' mounting height.

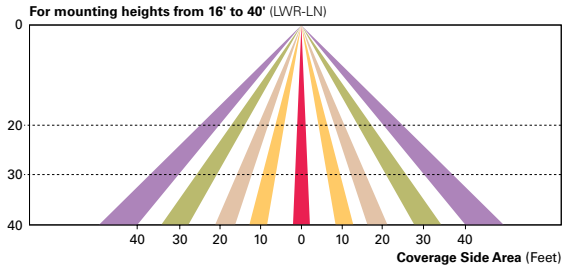




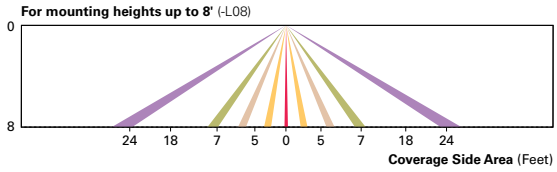
WaveLinx-Ready 4-PIN Twistlock Receptacle (ZW) Includes the WaveLinx control module, integrated 4-Pin receptacle, and standard 0-10V dimming driver, enabling the subsequent addition of a WaveLinx sensor.

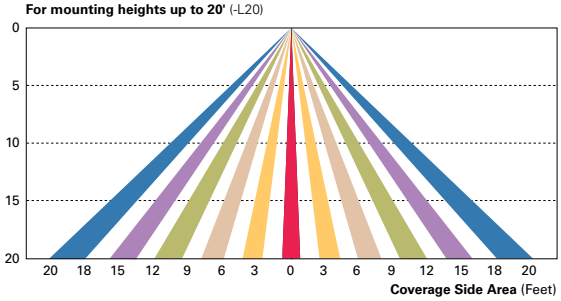
Enlighted Wireless Control and Monitoring System (LWR-LW and LWR-LN) The Enlighted control system is a connected lighting solution, combining LED luminaires with an integrated wireless sensor system. The sensor controls the lighting system in compliance with the latest energy codes while collecting valuable data about building performance and use. Software applications utilizing energy dashboards maximize data inputs to help optimize the use of other resources beyond lighting.





Synapse (DIM10) SimplySNAP integrated wireless controls system by Synapse. Includes factory installed DIM10 control module and MS/DC motion sensor; requires additional Synapse system components for operation. Contact Synapse at www.synapsewireless.com for product support, warranty, and terms and conditions.





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www.cooperlighting.com

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Specifications and dimensions
subject to change without notice.

Project		Catalog #	TYPE OC - ADD ALTERNATE BID
Prepared by		Notes	PROVIDE SPECIFIED FIXTURE BY APPROVED MANUFACTURER OR ENGINEER-APPROVED EQUAL BY: LITHONIA VCPG SERIES GARDCO SOFTVIEW SERIES



TopTier (D1-D6)



TopTier (D7-D10)

McGraw-Edison

TT TopTier

Parking Garage Luminaire

Product Features

Light ARchitect™

Interactive Menu

- Ordering Information page 2
- Product Specifications page 2
- Optical Configurations page 2
- Mounting Details page 3
- Energy and Performance Data page 4
- Control Options page 6

Product Certifications

Quick Facts

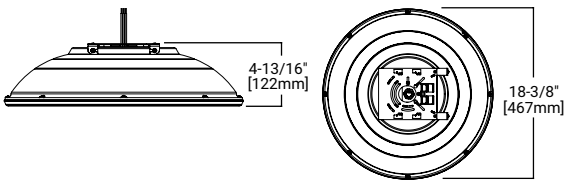
- Lumen packages range from 2,757 - 22,831
- Efficacies up to 146 lumens per watt
- Utilizes patented waveguide technology for maximum visual comfort
- Surface, pendant, trunnion, wall and direct conduit mount options

Connected Systems

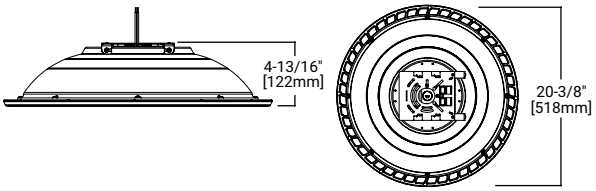
- WaveLinx Lite
- Synapse

Dimensional Details

SURFACE MOUNT
CQ, MQ, WQ and RW: D1-D6
DL: D1-D4
Base luminaire weight: 18.2 lbs (8.3 kg)



SURFACE MOUNT
CQ, MQ, WQ and RW: D7+
DL: D5+
Base luminaire weight: 20.1 lbs (9.1 kg)



NOTES:
1. Visit https://www.designlights.org/search/ to confirm qualification. Not all product variations are DLC qualified.
2. IDA Certified for 3000K CCT and warmer only.

McGraw-Edison — TT TopTier

Ordering Information

SAMPLE NUMBER: **TT-D3-740-U-WQ-STM-30L-AP**

Product Family	Configuration	Color Temperature	Voltage	Distribution	Mounting	Lead Length [7]	Finish
TT=TopTier [1] **BAA-TT**=TopTier, Buy American Act Compliant [27] **TAA-TT**=TopTier, Trade Agreements Act Compliant [27]	**D1**=4,000 Nominal Lumens **D2**=5,500 Nominal Lumens **D3**=6,500 Nominal Lumens **D4**=8,000 Nominal Lumens **D5**=10,000 Nominal Lumens **D6**=13,000 Nominal Lumens **D7**=15,000 Nominal Lumens **D8**=18,000 Nominal Lumens **D9**=20,000 Nominal Lumens **D10**=22,000 Nominal Lumens	**735**=70 CRI, 3500K CCT **740**=70 CRI, 4000K CCT **750**=70 CRI, 5000K CCT **830**=80 CRI, 3000K CCT **AMB**=Amber 590nm [29] 4000K 80CRI	**U**=120-277V **H**=347-480V [22, 26] **1**=120V **2**=208V **3**=240V **4**=277V **8**=480V **9**=347V	**CQ**=Concentrated **MQ**=Medium **WQ**=Wide **RW**=Rectangular Wide [3] **DL**=Drive Lane / Type 4 [3]	**[Blank]**=Surface Mount [16] **TMB**=Trunnion Mount with Connection Box **DPM**=Decorative Pendant Mount [4] **WM**=Wall Mount **STM**=Stem Mount to 1/2" conduit [16] 18" stem	**[Blank]**=6" **30L**=30" **36L**=36" **48L**=48" **72L**=72" **108L**=108" **120L**=120" **144L**=144"	**NW**=White **AP**=Grey **BZ**=Bronze **BK**=Black **DP**=Dark Platinum **GM**=Graphite Metallic

Options (Add as Suffix)

F=Single Fuse (120, 277 or 347V Specify Voltage)
FF=Double Fuse (208, 240 or 480V Specify Voltage)
IBP=Integral Battery Pack [5, 24]
IBP-CEC=Integral Battery Pack, CEC compliant [5]
ITS=Integral Transfer Switch [3]
924=UL924 listed luminaire [19]
CG=Clear Glass [8]
SG=Solite® Glass [9]
UPL=Uplight [6]
TR=Tamper Resistant Hardware
NAT=Natatorium finish
DALI=DALI Driver [15]
MS/DIM-L08=Dimming Occupancy Sensor (<9' Mounting) [11, 17]
MS/DIM-L20=Dimming Occupancy Sensor (9' - 20' Mounting) [11, 17]
ZW=WaveLinx-Enabled Module and 4-PIN Receptacle [23]
SPB1=Dimming Motion and Daylight Sensor, Bluetooth Programmable, < 8' Mounting [11, 21]
SPB2=Dimming Motion and Daylight Sensor, Bluetooth Programmable, 8' - 20' Mounting [11, 21]
SPB4=Dimming Motion and Daylight Sensor, Bluetooth Programmable, 20' - 40' Mounting [17, 21]
ZD=WaveLinx-Enabled Module with DALI Driver and 4-PIN Receptacle [23]
ZW-SWPD4WH=WaveLinx Control Module and Wireless Sensor – 7'-15'
ZW-SWPD5WH=WaveLinx Control Module and Wireless Sensor – 15'-40'
ZW-WOBWH=WaveLinx Control Module and LC Bluetooth Sensor – 7'-15'
ZW-WOFWH=WaveLinx Control Module and LC Bluetooth Sensor – 15'-40'
ZD-SWPD4WH=WaveLinx with DALI Driver and Wireless Sensor – 7'-15'
ZD-SWPD5WH=WaveLinx with DALI Driver and Wireless Sensor – 15'-40'
ZD-WOBWH=WaveLinx with DALI Driver and LC Bluetooth Sensor – 7'-15'
ZD-WOFWH=WaveLinx with DALI Driver and LC Bluetooth Sensor – 15 -40'
LWR-LW=Enlighted Wireless Sensor, Wide Lens 8' - 16' Mounting Height [11, 18]
LWR-LN=Enlighted Wireless Sensor, Narrow Lens 16' - 40' Mounting Height [11, 18]
DIM10-MS/DIM-L08=Synapse occupancy sensor (<8' Mounting)
DIM10-MS/DIM-L20=Synapse occupancy sensor (8'-20' Mounting)

Accessories (Order Separately) [28]

MA1252=Replacement 10kV Surge Module
TT/WG=Wire Guard [25]
TT/BG-UP-XX=Bird Guard [12, 13]
TT/HSS-XX=House Side Shield [25]
DPMS36-XX=36" Pendant Mount Stem [12, 14]
DPMS48-XX=48" Pendant Mount Stem [12, 14]
DPMS96-XX=96" Pendant Mount Stem [12, 14]
FSIR-100=Wireless Configuration Tool for Occupancy Sensor [17]
SWPD4-WH=WaveLinx Wireless Sensor, 7'–15' Mounting Height [20, 21, 22, 23]
SWPD5-WH=WaveLinx Wireless Sensor, 15'–40' Mounting Height [20, 21, 22, 23]

FOR LUMINAIRES NOTED AS EM, PROVIDE WITH INTEGRAL UL924 LISTED EMERGENCY BYPASS.

NOTES:

1. DesignLights Consortium® Qualified. Refer to www.designlights.org Qualified Products List under Family Models for details.
2. Only for use with 480V Wye systems. Per NEC, not for use with ungrounded systems, impedance grounded systems or corner grounded systems (commonly known as Three Phase Three Wire Delta, Three Phase High Leg Delta and Three Phase Corner Grounded Delta systems).
3. Not available with D7 - D10 configurations.
4. Order Pendant Mount Stem accessory.
5. IBP ambient operating temperature -20°C to 35°C (D1-D3), -20°C to 25°C (D4-D6). Not available with D7-D10 configurations, DALI, or ZD options.
6. Additional 8.0W. Provides 920 lumens. Not available with D10 configuration.
7. Choose lead length for Surface Mount and Stem Mount only. TMB, DPM and WM lengths predetermined.
8. Not available with CQ.
9. Standard with CQ, option available with WQ only.
10. U voltage only. Ambient operating temperature -20°C to 50°C (D1-D4) or -20°C to 40°C (D5-D6). UL924 listed component.
11. Includes integral photocell.
12. Specify color in place of XX.
13. Designed for use with Stem Mount and Decorative Pendant Mount only.
14. Designed for use with Decorative Pendant Mount only.
15. Not available with H voltage or IBP. Not compatible with MS/DIM or LWR sensors.
16. Specify Lead Length for wire harness length.
17. The FSIR-100 configuration tool is required to adjust parameters including high and low modes, sensitivity, time delay and more.
18. Enlighted wireless sensors are factory installed only, and require network components in appropriate quantities.
19. 924 option provides luminaire UL924 listing, used in conjunction with ITS or IBP-CEC.
20. Requires ZW or ZD receptacle.
21. Sensor configuration mobile application required for configuration. See controls page for details.
22. Cannot be used with other control options.
23. For WaveLinx applications, WAC Gateway required to enable field-configurability: Order WAC-PoE and WPOE-120 (10V to PoE injector) power supply if needed. Not required for WaveLinx Lite Commercial (LC) applications.
24. Specify 120V or 277V.
25. TT/WG and TT/HSS cannot be installed together. TT/HSS & TT/WG not available on D7-D10 configurations.
26. D4-D10 only. Not compatible with battery.
27. Only product configurations with these designated prefixes are built to be compliant with the Buy American Act of 1933 (BAA) or Trade Agreements Act of 1979 (TAA), respectively. Please refer to DOMESTIC PREFERENCES website for more information. Components shipped separately may be separately analyzed under domestic preference requirements.
28. Accessories sold separately will be separately analyzed under domestic preference requirements. Consult factory for further information.
29. Narrow-band 590nm +/- 5nm for wildlife and observatory use. Choose lumen package D1.

Product Specifications

Construction

- Low profile, die-cast aluminum housing provides a clean, symmetric aesthetic

Optics

- Five optical distributions utilizing visual comfort waveguide technology
- 10 lumen packages, ranging from 2,757 to 22,831
- Integral uplight option utilizes a dedicated, 8W light engine, producing 920 lumens for reduced visual contrast and cave effect
- IDA Certified for 3000k CCT and warmer only. Not available with uplight option.

Electrical

- D1-D6: -40C - 50C operating temperature
- D7-D10: -40C - 40C operating temperature
- Greater than 90% lumen maintenance at 50,000 hours
- IP66 rated
- 120-277V 50/60Hz, 347V 60Hz or 480V 60Hz operation
- 10kV surge module standard
- 0-10V dimming standard

Mounting

- Surface mount directly to square or octagonal 4" surface or recessed junction box using quick mount bracket
- Optional stem mount bracket with set screw for direct 1/2" NPS conduit mounting
- Trunnion, decorative pendant, and wall mount options also available

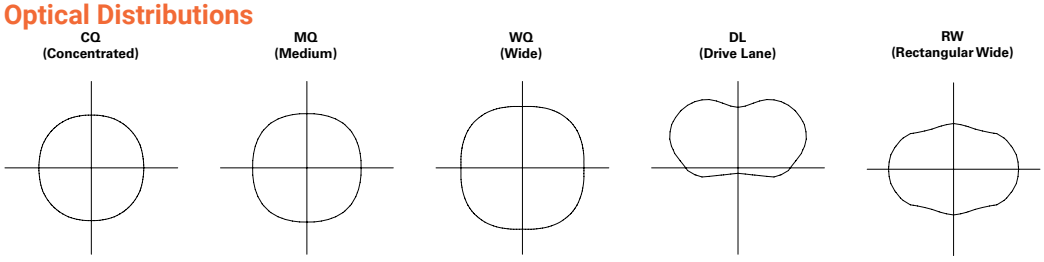
Finish

- 2.5 mil nominal TGIC powder coat thickness
- Finishes include white, black, bronze, gray, dark platinum and graphite metallic
- RAL and custom color matches available
- Natatorium option (NAT) available, providing 5,000 hour salt spray rating per ASTM B117, with a scribe rating of 9 per ASTM D1654

Warranty

- Five-year warranty

Optical Distributions

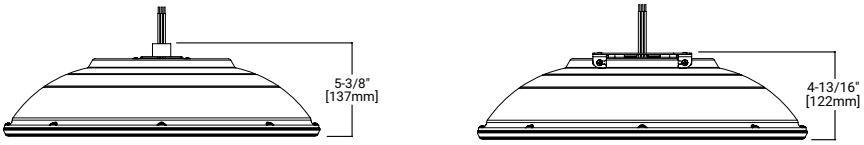


McGraw-Edison **TT TopTier**

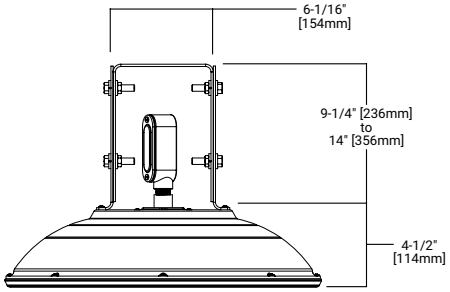
Mounting Details

***D1-D6 configuration shown (D1-D4 for DL distribution)**

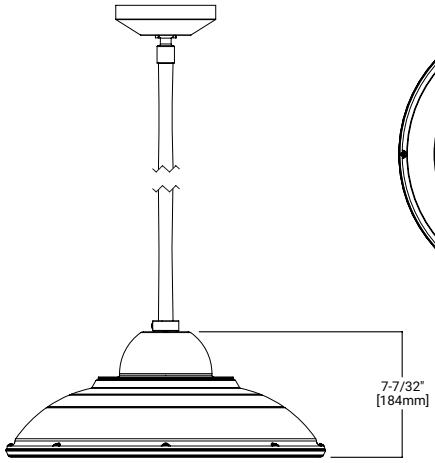
Stem Mount



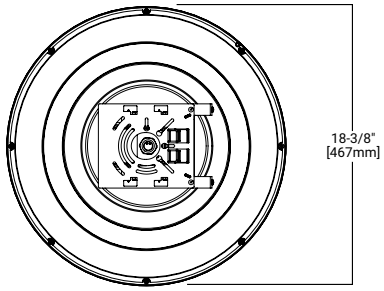
Trunnion Mount



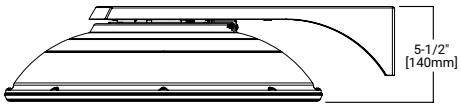
Decorative Pendant Mount



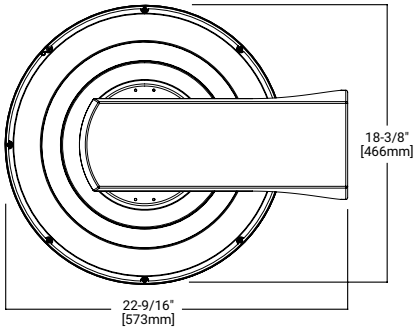
Top View



Wall Mount

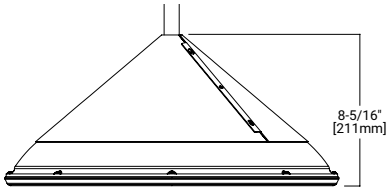


Top View - Wall Mount

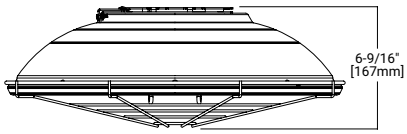


Accessories

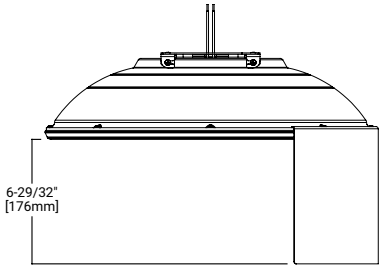
Bird Guard (TT/BG-UP-XX)



Wire Guard (TT/WG)



House Side Shield (TT/HSS-XX)



McGraw-Edison **TT TopTier**

Energy and Performance Data

View TopTier IES files

Power and Lumens (3000K/3500K/4000K/5000K)

Lumen Package			D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
Power (Wattage) CQ, MQ, WQ			28.0	39.2	47.2	57.6	74.7	105.2	124.7	148.7	173.1	193.8
Power (Wattage) RW Only			28.0	39.2	47.2	57.6	74.7	105.2	127.1	152.6	178.0	--
Power (Wattage) DL Only			28.8	40.5	48.8	59.8	62.3	97.4	127.1	152.6	178.0	--
Distribution												
3000K CCT 80 CRI	CQ Concentrated	Lumens	3,409	4,640	5,595	6,660	8,383	11,030	12,307	14,411	16,430	18,001
		BUG Rating	B1-U0-G1	B2-U0-G1	B2-U0-G1	B2-U0-G1	B3-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G2
		Lumens per Watt	122	118	119	116	112	105	99	97	95	93
	MQ Medium	Lumens	3,647	4,964	5,986	7,125	8,969	11,800	12,854	15,053	17,161	18,802
		BUG Rating	B2-U0-G1	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3
		Lumens per Watt	130	127	127	124	120	112	103	101	99	97
	WQ Wide	Lumens	3,449	4,695	5,662	6,740	8,483	11,161	12,350	14,463	16,489	18,065
		BUG Rating	B2-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3
		Lumens per Watt	123	120	120	117	114	106	99	97	95	93
	RW Rectangular Wide	Lumens	2,757	3,753	4,526	5,387	6,781	8,922	11,977	13,619	15,122	--
		BUG Rating	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	--
		Lumens per Watt	98	96	96	94	91	85	94	89	85	--
	DL Drive Lane / Type 4	Lumens	2,959	3,985	4,762	5,622	6,537	8,771	11,834	13,337	14,768	--
		BUG Rating	B1-U0-G2	B2-U0-G3	B2-U0-G3	B2-U0-G3	B1-U0-G3	B2-U0-G3	B2-U0-G4	B2-U0-G4	B2-U0-G4	--
		Lumens per Watt	103	98	98	94	105	90	93	87	83	--
3500K CCT 70 CRI	CQ Concentrated	Lumens	3,618	4,925	5,940	7,070	8,899	11,708	14,944	17,500	19,951	21,858
		BUG Rating	B1-U0-G1	B2-U0-G1	B2-U0-G1	B2-U0-G1	B3-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B4-U0-G2	B4-U0-G2
		Lumens per Watt	129	126	126	123	119	111	120	118	115	113
	MQ Medium	Lumens	3,872	5,270	6,355	7,564	9,520	12,527	15,609	18,279	20,839	22,831
		BUG Rating	B2-U0-G2	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3
		Lumens per Watt	138	134	135	131	127	119	125	123	120	118
	WQ Wide	Lumens	3,662	4,984	6,011	7,154	9,005	11,848	14,997	17,562	20,022	21,936
		BUG Rating	B2-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G4
		Lumens per Watt	131	127	127	124	121	113	120	118	116	113
	RW Rectangular Wide	Lumens	2,927	3,984	4,805	5,719	7,198	9,471	14,544	16,537	18,363	--
		BUG Rating	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	--
		Lumens per Watt	105	102	102	99	96	90	114	108	103	--
	DL Drive Lane / Type 4	Lumens	3,141	4,230	5,055	5,968	7,938	10,650	14,370	16,195	17,933	--
		BUG Rating	B1-U0-G2	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G4	B3-U0-G4	B3-U0-G5	--
		Lumens per Watt	109	104	104	100	127	109	113	106	101	--
4000K/ 5000K CCT 70 CRI	CQ Concentrated	Lumens	3,828	5,211	6,284	7,480	9,415	12,387	14,944	17,500	19,951	21,858
		BUG Rating	B1-U0-G1	B2-U0-G1	B2-U0-G1	B2-U0-G1	B3-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B4-U0-G2	B4-U0-G2
		Lumens per Watt	137	133	133	130	126	118	120	118	115	113
	MQ Medium	Lumens	4,096	5,575	6,723	8,002	10,072	13,253	15,609	18,279	20,839	22,831
		BUG Rating	B2-U0-G2	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3
		Lumens per Watt	146	142	142	139	135	126	125	123	120	118
	WQ Wide	Lumens	3,874	5,273	6,359	7,569	9,527	12,535	14,997	17,562	20,022	21,936
		BUG Rating	B2-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G4
		Lumens per Watt	138	135	135	131	128	119	120	118	116	113
	RW Rectangular Wide	Lumens	3,097	4,215	5,083	6,050	7,615	10,020	14,544	16,537	18,363	--
		BUG Rating	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	--
		Lumens per Watt	111	108	108	105	102	95	114	108	103	--
	DL Drive Lane / Type 4	Lumens	3,323	4,475	5,348	6,314	7,938	10,650	14,370	16,195	17,933	--
		BUG Rating	B1-U0-G2	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G4	B3-U0-G4	B3-U0-G5	--
		Lumens per Watt	115	110	110	106	127	109	113	106	101	--

McGraw-Edison **TT TopTier**

Energy and Performance Data

CQ, MQ and WQ Distributions

Lumen Package	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
Power (Wattage)	28.0	39.2	47.2	57.6	74.7	105.2	124.7	148.7	173.1	193.8
Input Current @ 120V (A)	0.23	0.33	0.39	0.48	0.62	0.88	1.09	1.31	1.53	1.72
Input Current @ 208V (A)	0.13	0.19	0.23	0.28	0.36	0.51	0.57	0.67	0.78	0.88
Input Current @ 240V (A)	0.12	0.16	0.20	0.24	0.31	0.44	0.56	0.66	0.76	0.85
Input Current @ 277V (A)	0.10	0.14	0.17	0.21	0.27	0.38	0.49	0.58	0.67	0.74
Input Current @ 347V (A)	0.08	0.11	0.14	0.17	0.22	0.30	0.40	0.47	0.55	0.62
Input Current @ 480V (A)	0.06	0.08	0.10	0.12	0.16	0.22	0.30	0.35	0.41	0.45

RW Distribution

Lumen Package	D1	D2	D3	D4	D5	D6	D7	D8	D9
Power (Wattage)	28.0	39.2	47.2	57.6	74.7	105.2	127.1	152.6	178.0
Input Current @ 120V (A)	0.23	0.33	0.39	0.48	0.62	0.88	1.11	1.34	1.58
Input Current @ 208V (A)	0.13	0.19	0.23	0.28	0.36	0.51	0.58	0.69	0.81
Input Current @ 240V (A)	0.12	0.16	0.20	0.24	0.31	0.44	0.56	0.67	0.78
Input Current @ 277V (A)	0.10	0.14	0.17	0.21	0.27	0.38	0.50	0.59	0.68
Input Current @ 347V (A)	0.08	0.11	0.14	0.17	0.22	0.30	0.41	0.48	0.57
Input Current @ 480V (A)	0.06	0.08	0.10	0.12	0.16	0.22	0.30	0.36	0.42

DL Distribution

Lumen Package	D1	D2	D3	D4	D5	D6	D7	D8	D9
Power (Wattage)	28.8	40.5	48.8	59.8	62.3	97.4	127.1	152.6	178.0
Input Current @ 120V (A)	0.24	0.34	0.41	0.50	0.55	0.86	1.11	1.34	1.58
Input Current @ 208V (A)	0.14	0.19	0.23	0.29	0.28	0.44	0.58	0.69	0.81
Input Current @ 240V (A)	0.12	0.17	0.20	0.25	0.28	0.43	0.56	0.67	0.78
Input Current @ 277V (A)	0.10	0.15	0.18	0.22	0.24	0.37	0.50	0.59	0.68
Input Current @ 347V (A)	0.08	0.12	0.14	0.17	0.21	0.31	0.41	0.48	0.57
Input Current @ 480V (A)	0.06	0.08	0.10	0.12	0.15	0.23	0.30	0.36	0.42

Lumen Maintenance

Lumen Package	Ambient Temperature	25,000 hours*	50,000 hours*	60,000 hours*	100,000 hours**	Theoretical L70 hours**
D1-D6 (D1 - D4 DL/T4)	25°C	98.0%	95.2%	94.1%	89.8%	> 300,000
	40°C	97.9%	94.8%	93.6%	89.0%	> 290,000
	50°C	97.7%	94.5%	93.2%	88.4%	> 270,000
D7 - D10 (D5+ DL/T4)	25°C	95.8%	93.2%	92.2%	88.2%	> 300,000
	40°C	93.9%	89.7%	88.1%	81.9%	> 180,000

* Supported by IES TM-21 standards
**Theoretical values represent estimations commonly used; however, refer to the IES position on LED Product Lifetime Prediction, IES PS-10-18, explaining proper use of IES TM-21 and LM-80.

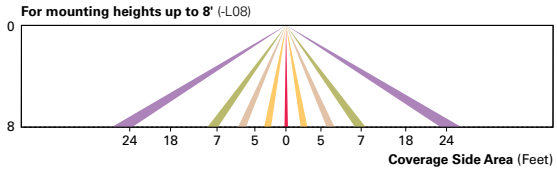
Lumen Multiplier

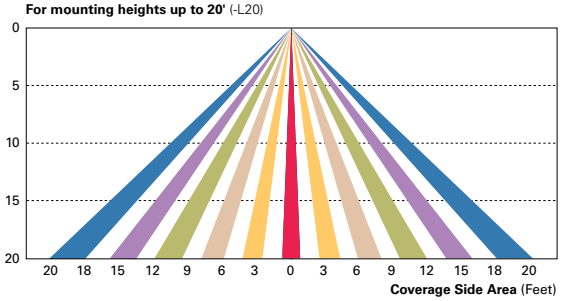
Ambient Temperature	Multiplier
0°C	1.03
10C	1.02
25°C	1.00
40°C	0.98
50°C	0.97

Control Options

0-10V (D) 0-10V dimming comes standard on all TopTier configurations for use with integrated or external lighting controls.

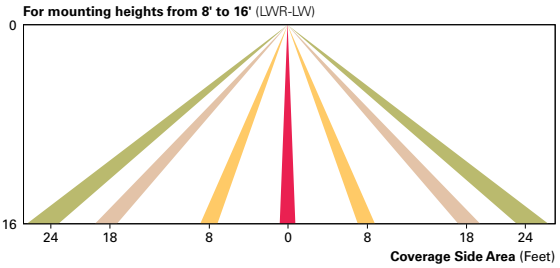
Dimming Occupancy Sensor (MS/DIM) These sensors are factory installed in the luminaire, dimming to 50% after five minutes of no motion detected. When motion is detected, the luminaire output is 100%. Includes an integral photocell that can be programmed for "dusk-to-dawn" operation. The FSIR-100 programming tool can be utilized to adjust dimming level, time delay, sensitivity and other parameters. Two lens options provide optimal coverage patterns up to 20' mounting height.

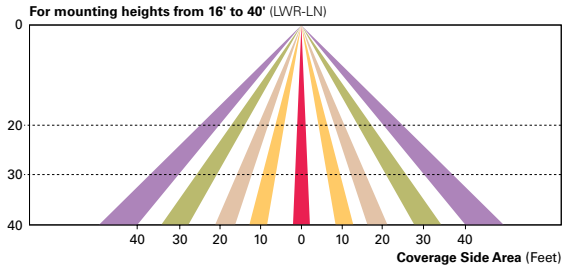




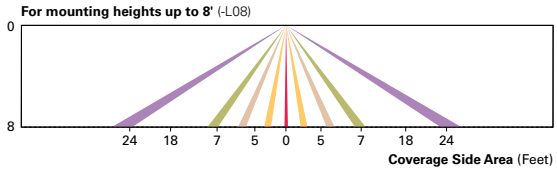
WaveLinx-Ready 4-PIN Twistlock Receptacle (ZW) Includes the WaveLinx control module, integrated 4-Pin receptacle, and standard 0-10V dimming driver, enabling the subsequent addition of a WaveLinx sensor.

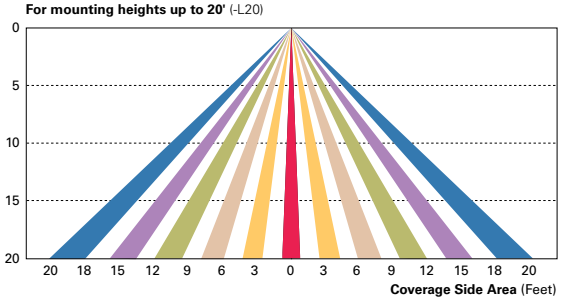
Enlighted Wireless Control and Monitoring System (LWR-LW and LWR-LN) The Enlighted control system is a connected lighting solution, combining LED luminaires with an integrated wireless sensor system. The sensor controls the lighting system in compliance with the latest energy codes while collecting valuable data about building performance and use. Software applications utilizing energy dashboards maximize data inputs to help optimize the use of other resources beyond lighting.





Synapse (DIM10) SimplySNAP integrated wireless controls system by Synapse. Includes factory installed DIM10 control module and MS/DC motion sensor; requires additional Synapse system components for operation. Contact Synapse at www.synapsewireless.com for product support, warranty, and terms and conditions.





Cooper Lighting Solutions
1121 Highway 74 South
Peachtree City, GA 30269
P: 770-486-4800
www.cooperlighting.com

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Specifications and dimensions
subject to change without notice.

Project		Catalog #	TYPE OD - ADD ALTERNATE BID
Prepared by		Notes	PROVIDE SPECIFIED FIXTURE BY APPROVED MANUFACTURER OR ENGINEER-APPROVED EQUAL BY: LITHONIA VCPG SERIES GARDCO SOFTVIEW SERIES



TopTier (D1-D6)



TopTier (D7-D10)

McGraw-Edison

TT TopTier

Parking Garage Luminaire

Product Features

Light ARchitect™

Interactive Menu

- Ordering Information page 2
- Product Specifications page 2
- Optical Configurations page 2
- Mounting Details page 3
- Energy and Performance Data page 4
- Control Options page 6

Product Certifications

Quick Facts

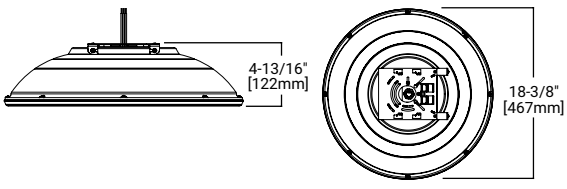
- Lumen packages range from 2,757 - 22,831
- Efficacies up to 146 lumens per watt
- Utilizes patented waveguide technology for maximum visual comfort
- Surface, pendant, trunnion, wall and direct conduit mount options

Connected Systems

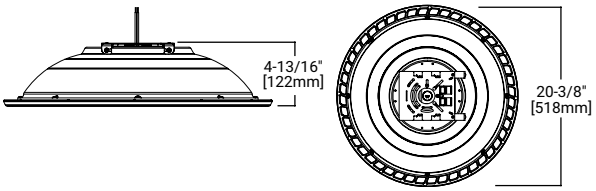
- WaveLinx Lite
- Synapse

Dimensional Details

SURFACE MOUNT
CQ, MQ, WQ and RW: D1-D6
DL: D1-D4
Base luminaire weight: 18.2 lbs (8.3 kg)



SURFACE MOUNT
CQ, MQ, WQ and RW: D7+
DL: D5+
Base luminaire weight: 20.1 lbs (9.1 kg)



NOTES:
1. Visit https://www.designlights.org/search/ to confirm qualification. Not all product variations are DLC qualified.
2. IDA Certified for 3000K CCT and warmer only.

McGraw-Edison — TT TopTier

Ordering Information

SAMPLE NUMBER: **TT-D3-740-U-WQ-STM-30L-AP**

Product Family	Configuration	Color Temperature	Voltage	Distribution	Mounting	Lead Length [7]	Finish
TT=TopTier [1] **BAA-TT**=TopTier, Buy American Act Compliant [27] **TAA-TT**=TopTier, Trade Agreements Act Compliant [27]	**D1**=4,000 Nominal Lumens **D2**=5,500 Nominal Lumens **D3**=6,500 Nominal Lumens **D4**=8,000 Nominal Lumens **D5**=10,000 Nominal Lumens **D6**=13,000 Nominal Lumens **D7**=15,000 Nominal Lumens **D8**=18,000 Nominal Lumens **D9**=20,000 Nominal Lumens **D10**=22,000 Nominal Lumens	**735**=70 CRI, 3500K CCT **740**=70 CRI, 4000K CCT **750**=70 CRI, 5000K CCT **830**=80 CRI, 3000K CCT **AMB**=Amber 590nm [29] 4000K 80CRI	**U**=120-277V **H**=347-480V [22, 26] **1**=120V **2**=208V **3**=240V **4**=277V **8**=480V **9**=347V	**CQ**=Concentrated **MQ**=Medium **WQ**=Wide **RW**=Rectangular Wide [3] **DL**=Drive Lane / Type 4 [3]	**[Blank]**=Surface Mount [16] **TMB**=Trunnion Mount with Connection Box **DPM**=Decorative Pendant Mount [4] **WM**=Wall Mount **STM**=Stem Mount to 1/2" conduit [16] 18" stem	**[Blank]**=6" **30L**=30" **36L**=36" **48L**=48" **72L**=72" **108L**=108" **120L**=120" **144L**=144"	**NW**=White **AP**=Grey **BZ**=Bronze **BK**=Black **DP**=Dark Platinum **GM**=Graphite Metallic

Options (Add as Suffix)

F=Single Fuse (120, 277 or 347V Specify Voltage)
FF=Double Fuse (208, 240 or 480V Specify Voltage)
IBP=Integral Battery Pack [5, 24]
IBP-CEC=Integral Battery Pack, CEC compliant [5]
ITS=Integral Transfer Switch [3]
924=UL924 listed luminaire [19]
CG=Clear Glass [8]
SG=Solite® Glass [9]
UPL=Uplight [6]
TR=Tamper Resistant Hardware
NAT=Natatorium finish
DALI=DALI Driver [15]
MS/DIM-L08=Dimming Occupancy Sensor (<9' Mounting) [11, 17]
MS/DIM-L20=Dimming Occupancy Sensor (9' - 20' Mounting) [11, 17]
ZW=WaveLinx-Enabled Module and 4-PIN Receptacle [23]
SPB1=Dimming Motion and Daylight Sensor, Bluetooth Programmable, < 8' Mounting [11, 21]
SPB2=Dimming Motion and Daylight Sensor, Bluetooth Programmable, 8' - 20' Mounting [11, 21]
SPB4=Dimming Motion and Daylight Sensor, Bluetooth Programmable, 20' - 40' Mounting [17, 21]
ZD=WaveLinx-Enabled Module with DALI Driver and 4-PIN Receptacle [23]
ZW-SWPD4WH=WaveLinx Control Module and Wireless Sensor – 7'-15'
ZW-SWPD5WH=WaveLinx Control Module and Wireless Sensor – 15'-40'
ZW-WOBWH=WaveLinx Control Module and LC Bluetooth Sensor – 7'-15'
ZW-WOFWH=WaveLinx Control Module and LC Bluetooth Sensor – 15'-40'
ZD-SWPD4WH=WaveLinx with DALI Driver and Wireless Sensor – 7'-15'
ZD-SWPD5WH=WaveLinx with DALI Driver and Wireless Sensor – 15'-40'
ZD-WOBWH=WaveLinx with DALI Driver and LC Bluetooth Sensor – 7'-15'
ZD-WOFWH=WaveLinx with DALI Driver and LC Bluetooth Sensor – 15 -40'
LWR-LW=Enlighted Wireless Sensor, Wide Lens 8' - 16' Mounting Height [11, 18]
LWR-LN=Enlighted Wireless Sensor, Narrow Lens 16' - 40' Mounting Height [11, 18]
DIM10-MS/DIM-L08=Synapse occupancy sensor (<8' Mounting)
DIM10-MS/DIM-L20=Synapse occupancy sensor (8'-20' Mounting)

Accessories (Order Separately) [28]

MA1252=Replacement 10kV Surge Module
TT/WG=Wire Guard [25]
TT/BG-UP-XX=Bird Guard [12, 13]
TT/HSS-XX=House Side Shield [25]
DPMS36-XX=36" Pendant Mount Stem [12, 14]
DPMS48-XX=48" Pendant Mount Stem [12, 14]
DPMS96-XX=96" Pendant Mount Stem [12, 14]
FSIR-100=Wireless Configuration Tool for Occupancy Sensor [17]
SWPD4-WH=WaveLinx Wireless Sensor, 7'–15' Mounting Height [20, 21, 22, 23]
SWPD5-WH=WaveLinx Wireless Sensor, 15'–40' Mounting Height [20, 21, 22, 23]

FOR LUMINAIRES NOTED AS EM, PROVIDE WITH INTEGRAL UL924 LISTED EMERGENCY BYPASS.

NOTES:

1. DesignLights Consortium® Qualified. Refer to www.designlights.org Qualified Products List under Family Models for details.
2. Only for use with 480V Wye systems. Per NEC, not for use with ungrounded systems, impedance grounded systems or corner grounded systems (commonly known as Three Phase Three Wire Delta, Three Phase High Leg Delta and Three Phase Corner Grounded Delta systems).
3. Not available with D7 - D10 configurations.
4. Order Pendant Mount Stem accessory.
5. IBP ambient operating temperature -20°C to 35°C (D1-D3), -20°C to 25°C (D4-D6). Not available with D7-D10 configurations, DALI, or ZD options.
6. Additional 8.0W. Provides 920 lumens. Not available with D10 configuration.
7. Choose lead length for Surface Mount and Stem Mount only. TMB, DPM and WM lengths predetermined.
8. Not available with CQ.
9. Standard with CQ, option available with WQ only.
10. U voltage only. Ambient operating temperature -20°C to 50°C (D1-D4) or -20°C to 40°C (D5-D6). UL924 listed component.
11. Includes integral photocell.
12. Specify color in place of XX.
13. Designed for use with Stem Mount and Decorative Pendant Mount only.
14. Designed for use with Decorative Pendant Mount only.
15. Not available with H voltage or IBP. Not compatible with MS/DIM or LWR sensors.
16. Specify Lead Length for wire harness length.
17. The FSIR-100 configuration tool is required to adjust parameters including high and low modes, sensitivity, time delay and more.
18. Enlighted wireless sensors are factory installed only, and require network components in appropriate quantities.
19. 924 option provides luminaire UL924 listing, used in conjunction with ITS or IBP-CEC.
20. Requires ZW or ZD receptacle.
21. Sensor configuration mobile application required for configuration. See controls page for details.
22. Cannot be used with other control options.
23. For WaveLinx applications, WAC Gateway required to enable field-configurability: Order WAC-PoE and WPOE-120 (10V to PoE injector) power supply if needed. Not required for WaveLinx Lite Commercial (LC) applications.
24. Specify 120V or 277V.
25. TT/WG and TT/HSS cannot be installed together. TT/HSS & TT/WG not available on D7-D10 configurations.
26. D4-D10 only. Not compatible with battery.
27. Only product configurations with these designated prefixes are built to be compliant with the Buy American Act of 1933 (BAA) or Trade Agreements Act of 1979 (TAA), respectively. Please refer to DOMESTIC PREFERENCES website for more information. Components shipped separately may be separately analyzed under domestic preference requirements.
28. Accessories sold separately will be separately analyzed under domestic preference requirements. Consult factory for further information.
29. Narrow-band 590nm +/- 5nm for wildlife and observatory use. Choose lumen package D1.

Product Specifications

Construction

- Low profile, die-cast aluminum housing provides a clean, symmetric aesthetic

Optics

- Five optical distributions utilizing visual comfort waveguide technology
- 10 lumen packages, ranging from 2,757 to 22,831
- Integral uplight option utilizes a dedicated, 8W light engine, producing 920 lumens for reduced visual contrast and cave effect
- IDA Certified for 3000k CCT and warmer only. Not available with uplight option.

Electrical

- D1-D6: -40C - 50C operating temperature
- D7-D10: -40C - 40C operating temperature
- Greater than 90% lumen maintenance at 50,000 hours
- IP66 rated
- 120-277V 50/60Hz, 347V 60Hz or 480V 60Hz operation
- 10kV surge module standard
- 0-10V dimming standard

Mounting

- Surface mount directly to square or octagonal 4" surface or recessed junction box using quick mount bracket
- Optional stem mount bracket with set screw for direct 1/2" NPS conduit mounting
- Trunnion, decorative pendant, and wall mount options also available

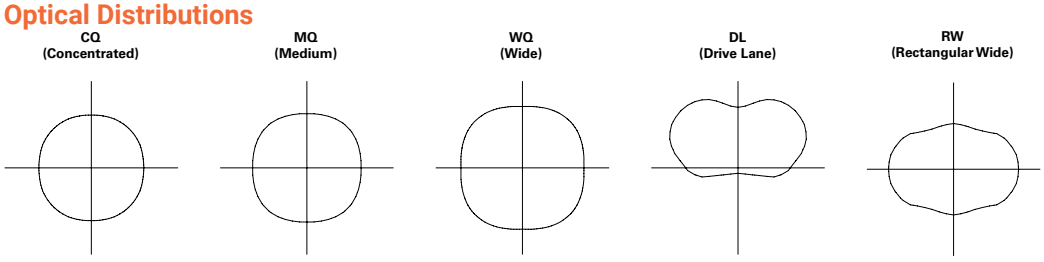
Finish

- 2.5 mil nominal TGIC powder coat thickness
- Finishes include white, black, bronze, gray, dark platinum and graphite metallic
- RAL and custom color matches available
- Natatorium option (NAT) available, providing 5,000 hour salt spray rating per ASTM B117, with a scribe rating of 9 per ASTM D1654

Warranty

- Five-year warranty

Optical Distributions

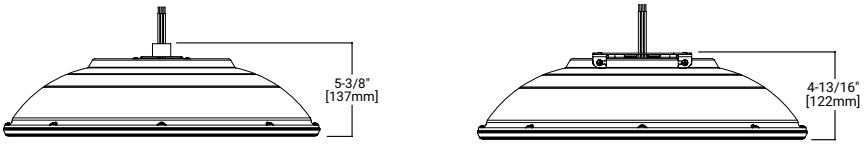


McGraw-Edison **TT TopTier**

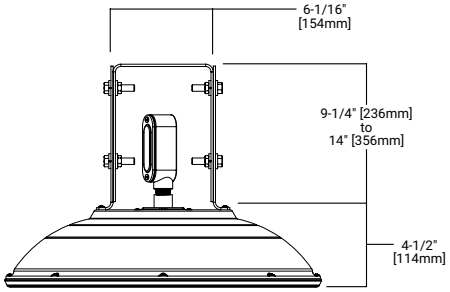
Mounting Details

***D1-D6 configuration shown (D1-D4 for DL distribution)**

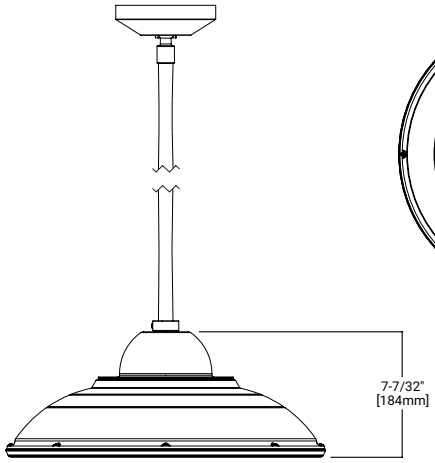
Stem Mount



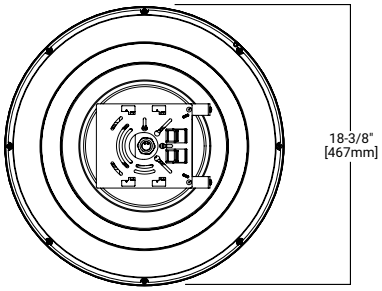
Trunnion Mount



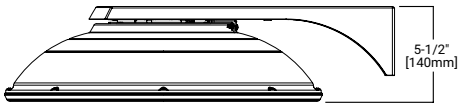
Decorative Pendant Mount



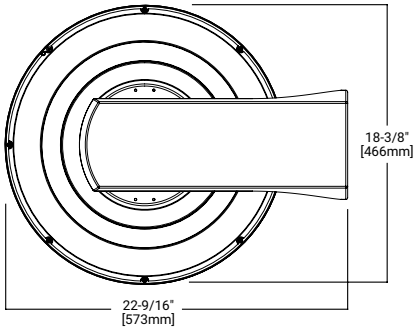
Top View



Wall Mount

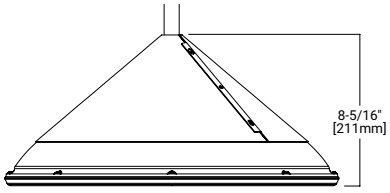


Top View - Wall Mount

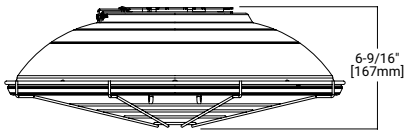


Accessories

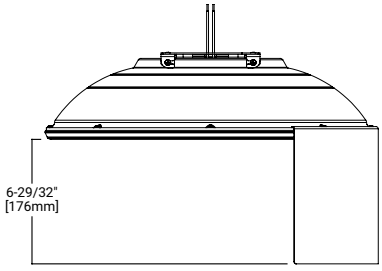
Bird Guard (TT/BG-UP-XX)



Wire Guard (TT/WG)



House Side Shield (TT/HSS-XX)



McGraw-Edison **TT TopTier**

Energy and Performance Data

View TopTier IES files

Power and Lumens (3000K/3500K/4000K/5000K)

Lumen Package			D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
Power (Wattage) CQ, MQ, WQ			28.0	39.2	47.2	57.6	74.7	105.2	124.7	148.7	173.1	193.8
Power (Wattage) RW Only			28.0	39.2	47.2	57.6	74.7	105.2	127.1	152.6	178.0	--
Power (Wattage) DL Only			28.8	40.5	48.8	59.8	62.3	97.4	127.1	152.6	178.0	--
Distribution												
3000K CCT 80 CRI	CQ Concentrated	Lumens	3,409	4,640	5,595	6,660	8,383	11,030	12,307	14,411	16,430	18,001
		BUG Rating	B1-U0-G1	B2-U0-G1	B2-U0-G1	B2-U0-G1	B3-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G2
		Lumens per Watt	122	118	119	116	112	105	99	97	95	93
	MQ Medium	Lumens	3,647	4,964	5,986	7,125	8,969	11,800	12,854	15,053	17,161	18,802
		BUG Rating	B2-U0-G1	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3
		Lumens per Watt	130	127	127	124	120	112	103	101	99	97
	WQ Wide	Lumens	3,449	4,695	5,662	6,740	8,483	11,161	12,350	14,463	16,489	18,065
		BUG Rating	B2-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3
		Lumens per Watt	123	120	120	117	114	106	99	97	95	93
	RW Rectangular Wide	Lumens	2,757	3,753	4,526	5,387	6,781	8,922	11,977	13,619	15,122	--
		BUG Rating	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	--
		Lumens per Watt	98	96	96	94	91	85	94	89	85	--
	DL Drive Lane / Type 4	Lumens	2,959	3,985	4,762	5,622	6,537	8,771	11,834	13,337	14,768	--
		BUG Rating	B1-U0-G2	B2-U0-G3	B2-U0-G3	B2-U0-G3	B1-U0-G3	B2-U0-G3	B2-U0-G4	B2-U0-G4	B2-U0-G4	--
		Lumens per Watt	103	98	98	94	105	90	93	87	83	--
3500K CCT 70 CRI	CQ Concentrated	Lumens	3,618	4,925	5,940	7,070	8,899	11,708	14,944	17,500	19,951	21,858
		BUG Rating	B1-U0-G1	B2-U0-G1	B2-U0-G1	B2-U0-G1	B3-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B4-U0-G2	B4-U0-G2
		Lumens per Watt	129	126	126	123	119	111	120	118	115	113
	MQ Medium	Lumens	3,872	5,270	6,355	7,564	9,520	12,527	15,609	18,279	20,839	22,831
		BUG Rating	B2-U0-G2	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3
		Lumens per Watt	138	134	135	131	127	119	125	123	120	118
	WQ Wide	Lumens	3,662	4,984	6,011	7,154	9,005	11,848	14,997	17,562	20,022	21,936
		BUG Rating	B2-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G4
		Lumens per Watt	131	127	127	124	121	113	120	118	116	113
	RW Rectangular Wide	Lumens	2,927	3,984	4,805	5,719	7,198	9,471	14,544	16,537	18,363	--
		BUG Rating	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	--
		Lumens per Watt	105	102	102	99	96	90	114	108	103	--
	DL Drive Lane / Type 4	Lumens	3,141	4,230	5,055	5,968	7,938	10,650	14,370	16,195	17,933	--
		BUG Rating	B1-U0-G2	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G4	B3-U0-G4	B3-U0-G5	--
		Lumens per Watt	109	104	104	100	127	109	113	106	101	--
4000K/ 5000K CCT 70 CRI	CQ Concentrated	Lumens	3,828	5,211	6,284	7,480	9,415	12,387	14,944	17,500	19,951	21,858
		BUG Rating	B1-U0-G1	B2-U0-G1	B2-U0-G1	B2-U0-G1	B3-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B4-U0-G2	B4-U0-G2
		Lumens per Watt	137	133	133	130	126	118	120	118	115	113
	MQ Medium	Lumens	4,096	5,575	6,723	8,002	10,072	13,253	15,609	18,279	20,839	22,831
		BUG Rating	B2-U0-G2	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3
		Lumens per Watt	146	142	142	139	135	126	125	123	120	118
	WQ Wide	Lumens	3,874	5,273	6,359	7,569	9,527	12,535	14,997	17,562	20,022	21,936
		BUG Rating	B2-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G4
		Lumens per Watt	138	135	135	131	128	119	120	118	116	113
	RW Rectangular Wide	Lumens	3,097	4,215	5,083	6,050	7,615	10,020	14,544	16,537	18,363	--
		BUG Rating	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	--
		Lumens per Watt	111	108	108	105	102	95	114	108	103	--
	DL Drive Lane / Type 4	Lumens	3,323	4,475	5,348	6,314	7,938	10,650	14,370	16,195	17,933	--
		BUG Rating	B1-U0-G2	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G4	B3-U0-G4	B3-U0-G5	--
		Lumens per Watt	115	110	110	106	127	109	113	106	101	--

McGraw-Edison **TT TopTier**

Energy and Performance Data

CQ, MQ and WQ Distributions

Lumen Package	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
Power (Wattage)	28.0	39.2	47.2	57.6	74.7	105.2	124.7	148.7	173.1	193.8
Input Current @ 120V (A)	0.23	0.33	0.39	0.48	0.62	0.88	1.09	1.31	1.53	1.72
Input Current @ 208V (A)	0.13	0.19	0.23	0.28	0.36	0.51	0.57	0.67	0.78	0.88
Input Current @ 240V (A)	0.12	0.16	0.20	0.24	0.31	0.44	0.56	0.66	0.76	0.85
Input Current @ 277V (A)	0.10	0.14	0.17	0.21	0.27	0.38	0.49	0.58	0.67	0.74
Input Current @ 347V (A)	0.08	0.11	0.14	0.17	0.22	0.30	0.40	0.47	0.55	0.62
Input Current @ 480V (A)	0.06	0.08	0.10	0.12	0.16	0.22	0.30	0.35	0.41	0.45

RW Distribution

Lumen Package	D1	D2	D3	D4	D5	D6	D7	D8	D9
Power (Wattage)	28.0	39.2	47.2	57.6	74.7	105.2	127.1	152.6	178.0
Input Current @ 120V (A)	0.23	0.33	0.39	0.48	0.62	0.88	1.11	1.34	1.58
Input Current @ 208V (A)	0.13	0.19	0.23	0.28	0.36	0.51	0.58	0.69	0.81
Input Current @ 240V (A)	0.12	0.16	0.20	0.24	0.31	0.44	0.56	0.67	0.78
Input Current @ 277V (A)	0.10	0.14	0.17	0.21	0.27	0.38	0.50	0.59	0.68
Input Current @ 347V (A)	0.08	0.11	0.14	0.17	0.22	0.30	0.41	0.48	0.57
Input Current @ 480V (A)	0.06	0.08	0.10	0.12	0.16	0.22	0.30	0.36	0.42

DL Distribution

Lumen Package	D1	D2	D3	D4	D5	D6	D7	D8	D9
Power (Wattage)	28.8	40.5	48.8	59.8	62.3	97.4	127.1	152.6	178.0
Input Current @ 120V (A)	0.24	0.34	0.41	0.50	0.55	0.86	1.11	1.34	1.58
Input Current @ 208V (A)	0.14	0.19	0.23	0.29	0.28	0.44	0.58	0.69	0.81
Input Current @ 240V (A)	0.12	0.17	0.20	0.25	0.28	0.43	0.56	0.67	0.78
Input Current @ 277V (A)	0.10	0.15	0.18	0.22	0.24	0.37	0.50	0.59	0.68
Input Current @ 347V (A)	0.08	0.12	0.14	0.17	0.21	0.31	0.41	0.48	0.57
Input Current @ 480V (A)	0.06	0.08	0.10	0.12	0.15	0.23	0.30	0.36	0.42

Lumen Maintenance

Lumen Package	Ambient Temperature	25,000 hours*	50,000 hours*	60,000 hours*	100,000 hours**	Theoretical L70 hours**
D1-D6 (D1 - D4 DL/T4)	25°C	98.0%	95.2%	94.1%	89.8%	> 300,000
	40°C	97.9%	94.8%	93.6%	89.0%	> 290,000
	50°C	97.7%	94.5%	93.2%	88.4%	> 270,000
D7 - D10 (D5+ DL/T4)	25°C	95.8%	93.2%	92.2%	88.2%	> 300,000
	40°C	93.9%	89.7%	88.1%	81.9%	> 180,000

* Supported by IES TM-21 standards
**Theoretical values represent estimations commonly used; however, refer to the IES position on LED Product Lifetime Prediction, IES PS-10-18, explaining proper use of IES TM-21 and LM-80.

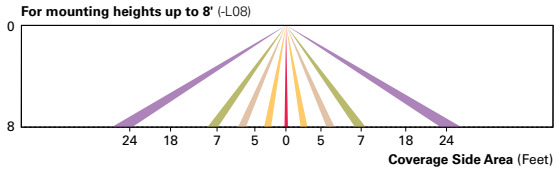
Lumen Multiplier

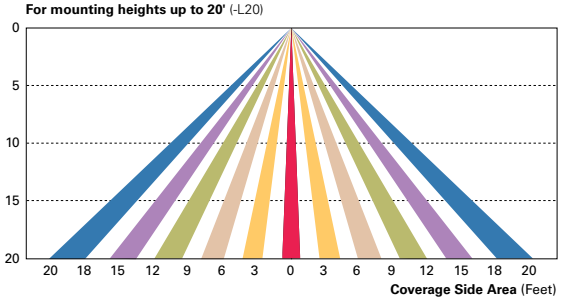
Ambient Temperature	Multiplier
0°C	1.03
10C	1.02
25°C	1.00
40°C	0.98
50°C	0.97

Control Options

0-10V (D) 0-10V dimming comes standard on all TopTier configurations for use with integrated or external lighting controls.

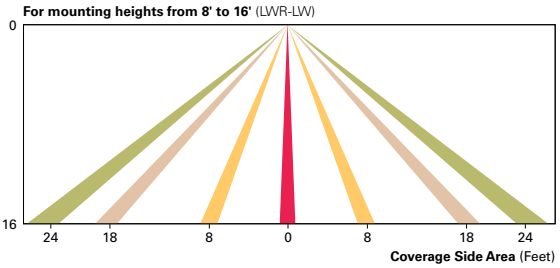
Dimming Occupancy Sensor (MS/DIM) These sensors are factory installed in the luminaire, dimming to 50% after five minutes of no motion detected. When motion is detected, the luminaire output is 100%. Includes an integral photocell that can be programmed for "dusk-to-dawn" operation. The FSIR-100 programming tool can be utilized to adjust dimming level, time delay, sensitivity and other parameters. Two lens options provide optimal coverage patterns up to 20' mounting height.

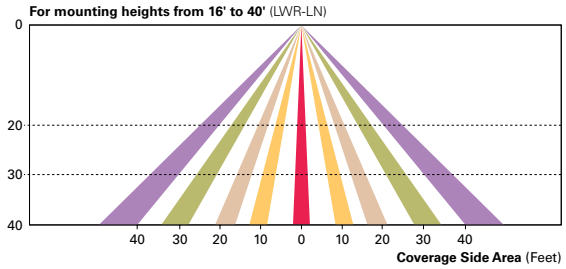




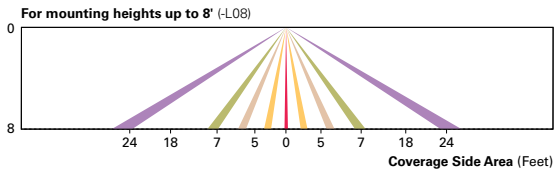
WaveLinx-Ready 4-PIN Twistlock Receptacle (ZW) Includes the WaveLinx control module, integrated 4-Pin receptacle, and standard 0-10V dimming driver, enabling the subsequent addition of a WaveLinx sensor.

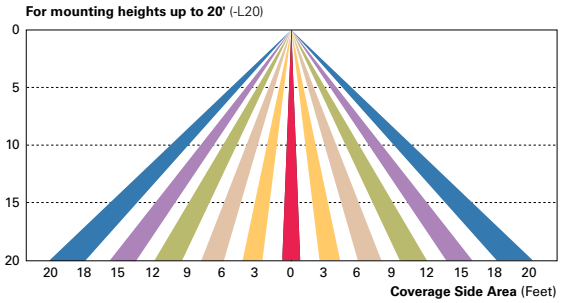
Enlighted Wireless Control and Monitoring System (LWR-LW and LWR-LN) The Enlighted control system is a connected lighting solution, combining LED luminaires with an integrated wireless sensor system. The sensor controls the lighting system in compliance with the latest energy codes while collecting valuable data about building performance and use. Software applications utilizing energy dashboards maximize data inputs to help optimize the use of other resources beyond lighting.





Synapse (DIM10) SimplySNAP integrated wireless controls system by Synapse. Includes factory installed DIM10 control module and MS/DC motion sensor; requires additional Synapse system components for operation. Contact Synapse at www.synapsewireless.com for product support, warranty, and terms and conditions.





Cooper Lighting Solutions
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Peachtree City, GA 30269
P: 770-486-4800
www.cooperlighting.com

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Specifications and dimensions
subject to change without notice.

Project		Catalog #	
Prepared by		Notes	

TYPE OA - BASE BID

PROVIDE SPECIFIED FIXTURE BY APPROVED MANUFACTURER OR ENGINEER-APPROVED EQUAL BY:
LITHONIA VCPG SERIES
LSI OPS SERIES
BEACON SRT2 SERIES
GARDCO SOFTVIEW SERIES



TopTier (D1-D6)



TopTier (D7-D10)

McGraw-Edison

TT TopTier

Parking Garage Luminaire

Product Features

Light ARchitect™

Interactive Menu

- Ordering Information page 2
- Product Specifications page 2
- Optical Configurations page 2
- Mounting Details page 3
- Energy and Performance Data page 4
- Control Options page 6

Product Certifications

Quick Facts

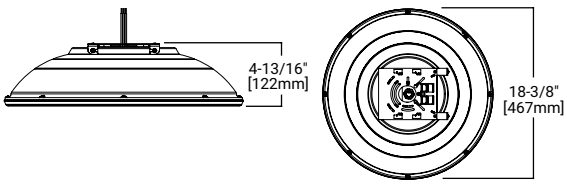
- Lumen packages range from 2,757 - 22,831
- Efficacies up to 146 lumens per watt
- Utilizes patented waveguide technology for maximum visual comfort
- Surface, pendant, trunnion, wall and direct conduit mount options

Connected Systems

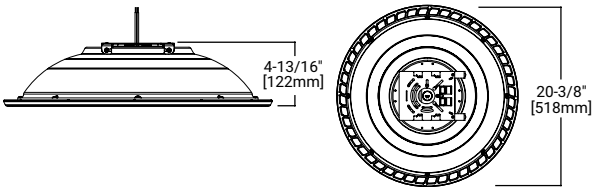
- WaveLinx Lite
- Synapse

Dimensional Details

SURFACE MOUNT
CQ, MQ, WQ and RW: D1-D6
DL: D1-D4
Base luminaire weight: 18.2 lbs (8.3 kg)



SURFACE MOUNT
CQ, MQ, WQ and RW: D7+
DL: D5+
Base luminaire weight: 20.1 lbs (9.1 kg)



NOTES:
1. Visit https://www.designlights.org/search/ to confirm qualification. Not all product variations are DLC qualified.
2. IDA Certified for 3000K CCT and warmer only.

McGraw-Edison — TT TopTier

Ordering Information

SAMPLE NUMBER: **TT-D3-740-U-WQ-STM-30L-AP**

Product Family	Configuration	Color Temperature	Voltage	Distribution	Mounting	Lead Length [7]	Finish
TT=TopTier [1] **BAA-TT**=TopTier, Buy American Act Compliant [27] **TAA-TT**=TopTier, Trade Agreements Act Compliant [27]	**D1**=4,000 Nominal Lumens **D2**=5,500 Nominal Lumens **D3**=6,500 Nominal Lumens **D4**=8,000 Nominal Lumens **D5**=10,000 Nominal Lumens **D6**=13,000 Nominal Lumens **D7**=15,000 Nominal Lumens **D8**=18,000 Nominal Lumens **D9**=20,000 Nominal Lumens **D10**=22,000 Nominal Lumens	**735**=70 CRI, 3500K CCT **740**=70 CRI, 4000K CCT **750**=70 CRI, 5000K CCT **830**=80 CRI, 3000K CCT **AMB**=Amber 590nm [29] 4000K 80CRI	**U**=120-277V **H**=347-480V [22, 26] **1**=120V **2**=208V **3**=240V **4**=277V **8**=480V **9**=347V	**CQ**=Concentrated **MQ**=Medium **WQ**=Wide **RW**=Rectangular Wide [3] **DL**=Drive Lane / Type 4 [3]	**[Blank]**=Surface Mount [16] **TMB**=Trunnion Mount with Connection Box **DPM**=Decorative Pendant Mount [4] **WM**=Wall Mount **STM**=Stem Mount to 1/2" conduit [16] MOUNT DIRECTLY TO J-BOX.	**[Blank]**=6" **30L**=30" **36L**=36" **48L**=48" **72L**=72" **108L**=108" **120L**=120" **144L**=144"	**NW**=White **AP**=Grey **BZ**=Bronze **BK**=Black **DP**=Dark Platinum **GM**=Graphite Metallic

Options (Add as Suffix)

F=Single Fuse (120, 277 or 347V Specify Voltage)
FF=Double Fuse (208, 240 or 480V Specify Voltage)
IBP=Integral Battery Pack [5, 24]
IBP-CEC=Integral Battery Pack, CEC compliant [5]
ITS=Integral Transfer Switch [3]
924=UL924 listed luminaire [19]
CG=Clear Glass [8]
SG=Solite® Glass [9]
UPL=Uplight [6]
TR=Tamper Resistant Hardware
NAT=Natatorium finish
DALI=DALI Driver [15]
MS/DIM-L08=Dimming Occupancy Sensor (<9' Mounting) [11, 17]
MS/DIM-L20=Dimming Occupancy Sensor (9' - 20' Mounting) [11, 17]
ZW=WaveLinx-Enabled Module and 4-PIN Receptacle [23]
SPB1=Dimming Motion and Daylight Sensor, Bluetooth Programmable, < 8' Mounting [11, 21]
SPB2=Dimming Motion and Daylight Sensor, Bluetooth Programmable, 8' - 20' Mounting [11, 21]
NO UPLIGHT
SPB4=Dimming Motion and Daylight Sensor, Bluetooth Programmable, 20' - 40' Mounting [11, 21]
ZD=Wavelinx-Enabled Module with DALI Driver and 4-PIN Receptacle [23]
ZW-SWPD4WH=WaveLinx Control Module and Wireless Sensor – 7'-15'
ZW-SWPD5WH=WaveLinx Control Module and Wireless Sensor – 15'-40'
ZW-WOBWH=WaveLinx Control Module and LC Bluetooth Sensor – 7'-15'
ZW-WOFWH=WaveLinx Control Module and LC Bluetooth Sensor – 15'-40'
ZD-SWPD4WH=WaveLinx with DALI Driver and Wireless Sensor – 7'-15'
ZD-SWPD5WH=WaveLinx with DALI Driver and Wireless Sensor – 15'-40'
ZD-WOBWH=WaveLinx with DALI Driver and LC Bluetooth Sensor – 7'-15'
ZD-WOFWH=WaveLinx with DALI Driver and LC Bluetooth Sensor – 15 -40'
LWR-LW=Enlighted Wireless Sensor, Wide Lens 8' - 16' Mounting Height [11, 18]
LWR-LN=Enlighted Wireless Sensor, Narrow Lens 16' - 40' Mounting Height [11, 18]
DIM10-MS/DIM-L08=Synapse occupancy sensor (<8' Mounting)
DIM10-MS/DIM-L20=Synapse occupancy sensor (8'-20' Mounting)

Accessories (Order Separately) [28]

MA1252=Replacement 10kV Surge Module
TT/WG=Wire Guard [25]
TT/BG-UP-XX=Bird Guard [12, 13]
TT/HSS-XX=House Side Shield [25]
DPMS36-XX=36" Pendant Mount Stem [12, 14]
DPMS48-XX=48" Pendant Mount Stem [12, 14]
DPMS96-XX=96" Pendant Mount Stem [12, 14]
FSIR-100=Wireless Configuration Tool for Occupancy Sensor [17]
SWPD4-WH=WaveLinx Wireless Sensor, 7'–15' Mounting Height [20, 21, 22, 23]
SWPD5-WH=WaveLinx Wireless Sensor, 15'–40' Mounting Height [20, 21, 22, 23]

FOR LUMINAIRES NOTED AS EM, PROVIDE WITH INTEGRAL UL924 LISTED EMERGENCY BYPASS.

NOTES:

1. DesignLights Consortium® Qualified. Refer to www.designlights.org Qualified Products List under Family Models for details.
2. Only for use with 480V Wye systems. Per NEC, not for use with ungrounded systems, impedance grounded systems or corner grounded systems (commonly known as Three Phase Three Wire Delta, Three Phase High Leg Delta and Three Phase Corner Grounded Delta systems).
3. Not available with D7 - D10 configurations.
4. Order Pendant Mount Stem accessory.
5. IBP ambient operating temperature -20°C to 35°C (D1-D3), -20°C to 25°C (D4-D6). Not available with D7-D10 configurations, DALI, or ZD options.
6. Additional 8.0W. Provides 920 lumens. Not available with D10 configuration.
7. Choose lead length for Surface Mount and Stem Mount only. TMB, DPM and WM lengths predetermined.
8. Not available with CQ.
9. Standard with CQ, option available with WQ only.
10. U voltage only. Ambient operating temperature -20°C to 50°C (D1-D4) or -20°C to 40°C (D5-D6). UL924 listed component.
11. Includes integral photocell.
12. Specify color in place of XX.
13. Designed for use with Stem Mount and Decorative Pendant Mount only.
14. Designed for use with Decorative Pendant Mount only.
15. Not available with H voltage or IBP. Not compatible with MS/DIM or LWR sensors.
16. Specify Lead Length for wire harness length.
17. The FSIR-100 configuration tool is required to adjust parameters including high and low modes, sensitivity, time delay and more.
18. Enlighted wireless sensors are factory installed only, and require network components in appropriate quantities.
19. 924 option provides luminaire UL924 listing, used in conjunction with ITS or IBP-CEC.
20. Requires ZW or ZD receptacle.
21. Sensor configuration mobile application required for configuration. See controls page for details.
22. Cannot be used with other control options.
23. For WaveLinx applications, WAC Gateway required to enable field-configurability: Order WAC-PoE and WPOE-120 (10V to PoE injector) power supply if needed. Not required for WaveLinx Lite Commercial (LC) applications.
24. Specify 120V or 277V.
25. TT/WG and TT/HSS cannot be installed together. TT/HSS & TT/WG not available on D7-D10 configurations.
26. D4-D10 only. Not compatible with battery.
27. Only product configurations with these designated prefixes are built to be compliant with the Buy American Act of 1933 (BAA) or Trade Agreements Act of 1979 (TAA), respectively. Please refer to DOMESTIC PREFERENCES website for more information. Components shipped separately may be separately analyzed under domestic preference requirements.
28. Accessories sold separately will be separately analyzed under domestic preference requirements. Consult factory for further information.
29. Narrow-band 590nm +/- 5nm for wildlife and observatory use. Choose lumen package D1.

Product Specifications

Construction

- Low profile, die-cast aluminum housing provides a clean, symmetric aesthetic

Optics

- Five optical distributions utilizing visual comfort waveguide technology
- 10 lumen packages, ranging from 2,757 to 22,831
- Integral uplight option utilizes a dedicated, 8W light engine, producing 920 lumens for reduced visual contrast and cave effect
- IDA Certified for 3000k CCT and warmer only. Not available with uplight option.

Electrical

- D1-D6: -40C - 50C operating temperature
- D7-D10: -40C - 40C operating temperature
- Greater than 90% lumen maintenance at 50,000 hours
- IP66 rated
- 120-277V 50/60Hz, 347V 60Hz or 480V 60Hz operation
- 10kV surge module standard
- 0-10V dimming standard

Mounting

- Surface mount directly to square or octagonal 4" surface or recessed junction box using quick mount bracket
- Optional stem mount bracket with set screw for direct 1/2" NPS conduit mounting
- Trunnion, decorative pendant, and wall mount options also available

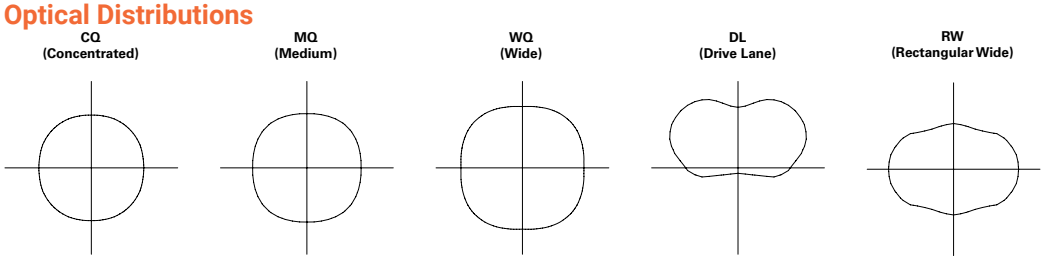
Finish

- 2.5 mil nominal TGIC powder coat thickness
- Finishes include white, black, bronze, gray, dark platinum and graphite metallic
- RAL and custom color matches available
- Natatorium option (NAT) available, providing 5,000 hour salt spray rating per ASTM B117, with a scribe rating of 9 per ASTM D1654

Warranty

- Five-year warranty

Optical Distributions

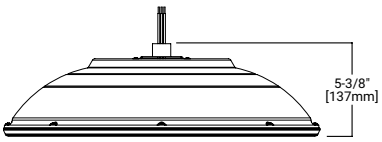


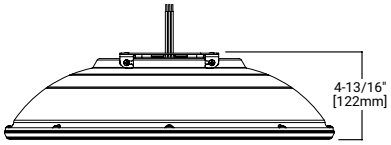
McGraw-Edison **TT TopTier**

Mounting Details

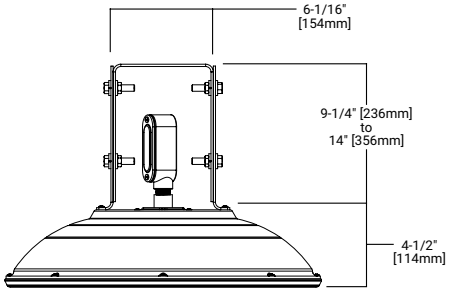
***D1-D6 configuration shown (D1-D4 for DL distribution)**

Stem Mount

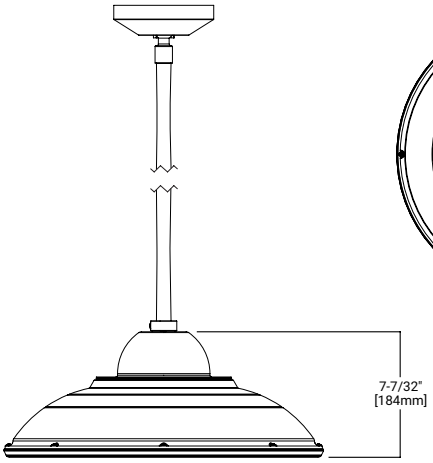




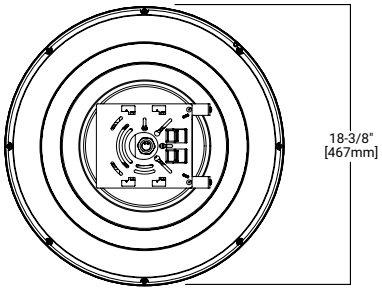
Trunnion Mount



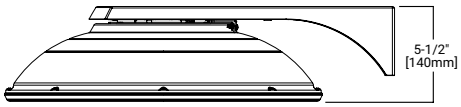
Decorative Pendant Mount



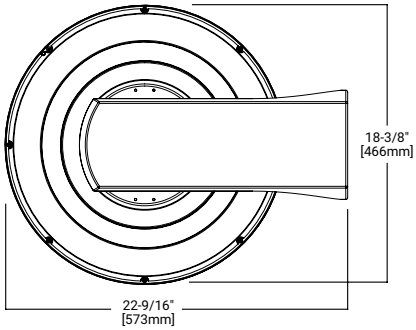
Top View



Wall Mount

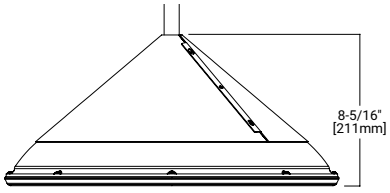


Top View - Wall Mount

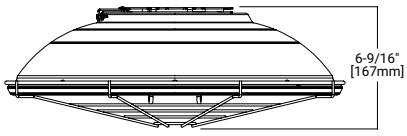


Accessories

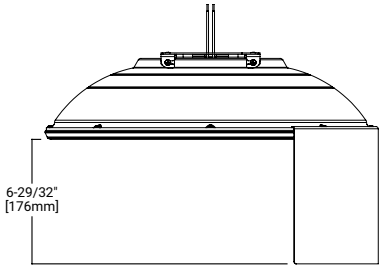
Bird Guard (TT/BG-UP-XX)



Wire Guard (TT/WG)



House Side Shield (TT/HSS-XX)



McGraw-Edison **TT TopTier**

Energy and Performance Data

View TopTier IES files

Power and Lumens (3000K/3500K/4000K/5000K)

Lumen Package			D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
Power (Wattage) CQ, MQ, WQ			28.0	39.2	47.2	57.6	74.7	105.2	124.7	148.7	173.1	193.8
Power (Wattage) RW Only			28.0	39.2	47.2	57.6	74.7	105.2	127.1	152.6	178.0	--
Power (Wattage) DL Only			28.8	40.5	48.8	59.8	62.3	97.4	127.1	152.6	178.0	--
Distribution												
3000K CCT 80 CRI	CQ Concentrated	Lumens	3,409	4,640	5,595	6,660	8,383	11,030	12,307	14,411	16,430	18,001
		BUG Rating	B1-U0-G1	B2-U0-G1	B2-U0-G1	B2-U0-G1	B3-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G2
		Lumens per Watt	122	118	119	116	112	105	99	97	95	93
	MQ Medium	Lumens	3,647	4,964	5,986	7,125	8,969	11,800	12,854	15,053	17,161	18,802
		BUG Rating	B2-U0-G1	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3
		Lumens per Watt	130	127	127	124	120	112	103	101	99	97
	WQ Wide	Lumens	3,449	4,695	5,662	6,740	8,483	11,161	12,350	14,463	16,489	18,065
		BUG Rating	B2-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3
		Lumens per Watt	123	120	120	117	114	106	99	97	95	93
	RW Rectangular Wide	Lumens	2,757	3,753	4,526	5,387	6,781	8,922	11,977	13,619	15,122	--
		BUG Rating	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	--
		Lumens per Watt	98	96	96	94	91	85	94	89	85	--
	DL Drive Lane / Type 4	Lumens	2,959	3,985	4,762	5,622	6,537	8,771	11,834	13,337	14,768	--
		BUG Rating	B1-U0-G2	B2-U0-G3	B2-U0-G3	B2-U0-G3	B1-U0-G3	B2-U0-G3	B2-U0-G4	B2-U0-G4	B2-U0-G4	--
		Lumens per Watt	103	98	98	94	105	90	93	87	83	--
3500K CCT 70 CRI	CQ Concentrated	Lumens	3,618	4,925	5,940	7,070	8,899	11,708	14,944	17,500	19,951	21,858
		BUG Rating	B1-U0-G1	B2-U0-G1	B2-U0-G1	B2-U0-G1	B3-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B4-U0-G2	B4-U0-G2
		Lumens per Watt	129	126	126	123	119	111	120	118	115	113
	MQ Medium	Lumens	3,872	5,270	6,355	7,564	9,520	12,527	15,609	18,279	20,839	22,831
		BUG Rating	B2-U0-G2	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3
		Lumens per Watt	138	134	135	131	127	119	125	123	120	118
	WQ Wide	Lumens	3,662	4,984	6,011	7,154	9,005	11,848	14,997	17,562	20,022	21,936
		BUG Rating	B2-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G4
		Lumens per Watt	131	127	127	124	121	113	120	118	116	113
	RW Rectangular Wide	Lumens	2,927	3,984	4,805	5,719	7,198	9,471	14,544	16,537	18,363	--
		BUG Rating	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	--
		Lumens per Watt	105	102	102	99	96	90	114	108	103	--
	DL Drive Lane / Type 4	Lumens	3,141	4,230	5,055	5,968	7,938	10,650	14,370	16,195	17,933	--
		BUG Rating	B1-U0-G2	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G4	B3-U0-G4	B3-U0-G5	--
		Lumens per Watt	109	104	104	100	127	109	113	106	101	--
4000K/ 5000K CCT 70 CRI	CQ Concentrated	Lumens	3,828	5,211	6,284	7,480	9,415	12,387	14,944	17,500	19,951	21,858
		BUG Rating	B1-U0-G1	B2-U0-G1	B2-U0-G1	B2-U0-G1	B3-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B4-U0-G2	B4-U0-G2
		Lumens per Watt	137	133	133	130	126	118	120	118	115	113
	MQ Medium	Lumens	4,096	5,575	6,723	8,002	10,072	13,253	15,609	18,279	20,839	22,831
		BUG Rating	B2-U0-G2	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3
		Lumens per Watt	146	142	142	139	135	126	125	123	120	118
	WQ Wide	Lumens	3,874	5,273	6,359	7,569	9,527	12,535	14,997	17,562	20,022	21,936
		BUG Rating	B2-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G4
		Lumens per Watt	138	135	135	131	128	119	120	118	116	113
	RW Rectangular Wide	Lumens	3,097	4,215	5,083	6,050	7,615	10,020	14,544	16,537	18,363	--
		BUG Rating	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	--
		Lumens per Watt	111	108	108	105	102	95	114	108	103	--
	DL Drive Lane / Type 4	Lumens	3,323	4,475	5,348	6,314	7,938	10,650	14,370	16,195	17,933	--
		BUG Rating	B1-U0-G2	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G4	B3-U0-G4	B3-U0-G5	--
		Lumens per Watt	115	110	110	106	127	109	113	106	101	--

McGraw-Edison **TT TopTier**

Energy and Performance Data

CQ, MQ and WQ Distributions

Lumen Package	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
Power (Wattage)	28.0	39.2	47.2	57.6	74.7	105.2	124.7	148.7	173.1	193.8
Input Current @ 120V (A)	0.23	0.33	0.39	0.48	0.62	0.88	1.09	1.31	1.53	1.72
Input Current @ 208V (A)	0.13	0.19	0.23	0.28	0.36	0.51	0.57	0.67	0.78	0.88
Input Current @ 240V (A)	0.12	0.16	0.20	0.24	0.31	0.44	0.56	0.66	0.76	0.85
Input Current @ 277V (A)	0.10	0.14	0.17	0.21	0.27	0.38	0.49	0.58	0.67	0.74
Input Current @ 347V (A)	0.08	0.11	0.14	0.17	0.22	0.30	0.40	0.47	0.55	0.62
Input Current @ 480V (A)	0.06	0.08	0.10	0.12	0.16	0.22	0.30	0.35	0.41	0.45

RW Distribution

Lumen Package	D1	D2	D3	D4	D5	D6	D7	D8	D9
Power (Wattage)	28.0	39.2	47.2	57.6	74.7	105.2	127.1	152.6	178.0
Input Current @ 120V (A)	0.23	0.33	0.39	0.48	0.62	0.88	1.11	1.34	1.58
Input Current @ 208V (A)	0.13	0.19	0.23	0.28	0.36	0.51	0.58	0.69	0.81
Input Current @ 240V (A)	0.12	0.16	0.20	0.24	0.31	0.44	0.56	0.67	0.78
Input Current @ 277V (A)	0.10	0.14	0.17	0.21	0.27	0.38	0.50	0.59	0.68
Input Current @ 347V (A)	0.08	0.11	0.14	0.17	0.22	0.30	0.41	0.48	0.57
Input Current @ 480V (A)	0.06	0.08	0.10	0.12	0.16	0.22	0.30	0.36	0.42

DL Distribution

Lumen Package	D1	D2	D3	D4	D5	D6	D7	D8	D9
Power (Wattage)	28.8	40.5	48.8	59.8	62.3	97.4	127.1	152.6	178.0
Input Current @ 120V (A)	0.24	0.34	0.41	0.50	0.55	0.86	1.11	1.34	1.58
Input Current @ 208V (A)	0.14	0.19	0.23	0.29	0.28	0.44	0.58	0.69	0.81
Input Current @ 240V (A)	0.12	0.17	0.20	0.25	0.28	0.43	0.56	0.67	0.78
Input Current @ 277V (A)	0.10	0.15	0.18	0.22	0.24	0.37	0.50	0.59	0.68
Input Current @ 347V (A)	0.08	0.12	0.14	0.17	0.21	0.31	0.41	0.48	0.57
Input Current @ 480V (A)	0.06	0.08	0.10	0.12	0.15	0.23	0.30	0.36	0.42

Lumen Maintenance

Lumen Package	Ambient Temperature	25,000 hours*	50,000 hours*	60,000 hours*	100,000 hours**	Theoretical L70 hours**
D1-D6 (D1 - D4 DL/T4)	25°C	98.0%	95.2%	94.1%	89.8%	> 300,000
	40°C	97.9%	94.8%	93.6%	89.0%	> 290,000
	50°C	97.7%	94.5%	93.2%	88.4%	> 270,000
D7 - D10 (D5+ DL/T4)	25°C	95.8%	93.2%	92.2%	88.2%	> 300,000
	40°C	93.9%	89.7%	88.1%	81.9%	> 180,000

* Supported by IES TM-21 standards
**Theoretical values represent estimations commonly used; however, refer to the IES position on LED Product Lifetime Prediction, IES PS-10-18, explaining proper use of IES TM-21 and LM-80.

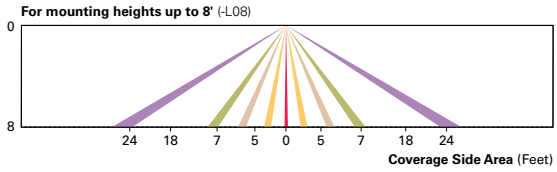
Lumen Multiplier

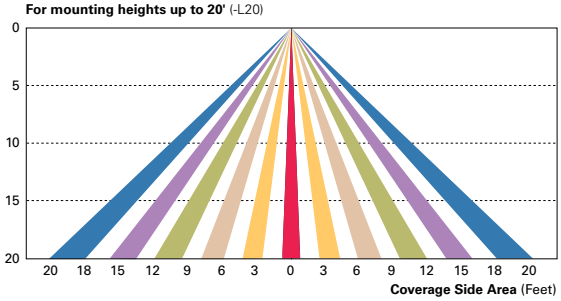
Ambient Temperature	Multiplier
0°C	1.03
10C	1.02
25°C	1.00
40°C	0.98
50°C	0.97

Control Options

0-10V (D) 0-10V dimming comes standard on all TopTier configurations for use with integrated or external lighting controls.

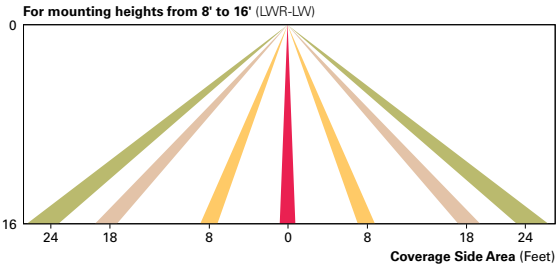
Dimming Occupancy Sensor (MS/DIM) These sensors are factory installed in the luminaire, dimming to 50% after five minutes of no motion detected. When motion is detected, the luminaire output is 100%. Includes an integral photocell that can be programmed for "dusk-to-dawn" operation. The FSIR-100 programming tool can be utilized to adjust dimming level, time delay, sensitivity and other parameters. Two lens options provide optimal coverage patterns up to 20' mounting height.

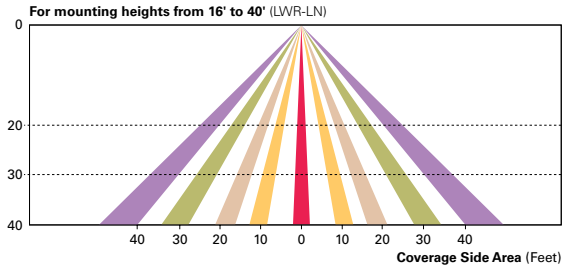




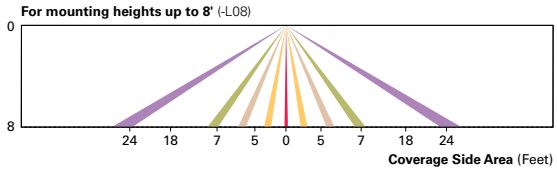
WaveLinx-Ready 4-PIN Twistlock Receptacle (ZW) Includes the WaveLinx control module, integrated 4-Pin receptacle, and standard 0-10V dimming driver, enabling the subsequent addition of a WaveLinx sensor.

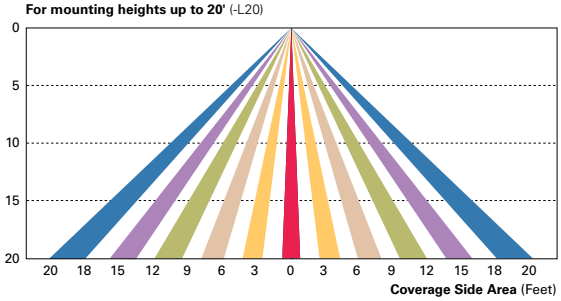
Enlighted Wireless Control and Monitoring System (LWR-LW and LWR-LN) The Enlighted control system is a connected lighting solution, combining LED luminaires with an integrated wireless sensor system. The sensor controls the lighting system in compliance with the latest energy codes while collecting valuable data about building performance and use. Software applications utilizing energy dashboards maximize data inputs to help optimize the use of other resources beyond lighting.





Synapse (DIM10) SimplySNAP integrated wireless controls system by Synapse. Includes factory installed DIM10 control module and MS/DC motion sensor; requires additional Synapse system components for operation. Contact Synapse at www.synapsewireless.com for product support, warranty, and terms and conditions.





Cooper Lighting Solutions
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Peachtree City, GA 30269
P: 770-486-4800
www.cooperlighting.com

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Specifications and dimensions
subject to change without notice.

Project		Catalog #	TYPE OB - BASE BID
Prepared by		Notes	PROVIDE SPECIFIED FIXTURE BY APPROVED MANUFACTURER OR ENGINEER-APPROVED EQUAL BY: LITHONIA VCPG SERIES GARDCO SOFTVIEW SERIES



TopTier (D1-D6)



TopTier (D7-D10)

McGraw-Edison

TT TopTier

Parking Garage Luminaire

Product Features

Light ARchitect™

Interactive Menu

- Ordering Information page 2
- Product Specifications page 2
- Optical Configurations page 2
- Mounting Details page 3
- Energy and Performance Data page 4
- Control Options page 6

Product Certifications

Quick Facts

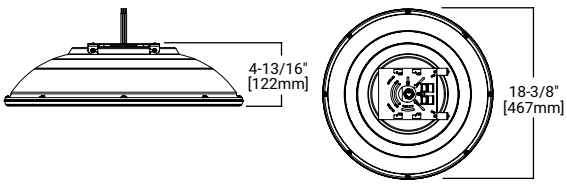
- Lumen packages range from 2,757 - 22,831
- Efficacies up to 146 lumens per watt
- Utilizes patented waveguide technology for maximum visual comfort
- Surface, pendant, trunnion, wall and direct conduit mount options

Connected Systems

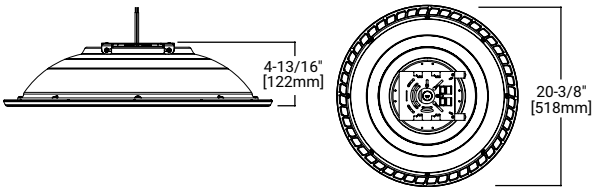
- WaveLinx Lite
- Synapse

Dimensional Details

SURFACE MOUNT
CQ, MQ, WQ and RW: D1-D6
DL: D1-D4
Base luminaire weight: 18.2 lbs (8.3 kg)



SURFACE MOUNT
CQ, MQ, WQ and RW: D7+
DL: D5+
Base luminaire weight: 20.1 lbs (9.1 kg)



NOTES:
1. Visit https://www.designlights.org/search/ to confirm qualification. Not all product variations are DLC qualified.
2. IDA Certified for 3000K CCT and warmer only.

McGraw-Edison — TT TopTier

Ordering Information

SAMPLE NUMBER: **TT-D3-740-U-WQ-STM-30L-AP**

Product Family	Configuration	Color Temperature	Voltage	Distribution	Mounting	Lead Length [7]	Finish
TT=TopTier [1] **BAA-TT**=TopTier, Buy American Act Compliant [27] **TAA-TT**=TopTier, Trade Agreements Act Compliant [27]	**D1**=4,000 Nominal Lumens **D2**=5,500 Nominal Lumens **D3**=6,500 Nominal Lumens **D4**=8,000 Nominal Lumens **D5**=10,000 Nominal Lumens **D6**=13,000 Nominal Lumens **D7**=15,000 Nominal Lumens **D8**=18,000 Nominal Lumens **D9**=20,000 Nominal Lumens **D10**=22,000 Nominal Lumens	**735**=70 CRI, 3500K CCT **740**=70 CRI, 4000K CCT **750**=70 CRI, 5000K CCT **830**=80 CRI, 3000K CCT **AMB**=Amber 590nm [29] 4000K 80CRI	**U**=120-277V **H**=347-480V [22, 26] **1**=120V **2**=208V **3**=240V **4**=277V **8**=480V **9**=347V	**CQ**=Concentrated **MQ**=Medium **WQ**=Wide **RW**=Rectangular Wide [3] **DL**=Drive Lane / Type 4 [3]	**[Blank]**=Surface Mount [16] **TMB**=Trunnion Mount with Connection Box **DPM**=Decorative Pendant Mount [4] **WM**=Wall Mount **STM**=Stem Mount to 1/2" conduit [16] MOUNT DIRECTLY TO J-BOX.	**[Blank]**=6" **30L**=30" **36L**=36" **48L**=48" **72L**=72" **108L**=108" **120L**=120" **144L**=144"	**NW**=White **AP**=Grey **BZ**=Bronze **BK**=Black **DP**=Dark Platinum **GM**=Graphite Metallic

Options (Add as Suffix)

F=Single Fuse (120, 277 or 347V Specify Voltage)
FF=Double Fuse (208, 240 or 480V Specify Voltage)
IBP=Integral Battery Pack [5, 24]
IBP-CEC=Integral Battery Pack, CEC compliant [5]
ITS=Integral Transfer Switch [3]
924=UL924 listed luminaire [19]
CG=Clear Glass [8]
SG=Solite® Glass [9]
UPL=Uplight [6]
TR=Tamper Resistant Hardware
NAT=Natatorium finish
DALI=DALI Driver [15]
NO UPLIGHT
MS/DIM-L08=Dimming Occupancy Sensor (<9' Mounting) [11, 17]
MS/DIM-L20=Dimming Occupancy Sensor (9' - 20' Mounting) [11, 17]
ZW=WaveLinx-Enabled Module and 4-PIN Receptacle [23]
SPB1=Dimming Motion and Daylight Sensor, Bluetooth Programmable, < 8' Mounting [11, 21]
SPB2=Dimming Motion and Daylight Sensor, Bluetooth Programmable, 8' - 20' Mounting [11, 21]
SPB4=Dimming Motion and Daylight Sensor, Bluetooth Programmable, 20' - 40' Mounting [17, 21]
ZD=Wavelinx-Enabled Module with DALI Driver and 4-PIN Receptacle [23]
ZW-SWPD4WH=WaveLinx Control Module and Wireless Sensor – 7'-15'
ZW-SWPD5WH=WaveLinx Control Module and Wireless Sensor – 15'-40'
ZW-WOBWH=WaveLinx Control Module and LC Bluetooth Sensor – 7'-15'
ZW-WOFWH=WaveLinx Control Module and LC Bluetooth Sensor – 15'-40'
ZD-SWPD4WH=WaveLinx with DALI Driver and Wireless Sensor – 7'-15'
ZD-SWPD5WH=WaveLinx with DALI Driver and Wireless Sensor – 15'-40'
ZD-WOBWH=WaveLinx with DALI Driver and LC Bluetooth Sensor – 7'-15'
ZD-WOFWH=WaveLinx with DALI Driver and LC Bluetooth Sensor – 15 -40'
LWR-LW=Enlighted Wireless Sensor, Wide Lens 8' - 16' Mounting Height [11, 18]
LWR-LN=Enlighted Wireless Sensor, Narrow Lens 16' - 40' Mounting Height [11, 18]
DIM10-MS/DIM-L08=Synapse occupancy sensor (<8' Mounting)
DIM10-MS/DIM-L20=Synapse occupancy sensor (8'-20' Mounting)

Accessories (Order Separately) [28]

MA1252=Replacement 10kV Surge Module
TT/WG=Wire Guard [25]
TT/BG-UP-XX=Bird Guard [12, 13]
TT/HSS-XX=House Side Shield [25]
DPMS36-XX=36" Pendant Mount Stem [12, 14]
DPMS48-XX=48" Pendant Mount Stem [12, 14]
DPMS96-XX=96" Pendant Mount Stem [12, 14]
FSIR-100=Wireless Configuration Tool for Occupancy Sensor [17]
SWPD4-WH=WaveLinx Wireless Sensor, 7'–15' Mounting Height [20, 21, 22, 23]
SWPD5-WH=WaveLinx Wireless Sensor, 15'–40' Mounting Height [20, 21, 22, 23]

FOR LUMINAIRES NOTED AS EM, PROVIDE WITH INTEGRAL UL924 LISTED EMERGENCY BYPASS.

NOTES:

1. DesignLights Consortium® Qualified. Refer to www.designlights.org Qualified Products List under Family Models for details.
2. Only for use with 480V Wye systems. Per NEC, not for use with ungrounded systems, impedance grounded systems or corner grounded systems (commonly known as Three Phase Three Wire Delta, Three Phase High Leg Delta and Three Phase Corner Grounded Delta systems).
3. Not available with D7 - D10 configurations.
4. Order Pendant Mount Stem accessory.
5. IBP ambient operating temperature -20°C to 35°C (D1-D3), -20°C to 25°C (D4-D6). Not available with D7-D10 configurations, DALI, or ZD options.
6. Additional 8.0W. Provides 920 lumens. Not available with D10 configuration.
7. Choose lead length for Surface Mount and Stem Mount only. TMB, DPM and WM lengths predetermined.
8. Not available with CQ.
9. Standard with CQ, option available with WQ only.
10. U voltage only. Ambient operating temperature -20°C to 50°C (D1-D4) or -20°C to 40°C (D5-D6). UL924 listed component.
11. Includes integral photocell.
12. Specify color in place of XX.
13. Designed for use with Stem Mount and Decorative Pendant Mount only.
14. Designed for use with Decorative Pendant Mount only.
15. Not available with H voltage or IBP. Not compatible with MS/DIM or LWR sensors.
16. Specify Lead Length for wire harness length.
17. The FSIR-100 configuration tool is required to adjust parameters including high and low modes, sensitivity, time delay and more.
18. Enlighted wireless sensors are factory installed only, and require network components in appropriate quantities.
19. 924 option provides luminaire UL924 listing, used in conjunction with ITS or IBP-CEC.
20. Requires ZW or ZD receptacle.
21. Sensor configuration mobile application required for configuration. See controls page for details.
22. Cannot be used with other control options.
23. For WaveLinx applications, WAC Gateway required to enable field-configurability: Order WAC-PoE and WPOE-120 (10V to PoE injector) power supply if needed. Not required for WaveLinx Lite Commercial (LC) applications.
24. Specify 120V or 277V.
25. TT/WG and TT/HSS cannot be installed together. TT/HSS & TT/WG not available on D7-D10 configurations.
26. D4-D10 only. Not compatible with battery.
27. Only product configurations with these designated prefixes are built to be compliant with the Buy American Act of 1933 (BAA) or Trade Agreements Act of 1979 (TAA), respectively. Please refer to DOMESTIC PREFERENCES website for more information. Components shipped separately may be separately analyzed under domestic preference requirements.
28. Accessories sold separately will be separately analyzed under domestic preference requirements. Consult factory for further information.
29. Narrow-band 590nm +/- 5nm for wildlife and observatory use. Choose lumen package D1.

Product Specifications

Construction

- Low profile, die-cast aluminum housing provides a clean, symmetric aesthetic

Optics

- Five optical distributions utilizing visual comfort waveguide technology
- 10 lumen packages, ranging from 2,757 to 22,831
- Integral uplight option utilizes a dedicated, 8W light engine, producing 920 lumens for reduced visual contrast and cave effect
- IDA Certified for 3000k CCT and warmer only. Not available with uplight option.

Electrical

- D1-D6: -40C - 50C operating temperature
- D7-D10: -40C - 40C operating temperature
- Greater than 90% lumen maintenance at 50,000 hours
- IP66 rated
- 120-277V 50/60Hz, 347V 60Hz or 480V 60Hz operation
- 10kV surge module standard
- 0-10V dimming standard

Mounting

- Surface mount directly to square or octagonal 4" surface or recessed junction box using quick mount bracket
- Optional stem mount bracket with set screw for direct 1/2" NPS conduit mounting
- Trunnion, decorative pendant, and wall mount options also available

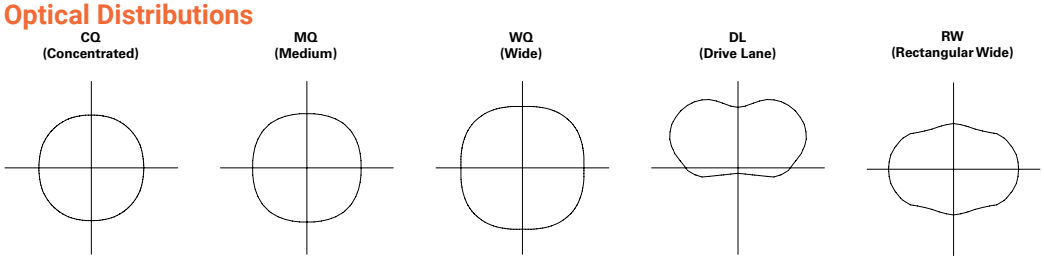
Finish

- 2.5 mil nominal TGIC powder coat thickness
- Finishes include white, black, bronze, gray, dark platinum and graphite metallic
- RAL and custom color matches available
- Natatorium option (NAT) available, providing 5,000 hour salt spray rating per ASTM B117, with a scribe rating of 9 per ASTM D1654

Warranty

- Five-year warranty

Optical Distributions

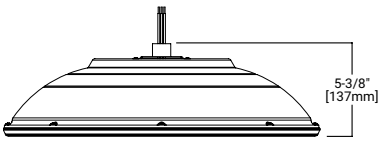


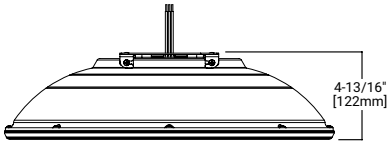
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Mounting Details

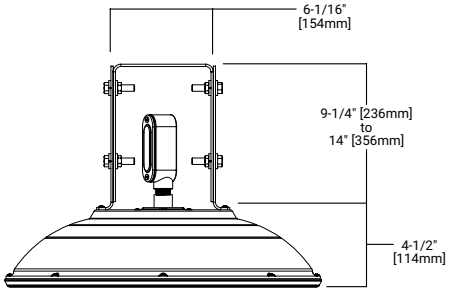
***D1-D6 configuration shown (D1-D4 for DL distribution)**

Stem Mount

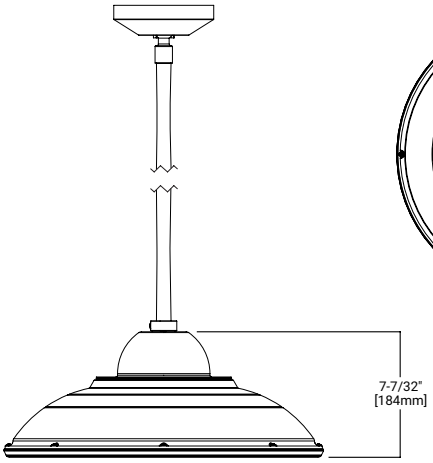




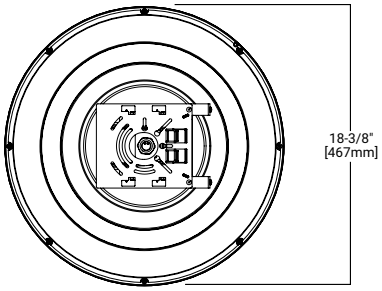
Trunnion Mount



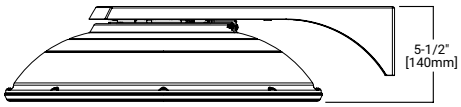
Decorative Pendant Mount



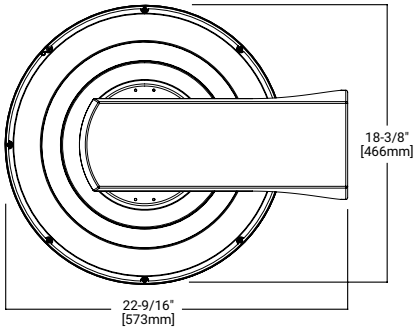
Top View



Wall Mount

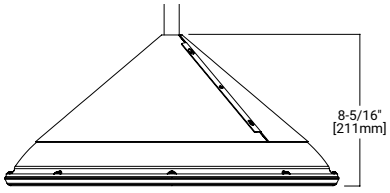


Top View - Wall Mount

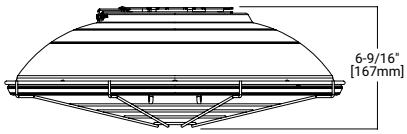


Accessories

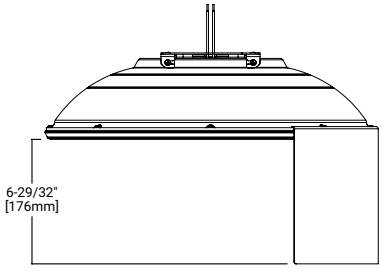
Bird Guard (TT/BG-UP-XX)



Wire Guard (TT/WG)



House Side Shield (TT/HSS-XX)



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Energy and Performance Data

View TopTier IES files

Power and Lumens (3000K/3500K/4000K/5000K)

Lumen Package			D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
Power (Wattage) CQ, MQ, WQ			28.0	39.2	47.2	57.6	74.7	105.2	124.7	148.7	173.1	193.8
Power (Wattage) RW Only			28.0	39.2	47.2	57.6	74.7	105.2	127.1	152.6	178.0	--
Power (Wattage) DL Only			28.8	40.5	48.8	59.8	62.3	97.4	127.1	152.6	178.0	--
Distribution												
3000K CCT 80 CRI	CQ Concentrated	Lumens	3,409	4,640	5,595	6,660	8,383	11,030	12,307	14,411	16,430	18,001
		BUG Rating	B1-U0-G1	B2-U0-G1	B2-U0-G1	B2-U0-G1	B3-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G2
		Lumens per Watt	122	118	119	116	112	105	99	97	95	93
	MQ Medium	Lumens	3,647	4,964	5,986	7,125	8,969	11,800	12,854	15,053	17,161	18,802
		BUG Rating	B2-U0-G1	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3
		Lumens per Watt	130	127	127	124	120	112	103	101	99	97
	WQ Wide	Lumens	3,449	4,695	5,662	6,740	8,483	11,161	12,350	14,463	16,489	18,065
		BUG Rating	B2-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3
		Lumens per Watt	123	120	120	117	114	106	99	97	95	93
	RW Rectangular Wide	Lumens	2,757	3,753	4,526	5,387	6,781	8,922	11,977	13,619	15,122	--
		BUG Rating	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	--
		Lumens per Watt	98	96	96	94	91	85	94	89	85	--
	DL Drive Lane / Type 4	Lumens	2,959	3,985	4,762	5,622	6,537	8,771	11,834	13,337	14,768	--
		BUG Rating	B1-U0-G2	B2-U0-G3	B2-U0-G3	B2-U0-G3	B1-U0-G3	B2-U0-G3	B2-U0-G4	B2-U0-G4	B2-U0-G4	--
		Lumens per Watt	103	98	98	94	105	90	93	87	83	--
3500K CCT 70 CRI	CQ Concentrated	Lumens	3,618	4,925	5,940	7,070	8,899	11,708	14,944	17,500	19,951	21,858
		BUG Rating	B1-U0-G1	B2-U0-G1	B2-U0-G1	B2-U0-G1	B3-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B4-U0-G2	B4-U0-G2
		Lumens per Watt	129	126	126	123	119	111	120	118	115	113
	MQ Medium	Lumens	3,872	5,270	6,355	7,564	9,520	12,527	15,609	18,279	20,839	22,831
		BUG Rating	B2-U0-G2	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3
		Lumens per Watt	138	134	135	131	127	119	125	123	120	118
	WQ Wide	Lumens	3,662	4,984	6,011	7,154	9,005	11,848	14,997	17,562	20,022	21,936
		BUG Rating	B2-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G4
		Lumens per Watt	131	127	127	124	121	113	120	118	116	113
	RW Rectangular Wide	Lumens	2,927	3,984	4,805	5,719	7,198	9,471	14,544	16,537	18,363	--
		BUG Rating	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	--
		Lumens per Watt	105	102	102	99	96	90	114	108	103	--
	DL Drive Lane / Type 4	Lumens	3,141	4,230	5,055	5,968	7,938	10,650	14,370	16,195	17,933	--
		BUG Rating	B1-U0-G2	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G4	B3-U0-G4	B3-U0-G5	--
		Lumens per Watt	109	104	104	100	127	109	113	106	101	--
4000K/ 5000K CCT 70 CRI	CQ Concentrated	Lumens	3,828	5,211	6,284	7,480	9,415	12,387	14,944	17,500	19,951	21,858
		BUG Rating	B1-U0-G1	B2-U0-G1	B2-U0-G1	B2-U0-G1	B3-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B4-U0-G2	B4-U0-G2
		Lumens per Watt	137	133	133	130	126	118	120	118	115	113
	MQ Medium	Lumens	4,096	5,575	6,723	8,002	10,072	13,253	15,609	18,279	20,839	22,831
		BUG Rating	B2-U0-G2	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3
		Lumens per Watt	146	142	142	139	135	126	125	123	120	118
	WQ Wide	Lumens	3,874	5,273	6,359	7,569	9,527	12,535	14,997	17,562	20,022	21,936
		BUG Rating	B2-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G4
		Lumens per Watt	138	135	135	131	128	119	120	118	116	113
	RW Rectangular Wide	Lumens	3,097	4,215	5,083	6,050	7,615	10,020	14,544	16,537	18,363	--
		BUG Rating	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	--
		Lumens per Watt	111	108	108	105	102	95	114	108	103	--
	DL Drive Lane / Type 4	Lumens	3,323	4,475	5,348	6,314	7,938	10,650	14,370	16,195	17,933	--
		BUG Rating	B1-U0-G2	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G4	B3-U0-G4	B3-U0-G5	--
		Lumens per Watt	115	110	110	106	127	109	113	106	101	--

McGraw-Edison **TT TopTier**

Energy and Performance Data

CQ, MQ and WQ Distributions

Lumen Package	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
Power (Wattage)	28.0	39.2	47.2	57.6	74.7	105.2	124.7	148.7	173.1	193.8
Input Current @ 120V (A)	0.23	0.33	0.39	0.48	0.62	0.88	1.09	1.31	1.53	1.72
Input Current @ 208V (A)	0.13	0.19	0.23	0.28	0.36	0.51	0.57	0.67	0.78	0.88
Input Current @ 240V (A)	0.12	0.16	0.20	0.24	0.31	0.44	0.56	0.66	0.76	0.85
Input Current @ 277V (A)	0.10	0.14	0.17	0.21	0.27	0.38	0.49	0.58	0.67	0.74
Input Current @ 347V (A)	0.08	0.11	0.14	0.17	0.22	0.30	0.40	0.47	0.55	0.62
Input Current @ 480V (A)	0.06	0.08	0.10	0.12	0.16	0.22	0.30	0.35	0.41	0.45

RW Distribution

Lumen Package	D1	D2	D3	D4	D5	D6	D7	D8	D9
Power (Wattage)	28.0	39.2	47.2	57.6	74.7	105.2	127.1	152.6	178.0
Input Current @ 120V (A)	0.23	0.33	0.39	0.48	0.62	0.88	1.11	1.34	1.58
Input Current @ 208V (A)	0.13	0.19	0.23	0.28	0.36	0.51	0.58	0.69	0.81
Input Current @ 240V (A)	0.12	0.16	0.20	0.24	0.31	0.44	0.56	0.67	0.78
Input Current @ 277V (A)	0.10	0.14	0.17	0.21	0.27	0.38	0.50	0.59	0.68
Input Current @ 347V (A)	0.08	0.11	0.14	0.17	0.22	0.30	0.41	0.48	0.57
Input Current @ 480V (A)	0.06	0.08	0.10	0.12	0.16	0.22	0.30	0.36	0.42

DL Distribution

Lumen Package	D1	D2	D3	D4	D5	D6	D7	D8	D9
Power (Wattage)	28.8	40.5	48.8	59.8	62.3	97.4	127.1	152.6	178.0
Input Current @ 120V (A)	0.24	0.34	0.41	0.50	0.55	0.86	1.11	1.34	1.58
Input Current @ 208V (A)	0.14	0.19	0.23	0.29	0.28	0.44	0.58	0.69	0.81
Input Current @ 240V (A)	0.12	0.17	0.20	0.25	0.28	0.43	0.56	0.67	0.78
Input Current @ 277V (A)	0.10	0.15	0.18	0.22	0.24	0.37	0.50	0.59	0.68
Input Current @ 347V (A)	0.08	0.12	0.14	0.17	0.21	0.31	0.41	0.48	0.57
Input Current @ 480V (A)	0.06	0.08	0.10	0.12	0.15	0.23	0.30	0.36	0.42

Lumen Maintenance

Lumen Package	Ambient Temperature	25,000 hours*	50,000 hours*	60,000 hours*	100,000 hours**	Theoretical L70 hours**
D1-D6 (D1 - D4 DL/T4)	25°C	98.0%	95.2%	94.1%	89.8%	> 300,000
	40°C	97.9%	94.8%	93.6%	89.0%	> 290,000
	50°C	97.7%	94.5%	93.2%	88.4%	> 270,000
D7 - D10 (D5+ DL/T4)	25°C	95.8%	93.2%	92.2%	88.2%	> 300,000
	40°C	93.9%	89.7%	88.1%	81.9%	> 180,000

* Supported by IES TM-21 standards
**Theoretical values represent estimations commonly used; however, refer to the IES position on LED Product Lifetime Prediction, IES PS-10-18, explaining proper use of IES TM-21 and LM-80.

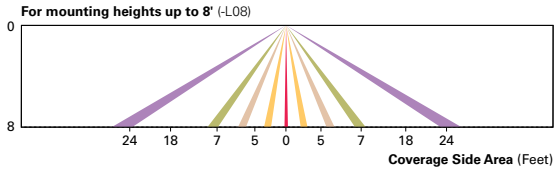
Lumen Multiplier

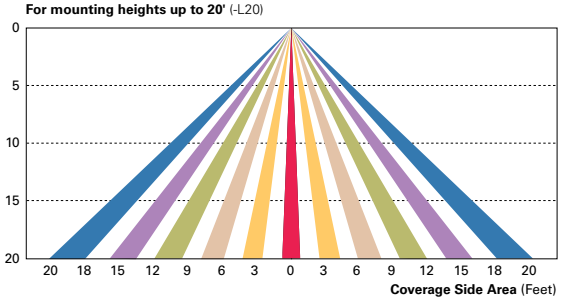
Ambient Temperature	Multiplier
0°C	1.03
10C	1.02
25°C	1.00
40°C	0.98
50°C	0.97

Control Options

0-10V (D) 0-10V dimming comes standard on all TopTier configurations for use with integrated or external lighting controls.

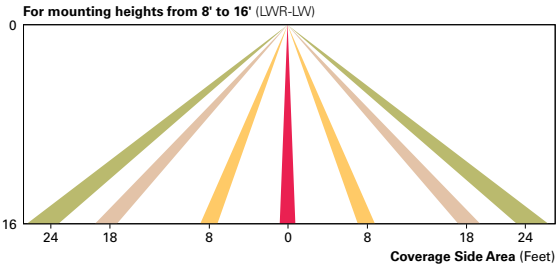
Dimming Occupancy Sensor (MS/DIM) These sensors are factory installed in the luminaire, dimming to 50% after five minutes of no motion detected. When motion is detected, the luminaire output is 100%. Includes an integral photocell that can be programmed for "dusk-to-dawn" operation. The FSIR-100 programming tool can be utilized to adjust dimming level, time delay, sensitivity and other parameters. Two lens options provide optimal coverage patterns up to 20' mounting height.

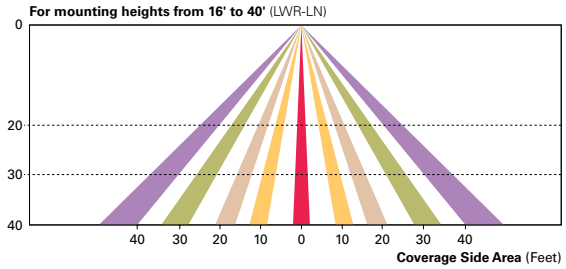




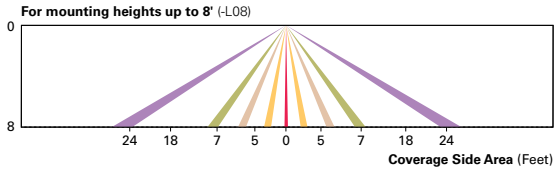
WaveLinx-Ready 4-PIN Twistlock Receptacle (ZW) Includes the WaveLinx control module, integrated 4-Pin receptacle, and standard 0-10V dimming driver, enabling the subsequent addition of a WaveLinx sensor.

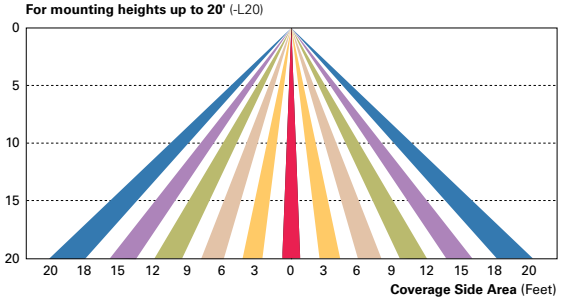
Enlighted Wireless Control and Monitoring System (LWR-LW and LWR-LN) The Enlighted control system is a connected lighting solution, combining LED luminaires with an integrated wireless sensor system. The sensor controls the lighting system in compliance with the latest energy codes while collecting valuable data about building performance and use. Software applications utilizing energy dashboards maximize data inputs to help optimize the use of other resources beyond lighting.





Synapse (DIM10) SimplySNAP integrated wireless controls system by Synapse. Includes factory installed DIM10 control module and MS/DC motion sensor; requires additional Synapse system components for operation. Contact Synapse at www.synapsewireless.com for product support, warranty, and terms and conditions.





Cooper Lighting Solutions
1121 Highway 74 South
Peachtree City, GA 30269
P: 770-486-4800
www.cooperlighting.com

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Specifications and dimensions
subject to change without notice.

Project		Catalog #	TYPE OC - BASE BID
Prepared by		Notes	PROVIDE SPECIFIED FIXTURE BY APPROVED MANUFACTURER OR ENGINEER-APPROVED EQUAL BY: LITHONIA VCPG SERIES GARDCO SOFTVIEW SERIES



TopTier (D1-D6)



TopTier (D7-D10)

McGraw-Edison

TT TopTier

Parking Garage Luminaire

Product Features

Light ARchitect™

Interactive Menu

- Ordering Information page 2
- Product Specifications page 2
- Optical Configurations page 2
- Mounting Details page 3
- Energy and Performance Data page 4
- Control Options page 6

Product Certifications

Quick Facts

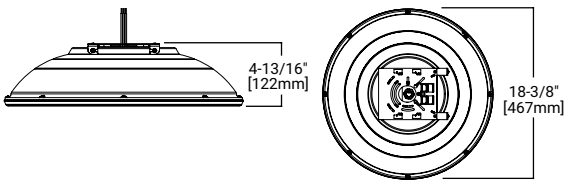
- Lumen packages range from 2,757 - 22,831
- Efficacies up to 146 lumens per watt
- Utilizes patented waveguide technology for maximum visual comfort
- Surface, pendant, trunnion, wall and direct conduit mount options

Connected Systems

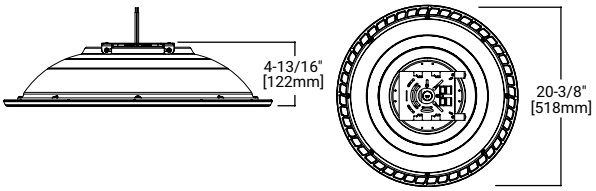
- WaveLinx Lite
- Synapse

Dimensional Details

SURFACE MOUNT
CQ, MQ, WQ and RW: D1-D6
DL: D1-D4
Base luminaire weight: 18.2 lbs (8.3 kg)



SURFACE MOUNT
CQ, MQ, WQ and RW: D7+
DL: D5+
Base luminaire weight: 20.1 lbs (9.1 kg)



NOTES:
1. Visit https://www.designlights.org/search/ to confirm qualification. Not all product variations are DLC qualified.
2. IDA Certified for 3000K CCT and warmer only.

McGraw-Edison — TT TopTier

Ordering Information

SAMPLE NUMBER: **TT-D3-740-U-WQ-STM-30L-AP**

Product Family	Configuration	Color Temperature	Voltage	Distribution	Mounting	Lead Length [7]	Finish
TT=TopTier [1] **BAA-TT**=TopTier, Buy American Act Compliant [27] **TAA-TT**=TopTier, Trade Agreements Act Compliant [27]	**D1**=4,000 Nominal Lumens **D2**=5,500 Nominal Lumens **D3**=6,500 Nominal Lumens **D4**=8,000 Nominal Lumens **D5**=10,000 Nominal Lumens **D6**=13,000 Nominal Lumens **D7**=15,000 Nominal Lumens **D8**=18,000 Nominal Lumens **D9**=20,000 Nominal Lumens **D10**=22,000 Nominal Lumens	**735**=70 CRI, 3500K CCT **740**=70 CRI, 4000K CCT **750**=70 CRI, 5000K CCT **830**=80 CRI, 3000K CCT **AMB**=Amber 590nm [29] 4000K 80CRI	**U**=120-277V **H**=347-480V [22, 26] **1**=120V **2**=208V **3**=240V **4**=277V **8**=480V **9**=347V	**CQ**=Concentrated **MQ**=Medium **WQ**=Wide **RW**=Rectangular Wide [3] **DL**=Drive Lane / Type 4 [3]	**[Blank]**=Surface Mount [16] **TMB**=Trunnion Mount with Connection Box **DPM**=Decorative Pendant Mount [4] **WM**=Wall Mount **STM**=Stem Mount to 1/2" conduit [16] MOUNT DIRECTLY TO J-BOX.	**[Blank]**=6" **30L**=30" **36L**=36" **48L**=48" **72L**=72" **108L**=108" **120L**=120" **144L**=144"	**NW**=White **AP**=Grey **BZ**=Bronze **BK**=Black **DP**=Dark Platinum **GM**=Graphite Metallic

Options (Add as Suffix)

F=Single Fuse (120, 277 or 347V Specify Voltage)
FF=Double Fuse (208, 240 or 480V Specify Voltage)
IBP=Integral Battery Pack [5, 24]
IBP-CEC=Integral Battery Pack, CEC compliant [5]
ITS=Integral Transfer Switch [3]
924=UL924 listed luminaire [19]
CG=Clear Glass [8]
SG=Solite® Glass [9]
UPL=Uplight [6]
TR=Tamper Resistant Hardware
NAT=Natatorium finish
DALI=DALI Driver [15]
MS/DIM-L08=Dimming Occupancy Sensor (<9' Mounting) [11, 17]
MS/DIM-L20=Dimming Occupancy Sensor (9' - 20' Mounting) [11, 17]
ZW=WaveLinx-Enabled Module and 4-PIN Receptacle [23]
SPB1=Dimming Motion and Daylight Sensor, Bluetooth Programmable, < 8' Mounting [11, 21]
SPB2=Dimming Motion and Daylight Sensor, Bluetooth Programmable, 8' - 20' Mounting [11, 21]
NO UPLIGHT
SPB4=Dimming Motion and Daylight Sensor, Bluetooth Programmable, 20' - 40' Mounting [11, 21]
ZD=WaveLinx-Enabled Module with DALI Driver and 4-PIN Receptacle [23]
ZW-SWPD4WH=WaveLinx Control Module and Wireless Sensor – 7'-15'
ZW-SWPD5WH=WaveLinx Control Module and Wireless Sensor – 15'-40'
ZW-WOBWH=WaveLinx Control Module and LC Bluetooth Sensor – 7'-15'
ZW-WOFWH=WaveLinx Control Module and LC Bluetooth Sensor – 15'-40'
ZD-SWPD4WH=WaveLinx with DALI Driver and Wireless Sensor – 7'-15'
ZD-SWPD5WH=WaveLinx with DALI Driver and Wireless Sensor – 15'-40'
ZD-WOBWH=WaveLinx with DALI Driver and LC Bluetooth Sensor – 7'-15'
ZD-WOFWH=WaveLinx with DALI Driver and LC Bluetooth Sensor – 15 -40'
LWR-LW=Enlighted Wireless Sensor, Wide Lens 8' - 16' Mounting Height [11, 18]
LWR-LN=Enlighted Wireless Sensor, Narrow Lens 16' - 40' Mounting Height [11, 18]
DIM10-MS/DIM-L08=Synapse occupancy sensor (<8' Mounting)
DIM10-MS/DIM-L20=Synapse occupancy sensor (8'-20' Mounting)

Accessories (Order Separately) [28]

MA1252=Replacement 10kV Surge Module
TT/WG=Wire Guard [25]
TT/BG-UP-XX=Bird Guard [12, 13]
TT/HSS-XX=House Side Shield [25]
DPMS36-XX=36" Pendant Mount Stem [12, 14]
DPMS48-XX=48" Pendant Mount Stem [12, 14]
DPMS96-XX=96" Pendant Mount Stem [12, 14]
FSIR-100=Wireless Configuration Tool for Occupancy Sensor [17]
SWPD4-WH=WaveLinx Wireless Sensor, 7'–15' Mounting Height [20, 21, 22, 23]
SWPD5-WH=WaveLinx Wireless Sensor, 15'–40' Mounting Height [20, 21, 22, 23]

FOR LUMINAIRES NOTED AS EM, PROVIDE WITH INTEGRAL UL924 LISTED EMERGENCY BYPASS.

NOTES:

1. DesignLights Consortium® Qualified. Refer to www.designlights.org Qualified Products List under Family Models for details.
2. Only for use with 480V Wye systems. Per NEC, not for use with ungrounded systems, impedance grounded systems or corner grounded systems (commonly known as Three Phase Three Wire Delta, Three Phase High Leg Delta and Three Phase Corner Grounded Delta systems).
3. Not available with D7 - D10 configurations.
4. Order Pendant Mount Stem accessory.
5. IBP ambient operating temperature -20°C to 35°C (D1-D3), -20°C to 25°C (D4-D6). Not available with D7-D10 configurations, DALI, or ZD options.
6. Additional 8.0W. Provides 920 lumens. Not available with D10 configuration.
7. Choose lead length for Surface Mount and Stem Mount only. TMB, DPM and WM lengths predetermined.
8. Not available with CQ.
9. Standard with CQ, option available with WQ only.
10. U voltage only. Ambient operating temperature -20°C to 50°C (D1-D4) or -20°C to 40°C (D5-D6). UL924 listed component.
11. Includes integral photocell.
12. Specify color in place of XX.
13. Designed for use with Stem Mount and Decorative Pendant Mount only.
14. Designed for use with Decorative Pendant Mount only.
15. Not available with H voltage or IBP. Not compatible with MS/DIM or LWR sensors.
16. Specify Lead Length for wire harness length.
17. The FSIR-100 configuration tool is required to adjust parameters including high and low modes, sensitivity, time delay and more.
18. Enlighted wireless sensors are factory installed only, and require network components in appropriate quantities.
19. 924 option provides luminaire UL924 listing, used in conjunction with ITS or IBP-CEC.
20. Requires ZW or ZD receptacle.
21. Sensor configuration mobile application required for configuration. See controls page for details.
22. Cannot be used with other control options.
23. For WaveLinx applications, WAC Gateway required to enable field-configurability: Order WAC-PoE and WPOE-120 (10V to PoE injector) power supply if needed. Not required for WaveLinx Lite Commercial (LC) applications.
24. Specify 120V or 277V.
25. TT/WG and TT/HSS cannot be installed together. TT/HSS & TT/WG not available on D7-D10 configurations.
26. D4-D10 only. Not compatible with battery.
27. Only product configurations with these designated prefixes are built to be compliant with the Buy American Act of 1933 (BAA) or Trade Agreements Act of 1979 (TAA), respectively. Please refer to DOMESTIC PREFERENCES website for more information. Components shipped separately may be separately analyzed under domestic preference requirements.
28. Accessories sold separately will be separately analyzed under domestic preference requirements. Consult factory for further information.
29. Narrow-band 590nm +/- 5nm for wildlife and observatory use. Choose lumen package D1.

Product Specifications

Construction

- Low profile, die-cast aluminum housing provides a clean, symmetric aesthetic

Optics

- Five optical distributions utilizing visual comfort waveguide technology
- 10 lumen packages, ranging from 2,757 to 22,831
- Integral uplight option utilizes a dedicated, 8W light engine, producing 920 lumens for reduced visual contrast and cave effect
- IDA Certified for 3000k CCT and warmer only. Not available with uplight option.

Electrical

- D1-D6: -40C - 50C operating temperature
- D7-D10: -40C - 40C operating temperature
- Greater than 90% lumen maintenance at 50,000 hours
- IP66 rated
- 120-277V 50/60Hz, 347V 60Hz or 480V 60Hz operation
- 10kV surge module standard
- 0-10V dimming standard

Mounting

- Surface mount directly to square or octagonal 4" surface or recessed junction box using quick mount bracket
- Optional stem mount bracket with set screw for direct 1/2" NPS conduit mounting
- Trunnion, decorative pendant, and wall mount options also available

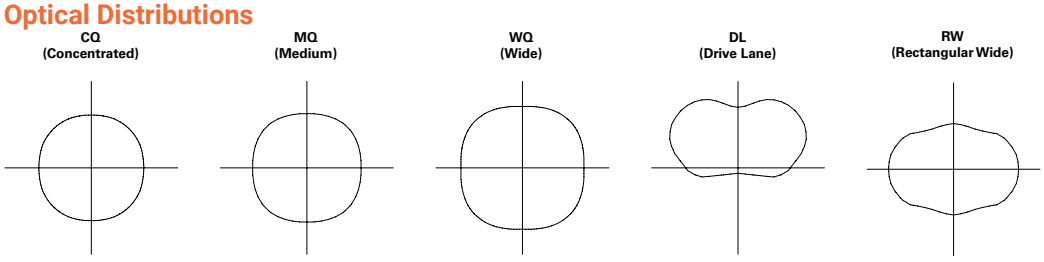
Finish

- 2.5 mil nominal TGIC powder coat thickness
- Finishes include white, black, bronze, gray, dark platinum and graphite metallic
- RAL and custom color matches available
- Natatorium option (NAT) available, providing 5,000 hour salt spray rating per ASTM B117, with a scribe rating of 9 per ASTM D1654

Warranty

- Five-year warranty

Optical Distributions

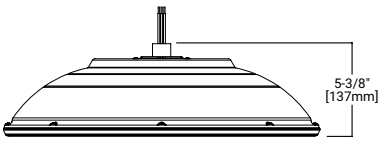


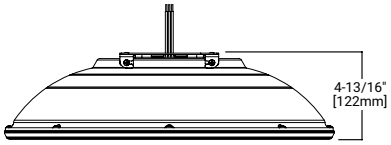
McGraw-Edison **TT TopTier**

Mounting Details

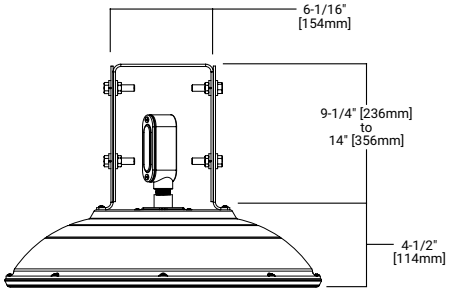
***D1-D6 configuration shown (D1-D4 for DL distribution)**

Stem Mount

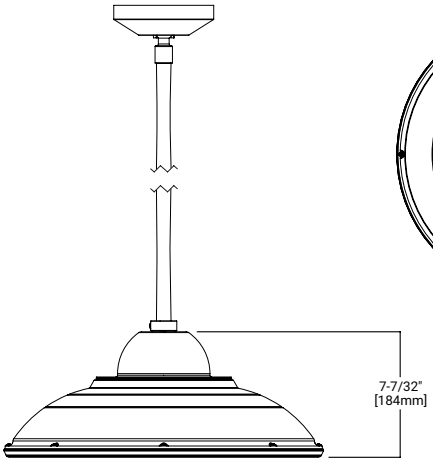




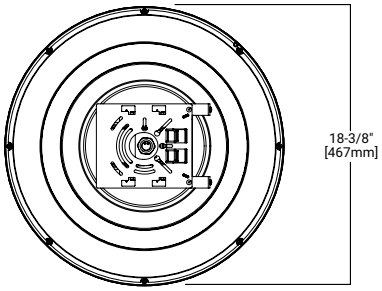
Trunnion Mount



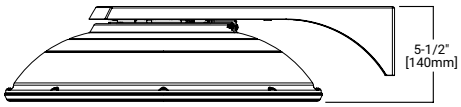
Decorative Pendant Mount



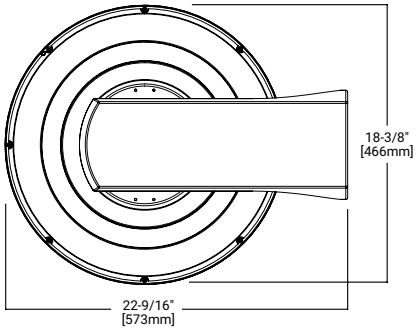
Top View



Wall Mount

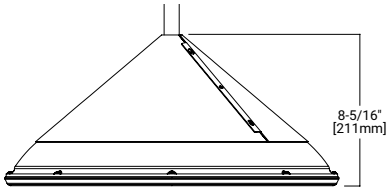


Top View - Wall Mount

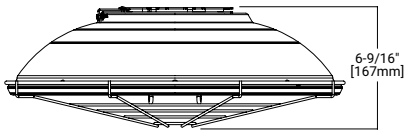


Accessories

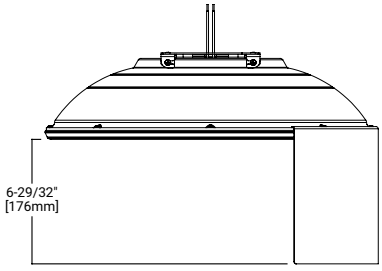
Bird Guard (TT/BG-UP-XX)



Wire Guard (TT/WG)



House Side Shield (TT/HSS-XX)



McGraw-Edison TT TopTier

Energy and Performance Data

View TopTier IES files

Power and Lumens (3000K/3500K/4000K/5000K)

Lumen Package			D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
Power (Wattage) CQ, MQ, WQ			28.0	39.2	47.2	57.6	74.7	105.2	124.7	148.7	173.1	193.8
Power (Wattage) RW Only			28.0	39.2	47.2	57.6	74.7	105.2	127.1	152.6	178.0	--
Power (Wattage) DL Only			28.8	40.5	48.8	59.8	62.3	97.4	127.1	152.6	178.0	--
Distribution												
3000K CCT 80 CRI	CQ Concentrated	Lumens	3,409	4,640	5,595	6,660	8,383	11,030	12,307	14,411	16,430	18,001
		BUG Rating	B1-U0-G1	B2-U0-G1	B2-U0-G1	B2-U0-G1	B3-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G2
		Lumens per Watt	122	118	119	116	112	105	99	97	95	93
	MQ Medium	Lumens	3,647	4,964	5,986	7,125	8,969	11,800	12,854	15,053	17,161	18,802
		BUG Rating	B2-U0-G1	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3
		Lumens per Watt	130	127	127	124	120	112	103	101	99	97
	WQ Wide	Lumens	3,449	4,695	5,662	6,740	8,483	11,161	12,350	14,463	16,489	18,065
		BUG Rating	B2-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3
		Lumens per Watt	123	120	120	117	114	106	99	97	95	93
	RW Rectangular Wide	Lumens	2,757	3,753	4,526	5,387	6,781	8,922	11,977	13,619	15,122	--
		BUG Rating	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	--
		Lumens per Watt	98	96	96	94	91	85	94	89	85	--
	DL Drive Lane / Type 4	Lumens	2,959	3,985	4,762	5,622	6,537	8,771	11,834	13,337	14,768	--
		BUG Rating	B1-U0-G2	B2-U0-G3	B2-U0-G3	B2-U0-G3	B1-U0-G3	B2-U0-G3	B2-U0-G4	B2-U0-G4	B2-U0-G4	--
		Lumens per Watt	103	98	98	94	105	90	93	87	83	--
3500K CCT 70 CRI	CQ Concentrated	Lumens	3,618	4,925	5,940	7,070	8,899	11,708	14,944	17,500	19,951	21,858
		BUG Rating	B1-U0-G1	B2-U0-G1	B2-U0-G1	B2-U0-G1	B3-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B4-U0-G2	B4-U0-G2
		Lumens per Watt	129	126	126	123	119	111	120	118	115	113
	MQ Medium	Lumens	3,872	5,270	6,355	7,564	9,520	12,527	15,609	18,279	20,839	22,831
		BUG Rating	B2-U0-G2	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3
		Lumens per Watt	138	134	135	131	127	119	125	123	120	118
	WQ Wide	Lumens	3,662	4,984	6,011	7,154	9,005	11,848	14,997	17,562	20,022	21,936
		BUG Rating	B2-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G4
		Lumens per Watt	131	127	127	124	121	113	120	118	116	113
	RW Rectangular Wide	Lumens	2,927	3,984	4,805	5,719	7,198	9,471	14,544	16,537	18,363	--
		BUG Rating	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	--
		Lumens per Watt	105	102	102	99	96	90	114	108	103	--
	DL Drive Lane / Type 4	Lumens	3,141	4,230	5,055	5,968	7,938	10,650	14,370	16,195	17,933	--
		BUG Rating	B1-U0-G2	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G4	B3-U0-G4	B3-U0-G5	--
		Lumens per Watt	109	104	104	100	127	109	113	106	101	--
4000K/ 5000K CCT 70 CRI	CQ Concentrated	Lumens	3,828	5,211	6,284	7,480	9,415	12,387	14,944	17,500	19,951	21,858
		BUG Rating	B1-U0-G1	B2-U0-G1	B2-U0-G1	B2-U0-G1	B3-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B4-U0-G2	B4-U0-G2
		Lumens per Watt	137	133	133	130	126	118	120	118	115	113
	MQ Medium	Lumens	4,096	5,575	6,723	8,002	10,072	13,253	15,609	18,279	20,839	22,831
		BUG Rating	B2-U0-G2	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3
		Lumens per Watt	146	142	142	139	135	126	125	123	120	118
	WQ Wide	Lumens	3,874	5,273	6,359	7,569	9,527	12,535	14,997	17,562	20,022	21,936
		BUG Rating	B2-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G4
		Lumens per Watt	138	135	135	131	128	119	120	118	116	113
	RW Rectangular Wide	Lumens	3,097	4,215	5,083	6,050	7,615	10,020	14,544	16,537	18,363	--
		BUG Rating	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	--
		Lumens per Watt	111	108	108	105	102	95	114	108	103	--
	DL Drive Lane / Type 4	Lumens	3,323	4,475	5,348	6,314	7,938	10,650	14,370	16,195	17,933	--
		BUG Rating	B1-U0-G2	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G4	B3-U0-G4	B3-U0-G5	--
		Lumens per Watt	115	110	110	106	127	109	113	106	101	--

McGraw-Edison **TT TopTier**

Energy and Performance Data

CQ, MQ and WQ Distributions

Lumen Package	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
Power (Wattage)	28.0	39.2	47.2	57.6	74.7	105.2	124.7	148.7	173.1	193.8
Input Current @ 120V (A)	0.23	0.33	0.39	0.48	0.62	0.88	1.09	1.31	1.53	1.72
Input Current @ 208V (A)	0.13	0.19	0.23	0.28	0.36	0.51	0.57	0.67	0.78	0.88
Input Current @ 240V (A)	0.12	0.16	0.20	0.24	0.31	0.44	0.56	0.66	0.76	0.85
Input Current @ 277V (A)	0.10	0.14	0.17	0.21	0.27	0.38	0.49	0.58	0.67	0.74
Input Current @ 347V (A)	0.08	0.11	0.14	0.17	0.22	0.30	0.40	0.47	0.55	0.62
Input Current @ 480V (A)	0.06	0.08	0.10	0.12	0.16	0.22	0.30	0.35	0.41	0.45

RW Distribution

Lumen Package	D1	D2	D3	D4	D5	D6	D7	D8	D9
Power (Wattage)	28.0	39.2	47.2	57.6	74.7	105.2	127.1	152.6	178.0
Input Current @ 120V (A)	0.23	0.33	0.39	0.48	0.62	0.88	1.11	1.34	1.58
Input Current @ 208V (A)	0.13	0.19	0.23	0.28	0.36	0.51	0.58	0.69	0.81
Input Current @ 240V (A)	0.12	0.16	0.20	0.24	0.31	0.44	0.56	0.67	0.78
Input Current @ 277V (A)	0.10	0.14	0.17	0.21	0.27	0.38	0.50	0.59	0.68
Input Current @ 347V (A)	0.08	0.11	0.14	0.17	0.22	0.30	0.41	0.48	0.57
Input Current @ 480V (A)	0.06	0.08	0.10	0.12	0.16	0.22	0.30	0.36	0.42

DL Distribution

Lumen Package	D1	D2	D3	D4	D5	D6	D7	D8	D9
Power (Wattage)	28.8	40.5	48.8	59.8	62.3	97.4	127.1	152.6	178.0
Input Current @ 120V (A)	0.24	0.34	0.41	0.50	0.55	0.86	1.11	1.34	1.58
Input Current @ 208V (A)	0.14	0.19	0.23	0.29	0.28	0.44	0.58	0.69	0.81
Input Current @ 240V (A)	0.12	0.17	0.20	0.25	0.28	0.43	0.56	0.67	0.78
Input Current @ 277V (A)	0.10	0.15	0.18	0.22	0.24	0.37	0.50	0.59	0.68
Input Current @ 347V (A)	0.08	0.12	0.14	0.17	0.21	0.31	0.41	0.48	0.57
Input Current @ 480V (A)	0.06	0.08	0.10	0.12	0.15	0.23	0.30	0.36	0.42

Lumen Maintenance

Lumen Package	Ambient Temperature	25,000 hours*	50,000 hours*	60,000 hours*	100,000 hours**	Theoretical L70 hours**
D1-D6 (D1 - D4 DL/T4)	25°C	98.0%	95.2%	94.1%	89.8%	> 300,000
	40°C	97.9%	94.8%	93.6%	89.0%	> 290,000
	50°C	97.7%	94.5%	93.2%	88.4%	> 270,000
D7 - D10 (D5+ DL/T4)	25°C	95.8%	93.2%	92.2%	88.2%	> 300,000
	40°C	93.9%	89.7%	88.1%	81.9%	> 180,000

* Supported by IES TM-21 standards
**Theoretical values represent estimations commonly used; however, refer to the IES position on LED Product Lifetime Prediction, IES PS-10-18, explaining proper use of IES TM-21 and LM-80.

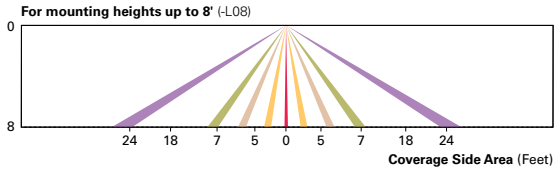
Lumen Multiplier

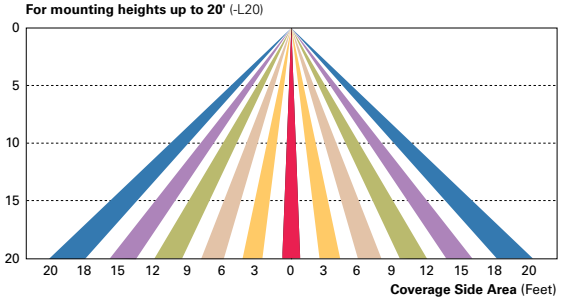
Ambient Temperature	Multiplier
0°C	1.03
10C	1.02
25°C	1.00
40°C	0.98
50°C	0.97

Control Options

0-10V (D) 0-10V dimming comes standard on all TopTier configurations for use with integrated or external lighting controls.

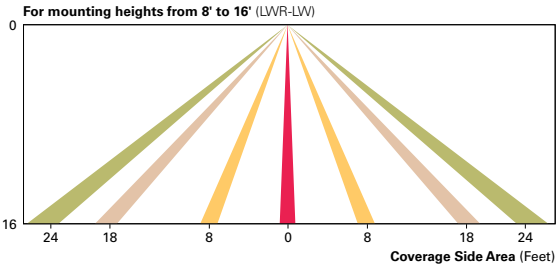
Dimming Occupancy Sensor (MS/DIM) These sensors are factory installed in the luminaire, dimming to 50% after five minutes of no motion detected. When motion is detected, the luminaire output is 100%. Includes an integral photocell that can be programmed for "dusk-to-dawn" operation. The FSIR-100 programming tool can be utilized to adjust dimming level, time delay, sensitivity and other parameters. Two lens options provide optimal coverage patterns up to 20' mounting height.

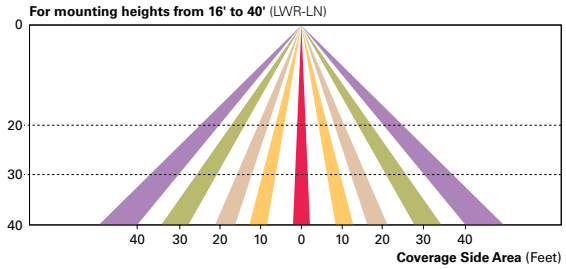




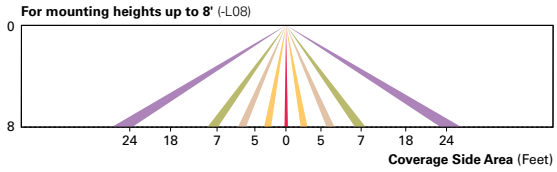
WaveLinx-Ready 4-PIN Twistlock Receptacle (ZW) Includes the WaveLinx control module, integrated 4-Pin receptacle, and standard 0-10V dimming driver, enabling the subsequent addition of a WaveLinx sensor.

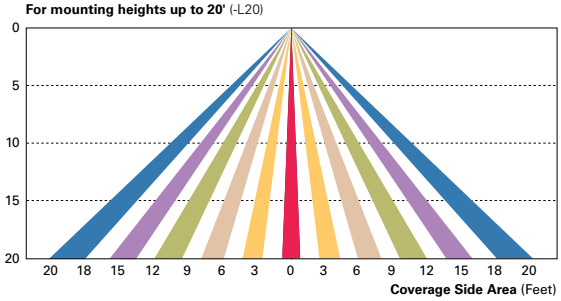
Enlighted Wireless Control and Monitoring System (LWR-LW and LWR-LN) The Enlighted control system is a connected lighting solution, combining LED luminaires with an integrated wireless sensor system. The sensor controls the lighting system in compliance with the latest energy codes while collecting valuable data about building performance and use. Software applications utilizing energy dashboards maximize data inputs to help optimize the use of other resources beyond lighting.





Synapse (DIM10) SimplySNAP integrated wireless controls system by Synapse. Includes factory installed DIM10 control module and MS/DC motion sensor; requires additional Synapse system components for operation. Contact Synapse at www.synapsewireless.com for product support, warranty, and terms and conditions.





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Specifications and dimensions
subject to change without notice.

Project		Catalog #		TYPE OD - BASE BID
Prepared by		Notes	PROVIDE SPECIFIED FIXTURE BY APPROVED MANUFACTURER OR ENGINEER-APPROVED EQUAL BY: LITHONIA VCPG SERIES GARDCO SOFTVIEW SERIES	



TopTier (D1-D6)



TopTier (D7-D10)

McGraw-Edison

TT TopTier

Parking Garage Luminaire

Product Features

Light ARchitect™

Interactive Menu

- Ordering Information page 2
- Product Specifications page 2
- Optical Configurations page 2
- Mounting Details page 3
- Energy and Performance Data page 4
- Control Options page 6

Product Certifications

Quick Facts

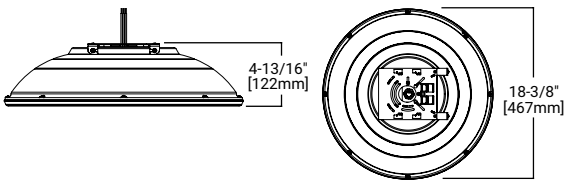
- Lumen packages range from 2,757 - 22,831
- Efficacies up to 146 lumens per watt
- Utilizes patented waveguide technology for maximum visual comfort
- Surface, pendant, trunnion, wall and direct conduit mount options

Connected Systems

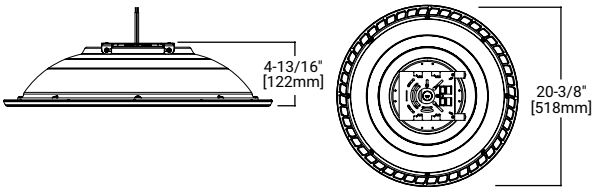
- WaveLinx Lite
- Synapse

Dimensional Details

SURFACE MOUNT
CQ, MQ, WQ and RW: D1-D6
DL: D1-D4
Base luminaire weight: 18.2 lbs (8.3 kg)



SURFACE MOUNT
CQ, MQ, WQ and RW: D7+
DL: D5+
Base luminaire weight: 20.1 lbs (9.1 kg)



NOTES:
1. Visit https://www.designlights.org/search/ to confirm qualification. Not all product variations are DLC qualified.
2. IDA Certified for 3000K CCT and warmer only.

McGraw-Edison — TT TopTier

Ordering Information

SAMPLE NUMBER: **TT-D3-740-U-WQ-STM-30L-AP**

Product Family	Configuration	Color Temperature	Voltage	Distribution	Mounting	Lead Length [7]	Finish
TT=TopTier [1] **BAA-TT**=TopTier, Buy American Act Compliant [27] **TAA-TT**=TopTier, Trade Agreements Act Compliant [27]	**D1**=4,000 Nominal Lumens **D2**=5,500 Nominal Lumens **D3**=6,500 Nominal Lumens **D4**=8,000 Nominal Lumens **D5**=10,000 Nominal Lumens **D6**=13,000 Nominal Lumens **D7**=15,000 Nominal Lumens **D8**=18,000 Nominal Lumens **D9**=20,000 Nominal Lumens **D10**=22,000 Nominal Lumens	**735**=70 CRI, 3500K CCT **740**=70 CRI, 4000K CCT **750**=70 CRI, 5000K CCT **830**=80 CRI, 3000K CCT **AMB**=Amber 590nm [29] 4000K 80CRI	**U**=120-277V **H**=347-480V [22, 26] **1**=120V **2**=208V **3**=240V **4**=277V **8**=480V **9**=347V	**CQ**=Concentrated **MQ**=Medium **WQ**=Wide **RW**=Rectangular Wide [3] **DL**=Drive Lane / Type 4 [3]	**[Blank]**=Surface Mount [16] **TMB**=Trunnion Mount with Connection Box **DPM**=Decorative Pendant Mount [4] **WM**=Wall Mount **STM**=Stem Mount to 1/2" conduit [16] MOUNT DIRECTLY TO J-BOX.	**[Blank]**=6" **30L**=30" **36L**=36" **48L**=48" **72L**=72" **108L**=108" **120L**=120" **144L**=144"	**NW**=White **AP**=Grey **BZ**=Bronze **BK**=Black **DP**=Dark Platinum **GM**=Graphite Metallic

Options (Add as Suffix)

F=Single Fuse (120, 277 or 347V Specify Voltage)
FF=Double Fuse (208, 240 or 480V Specify Voltage)
IBP=Integral Battery Pack [5, 24]
IBP-CEC=Integral Battery Pack, CEC compliant [5]
ITS=Integral Transfer Switch [3]
924=UL924 listed luminaire [19]
CG=Clear Glass [8]
SG=Solite® Glass [9]
UPL=Uplight [6]
NO UPLIGHT
TR=Tamper Resistant Hardware
NAT=Natatorium finish
DALI=DALI Driver [15]
MS/DIM-L08=Dimming Occupancy Sensor (<9' Mounting) [11, 17]
MS/DIM-L20=Dimming Occupancy Sensor (9' - 20' Mounting) [11, 17]
ZW=WaveLinx-Enabled Module and 4-PIN Receptacle [23]
SPB1=Dimming Motion and Daylight Sensor, Bluetooth Programmable, < 8' Mounting [11, 21]
SPB2=Dimming Motion and Daylight Sensor, Bluetooth Programmable, 8' - 20' Mounting [11, 21]
SPB4=Dimming Motion and Daylight Sensor, Bluetooth Programmable, 20' - 40' Mounting [17, 21]
ZD=WaveLinx-Enabled Module with DALI Driver and 4-PIN Receptacle [23]
ZW-SWPD4WH=WaveLinx Control Module and Wireless Sensor – 7'-15'
ZW-SWPD5WH=WaveLinx Control Module and Wireless Sensor – 15'-40'
ZW-WOBWH=WaveLinx Control Module and LC Bluetooth Sensor – 7'-15'
ZW-WOFWH=WaveLinx Control Module and LC Bluetooth Sensor – 15'-40'
ZD-SWPD4WH=WaveLinx with DALI Driver and Wireless Sensor – 7'-15'
ZD-SWPD5WH=WaveLinx with DALI Driver and Wireless Sensor – 15'-40'
ZD-WOBWH=WaveLinx with DALI Driver and LC Bluetooth Sensor – 7'-15'
ZD-WOFWH=WaveLinx with DALI Driver and LC Bluetooth Sensor – 15 -40'
LWR-LW=Enlighted Wireless Sensor, Wide Lens 8' - 16' Mounting Height [11, 18]
LWR-LN=Enlighted Wireless Sensor, Narrow Lens 16' - 40' Mounting Height [11, 18]
DIM10-MS/DIM-L08=Synapse occupancy sensor (<8' Mounting)
DIM10-MS/DIM-L20=Synapse occupancy sensor (8'-20' Mounting)

Accessories (Order Separately) [28]

MA1252=Replacement 10kV Surge Module
TT/WG=Wire Guard [25]
TT/BG-UP-XX=Bird Guard [12, 13]
TT/HSS-XX=House Side Shield [25]
DPMS36-XX=36" Pendant Mount Stem [12, 14]
DPMS48-XX=48" Pendant Mount Stem [12, 14]
DPMS96-XX=96" Pendant Mount Stem [12, 14]
FSIR-100=Wireless Configuration Tool for Occupancy Sensor [17]
SWPD4-WH=WaveLinx Wireless Sensor, 7'–15' Mounting Height [20, 21, 22, 23]
SWPD5-WH=WaveLinx Wireless Sensor, 15'–40' Mounting Height [20, 21, 22, 23]

FOR LUMINAIRES NOTED AS EM, INCLUDE INTEGRAL UL924 LISTED EMERGENCY BYPASS.

NOTES:

1. DesignLights Consortium® Qualified. Refer to www.designlights.org Qualified Products List under Family Models for details.
2. Only for use with 480V Wye systems. Per NEC, not for use with ungrounded systems, impedance grounded systems or corner grounded systems (commonly known as Three Phase Three Wire Delta, Three Phase High Leg Delta and Three Phase Corner Grounded Delta systems).
3. Not available with D7 - D10 configurations.
4. Order Pendant Mount Stem accessory.
5. IBP ambient operating temperature -20°C to 35°C (D1-D3), -20°C to 25°C (D4-D6). Not available with D7-D10 configurations, DALI, or ZD options.
6. Additional 8.0W. Provides 920 lumens. Not available with D10 configuration.
7. Choose lead length for Surface Mount and Stem Mount only. TMB, DPM and WM lengths predetermined.
8. Not available with CQ.
9. Standard with CQ, option available with WQ only.
10. U voltage only. Ambient operating temperature -20°C to 50°C (D1-D4) or -20°C to 40°C (D5-D6). UL924 listed component.
11. Includes integral photocell.
12. Specify color in place of XX.
13. Designed for use with Stem Mount and Decorative Pendant Mount only.
14. Designed for use with Decorative Pendant Mount only.
15. Not available with H voltage or IBP. Not compatible with MS/DIM or LWH sensors.
16. Specify Lead Length for wire harness length.
17. The FSIR-100 configuration tool is required to adjust parameters including high and low modes, sensitivity, time delay and more.
18. Enlighted wireless sensors are factory installed only, and require network components in appropriate quantities.
19. 924 option provides luminaire UL924 listing, used in conjunction with ITS or IBP-CEC.
20. Requires ZW or ZD receptacle.
21. Sensor configuration mobile application required for configuration. See controls page for details.
22. Cannot be used with other control options.
23. For WaveLinx applications, WAC Gateway required to enable field-configurability: Order WAC-PoE and WPOE-120 (10V to PoE injector) power supply if needed. Not required for WaveLinx Lite Commercial (LC) applications.
24. Specify 120V or 277V.
25. TT/WG and TT/HSS cannot be installed together. TT/HSS & TT/WG not available on D7-D10 configurations.
26. D4-D10 only. Not compatible with battery.
27. Only product configurations with these designated prefixes are built to be compliant with the Buy American Act of 1933 (BAA) or Trade Agreements Act of 1979 (TAA), respectively. Please refer to DOMESTIC PREFERENCES website for more information. Components shipped separately may be separately analyzed under domestic preference requirements.
28. Accessories sold separately will be separately analyzed under domestic preference requirements. Consult factory for further information.
29. Narrow-band 590nm +/- 5nm for wildlife and observatory use. Choose lumen package D1.

Product Specifications

Construction

- Low profile, die-cast aluminum housing provides a clean, symmetric aesthetic

Optics

- Five optical distributions utilizing visual comfort waveguide technology
- 10 lumen packages, ranging from 2,757 to 22,831
- Integral uplight option utilizes a dedicated, 8W light engine, producing 920 lumens for reduced visual contrast and cave effect
- IDA Certified for 3000k CCT and warmer only. Not available with uplight option.

Electrical

- D1-D6: -40C - 50C operating temperature
- D7-D10: -40C - 40C operating temperature
- Greater than 90% lumen maintenance at 50,000 hours
- IP66 rated
- 120-277V 50/60Hz, 347V 60Hz or 480V 60Hz operation
- 10kV surge module standard
- 0-10V dimming standard

Mounting

- Surface mount directly to square or octagonal 4" surface or recessed junction box using quick mount bracket
- Optional stem mount bracket with set screw for direct 1/2" NPS conduit mounting
- Trunnion, decorative pendant, and wall mount options also available

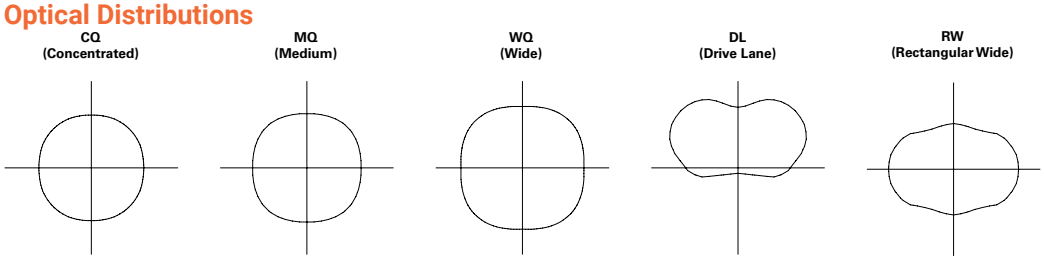
Finish

- 2.5 mil nominal TGIC powder coat thickness
- Finishes include white, black, bronze, gray, dark platinum and graphite metallic
- RAL and custom color matches available
- Natatorium option (NAT) available, providing 5,000 hour salt spray rating per ASTM B117, with a scribe rating of 9 per ASTM D1654

Warranty

- Five-year warranty

Optical Distributions

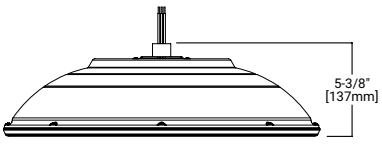


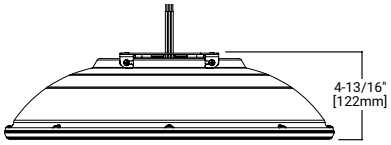
McGraw-Edison **TT TopTier**

Mounting Details

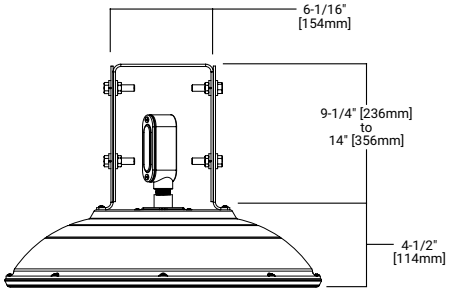
***D1-D6 configuration shown (D1-D4 for DL distribution)**

Stem Mount

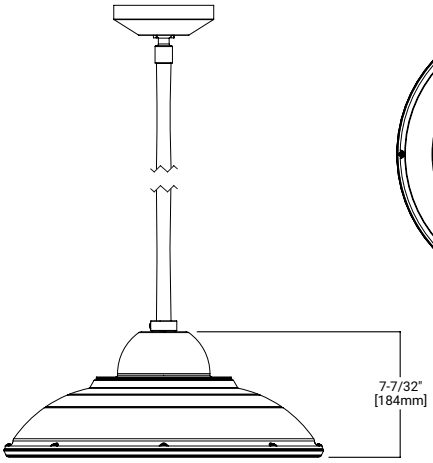




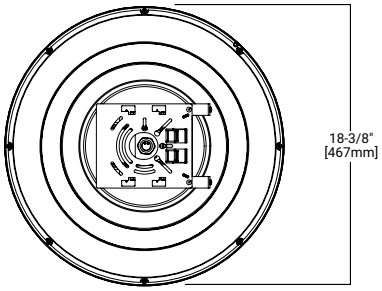
Trunnion Mount



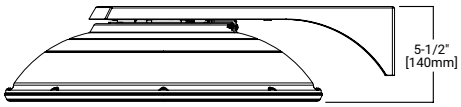
Decorative Pendant Mount



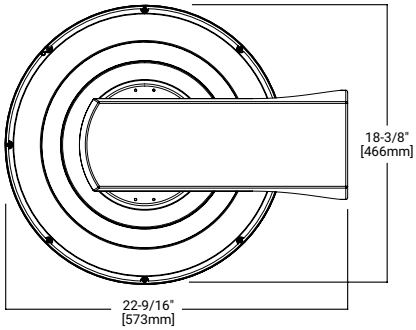
Top View



Wall Mount

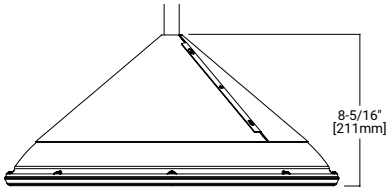


Top View - Wall Mount

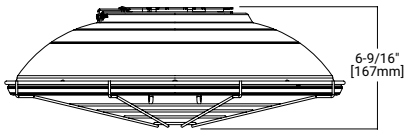


Accessories

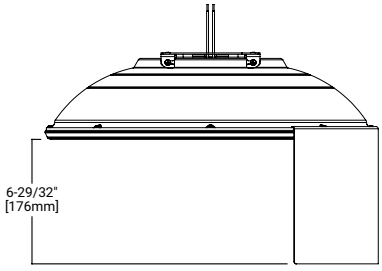
Bird Guard (TT/BG-UP-XX)



Wire Guard (TT/WG)



House Side Shield (TT/HSS-XX)



McGraw-Edison **TT TopTier**

Energy and Performance Data

View TopTier IES files

Power and Lumens (3000K/3500K/4000K/5000K)

Lumen Package			D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
Power (Wattage) CQ, MQ, WQ			28.0	39.2	47.2	57.6	74.7	105.2	124.7	148.7	173.1	193.8
Power (Wattage) RW Only			28.0	39.2	47.2	57.6	74.7	105.2	127.1	152.6	178.0	--
Power (Wattage) DL Only			28.8	40.5	48.8	59.8	62.3	97.4	127.1	152.6	178.0	--
Distribution												
3000K CCT 80 CRI	CQ Concentrated	Lumens	3,409	4,640	5,595	6,660	8,383	11,030	12,307	14,411	16,430	18,001
		BUG Rating	B1-U0-G1	B2-U0-G1	B2-U0-G1	B2-U0-G1	B3-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G2
		Lumens per Watt	122	118	119	116	112	105	99	97	95	93
	MQ Medium	Lumens	3,647	4,964	5,986	7,125	8,969	11,800	12,854	15,053	17,161	18,802
		BUG Rating	B2-U0-G1	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3
		Lumens per Watt	130	127	127	124	120	112	103	101	99	97
	WQ Wide	Lumens	3,449	4,695	5,662	6,740	8,483	11,161	12,350	14,463	16,489	18,065
		BUG Rating	B2-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3
		Lumens per Watt	123	120	120	117	114	106	99	97	95	93
	RW Rectangular Wide	Lumens	2,757	3,753	4,526	5,387	6,781	8,922	11,977	13,619	15,122	--
		BUG Rating	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	--
		Lumens per Watt	98	96	96	94	91	85	94	89	85	--
	DL Drive Lane / Type 4	Lumens	2,959	3,985	4,762	5,622	6,537	8,771	11,834	13,337	14,768	--
		BUG Rating	B1-U0-G2	B2-U0-G3	B2-U0-G3	B2-U0-G3	B1-U0-G3	B2-U0-G3	B2-U0-G4	B2-U0-G4	B2-U0-G4	--
		Lumens per Watt	103	98	98	94	105	90	93	87	83	--
3500K CCT 70 CRI	CQ Concentrated	Lumens	3,618	4,925	5,940	7,070	8,899	11,708	14,944	17,500	19,951	21,858
		BUG Rating	B1-U0-G1	B2-U0-G1	B2-U0-G1	B2-U0-G1	B3-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B4-U0-G2	B4-U0-G2
		Lumens per Watt	129	126	126	123	119	111	120	118	115	113
	MQ Medium	Lumens	3,872	5,270	6,355	7,564	9,520	12,527	15,609	18,279	20,839	22,831
		BUG Rating	B2-U0-G2	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3
		Lumens per Watt	138	134	135	131	127	119	125	123	120	118
	WQ Wide	Lumens	3,662	4,984	6,011	7,154	9,005	11,848	14,997	17,562	20,022	21,936
		BUG Rating	B2-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G4
		Lumens per Watt	131	127	127	124	121	113	120	118	116	113
	RW Rectangular Wide	Lumens	2,927	3,984	4,805	5,719	7,198	9,471	14,544	16,537	18,363	--
		BUG Rating	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	--
		Lumens per Watt	105	102	102	99	96	90	114	108	103	--
	DL Drive Lane / Type 4	Lumens	3,141	4,230	5,055	5,968	7,938	10,650	14,370	16,195	17,933	--
		BUG Rating	B1-U0-G2	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G4	B3-U0-G4	B3-U0-G5	--
		Lumens per Watt	109	104	104	100	127	109	113	106	101	--
4000K/ 5000K CCT 70 CRI	CQ Concentrated	Lumens	3,828	5,211	6,284	7,480	9,415	12,387	14,944	17,500	19,951	21,858
		BUG Rating	B1-U0-G1	B2-U0-G1	B2-U0-G1	B2-U0-G1	B3-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B4-U0-G2	B4-U0-G2
		Lumens per Watt	137	133	133	130	126	118	120	118	115	113
	MQ Medium	Lumens	4,096	5,575	6,723	8,002	10,072	13,253	15,609	18,279	20,839	22,831
		BUG Rating	B2-U0-G2	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3
		Lumens per Watt	146	142	142	139	135	126	125	123	120	118
	WQ Wide	Lumens	3,874	5,273	6,359	7,569	9,527	12,535	14,997	17,562	20,022	21,936
		BUG Rating	B2-U0-G1	B3-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G4
		Lumens per Watt	138	135	135	131	128	119	120	118	116	113
	RW Rectangular Wide	Lumens	3,097	4,215	5,083	6,050	7,615	10,020	14,544	16,537	18,363	--
		BUG Rating	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	B4-U0-G3	--
		Lumens per Watt	111	108	108	105	102	95	114	108	103	--
	DL Drive Lane / Type 4	Lumens	3,323	4,475	5,348	6,314	7,938	10,650	14,370	16,195	17,933	--
		BUG Rating	B1-U0-G2	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G3	B2-U0-G4	B3-U0-G4	B3-U0-G5	--
		Lumens per Watt	115	110	110	106	127	109	113	106	101	--

McGraw-Edison **TT TopTier**

Energy and Performance Data

CQ, MQ and WQ Distributions

Lumen Package	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
Power (Wattage)	28.0	39.2	47.2	57.6	74.7	105.2	124.7	148.7	173.1	193.8
Input Current @ 120V (A)	0.23	0.33	0.39	0.48	0.62	0.88	1.09	1.31	1.53	1.72
Input Current @ 208V (A)	0.13	0.19	0.23	0.28	0.36	0.51	0.57	0.67	0.78	0.88
Input Current @ 240V (A)	0.12	0.16	0.20	0.24	0.31	0.44	0.56	0.66	0.76	0.85
Input Current @ 277V (A)	0.10	0.14	0.17	0.21	0.27	0.38	0.49	0.58	0.67	0.74
Input Current @ 347V (A)	0.08	0.11	0.14	0.17	0.22	0.30	0.40	0.47	0.55	0.62
Input Current @ 480V (A)	0.06	0.08	0.10	0.12	0.16	0.22	0.30	0.35	0.41	0.45

RW Distribution

Lumen Package	D1	D2	D3	D4	D5	D6	D7	D8	D9
Power (Wattage)	28.0	39.2	47.2	57.6	74.7	105.2	127.1	152.6	178.0
Input Current @ 120V (A)	0.23	0.33	0.39	0.48	0.62	0.88	1.11	1.34	1.58
Input Current @ 208V (A)	0.13	0.19	0.23	0.28	0.36	0.51	0.58	0.69	0.81
Input Current @ 240V (A)	0.12	0.16	0.20	0.24	0.31	0.44	0.56	0.67	0.78
Input Current @ 277V (A)	0.10	0.14	0.17	0.21	0.27	0.38	0.50	0.59	0.68
Input Current @ 347V (A)	0.08	0.11	0.14	0.17	0.22	0.30	0.41	0.48	0.57
Input Current @ 480V (A)	0.06	0.08	0.10	0.12	0.16	0.22	0.30	0.36	0.42

DL Distribution

Lumen Package	D1	D2	D3	D4	D5	D6	D7	D8	D9
Power (Wattage)	28.8	40.5	48.8	59.8	62.3	97.4	127.1	152.6	178.0
Input Current @ 120V (A)	0.24	0.34	0.41	0.50	0.55	0.86	1.11	1.34	1.58
Input Current @ 208V (A)	0.14	0.19	0.23	0.29	0.28	0.44	0.58	0.69	0.81
Input Current @ 240V (A)	0.12	0.17	0.20	0.25	0.28	0.43	0.56	0.67	0.78
Input Current @ 277V (A)	0.10	0.15	0.18	0.22	0.24	0.37	0.50	0.59	0.68
Input Current @ 347V (A)	0.08	0.12	0.14	0.17	0.21	0.31	0.41	0.48	0.57
Input Current @ 480V (A)	0.06	0.08	0.10	0.12	0.15	0.23	0.30	0.36	0.42

Lumen Maintenance

Lumen Package	Ambient Temperature	25,000 hours*	50,000 hours*	60,000 hours*	100,000 hours**	Theoretical L70 hours**
D1-D6 (D1 - D4 DL/T4)	25°C	98.0%	95.2%	94.1%	89.8%	> 300,000
	40°C	97.9%	94.8%	93.6%	89.0%	> 290,000
	50°C	97.7%	94.5%	93.2%	88.4%	> 270,000
D7 - D10 (D5+ DL/T4)	25°C	95.8%	93.2%	92.2%	88.2%	> 300,000
	40°C	93.9%	89.7%	88.1%	81.9%	> 180,000

* Supported by IES TM-21 standards
**Theoretical values represent estimations commonly used; however, refer to the IES position on LED Product Lifetime Prediction, IES PS-10-18, explaining proper use of IES TM-21 and LM-80.

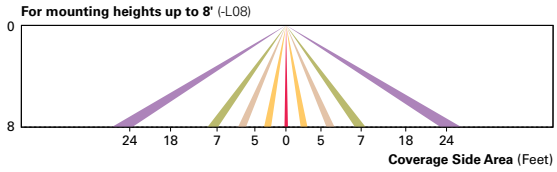
Lumen Multiplier

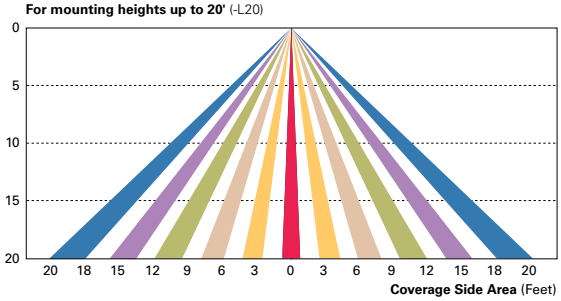
Ambient Temperature	Multiplier
0°C	1.03
10C	1.02
25°C	1.00
40°C	0.98
50°C	0.97

Control Options

0-10V (D) 0-10V dimming comes standard on all TopTier configurations for use with integrated or external lighting controls.

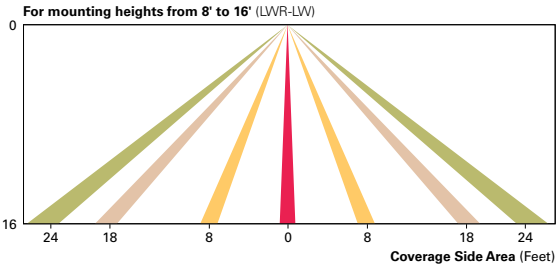
Dimming Occupancy Sensor (MS/DIM) These sensors are factory installed in the luminaire, dimming to 50% after five minutes of no motion detected. When motion is detected, the luminaire output is 100%. Includes an integral photocell that can be programmed for "dusk-to-dawn" operation. The FSIR-100 programming tool can be utilized to adjust dimming level, time delay, sensitivity and other parameters. Two lens options provide optimal coverage patterns up to 20' mounting height.

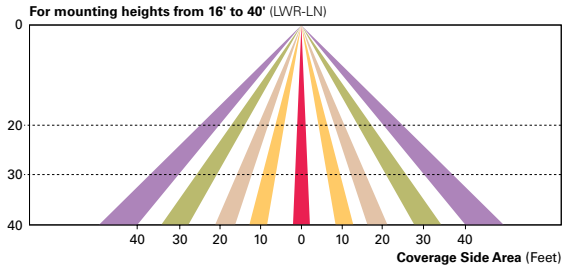




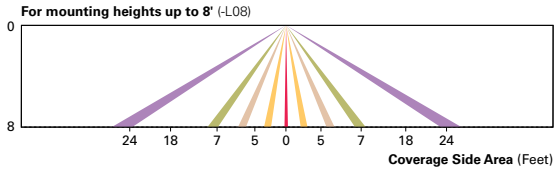
WaveLinx-Ready 4-PIN Twistlock Receptacle (ZW) Includes the WaveLinx control module, integrated 4-Pin receptacle, and standard 0-10V dimming driver, enabling the subsequent addition of a WaveLinx sensor.

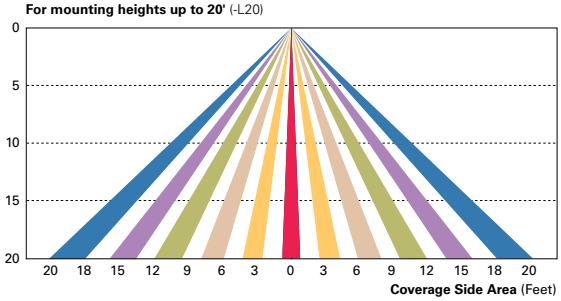
Enlighted Wireless Control and Monitoring System (LWR-LW and LWR-LN) The Enlighted control system is a connected lighting solution, combining LED luminaires with an integrated wireless sensor system. The sensor controls the lighting system in compliance with the latest energy codes while collecting valuable data about building performance and use. Software applications utilizing energy dashboards maximize data inputs to help optimize the use of other resources beyond lighting.





Synapse (DIM10) SimplySNAP integrated wireless controls system by Synapse. Includes factory installed DIM10 control module and MS/DC motion sensor; requires additional Synapse system components for operation. Contact Synapse at www.synapsewireless.com for product support, warranty, and terms and conditions.





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Specifications and dimensions
subject to change without notice.

gotham® | EVO®
Multiple Layers of Light

Luminaire Type: TYPE L1A
Catalog Number: STAIRWELL

PROVIDE SPECIFIED FIXTURE BY APPROVED MANUFACTURER OR ENGINEER-APPROVED EQUAL BY:
PORTFOLIO
PRESCOLITE
LIGHTOLIER

General Illumination Pendant Stem Cylinder 6"



OVERVIEW

Feature Set

- Batwing distribution with feathered edges provides even illumination on horizontal and vertical surfaces
- Bounding Ray™ optical design
- 45° cutoff to source and source image
- Fully serviceable lensed LED light engine
- 70% lumen maintenance at 60,000 hours
- 2.5 MacAdam Ellipse; 85 CRI typical, 90+ CRI optional
- Fixtures are damp location standard; Wet location (WL) optional, requires covered ceiling
- 20 standard colors in textured and gloss finish; custom or RAL colors also available
- Multiple recessed or surface j-box mounting configurations available
- Field cuttable 5/8" stems with concealed couplers.
- ENERGY STAR® Certified product
- UGR of zero for fixtures aimed at nadir with a cut-off equal to or less than 60deg per CIE 117-1995 Discomfort Glare in Interior Lighting. UGR FAQ

Distribution



Superior Perfomance

Nominal Lumens	250	500	750	1000	1500	2000	2500	3000	3500	4000	4500	5000	6000	8000
Delivered Lumens	297	519	776	994	1471	2006	2537	3077	3542	4027	4533	5256	6371	8247
Wattage	3.4	6.2	8.2	9.6	14.7	19.7	24.7	29.5	33.8	39.0	47.3	48.7	57.6	74.9
Lumens per Watt	87.4	83.7	94.6	103.5	100.1	101.8	102.7	104.3	104.8	103.3	95.8	107.9	110.6	110.1

COMPLEMENTARY PRODUCTS

Coordinated Apertures | Multiple Layers of Light



General Illumination Layer | EVO



High Center Beam Layer | Incito



EVO + Incito — Multiple Layers of Light

Core



Healthcare



Special Applications



GOTHAM ARCHITECTURAL DOWNLIGHTING | 1400 Lester Road Conyers, GA 30012 | P 800-705-SERV (7378) | gothamlighting.com
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The product images shown are for illustration purposes only and may not be an exact representation of the product.

gotham® | EVO®

6" General Illumination Pendant Stem Cylinder

ORDERING INFORMATION

A+ Capable options indicated by this color background.

Luminaire Type:

Catalog Number:

EXAMPLE: EVO6PC 35/15 AR MWD LSS MVOLT EZ1 JBXCC PCAN S12 DWHG

Series		Color Temperature		Lumens		Reflector Color		Reflector Finish		Distribution		Voltage	
EVO6PC	EVO 6in Pendent Stem Round Cylinder Open Downlight	**27/**	2700 K	**02**	250 lumens	**AR**	Clear	**LSS**	Semi-specular	**VND**	Very narrow (0.5 s/mh)	**MVOLT**	120V - 277V
		30/	3000 K	**05**	500 lumens	**PR**	Pewter	**LD**	Matte diffuse	**ND**	Narrow (0.7 s/mh)	**120**	120V
		35/	3500 K	**07**	750 lumens	**WTR**	Wheat	**LS**	Specular	**MD**	Medium (0.9 s/mh)	**277**	277V
		40/	4000 K	**10**	1000 lumens	**GR**	Gold			**MWD**	Medium wide (1.0 s/mh)	**347**[2]	347V
		50/	5000 K	**15**	1500 lumens	**WR**[1]	White painted			**WD**	Wide (1.2 s/mh)		
				20	2000 lumens	**BR**[1]	Black						
				25	2500 lumens	**WRAMF**[1]	White Anti-microbial						
				30	3000 lumens	**BZR**[1]	Dark Bronze painted						
				35	3500 lumens	**TRALTBD**[1]	Trim RAL # TBD (TBD for pricing only)						
				40	4000 lumens	**TCPC**[1]	Trim Custom Paint Color TBD (TBD for pricing only)						
				45	4500 lumens								
				50	5000 lumens								
				60	6000 lumens								
				80	8000 lumens								

Driver[3]		Mounting		Canopy Type		Stem Length[10]	
GZ10	0-10V driver dims to 10%	**JBX**	Integral driver, Recessed or Surface J-box	**PCAN**	5° Stem canopy with "hang straight" swivel	**S2**	2 foot 5/8" stem
GZ1	0-10V driver dims to 1%	**JBXCC**	Integral driver, Surface J-box with Conduit Covers	**PCAN45**[9]	45° Stem canopy with "hang straight" swivel	**S4**	4 foot 5/8" stem
EZ10	eldoLED 0-10V ECOdrive. Linear dimming to 10% min.	**SGB**[7]	Surface gear box. Recessed or surface J-box			**S6**	6 foot 5/8" stem
EZ1	eldoLED 0-10V ECOdrive. Linear dimming to 1% min.	**SGBCC**[7]	Surface gear box (for driver at ceiling), surface J-box with Conduit Covers.			**S8**	8 foot 5/8" stem
EZB	eldoLED 0-10V SOLOdrive. Logarithmic dimming to <1%.	**RGH**[8]	Recessed Gear Housing			**S10**	10 foot 5/8" stem
EDAB[4]	eldoLED SOLOdrive DALI. Logarithmic dimming to <1%.					**S12**	12 foot 5/8" stem
EDXB[4,5,6]	eldoLED POWERdrive DMX with RDM (remote device management). Square Law dimming to <1%. Min: 1000LM; Max: 8000LM. Not available with Emergency Options.					**S16**	16 foot 5/8" stem
ECOD[4]	Lutron® EcoSystem® digital Hi-Lume 1% soft-on, fade to black. Max: 8000LM except 4500LM.					**S20**	20 foot 5/8" stem
ELV[4]	Electronic line voltage / Forward phase / Triac dimming, 120V Only.						

Field verify existing mounting height and provide length to match.

Emergency Option		Control Interface[11]		Options		Architectural Colors - Powder Paint[17]			
(blank)	No emergency options	**(blank)**	No controls	**SF**	Single fuse. Specify 120V or 277V.	**DDB**	Gloss Dark Bronze	**DDBT**	Textured Dark Bronze
E6W	6W integral Constant Power, CA Title 20 compliant emergency battery pack with integral test switch. Only available with GZ10, GZ1 and ELV Drivers. Only for use with 500-4500 lumen options.	**NLT**	nLight® dimming pack. Specify 120V or 277V.	**90CRI**	High CRI (90+)	**DBL**	Matte Black	**DBLB**	Textured Black
		NLTER[12]	nLight® dimming pack for fixtures on emergency circuit. Specify 120V or 277V.	**N80**[13]	nLight Lumen Compensation	**DWH**	Gloss White	**DWHG**	Textured White
E7WCP	IOTA® 7W emergency battery (sidecar). Only for use with 750-8000 lumen options.	**NLTAIR2**	nLight® AIR dimming pack. Specify 120V or 277V.	**HAO**[14]	HAO High Ambient Option (40°C)	**DMB**	Matte Medium Bronze	**DBNH**	Textured Bronze
		NLTAIRER2[12]	nLight® AIR dimming pack for fixtures on emergency circuit. Specify 120V or 277V.	**WL**[15]	Wet Location	**DNA**	Gloss Natural Aluminum	**DNAT**	Textured Natural Aluminum
E10WCP	IOTA® 10W Constant Power, CA Title 20 compliant emergency battery pack with integral test switch. Only for use with 1000-8000 lumen options. (sidecar or RGH)			**CP**[16]	Chicago Plenum. Specify 120V or 277V (requires RGH)	**DSS**	Gloss Sandstone	**DSST**	Textured Sandstone
						DGC	Gloss Charcoal Grey	**DSPD**	Textured Dark Grey
E10WCPR	IOTA® 10W Constant Power, CA Title 20 compliant emergency battery pack with remote test switch (requires RGH)					**DTG**	Gloss Tennis Green	**DSPE**	Textured Green
						DBR	Gloss Bright Red	**DSPH**	Textured Light Red
E15WCP	IOTA® 15W emergency battery. Only for use with 1500-8000 lumen options. (sidecar)					**DSB**	Gloss Steel Blue	**DWHAMF**	Gloss White with Anti-microbial finish
								RALTBD	Cylinder RAL # TBD (TBD for pricing only)
GTD	IOTA® Generator Transfer Device. Specify 120V or 277V (requires RGH)							**CPC**	Cylinder Custom Paint Color TBD (TBD for pricing only)

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6" **General Illumination Pendant Stem Cylinder**

ORDERING INFORMATION

ACCESSORIES — order as separate catalog numbers (shipped separately)

GCOLORS KIT	Architectural colors chip kit, consisting of powder-coat and plated finishes
CYLJBOXADPT 4SQ2OCT __	4in Square J-box to 4in Octagonal J-box adaptor. Replace __ with Architectural Color or PRM for primed ready for field painting
CYLSTBL KIT	Stabilization Kit for securing pendant stem fixtures

ORDERING NOTES

1. Not Available with Finishes.
2. Integral 347V drivers available with GZ10 and GZ1 driver options only - 3000LM max. All other drivers (and GZ1 & GZ10 above 3000LM) will come with a step-down transformer - factory installed with RGH mounting, and field installed with JBX and JBXCC mounting (remote mount location and access to device required). Not available with Emergency Options.
3. Refer to Tech 240 for compatible dimmers.
4. Not Available with Control Interfaces.
5. Requires SGB or SGBCC mounting option.
6. Includes terminator resistor.
7. Only available with DMX driver (EDXB).
8. Not available with E6W, E7W or E15WCP Emergency Options.
9. Not available with SGB or SGBCC: those mountings require a flat ceiling.
10. Stem section adjacent to cylinder can be cut in field to achieve non-uniform lengths (i.e. for a field cut 3' length, order 4' stem).
11. Factory installed with RGH option otherwise field installed. Access required to location of remote mounted device.
12. ER for use as UL924 Emergency Operation via power sense lead. Will require an emergency hot feed and normal hot feed. EM for use as UL924 Emergency Operation
13. Fixture begins at 80% light level. Must be specified with NLT or NLTER. Only available with EZ10 and EZ1Ýrivers.
14. Only available up to 3500 lumens. Not available with ECOS2 or WL or sidecar Emergency Options.
15. Not available with JBXCC, SGB, or SGBCC. Max: 3500LM.
16. CP not valid with NLTAIR2, NLTAIRER2 or Emergency Options.
17. For details on RAL and Custom colors please see Architectural colors.

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6" **General Illumination Pendant Stem Cylinder**

SPECIFICATIONS

Optical Assembly
Fully serviceable and upgradeable lensed LED light engine suitable for field maintenance or service from below the ceiling.

Optical design is a Bounding Ray™ design with 45° cutoff to source and source image. Top down flash characteristic for superior glare control.

Electrical
The luminaire shall operate from a 50 or 60 Hz ±3 Hz AC line over a voltage ranging from 120 VAC to 277 VAC. Support 347V via remote-mounted stepdown transformer. The fluctuations of line voltage shall have no visible effect on the luminous output.

The luminaire shall have a power factor of 90% or greater at all standard operating voltages and full luminaire output.

Sound Rated A+. Driver shall be >80% efficient at full load across all input voltages.

Input wires shall be 18AWG, 300V minimum solid copper.

Controls
Luminaire shall be equipped with interface for nLight wired or nLight AIR networks with integral power supply as per specification.

Emergency
Luminaires supplied with a battery pack comply with NFPA 101 (Life Safety code) and deliver constant light output throughout the 90 minutes of code required emergency operation period when there is a normal AC power loss.

Luminaires equipped with a generator transfer device work in conjunction with an auxiliary generator or a central inverter system to power fixtures for safe egress lighting.

Dimming
The luminaire shall be capable of continuous dimming without perceivable stroboscopic flicker as measured by flicker index (ANSI/IES RP-16-10) over a range of 100 – 10%, 100 – 1.0% or 100 – 0.1% of rated lumen output with a smooth shut off function to step to 0%.

eldoLED LED drivers shall conform to IEEE P1789 standards. Alternatively, manufacturers must demonstrate conformance with product literature and testing which demonstrates this performance. Systems that do not meet IEEE P1789 will not be considered.

Driver is inaudible in 24dB environment, and stable when input voltage conditions fluctuate over what is typically experienced in a commercial environment.

Construction
Heaving-gauge aluminum construction. Extruded cylinder body with flangeless reflector allows flow-through passive thermal management. Canopy matches cylinder in finish and diameter.

Pendant stem mount for installation to 4" recessed or surface octagonal junction box with integral driver.

Recessed gear box available for driver above ceiling, nLight, CP, GTD or battery pack options.

Surface gear box available for driver at ceiling installation.

Optional field configurable conduit covers available. Conduit covers match cylinder in finish and diameter.

WARNING: All pendant fixtures exposed to wind require tethering – see page 6.

Listings
Fixtures are CSA Certified to meet US and Canadian Standards: All fixtures manufactured in strict accordance with the appropriate and current requirements of the "Standards for Safety" to UL, damp location standard; wet location (WL) optional, requires covered ceiling.

Luminaire configurations are Energy Star certified through testing in EPA–recognized laboratories, with the results reviewed by an independent, accredited certification organization. Visit www.energystar.gov for specific configurations listed.

Photometrics
LEDs tested to LM-80 standards. Measured by IESNA Standard LM-79-08 in an accredited lab. Lumen output shall not decrease by more than 30% over the minimum operational life of 60,000 hours.

Color appearance from luminaire to luminaire of the same type and in all configurations, shall be consistent both initially and at 60,000 hours and operate within a tolerance of <2.5 MacAdam ellipse as defined by the center of the quadrangles defined in ANSI C78.377-2015.

BUY AMERICAN ACT
This product is assembled in the USA and meets the Buy America(n) government procurement requirements under FAR, DFARS and DOT regulations. Please refer to www.acuitybrands.com/buy-american for additional information.

Warranty
5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

Note:
Actual performance may differ as a result of end user environment and application.
All values are design or typical values, measured under laboratory conditions at 25 °C.

A+ Capable Luminaire
This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is part of an A+ Certified solution for nLight® control networks when ordered with drivers marked by a shaded background*
- This luminaire is part of an A+ Certified solution for nLight® control networks, providing advanced control functionality at the luminaire level, when selection includes driver and control options marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

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6" **General Illumination Pendant Stem Cylinder**

EVO - eldoLED Driver Default Dimming Curve			
Nomenclature	Min Dimming	Driver Dim Curve	Control Dim Curve
EZ10	10%	Linear	Linear/Logarithmic
EZ1	1%	Linear	Linear/Logarithmic
EZB	<1%	Logarithmic	Linear
EDAB	<1%	Logarithmic*	Linear
EDXB	<1%	Square	Linear

*Changable thorugh DALI controller

Driver		Control Provided (note: 347V/UVOLT versions provided with 347 option selected)			
Nomenclature	Description	NLT	NLTER	NLTAIR2	NLTAIRER2
GZ10	0-10V driver dims to 10%	nPP16 D EFP	nPP16 D ER EFP	RPP20 D 24V G2	RPP20 D 24V ER G2
GZ1	0-10V driver dims to 1%	nPP16 D EFP	nPP16 D ER EFP	RPP20 D 24V G2	RPP20 D 24V ER G2
EZ10	eldoLED 0-10V ECOdrive	nPS 80 EZ	nPS 80 EZ ER	RPP20 D 24V G2	RPP20 D 24V ER G2
EZ1	eldoLED 0-10V ECOdrive	nPS 80 EZ	nPS 80 EZ ER	RPP20 D 24V G2	RPP20 D 24V ER G2
EZB	eldoLED 0-10V SOLOdrive	nPS 80 EZ	nPS 80 EZ ER	RPP20 D 24V G2	RPP20 D 24V ER G2

J-box Compatibility Matrix		Cylinder Configurations					
		JBX	SGB	SGBCC	SGB w/EDXB Driver	SGBCC w/EDXB Driver	JBXCC
Recommended J-box (by others)	4" Octagonal 4x4x1.5 deep"	✓	✓	✓	✓	✓	✓
	4" Octagonal 4x4x2.125 deep	✓	✓	×	✓	×	×
	4" Square 4x4x1.5 deep	✓ *with adaptor plate accessory	✓ *with adaptor plate accessory	×	✓ *with adaptor plate accessory	×	×

Standard Architectural Color Options for Cylinder Bodies

DSS P12 **LITHONIA** Sandstone

DSST P90 **TEXTURED** Sandstone

DBR P34 **LITHONIA** Bright Red

DSPH P80 **TEXTURED** Light Red

DMB P11 **LITHONIA** Medium Bronze

DBNH P74 **TEXTURED** Bronze

DTG P33 **LITHONIA** Tennis Green

DSPE P78 **TEXTURED** Green

DSB P49 **LITHONIA** Steel Blue

DNA P07 **LITHONIA** Natural Aluminum

DNAT P89 **TEXTURED** Natural Aluminum

DGC P32 **LITHONIA** Charcoal Gray

DSPD P77 **TEXTURED** Dark Grey

DDB P50 **LITHONIA** Dark Bronze

DDBT P88 **TEXTURED** Dark Bronze

DBL P13 **LITHONIA** Black

DBLB P75 **TEXTURED** Black

DWH P21 **LITHONIA** White

DWHG P86 **TEXTURED** White

NOTE: These colors were carefully reproduced to give as true a depiction as possible of finished product color. Some colors, however, may vary slightly from actual appearance due to display/printing variations and limitations. Please order the GCOLORS KIT listed in the 'Accessories' section of the spec sheet for an accurate paint chip sample.

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6" **General Illumination Pendant Stem Cylinder**

SPECIFICATIONS

Stabilization Kit (CYLSTBL KIT) Accessory

The Stabilization Kit offers additional support for applications where wind may be a factor and the pendant stem cylinder needs to be secured.

Cables

Three (3) 20 ft. 304 grade stainless steel aircraft cables with outer diameters of 1/16" are attached to anchoring mechanisms in the mounting surface at one end and the provided stem collar around the pendant stem at the other end.

Cables should be anchored 120° +/- 10° from each other radially and positioned at 45° or greater from the stem for optimal support of the fixture.

Clamps and Stem Collars

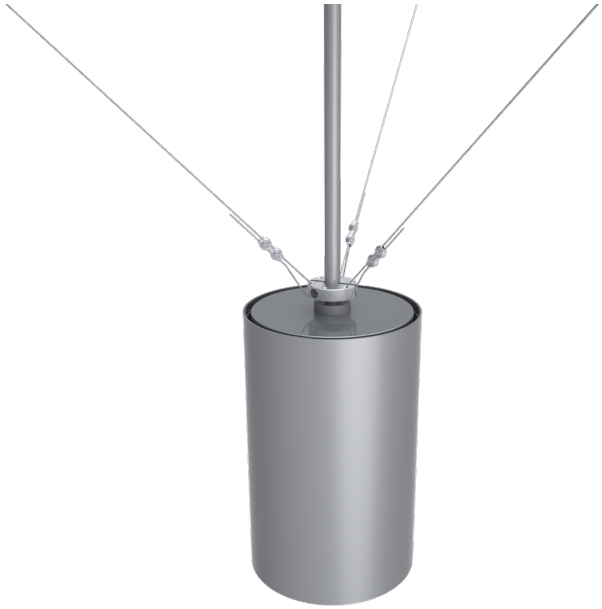
The stem collar consists of two (2) half stem collars made of 304 stainless steel. Both stem collar halves are attached around the pendant stem with 304 stainless steel socket head cap screws.

Six (6) cable clamps made of 304 stainless steel are used in the stabilization kit with two (2) clamps per cable attached to each anchoring point and the stem collar.

The cable tension can be adjusted from either end.

Wind Load

The Stabilization Kit is designed to withstand 90mph winds for 3 seconds comparable to ASCE 7-10, MRI 50-year (fixture EPA is 0.3 sq ft)



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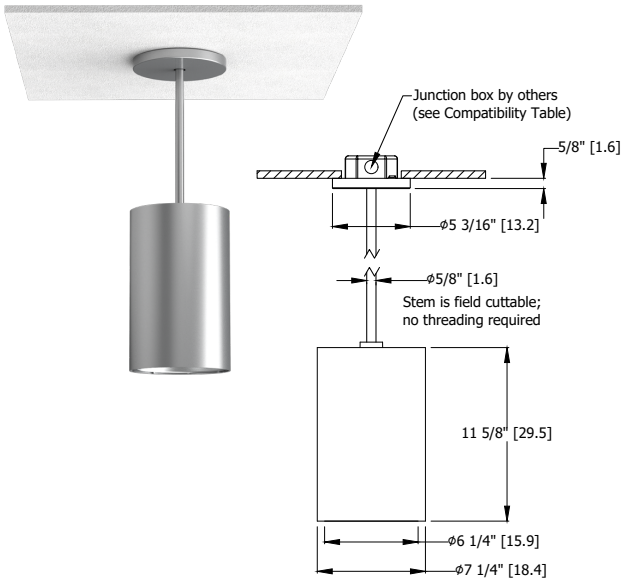
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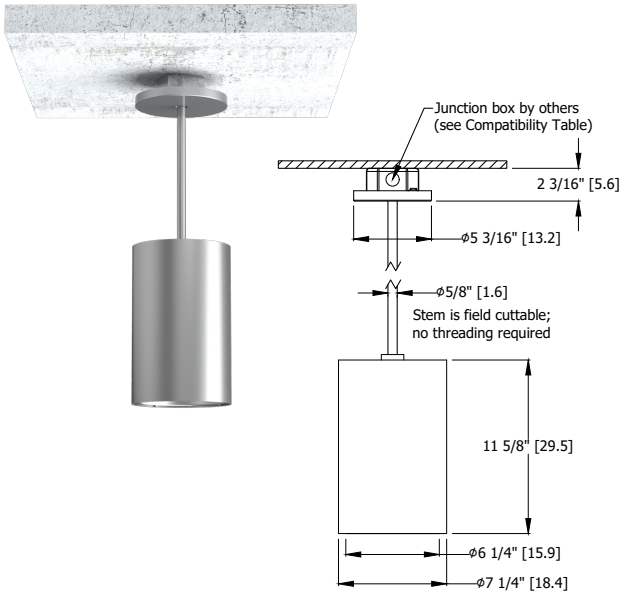
6" **General Illumination Pendant Stem Cylinder**

DIMENSIONAL DATA

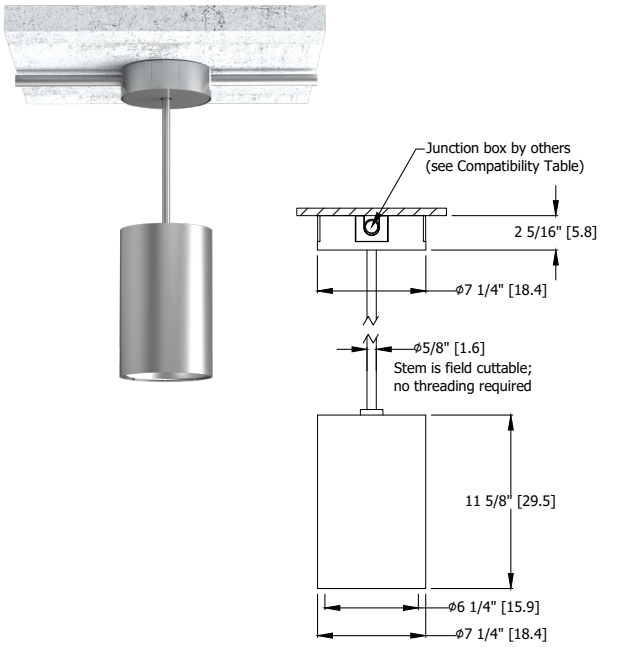
JBX Recessed J-Box



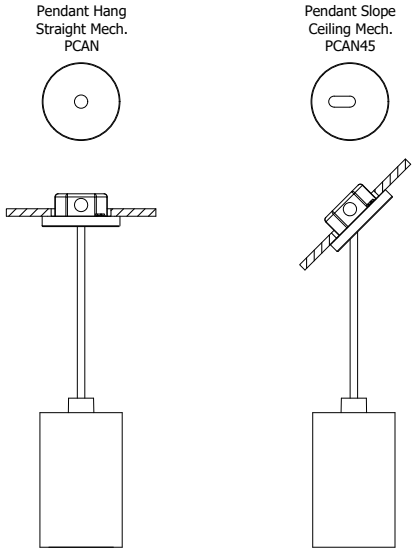
JBX Surface J-Box



JBXCC Surface J-Box with Conduit Covers



Stem_PCAN vs PCAN45



*Dimensions in inches [centimeters]

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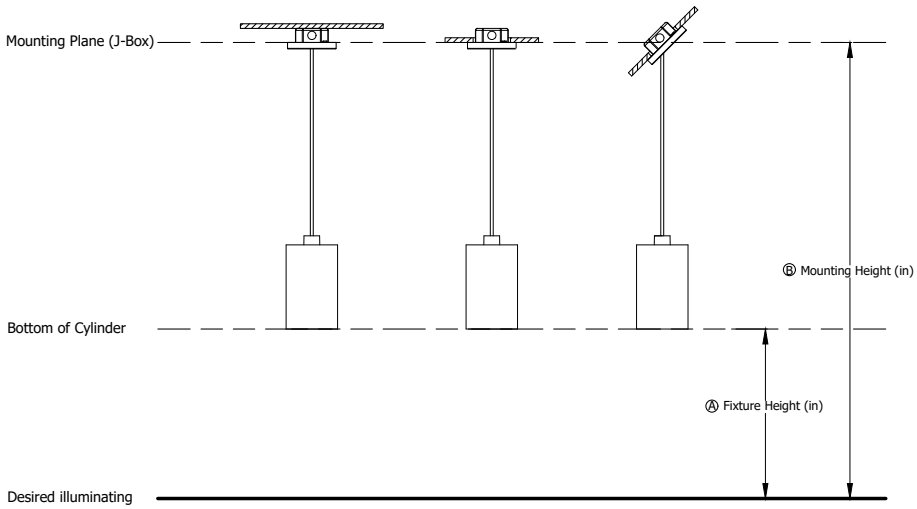
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6" **General Illumination Pendant Stem Cylinder**

DIMENSIONAL DATA

Stem Cutting Formulas for JBX



Cord Length=Ⓑ-Ⓐ- 6"

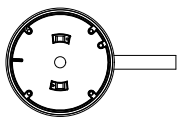
Conduit Feed Examples and Keys



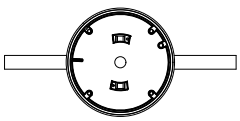
Conduit Key
(4) provided with each,
for use with 1/2" or 3/4" conduit



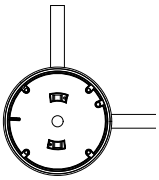
Blank Key
(4) provided with each



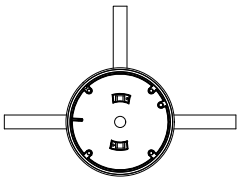
Single Conduit Feed



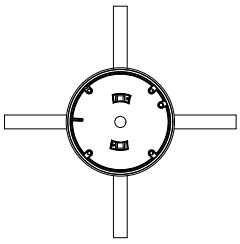
Double 180° conduit



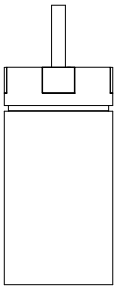
Double 90° conduit



Triple 0°, 90° & 180° conduit



Quad 0°, 90°, 180°, & 270° conduit



Top conduit feed

*Dimensions in inches [centimeters]

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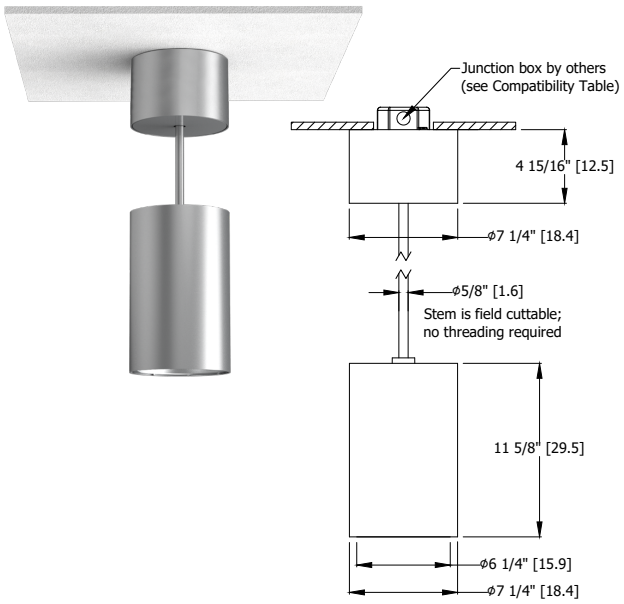
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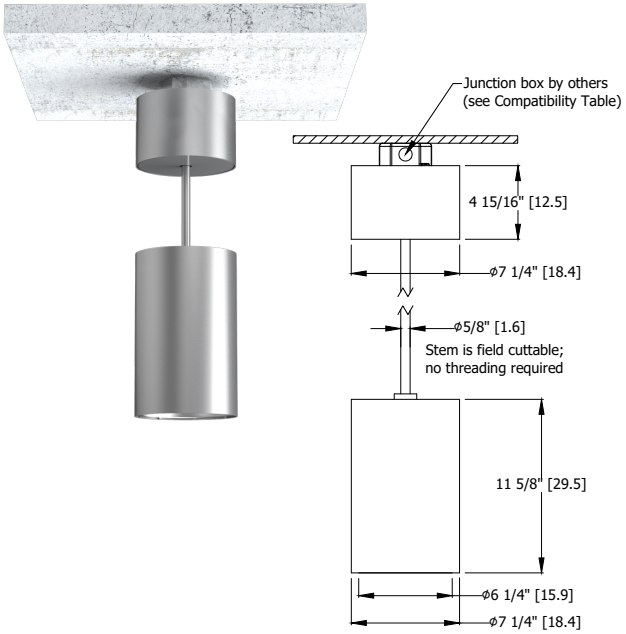
6" **General Illumination Pendant Stem Cylinder**

DIMENSIONAL DATA

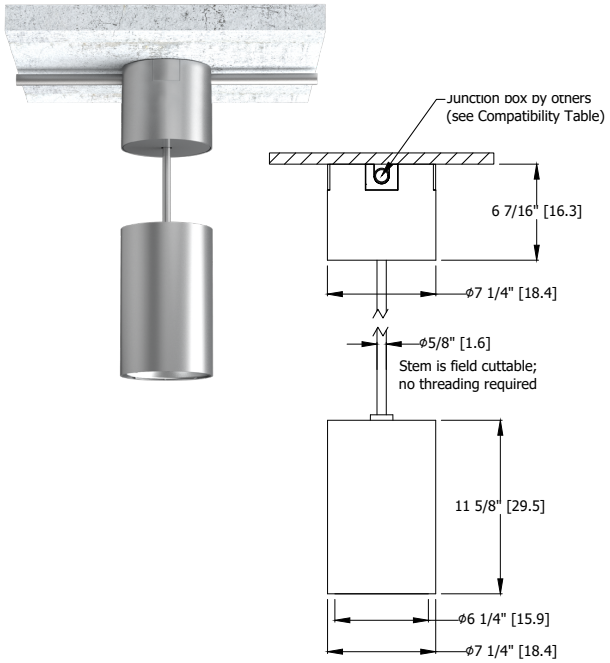
SGB Surface Gear Box for EDXB recessed J-box



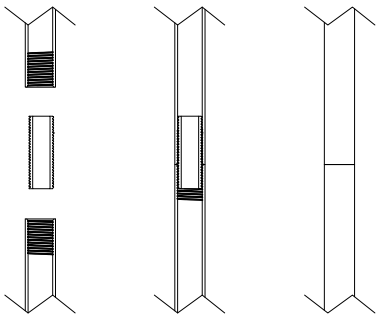
SGB Surface Gear Box for EDXB surface J-box



SGBCC Surface Gear Box for EDXB with Conduit Covers



Stem Connection Method



*Dimensions in inches [centimeters]

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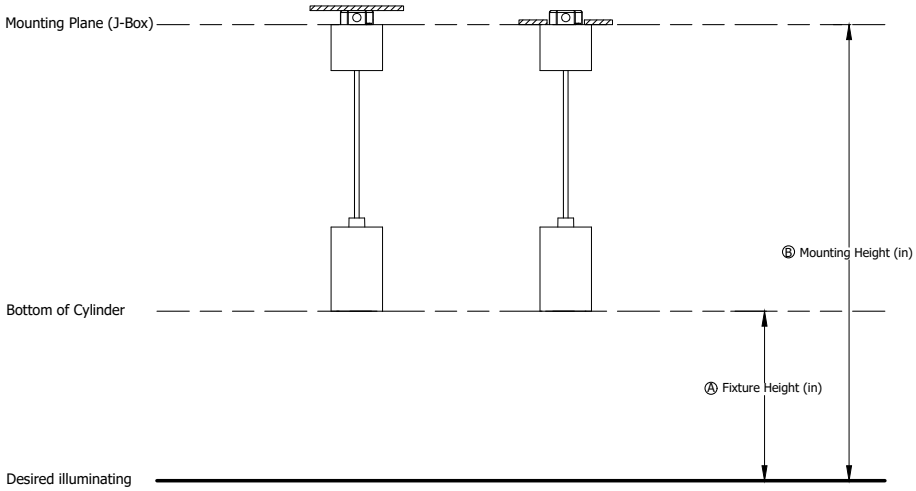
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6" **General Illumination Pendant Stem Cylinder**

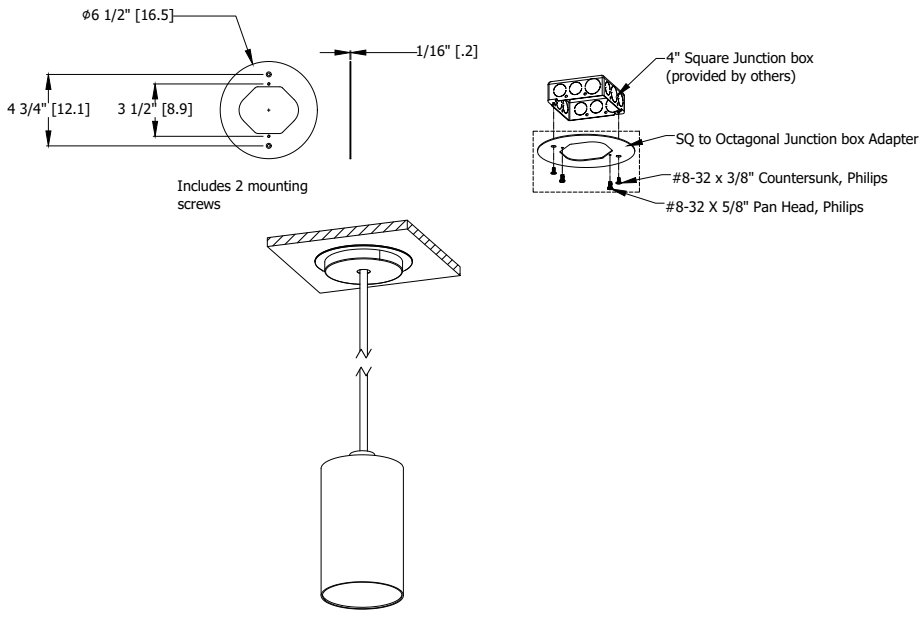
DIMENSIONAL DATA

Stem Cutting Formulas for SGB



Stem Length=Ⓑ-Ⓐ- 15"

Cylinder Adaptor Plate



*Dimensions in inches [centimeters]

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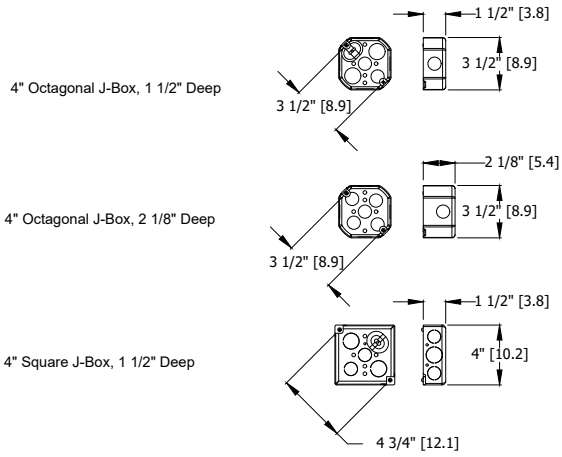
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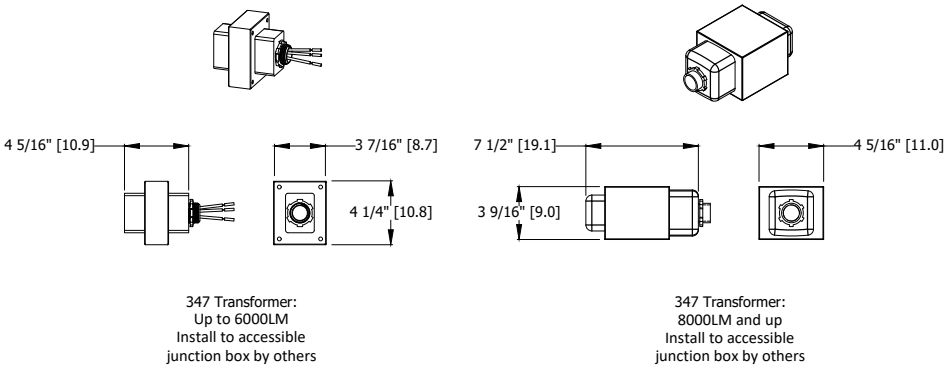
6" **General Illumination Pendant Stem Cylinder**

DIMENSIONAL DATA

Junction Box Dimensions (by others)



347V Stepdown Transformer



347 Transformer:
Up to 6000LM
Install to accessible
junction box by others

347 Transformer:
8000LM and up
Install to accessible
junction box by others

*Dimensions in inches [centimeters]

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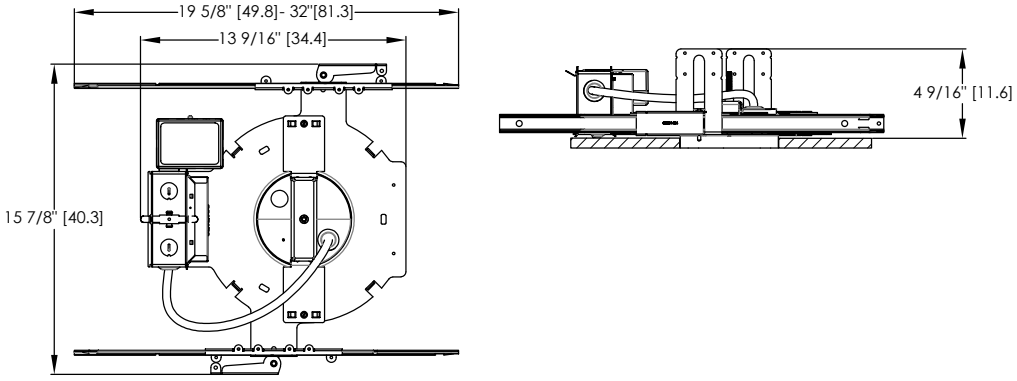
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6" **General Illumination Pendant Stem Cylinder**

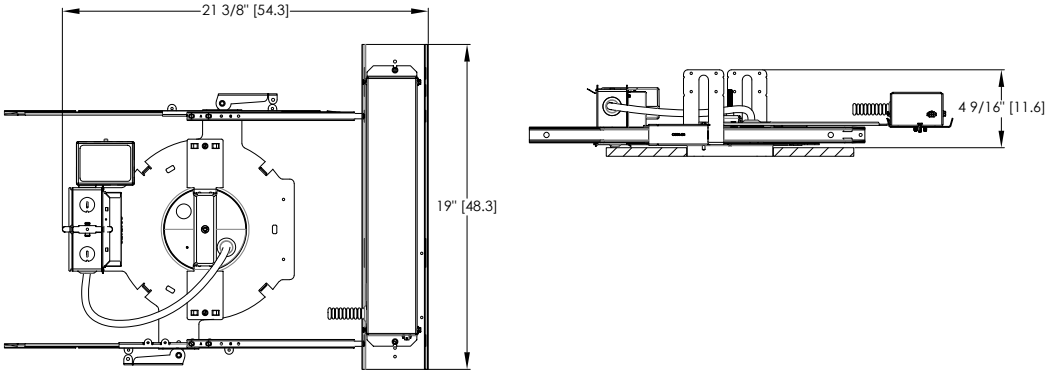
DIMENSIONAL DATA

RGH 2500LM-5000LM and with EDXB up to 4500LM & ECOD up to 4000LM Standard



Ceiling thickness range: 1/2"[1.3] to 3"[7.6]
Ceiling cutout: 5 1/16"[12.9]

RGH with Battery Backup (E10WCPR) 2500LM-5000LM and with EDXB up to 4500LM & ECOD up to 4000LM Standard



With Emergency Battery or GTD option

Minimum plenum height for emergency batteries in non-accessible ceilings: 12 1/2"[31.8]
Ceiling thickness range: 1/2"[1.3] to 3"[7.6]
Ceiling cutout: 5 1/16"[12.9]

*Dimensions in inches [centimeters]

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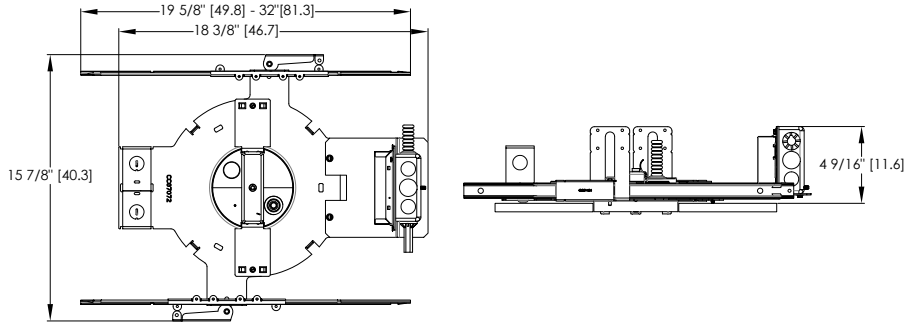
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6" General Illumination Pendant Stem Cylinder

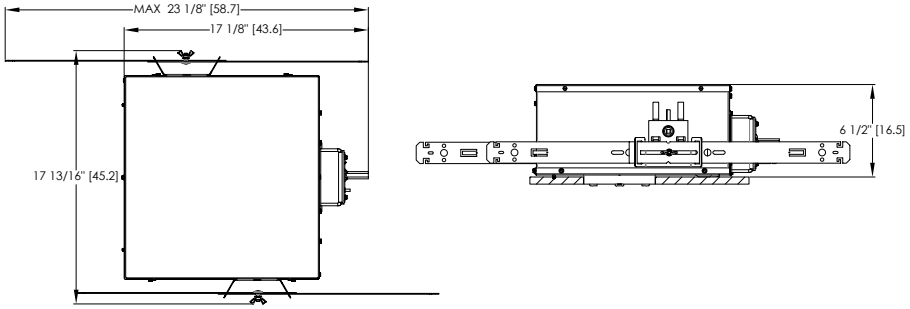
DIMENSIONAL DATA

RGH with CP 2500LM-5000LM and for use with EDXB up to 4500LM & ECOD up to 4000LM Standard



Ceiling thickness range: 1/2"[1.3] to 3"[7.6]
Ceiling cutout: 5 1/16"[12.9]

RGH with Chicago Plenum (CP) for use with nLight Enclosed



Ceiling thickness range: 1/2"[1.3] to 3"[7.6]
Ceiling cutout: 5 1/16"[12.9]

*Dimensions in inches [centimeters]

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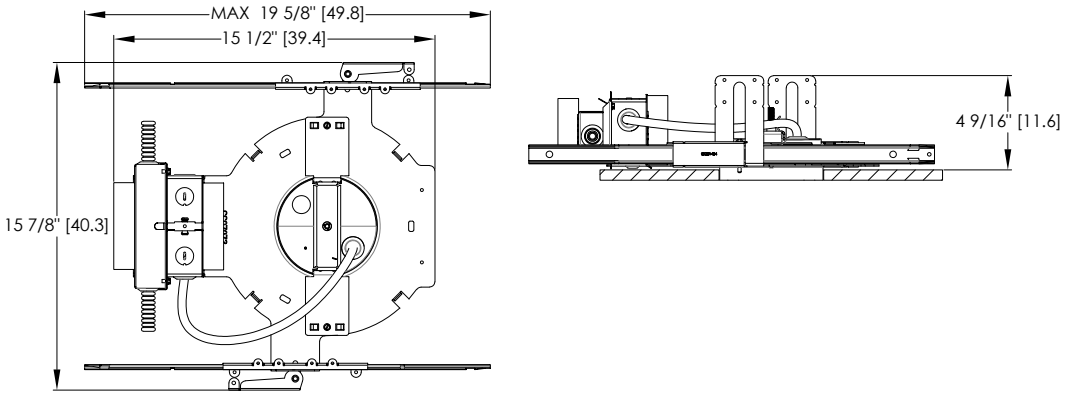
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6" **General Illumination Pendant Stem Cylinder**

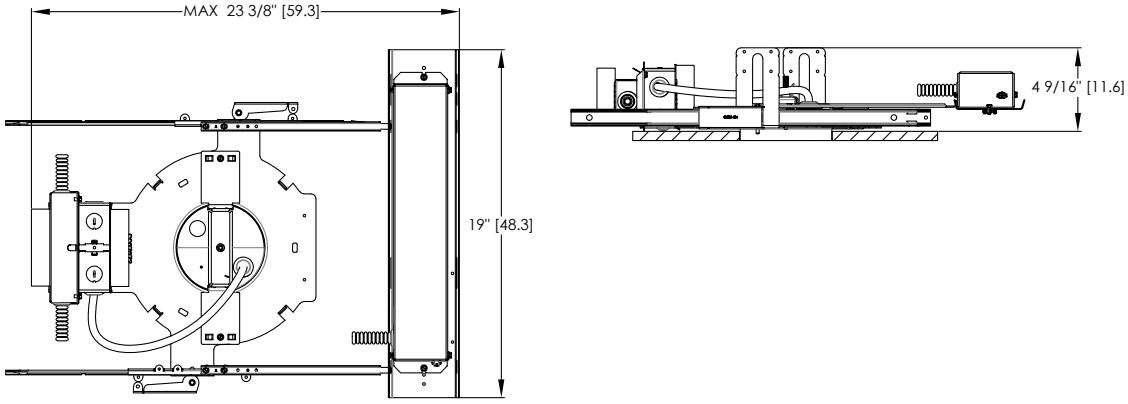
DIMENSIONAL DATA

RGH Double Driver 5000LM+ EDXB & EC0D, 6000LM & 8000LM Standard



Ceiling thickness range: 1/2"[1.3] to 3"[7.6]
Ceiling cutout: 5 1/16"[12.9]

RGH Double Driver with Battery Backup (E10WCPR) for use with 5000LM+ EDXB & EC0D, 6000LM & 8000LM Standard



With Emergency Battery or GTD option
Minimum plenum height for emergency batteries in non-accessible ceilings: 12 1/2"[31.8]
Ceiling thickness range: 1/2"[1.3] to 3"[7.6]
Ceiling cutout: 5 1/16"[12.9]

*Dimensions in inches [centimeters]

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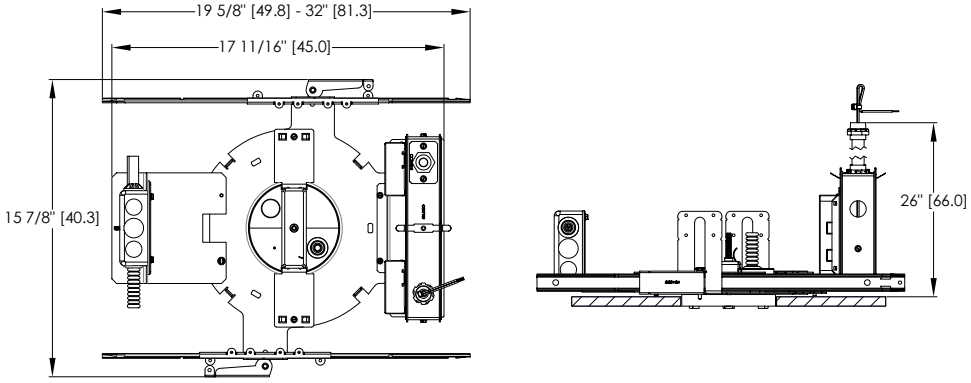
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6" **General Illumination Pendant Stem Cylinder**

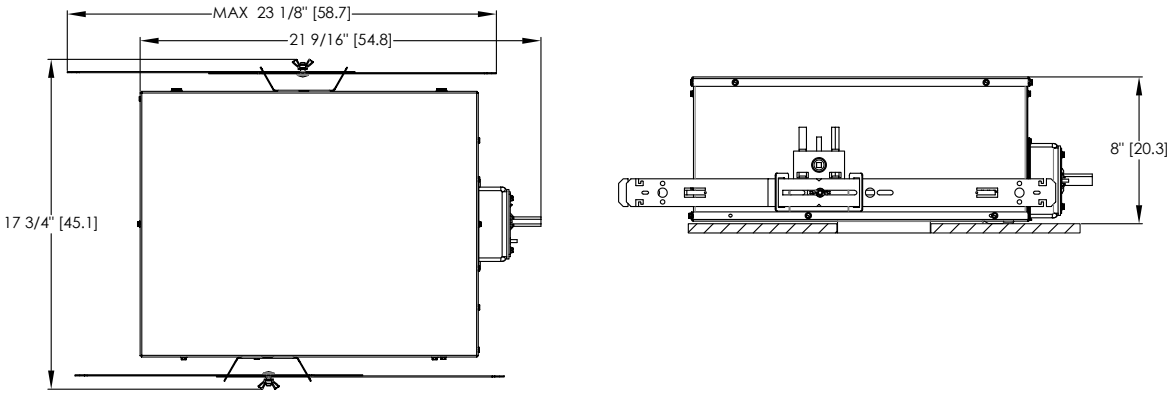
DIMENSIONAL DATA

RGH Double Driver CP Standard



Ceiling thickness range: 1/2"[1.3] to 3"[7.6]
Ceiling cutout: 5 1/16"[12.9]

RGH Double Driver with CP for use with 5000LM+ EDXB & ECOD, 6000LM & 8000LM Enclosed



Ceiling thickness range: 1/2"[1.3] to 3"[7.6]
Ceiling cutout: 5 1/16"[12.9]

*Dimensions in inches [centimeters]

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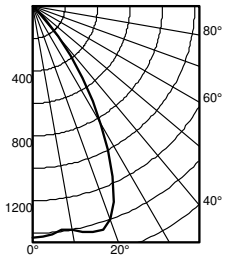
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6" **General Illumination Pendant Stem Cylinder**

Photometry

CONSULT WWW.GOTHAMLIGHTING.COM FOR ADDITIONAL PHOTOMETRY.

EV06PC 35/15 AR MWD LS INPUT WATTS: 14.7, DELIVERED LUMENS: 1471LM, LPW= 100, 1.03 S/MH, TEST NO. LTL27783P

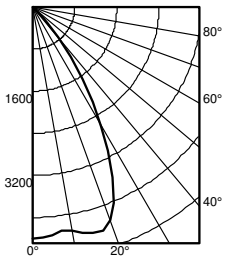


	Ave	Lumens
0	1431	
5	1410	134
15	1442	405
25	1161	523
35	540	332
45	78	72
55	3	4
65	1	1
75	0	1
85	0	0
90	0	

Zone	Lumens	% Lamp
0° - 30°	1061.4	72.2
0° - 40°	1393.5	94.7
0° - 60°	1469.5	99.9
0° - 90°	1470.9	100.0
90° - 180°	0.0	0.0
0° - 180°	1470.9	*100.0
	*Efficiency	

Mounting Height	Inital FC Center Beam	50% beam - 54.4° Diameter	50% beam - 54.4° FC	10% beam - 77.9° Diameter	10% beam - 77.9° FC
8.0	47.3	5.7	23.7	8.9	4.7
10.0	25.4	7.7	12.7	12.1	2.5
12.0	15.9	9.8	7.9	15.3	1.6
14.0	10.8	11.8	5.4	18.6	1.1
16.0	7.9	13.9	3.9	21.8	0.8

EV06PC 35/45 AR MWD LS INPUT WATTS: 47.3, DELIVERED LUMENS: 4532.7LM, LPW= 95.8, 1.03 S/MH, TEST NO. LTL27783P

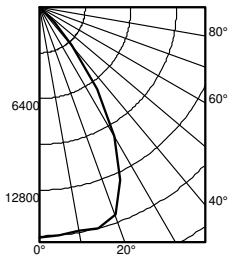


	Ave	Lumens
0	4411	
5	4346	413
15	4443	1247
25	3578	1610
35	1665	1024
45	242	222
55	8	12
65	2	3
75	1	2
85	0	0
90	0	

Zone	Lumens	% Lamp
0° - 30°	3270.7	72.2
0° - 40°	4294.2	94.7
0° - 60°	4528.3	99.9
0° - 90°	4532.7	100.0
90° - 180°	0.0	0.0
0° - 180°	4532.7	*100.0
	*Efficiency	

Mounting Height	Inital FC Center Beam	50% beam - 54.4° Diameter	50% beam - 54.4° FC	10% beam - 77.9° Diameter	10% beam - 77.9° FC
8.0	145.8	5.7	72.9	8.9	14.6
10.0	78.4	7.7	39.2	12.1	7.8
12.0	48.9	9.8	24.4	15.3	4.9
14.0	33.4	11.8	16.7	18.6	3.3
16.0	24.2	13.9	12.1	21.8	2.4

EV06PC 35/175 AR MWD LS INPUT WATTS: 175.3, DELIVERED LUMENS: 17801LM, LPW=101.5, 1.06 S/MH, TEST NO. ISF 34035P



	Ave	Lumens
0	16146	
5	15998	1521
15	16006	4479
25	13362	6001
35	7018	4289
45	1470	1299
55	100	156
65	37	38
75	13	14
85	2	2
90	0	

Zone	Lumens	% Lamp
0° - 30°	12002.3	67.4
0° - 40°	16291.0	91.5
0° - 60°	17746.3	99.7
0° - 90°	17801.0	100.0
90° - 120°	0.0	0.0
90° - 130°	0.0	0.0
90° - 150°	0.0	0.0
90° - 180°	0.0	0.0
0° - 180°	17801.0	*100.0
	*Efficiency	

Mounting Height	Inital FC Center Beam	50% beam - 55.7° Diameter	50% beam - 55.7° FC	10% beam - 79.8° Diameter	10% beam - 79.8° FC
8.0	533.7	5.8	266.9	9.2	53.4
10.0	287.0	7.9	143.5	12.5	28.7
12.0	178.9	10.0	89.4	15.9	17.9
14.0	122.1	12.1	61.0	19.2	12.2
16.0	88.6	14.3	44.3	22.6	8.9

Lumen Output Multiplier		
CRI	**CCT**	**Multplier**
80	2700K	0.916
	3000K	0.948
	3500K	1
	4000K	1.032
	5000K	1.1
90	2700K	0.748
	3000K	0.8
	3500K	0.838
	4000K	0.845
	5000K	0.945

Reflector Finish Multiplier	
Reflector Finish	**Multiplier**
LS - Specular	1
LSS - Semi Specular	0.956
WR - White	0.87
LD - Matte Diffuse	0.85
BR - Black	0.73
BZR - Bronze	0.73

Distributions		
Nomenclature	**Beam Angle**	**Field Angle**
VND	30	64
ND	44	69
MD	54	82
MWD	67	89
WD	71	92

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6" General Illumination Pendant Stem Cylinder

NLIGHT AIR

nLight® AIR is the ideal solution for retrofit or new construction spaces where adding communication wiring is cost prohibitive. The integrated nLight AIR rPP20 Power Pack is part of each EVO Luminaire ordered with the NLTAIR option. These individually addressable controls offer the ultimate in flexibility during initial setup and for space repurposing.

nLight® AIR Control Accessories
Order as separate catalog number. Visit nLight AIR.

Wall Switches	Model Number
On/Off single pole	rPODB (color) G2
On/Off two pole	rPODB 2P (color) G2
On/Off & raise/lower single pole	rPODB DX (color) G2
On/Off & raise/lower two pole	rPODB 2P DX (color) G2

nLight® AIR Control Accessories *(cont.)*

Occupancy Sensors (PIR/dual tech)	Model Number
Small motion 360°, ceiling	rCMS 9 / rCMS PDT 9
Large motion 360°, ceiling	rCMS 10 / rCMS PDT 10

UL924 Sequence of Operation

The below information applies to all nLight AIR devices with an EM option.

- EM devices will remain at their high-end trim and ignore wireless lighting control commands, unless a normal-power-sensed (NPS) broadcast is received at least every 8 seconds.
- Using the CLAIRITY+ mobile app, EM devices must be associated with a group that includes a normal power sensing device to receive NPS broadcasts.
- Only non-emergency rPP20, rLSXR, rSBOR, rSDGR, and nLight AIR luminaires with version 3.4 or later firmware can provide normal power sensing for EM devices. See specification sheets for control devices and luminaires for more information on options that support normal power sensing.

NLIGHT

nLight® Wired The nLight® solution is a digital networked lighting control system that provides both energy savings and increased user configurability by cost effectively integrating time-based, daylight-based, sensor-based and manual lighting control schemes.

nLight® Wired Control Accessories
Order as separate catalog number. Visit nLight.

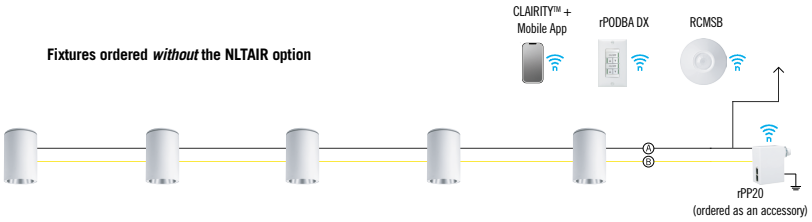
Wall Switches	Model Number
On/Off single pole	nPODM (color)
On/Off two pole	nPODM 2P (color)
On/Off & raise/lower single pole	nPOD DX (color)
On/Off & raise/lower two pole	nPODM 2P DX (color)
Graphic touchscreen	nPOD GFX (color)
Photocell Controls	
Dimming	nCM ADCX

nLight® Wired Control Accessories *(cont.)*

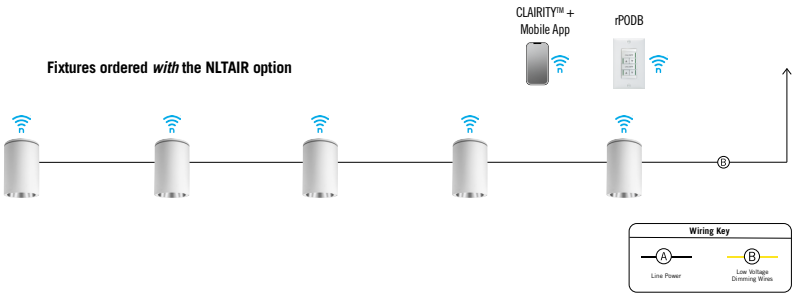
Occupancy Sensors (PIR/dual tech)	Model Number
Small motion 360°, ceiling	nCM 9 / nCM PDT 9
Large motion 360°, ceiling	nCM 10 / nCM PDT 10
Wide View	nWV 16 / nWV PDT 16
Wall switch with raise/lower	nWSX LV DX / nWSX PDT LV DX
Cat-5 Cables (plenum rated)	
10', CAT5	CAT5 10FT J1
15', CAT5	CAT5 15FT J1

Possibilites for nLight® AIR

Fixtures ordered *without* the NLTAIR option

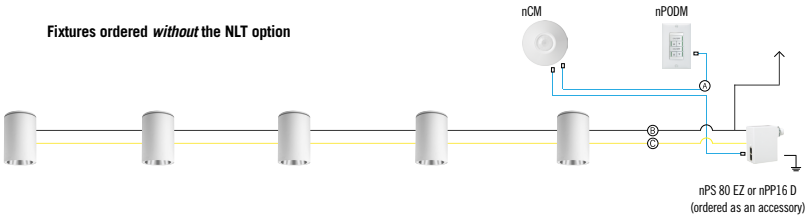


Fixtures ordered *with* the NLTAIR option

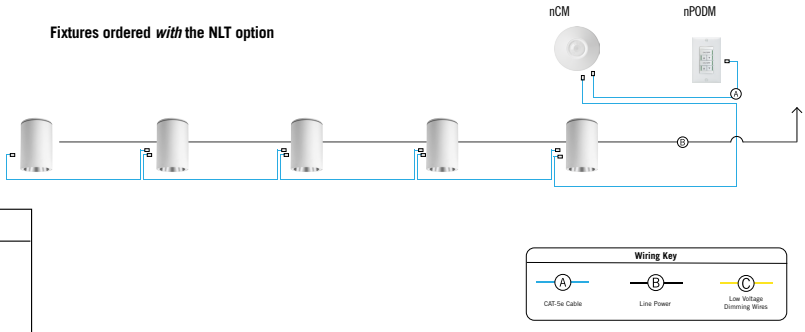


Possibilites for nLight® wired

Fixtures ordered *without* the NLT option



Fixtures ordered *with* the NLT option



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Multiple Layers of Light

Luminaire Type: TYPE L1B
Catalog Number: STAIRWELL

PROVIDE SPECIFIED FIXTURE BY APPROVED MANUFACTURER OR ENGINEER-APPROVED EQUAL BY:
PORTFOLIO
PRESCOLITE
LIGHTOLIER

General Illumination Pendant Stem Cylinder 6"



OVERVIEW

Feature Set

- Batwing distribution with feathered edges provides even illumination on horizontal and vertical surfaces
- Bounding Ray™ optical design
- 45° cutoff to source and source image
- Fully serviceable lensed LED light engine
- 70% lumen maintenance at 60,000 hours
- 2.5 MacAdam Ellipse; 85 CRI typical, 90+ CRI optional
- Fixtures are damp location standard; Wet location (WL) optional, requires covered ceiling
- 20 standard colors in textured and gloss finish; custom or RAL colors also available
- Multiple recessed or surface j-box mounting configurations available
- Field cuttable 5/8" stems with concealed couplers.
- ENERGY STAR® Certified product
- UGR of zero for fixtures aimed at nadir with a cut-off equal to or less than 60deg per CIE 117-1995 Discomfort Glare in Interior Lighting. UGR FAQ

Distribution



Superior Perfomance

Nominal Lumens	250	500	750	1000	1500	2000	2500	3000	3500	4000	4500	5000	6000	8000
Delivered Lumens	297	519	776	994	1471	2006	2537	3077	3542	4027	4533	5256	6371	8247
Wattage	3.4	6.2	8.2	9.6	14.7	19.7	24.7	29.5	33.8	39.0	47.3	48.7	57.6	74.9
Lumens per Watt	87.4	83.7	94.6	103.5	100.1	101.8	102.7	104.3	104.8	103.3	95.8	107.9	110.6	110.1

COMPLEMENTARY PRODUCTS

Coordinated Apertures | Multiple Layers of Light



General Illumination Layer | EVO



High Center Beam Layer | Incito



EVO + Incito — Multiple Layers of Light

Core



Healthcare



Special Applications



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6" General Illumination Pendant Stem Cylinder

ORDERING INFORMATION

A+ Capable options indicated by this color background.

Luminaire Type:

Catalog Number:

EXAMPLE: EVO6PC 35/15 AR MWD LSS MVOLT EZ1 JBXCC PCAN S12 DWHG

Series		Color Temperature		Lumens		Reflector Color		Reflector Finish		Distribution		Voltage	
EVO6PC	EVO 6in Pendent Stem Round Cylinder Open Downlight	27/	2700 K	02	250 lumens	AR	Clear	LSS	Semi-specular	VND	Very narrow (0.5 s/mh)	MVOLT	120V - 277V
		30/	3000 K	05	500 lumens	PR	Pewter	LD	Matte diffuse	ND	Narrow (0.7 s/mh)	120	120V
		35/	3500 K	07	750 lumens	WTR	Wheat	LS	Specular	MD	Medium (0.9 s/mh)	277	277V
		40/	4000 K	10	1000 lumens	GR	Gold			MWD	Medium wide (1.0 s/mh)	347[2]	347V
		50/	5000 K	15	1500 lumens	WR[1]	White painted			WD	Wide (1.2 s/mh)		
				20	2000 lumens	BR[1]	Black						
				25	2500 lumens	WRAMF[1]	White Anti-microbial						
				30	3000 lumens	BZR[1]	Dark Bronze painted						
				35	3500 lumens	TRALTBD[1]	Trim RAL # TBD (TBD for pricing only)						
				40	4000 lumens	TCPC[1]	Trim Custom Paint Color TBD (TBD for pricing only)						
				45	4500 lumens								
				50	5000 lumens								
				60	6000 lumens								
				80	8000 lumens								

Driver[3]		Mounting		Canopy Type		Stem Length[10]	
GZ10	0-10V driver dims to 10%	JBX	Integral driver, Recessed or Surface J-box	PCAN	5° Stem canopy with "hang straight" swivel	S2	2 foot 5/8" stem
GZ1	0-10V driver dims to 1%	JBXCC	Integral driver, Surface J-box with Conduit Covers	PCAN45[9]	45° Stem canopy with "hang straight" swivel	S4	4 foot 5/8" stem
EZ10	eldoLED 0-10V ECOdrive. Linear dimming to 10% min.	SGB[7]	Surface gear box. Recessed or surface J-box			S6	6 foot 5/8" stem
EZ1	eldoLED 0-10V ECOdrive. Linear dimming to 1% min.	SGBCC[7]	Surface gear box (for driver at ceiling), surface J-box with Conduit Covers.			S8	8 foot 5/8" stem
EZB	eldoLED 0-10V SOLOdrive. Logarithmic dimming to <1%.	RGH[8]	Recessed Gear Housing			S10	10 foot 5/8" stem
EDAB[4]	eldoLED SOLOdrive DALI. Logarithmic dimming to <1%.					S12	12 foot 5/8" stem
EDXB[4,5,6]	eldoLED POWERdrive DMX with RDM (remote device management). Square Law dimming to <1%. Min: 1000LM; Max: 8000LM. Not available with Emergency Options.					S16	16 foot 5/8" stem
ECOD[4]	Lutron® EcoSystem® digital Hi-Lume 1% soft-on, fade to black. Max: 8000LM except 4500LM.					S20	20 foot 5/8" stem
ELV[4]	Electronic line voltage / Forward phase / Triac dimming, 120V Only.						

Emergency Option		Control Interface[11]		Options		Architectural Colors - Powder Paint[17]			
(blank)	No emergency options	(blank)	No controls	SF	Single fuse. Specify 120V or 277V.	DDB	Gloss Dark Bronze	DDBT	Textured Dark Bronze
E6W	6W integral Constant Power, CA Title 20 compliant emergency battery pack with integral test switch. Only available with GZ10, GZ1 and ELV Drivers. Only for use with 500-4500 lumen options.	NLT	nLight® dimming pack. Specify 120V or 277V.	90CRI	High CRI (90+)	DBL	Matte Black	DBLB	Textured Black
		NLTER[12]	nLight® dimming pack for fixtures on emergency circuit. Specify 120V or 277V.	N80[13]	nLight Lumen Compensation	DWH	Gloss White	DWHG	Textured White
E7WCP	IOTA® 7W emergency battery (sidecar). Only for use with 750-8000 lumen options.	NLTAIR2	nLight® AIR dimming pack. Specify 120V or 277V.	HAO[14]	HAO High Ambient Option (40°C)	DMB	Matte Medium Bronze	DBNH	Textured Bronze
		NLTAIRER2[12]	nLight® AIR dimming pack for fixtures on emergency circuit. Specify 120V or 277V.	WL[15]	Wet Location	DNA	Gloss Natural Aluminum	DNAT	Textured Natural Aluminum
E10WCP	IOTA® 10W Constant Power, CA Title 20 compliant emergency battery pack with integral test switch. Only for use with 1000-8000 lumen options. (sidecar or RGH)			CP[16]	Chicago Plenum. Specify 120V or 277V (requires RGH)	DSS	Gloss Sandstone	DSST	Textured Sandstone
						DGC	Gloss Charcoal Grey	DSPD	Textured Dark Grey
E10WCPR	IOTA® 10W Constant Power, CA Title 20 compliant emergency battery pack with remote test switch (requires RGH)					DTG	Gloss Tennis Green	DSPE	Textured Green
						DBR	Gloss Bright Red	DSPH	Textured Light Red
E15WCP	IOTA® 15W emergency battery. Only for use with 1500-8000 lumen options. (sidecar)					DSB	Gloss Steel Blue	DWHAMF	Gloss White with Anti-microbial finish
GTD	IOTA® Generator Transfer Device. Specify 120V or 277V (requires RGH)							RALTBD	Cylinder RAL # TBD (TBD for pricing only)
								CPC	Cylinder Custom Paint Color TBD (TBD for pricing only)

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6" **General Illumination Pendant Stem Cylinder**

ORDERING INFORMATION

ACCESSORIES — order as separate catalog numbers (shipped separately)

GCOLORS KIT	Architectural colors chip kit, consisting of powder-coat and plated finishes
CYLJBOXADPT 4SQ2OCT __	4in Square J-box to 4in Octagonal J-box adaptor. Replace __ with Architectural Color or PRM for primed ready for field painting
CYLSTBL KIT	Stabilization Kit for securing pendant stem fixtures

ORDERING NOTES

1. Not Available with Finishes.
2. Integral 347V drivers available with GZ10 and GZ1 driver options only - 3000LM max. All other drivers (and GZ1 & GZ10 above 3000LM) will come with a step-down transformer - factory installed with RGH mounting, and field installed with JBX and JBXCC mounting (remote mount location and access to device required). Not available with Emergency Options.
3. Refer to Tech 240 for compatible dimmers.
4. Not Available with Control Interfaces.
5. Requires SGB or SGBCC mounting option.
6. Includes terminator resistor.
7. Only available with DMX driver (EDXB).
8. Not available with E6W, E7W or E15WCP Emergency Options.
9. Not available with SGB or SGBCC: those mountings require a flat ceiling.
10. Stem section adjacent to cylinder can be cut in field to achieve non-uniform lengths (i.e. for a field cut 3' length, order 4' stem).
11. Factory installed with RGH option otherwise field installed. Access required to location of remote mounted device.
12. ER for use as UL924 Emergency Operation via power sense lead. Will require an emergency hot feed and normal hot feed. EM for use as UL924 Emergency Operation
13. Fixture begins at 80% light level. Must be specified with NLT or NLTER. Only available with EZ10 and EZ1Ýrivers.
14. Only available up to 3500 lumens. Not available with ECOS2 or WL or sidecar Emergency Options.
15. Not available with JBXCC, SGB, or SGBCC. Max: 3500LM.
16. CP not valid with NLTAIR2, NLTAIRER2 or Emergency Options.
17. For details on RAL and Custom colors please see Architectural colors.

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6" **General Illumination Pendant Stem Cylinder**

SPECIFICATIONS

Optical Assembly
Fully serviceable and upgradeable lensed LED light engine suitable for field maintenance or service from below the ceiling.

Optical design is a Bounding Ray™ design with 45° cutoff to source and source image. Top down flash characteristic for superior glare control.

Electrical
The luminaire shall operate from a 50 or 60 Hz ±3 Hz AC line over a voltage ranging from 120 VAC to 277 VAC. Support 347V via remote-mounted stepdown transformer. The fluctuations of line voltage shall have no visible effect on the luminous output.

The luminaire shall have a power factor of 90% or greater at all standard operating voltages and full luminaire output.

Sound Rated A+. Driver shall be >80% efficient at full load across all input voltages.

Input wires shall be 18AWG, 300V minimum solid copper.

Controls
Luminaire shall be equipped with interface for nLight wired or nLight AIR networks with integral power supply as per specification.

Emergency
Luminaires supplied with a battery pack comply with NFPA 101 (Life Safety code) and deliver constant light output throughout the 90 minutes of code required emergency operation period when there is a normal AC power loss.

Luminaires equipped with a generator transfer device work in conjunction with an auxiliary generator or a central inverter system to power fixtures for safe egress lighting.

Dimming
The luminaire shall be capable of continuous dimming without perceivable stroboscopic flicker as measured by flicker index (ANSI/IES RP-16-10) over a range of 100 – 10%, 100 – 1.0% or 100 – 0.1% of rated lumen output with a smooth shut off function to step to 0%.

eldoLED LED drivers shall conform to IEEE P1789 standards. Alternatively, manufacturers must demonstrate conformance with product literature and testing which demonstrates this performance. Systems that do not meet IEEE P1789 will not be considered.

Driver is inaudible in 24dB environment, and stable when input voltage conditions fluctuate over what is typically experienced in a commercial environment.

Construction
Heaving-gauge aluminum construction. Extruded cylinder body with flangeless reflector allows flow-through passive thermal management. Canopy matches cylinder in finish and diameter.

Pendant stem mount for installation to 4" recessed or surface octagonal junction box with integral driver.

Recessed gear box available for driver above ceiling, nLight, CP, GTD or battery pack options.

Surface gear box available for driver at ceiling installation.

Optional field configurable conduit covers available. Conduit covers match cylinder in finish and diameter.

WARNING: All pendant fixtures exposed to wind require tethering – see page 6.

Listings
Fixtures are CSA Certified to meet US and Canadian Standards: All fixtures manufactured in strict accordance with the appropriate and current requirements of the "Standards for Safety" to UL, damp location standard; wet location (WL) optional, requires covered ceiling.

Luminaire configurations are Energy Star certified through testing in EPA–recognized laboratories, with the results reviewed by an independent, accredited certification organization. Visit www.energystar.gov for specific configurations listed.

Photometrics
LEDs tested to LM-80 standards. Measured by IESNA Standard LM-79-08 in an accredited lab. Lumen output shall not decrease by more than 30% over the minimum operational life of 60,000 hours.

Color appearance from luminaire to luminaire of the same type and in all configurations, shall be consistent both initially and at 60,000 hours and operate within a tolerance of <2.5 MacAdam ellipse as defined by the center of the quadrangles defined in ANSI C78.377-2015.

BUY AMERICAN ACT
This product is assembled in the USA and meets the Buy America(n) government procurement requirements under FAR, DFARS and DOT regulations. Please refer to www.acuitybrands.com/buy-american for additional information.

Warranty
5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

Note:
Actual performance may differ as a result of end user environment and application.
All values are design or typical values, measured under laboratory conditions at 25 °C.

A+ Capable Luminaire
This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is part of an A+ Certified solution for nLight® control networks when ordered with drivers marked by a shaded background*
- This luminaire is part of an A+ Certified solution for nLight® control networks, providing advanced control functionality at the luminaire level, when selection includes driver and control options marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

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6" **General Illumination Pendant Stem Cylinder**

EVO - eldoLED Driver Default Dimming Curve			
Nomenclature	Min Dimming	Driver Dim Curve	Control Dim Curve
EZ10	10%	Linear	Linear/Logarithmic
EZ1	1%	Linear	Linear/Logarithmic
EZB	<1%	Logarithmic	Linear
EDAB	<1%	Logarithmic*	Linear
EDXB	<1%	Square	Linear

*Changable thorugh DALI controller

Driver		Control Provided (note: 347V/UVOLT versions provided with 347 option selected)			
Nomenclature	Description	NLT	NLTER	NLTAIR2	NLTAIRER2
GZ10	0-10V driver dims to 10%	nPP16 D EFP	nPP16 D ER EFP	RPP20 D 24V G2	RPP20 D 24V ER G2
GZ1	0-10V driver dims to 1%	nPP16 D EFP	nPP16 D ER EFP	RPP20 D 24V G2	RPP20 D 24V ER G2
EZ10	eldoLED 0-10V ECOdrive	nPS 80 EZ	nPS 80 EZ ER	RPP20 D 24V G2	RPP20 D 24V ER G2
EZ1	eldoLED 0-10V ECOdrive	nPS 80 EZ	nPS 80 EZ ER	RPP20 D 24V G2	RPP20 D 24V ER G2
EZB	eldoLED 0-10V SOLOdrive	nPS 80 EZ	nPS 80 EZ ER	RPP20 D 24V G2	RPP20 D 24V ER G2

J-box Compatibility Matrix		Cylinder Configurations					
		JBX	SGB	SGBCC	SGB w/EDXB Driver	SGBCC w/EDXB Driver	JBXCC
Recommended J-box (by others)	4" Octagonal 4x4x1.5 deep"	✓	✓	✓	✓	✓	✓
	4" Octagonal 4x4x2.125 deep	✓	✓	×	✓	×	×
	4" Square 4x4x1.5 deep	✓ *with adaptor plate accessory	✓ *with adaptor plate accessory	×	✓ *with adaptor plate accessory	×	×

Standard Architectural Color Options for Cylinder Bodies

DSS P12 **LITHONIA** Sandstone

DSST P90 **TEXTURED** Sandstone

DBR P34 **LITHONIA** Bright Red

DSPH P80 **TEXTURED** Light Red

DMB P11 **LITHONIA** Medium Bronze

DBNH P74 **TEXTURED** Bronze

DTG P33 **LITHONIA** Tennis Green

DSPE P78 **TEXTURED** Green

DSB P49 **LITHONIA** Steel Blue

DNA P07 **LITHONIA** Natural Aluminum

DNAT P89 **TEXTURED** Natural Aluminum

DGC P32 **LITHONIA** Charcoal Gray

DSPD P77 **TEXTURED** Dark Grey

DDB P50 **LITHONIA** Dark Bronze

DDBT P88 **TEXTURED** Dark Bronze

DBL P13 **LITHONIA** Black

DBLB P75 **TEXTURED** Black

DWH P21 **LITHONIA** White

DWHG P86 **TEXTURED** White

NOTE: These colors were carefully reproduced to give as true a depiction as possible of finished product color. Some colors, however, may vary slightly from actual appearance due to display/printing variations and limitations. Please order the GCOLORS KIT listed in the 'Accessories' section of the spec sheet for an accurate paint chip sample.

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6" **General Illumination Pendant Stem Cylinder**

SPECIFICATIONS

Stabilization Kit (CYLSTBL KIT) Accessory

The Stabilization Kit offers additional support for applications where wind may be a factor and the pendant stem cylinder needs to be secured.

Cables

Three (3) 20 ft. 304 grade stainless steel aircraft cables with outer diameters of 1/16" are attached to anchoring mechanisms in the mounting surface at one end and the provided stem collar around the pendant stem at the other end.

Cables should be anchored 120° +/- 10° from each other radially and positioned at 45° or greater from the stem for optimal support of the fixture.

Clamps and Stem Collars

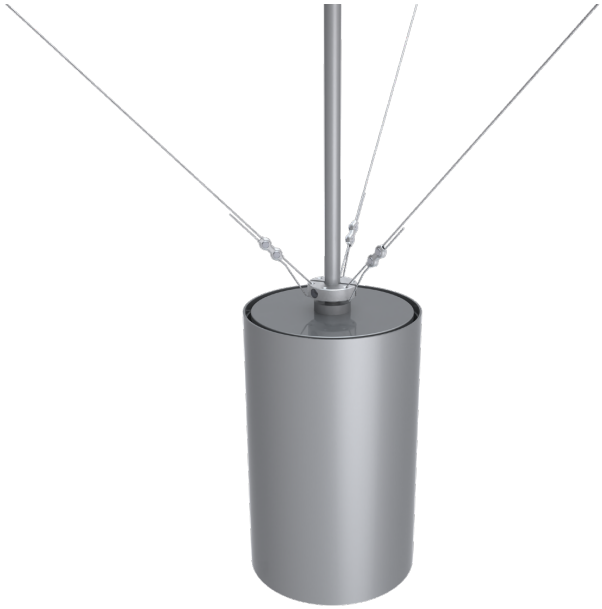
The stem collar consists of two (2) half stem collars made of 304 stainless steel. Both stem collar halves are attached around the pendant stem with 304 stainless steel socket head cap screws.

Six (6) cable clamps made of 304 stainless steel are used in the stabilization kit with two (2) clamps per cable attached to each anchoring point and the stem collar.

The cable tension can be adjusted from either end.

Wind Load

The Stabilization Kit is designed to withstand 90mph winds for 3 seconds comparable to ASCE 7-10, MRI 50-year (fixture EPA is 0.3 sq ft)



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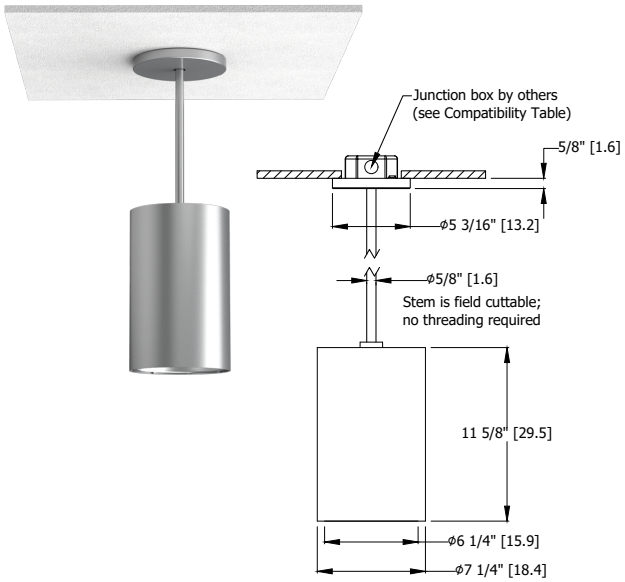
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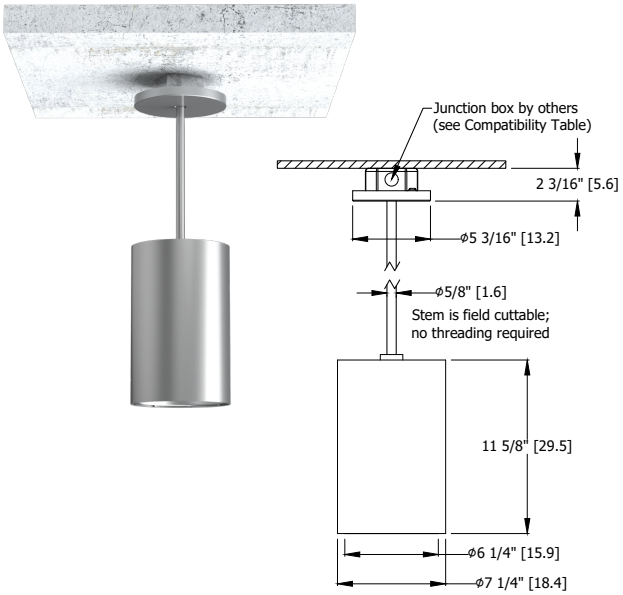
6" **General Illumination Pendant Stem Cylinder**

DIMENSIONAL DATA

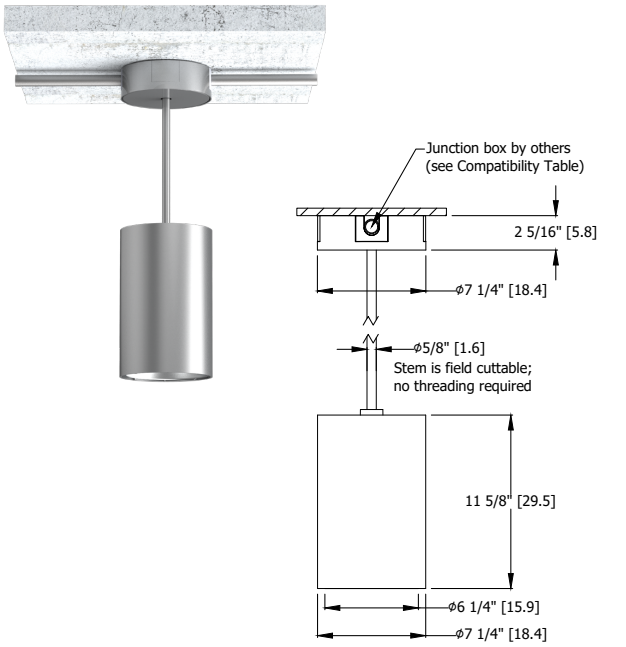
JBX Recessed J-Box



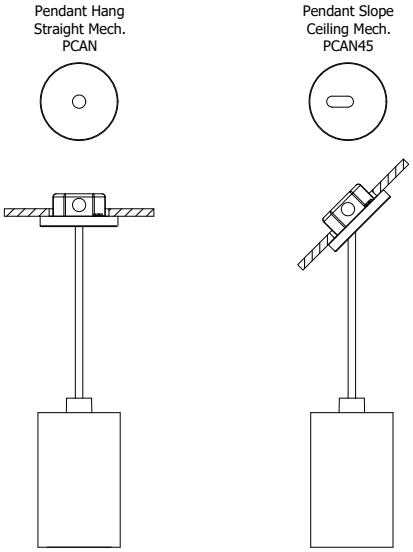
JBX Surface J-Box



JBXCC Surface J-Box with Conduit Covers



Stem_PCAN vs PCAN45



*Dimensions in inches [centimeters]

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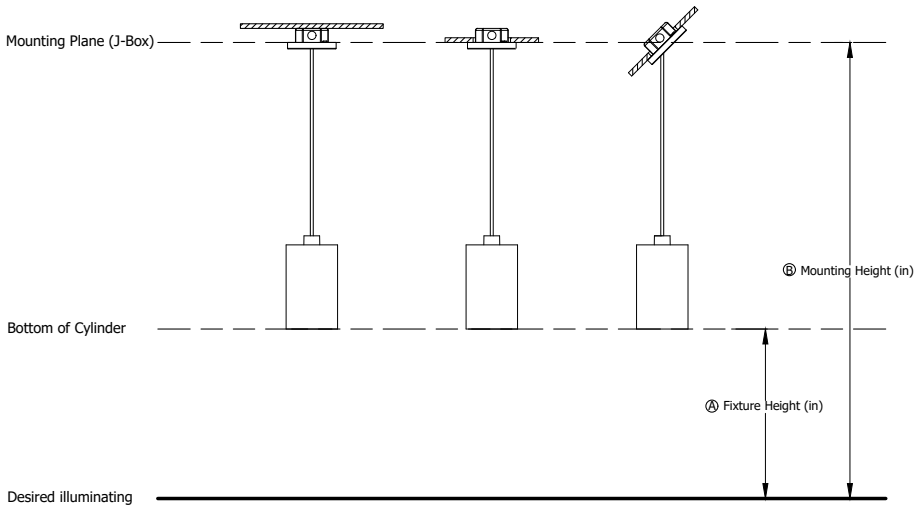
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6" **General Illumination Pendant Stem Cylinder**

DIMENSIONAL DATA

Stem Cutting Formulas for JBX



Cord Length=Ⓑ-Ⓐ- 6"

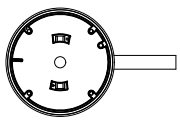
Conduit Feed Examples and Keys



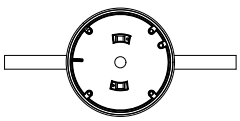
Conduit Key
(4) provided with each,
for use with 1/2" or 3/4" conduit



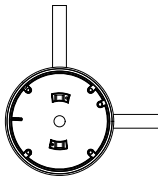
Blank Key
(4) provided with each



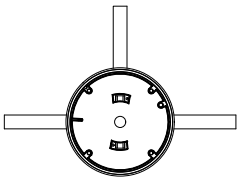
Single Conduit Feed



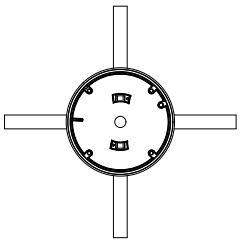
Double 180° conduit



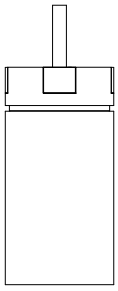
Double 90° conduit



Triple 0°, 90° & 180° conduit



Quad 0°, 90°, 180°, & 270° conduit



Top conduit feed

*Dimensions in inches [centimeters]

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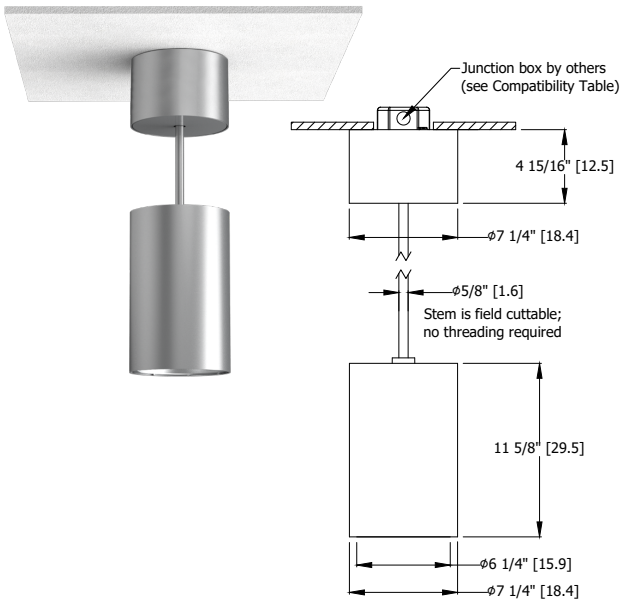
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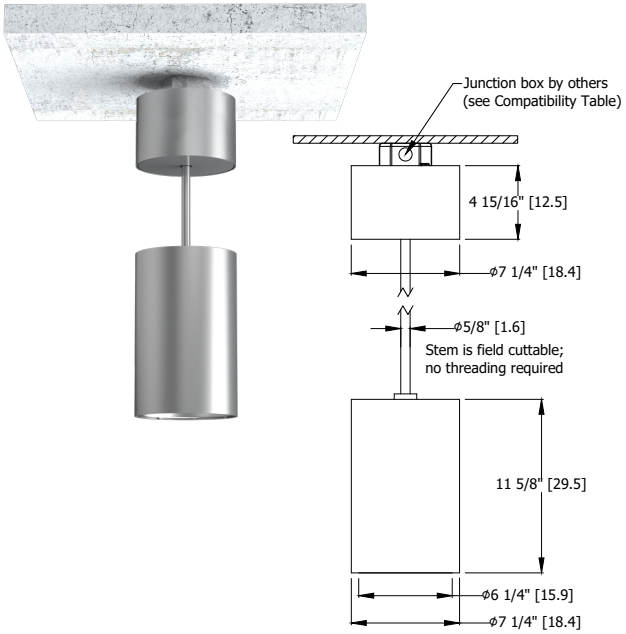
6" **General Illumination Pendant Stem Cylinder**

DIMENSIONAL DATA

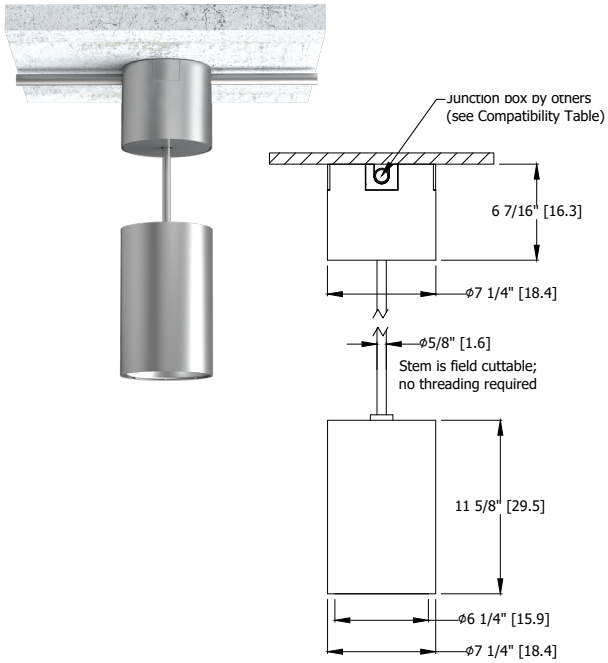
SGB Surface Gear Box for EDXB recessed J-box



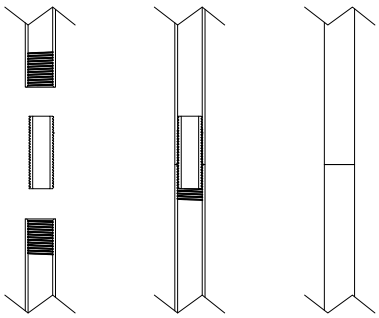
SGB Surface Gear Box for EDXB surface J-box



SGBCC Surface Gear Box for EDXB with Conduit Covers



Stem Connection Method



*Dimensions in inches [centimeters]

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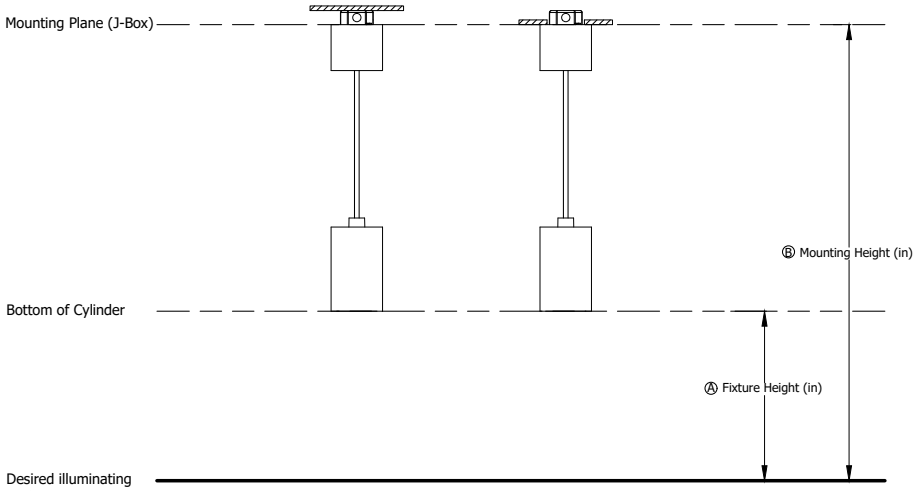
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6" **General Illumination Pendant Stem Cylinder**

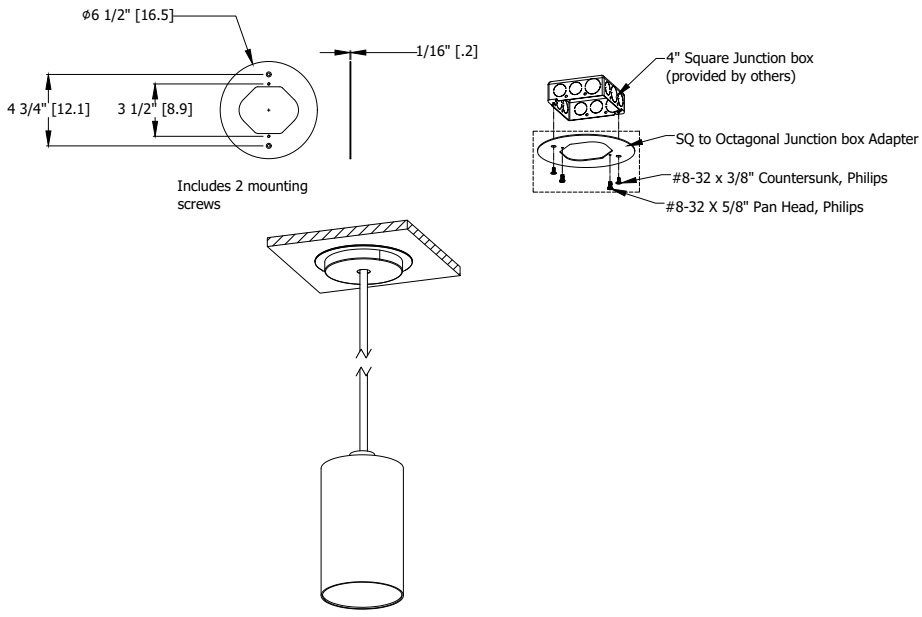
DIMENSIONAL DATA

Stem Cutting Formulas for SGB



Stem Length=Ⓑ-Ⓐ- 15"

Cylinder Adaptor Plate



*Dimensions in inches [centimeters]

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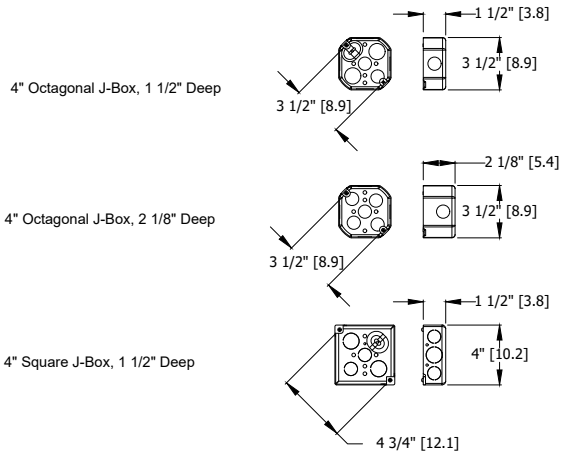
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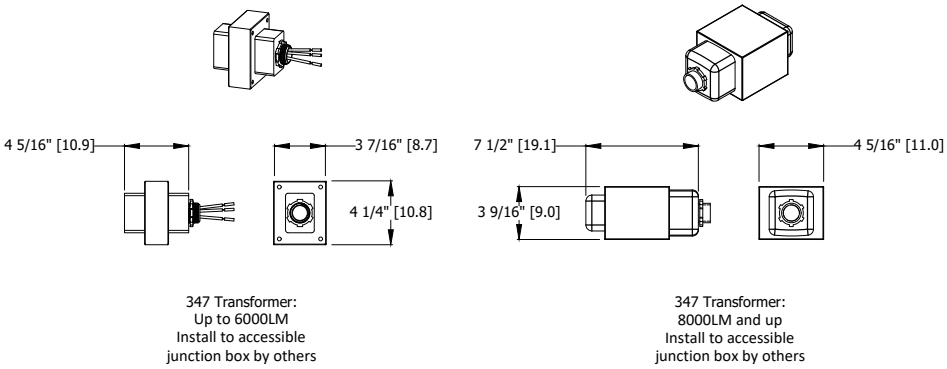
6" **General Illumination Pendant Stem Cylinder**

DIMENSIONAL DATA

Junction Box Dimensions (by others)



347V Stepdown Transformer



347 Transformer:
Up to 6000LM
Install to accessible
junction box by others

347 Transformer:
8000LM and up
Install to accessible
junction box by others

*Dimensions in inches [centimeters]

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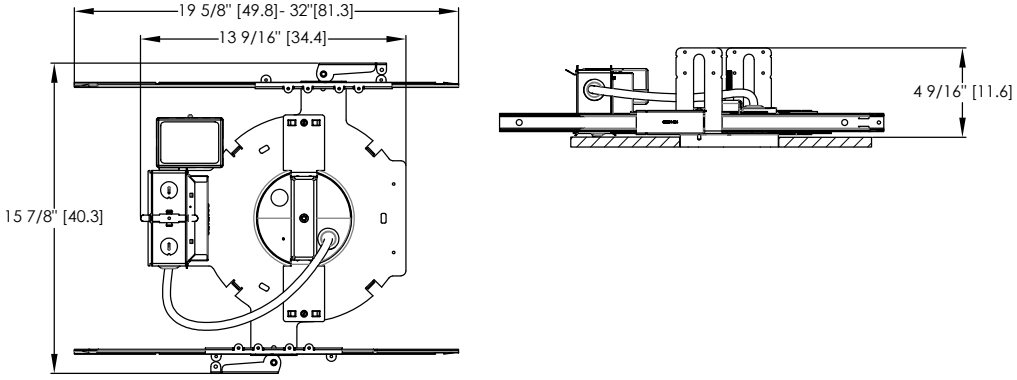
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6" **General Illumination Pendant Stem Cylinder**

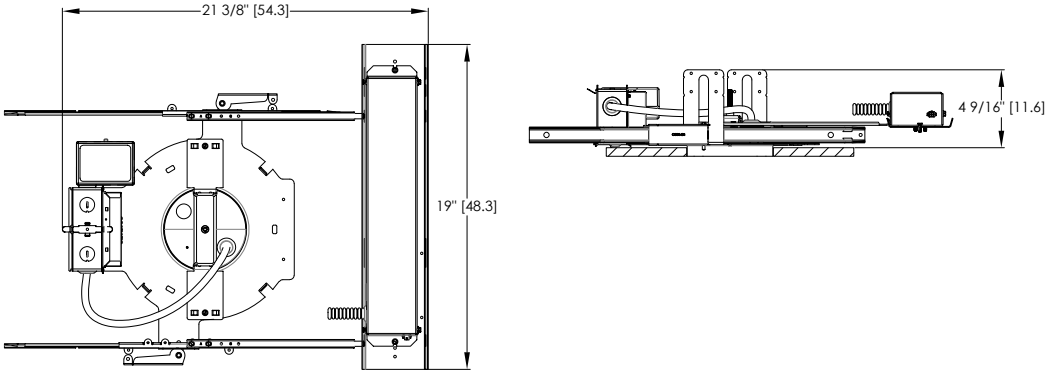
DIMENSIONAL DATA

RGH 2500LM-5000LM and with EDXB up to 4500LM & ECOD up to 4000LM Standard



Ceiling thickness range: 1/2"[1.3] to 3"[7.6]
Ceiling cutout: 5 1/16"[12.9]

RGH with Battery Backup (E10WCPR) 2500LM-5000LM and with EDXB up to 4500LM & ECOD up to 4000LM Standard



With Emergency Battery or GTD option

Minimum plenum height for emergency batteries in non-accessible ceilings: 12 1/2"[31.8]
Ceiling thickness range: 1/2"[1.3] to 3"[7.6]
Ceiling cutout: 5 1/16"[12.9]

*Dimensions in inches [centimeters]

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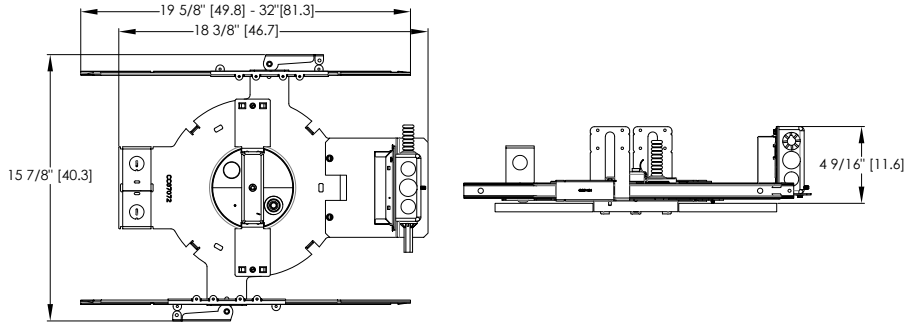
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6" **General Illumination Pendant Stem Cylinder**

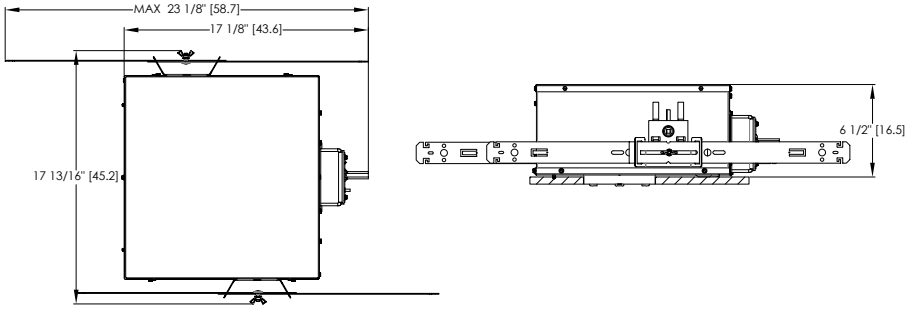
DIMENSIONAL DATA

RGH with CP 2500LM-5000LM and for use with EDXB up to 4500LM & ECOD up to 4000LM Standard



Ceiling thickness range: 1/2"[1.3] to 3"[7.6]
Ceiling cutout: 5 1/16"[12.9]

RGH with Chicago Plenum (CP) for use with nLight Enclosed



Ceiling thickness range: 1/2"[1.3] to 3"[7.6]
Ceiling cutout: 5 1/16"[12.9]

*Dimensions in inches [centimeters]

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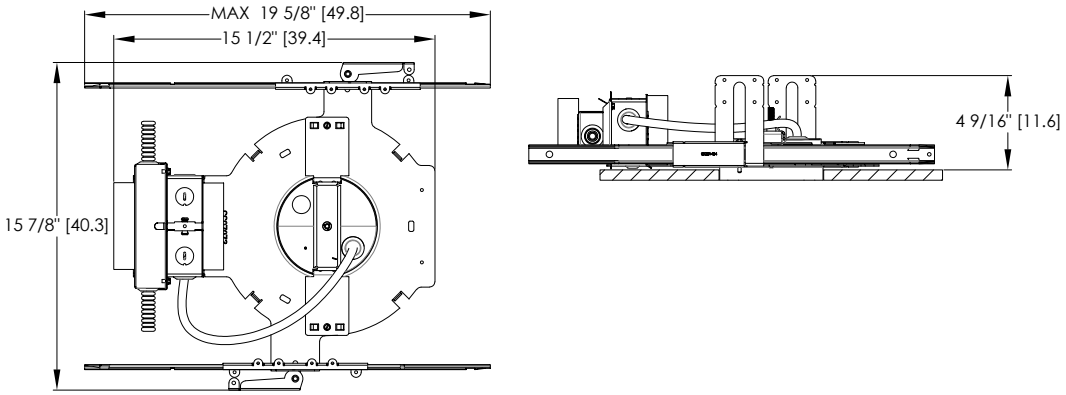
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gotham® | EVO®

6" **General Illumination Pendant Stem Cylinder**

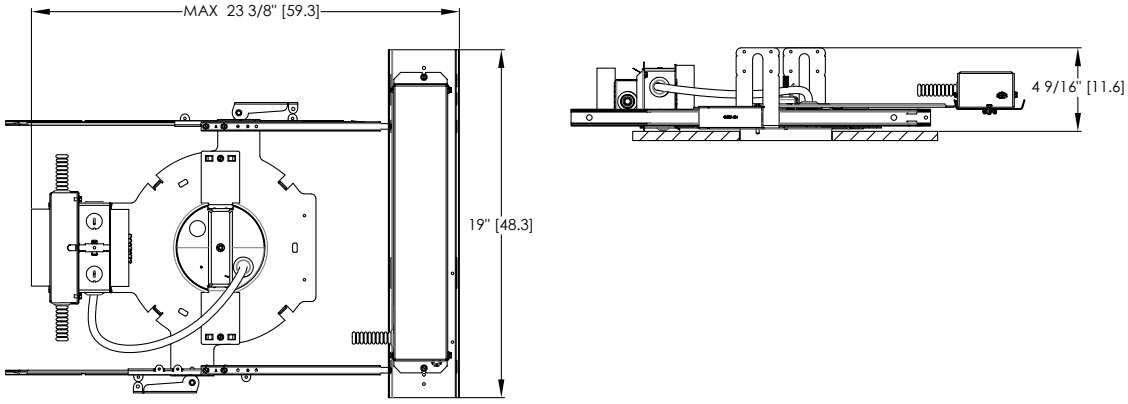
DIMENSIONAL DATA

RGH Double Driver 5000LM+ EDXB & EC0D, 6000LM & 8000LM Standard



Ceiling thickness range: 1/2"[1.3] to 3"[7.6]
Ceiling cutout: 5 1/16"[12.9]

RGH Double Driver with Battery Backup (E10WCPR) for use with 5000LM+ EDXB & EC0D, 6000LM & 8000LM Standard



With Emergency Battery or GTD option
Minimum plenum height for emergency batteries in non-accessible ceilings: 12 1/2"[31.8]
Ceiling thickness range: 1/2"[1.3] to 3"[7.6]
Ceiling cutout: 5 1/16"[12.9]

*Dimensions in inches [centimeters]

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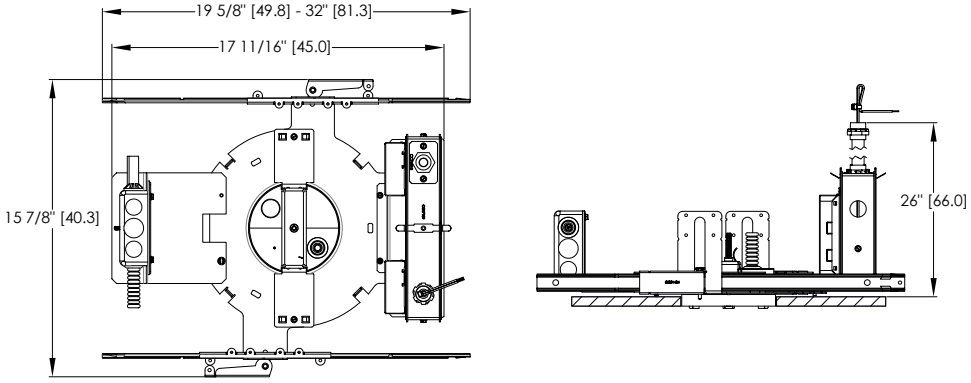
gotham®

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6" **General Illumination Pendant Stem Cylinder**

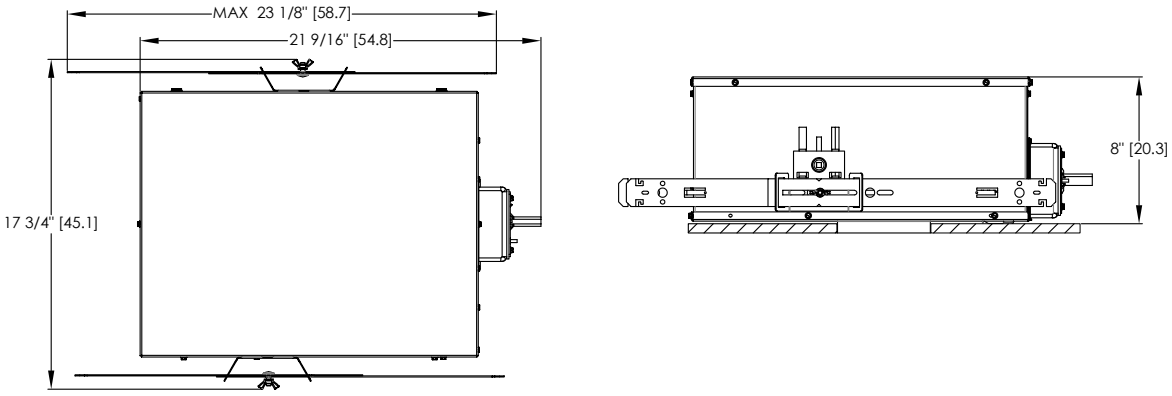
DIMENSIONAL DATA

RGH Double Driver CP Standard



Ceiling thickness range: 1/2"[1.3] to 3"[7.6]
Ceiling cutout: 5 1/16"[12.9]

RGH Double Driver with CP for use with 5000LM+ EDXB & ECOD, 6000LM & 8000LM Enclosed



Ceiling thickness range: 1/2"[1.3] to 3"[7.6]
Ceiling cutout: 5 1/16"[12.9]

*Dimensions in inches [centimeters]

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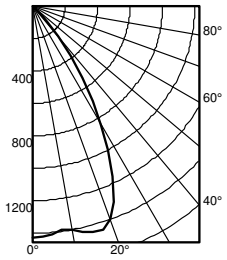
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6" **General Illumination Pendant Stem Cylinder**

Photometry

CONSULT WWW.GOTHAMLIGHTING.COM FOR ADDITIONAL PHOTOMETRY.

EV06PC 35/15 AR MWD LS INPUT WATTS: 14.7, DELIVERED LUMENS: 1471LM, LPW= 100, 1.03 S/MH, TEST NO. LTL27783P

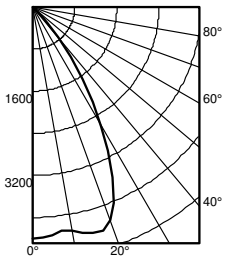


	Ave	Lumens
0	1431	
5	1410	134
15	1442	405
25	1161	523
35	540	332
45	78	72
55	3	4
65	1	1
75	0	1
85	0	0
90	0	

Zone	Lumens	% Lamp
0° - 30°	1061.4	72.2
0° - 40°	1393.5	94.7
0° - 60°	1469.5	99.9
0° - 90°	1470.9	100.0
90° - 180°	0.0	0.0
0° - 180°	1470.9	*100.0
	*Efficiency	

Mounting Height	Inital FC Center Beam	50% beam - 54.4° Diameter	50% beam - 54.4° FC	10% beam - 77.9° Diameter	10% beam - 77.9° FC
8.0	47.3	5.7	23.7	8.9	4.7
10.0	25.4	7.7	12.7	12.1	2.5
12.0	15.9	9.8	7.9	15.3	1.6
14.0	10.8	11.8	5.4	18.6	1.1
16.0	7.9	13.9	3.9	21.8	0.8

EV06PC 35/45 AR MWD LS INPUT WATTS: 47.3, DELIVERED LUMENS: 4532.7LM, LPW= 95.8, 1.03 S/MH, TEST NO. LTL27783P

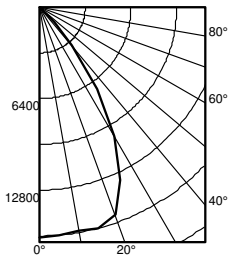


	Ave	Lumens
0	4411	
5	4346	413
15	4443	1247
25	3578	1610
35	1665	1024
45	242	222
55	8	12
65	2	3
75	1	2
85	0	0
90	0	

Zone	Lumens	% Lamp
0° - 30°	3270.7	72.2
0° - 40°	4294.2	94.7
0° - 60°	4528.3	99.9
0° - 90°	4532.7	100.0
90° - 180°	0.0	0.0
0° - 180°	4532.7	*100.0
	*Efficiency	

Mounting Height	Inital FC Center Beam	50% beam - 54.4° Diameter	50% beam - 54.4° FC	10% beam - 77.9° Diameter	10% beam - 77.9° FC
8.0	145.8	5.7	72.9	8.9	14.6
10.0	78.4	7.7	39.2	12.1	7.8
12.0	48.9	9.8	24.4	15.3	4.9
14.0	33.4	11.8	16.7	18.6	3.3
16.0	24.2	13.9	12.1	21.8	2.4

EV06PC 35/175 AR MWD LS INPUT WATTS: 175.3, DELIVERED LUMENS: 17801LM, LPW=101.5, 1.06 S/MH, TEST NO. ISF 34035P



	Ave	Lumens
0	16146	
5	15998	1521
15	16006	4479
25	13362	6001
35	7018	4289
45	1470	1299
55	100	156
65	37	38
75	13	14
85	2	2
90	0	

Zone	Lumens	% Lamp
0° - 30°	12002.3	67.4
0° - 40°	16291.0	91.5
0° - 60°	17746.3	99.7
0° - 90°	17801.0	100.0
90° - 120°	0.0	0.0
90° - 130°	0.0	0.0
90° - 150°	0.0	0.0
90° - 180°	0.0	0.0
0° - 180°	17801.0	*100.0
	*Efficiency	

Mounting Height	Inital FC Center Beam	50% beam - 55.7° Diameter	50% beam - 55.7° FC	10% beam - 79.8° Diameter	10% beam - 79.8° FC
8.0	533.7	5.8	266.9	9.2	53.4
10.0	287.0	7.9	143.5	12.5	28.7
12.0	178.9	10.0	89.4	15.9	17.9
14.0	122.1	12.1	61.0	19.2	12.2
16.0	88.6	14.3	44.3	22.6	8.9

Lumen Output Multiplier		
CRI	CCT	Multplier
80	2700K	0.916
	3000K	0.948
	3500K	1
	4000K	1.032
	5000K	1.1
90	2700K	0.748
	3000K	0.8
	3500K	0.838
	4000K	0.845
	5000K	0.945

Reflector Finish Multiplier	
Reflector Finish	Multiplier
LS - Specular	1
LSS - Semi Specular	0.956
WR - White	0.87
LD - Matte Diffuse	0.85
BR - Black	0.73
BZR - Bronze	0.73

Distributions		
Nomenclature	Beam Angle	Field Angle
VND	30	64
ND	44	69
MD	54	82
MWD	67	89
WD	71	92

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6" General Illumination Pendant Stem Cylinder

NLIGHT AIR

nLight® AIR is the ideal solution for retrofit or new construction spaces where adding communication wiring is cost prohibitive. The integrated nLight AIR rPP20 Power Pack is part of each EVO Luminaire ordered with the NLTAIR option. These individually addressable controls offer the ultimate in flexibility during initial setup and for space repurposing.

nLight® AIR Control Accessories
Order as separate catalog number. Visit nLight AIR.

Wall Switches	Model Number
On/Off single pole	rPODB (color) G2
On/Off two pole	rPODB 2P (color) G2
On/Off & raise/lower single pole	rPODB DX (color) G2
On/Off & raise/lower two pole	rPODB 2P DX (color) G2

nLight® AIR Control Accessories *(cont.)*

Occupancy Sensors (PIR/dual tech)	Model Number
Small motion 360°, ceiling	rCMS 9 / rCMS PDT 9
Large motion 360°, ceiling	rCMS 10 / rCMS PDT 10

UL924 Sequence of Operation

The below information applies to all nLight AIR devices with an EM option.

- EM devices will remain at their high-end trim and ignore wireless lighting control commands, unless a normal-power-sensed (NPS) broadcast is received at least every 8 seconds.
- Using the CLAIRITY+ mobile app, EM devices must be associated with a group that includes a normal power sensing device to receive NPS broadcasts.
- Only non-emergency rPP20, rLSXR, rSBOR, rSDGR, and nLight AIR luminaires with version 3.4 or later firmware can provide normal power sensing for EM devices. See specification sheets for control devices and luminaires for more information on options that support normal power sensing.

NLIGHT

nLight® Wired The nLight® solution is a digital networked lighting control system that provides both energy savings and increased user configurability by cost effectively integrating time-based, daylight-based, sensor-based and manual lighting control schemes.

nLight® Wired Control Accessories
Order as separate catalog number. Visit nLight.

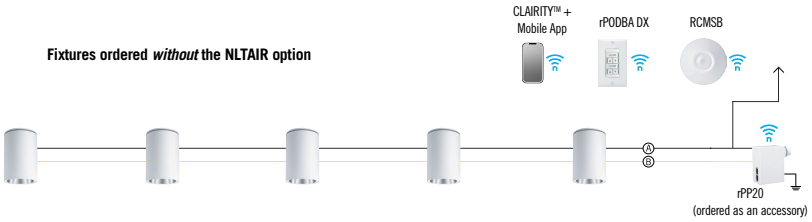
Wall Switches	Model Number
On/Off single pole	nPODM (color)
On/Off two pole	nPODM 2P (color)
On/Off & raise/lower single pole	nPOD DX (color)
On/Off & raise/lower two pole	nPODM 2P DX (color)
Graphic touchscreen	nPOD GFX (color)
Photocell Controls	
Dimming	nCM ADCX

nLight® Wired Control Accessories *(cont.)*

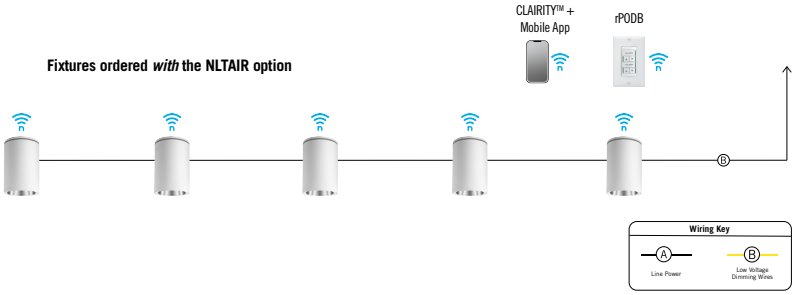
Occupancy Sensors (PIR/dual tech)	Model Number
Small motion 360°, ceiling	nCM 9 / nCM PDT 9
Large motion 360°, ceiling	nCM 10 / nCM PDT 10
Wide View	nWV 16 / nWV PDT 16
Wall switch with raise/lower	nWSX LV DX / nWSX PDT LV DX
Cat-5 Cables (plenum rated)	
10', CAT5	CAT5 10FT J1
15', CAT5	CAT5 15FT J1

Possibilites for nLight® AIR

Fixtures ordered *without* the NLTAIR option

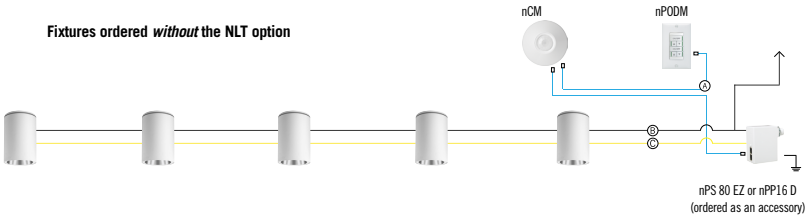


Fixtures ordered *with* the NLTAIR option

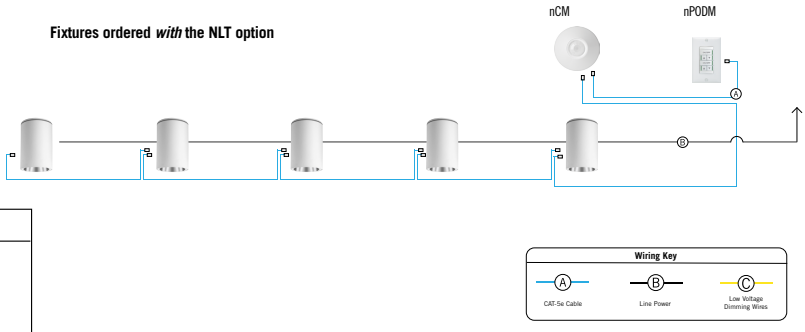


Possibilites for nLight® wired

Fixtures ordered *without* the NLT option



Fixtures ordered *with* the NLT option



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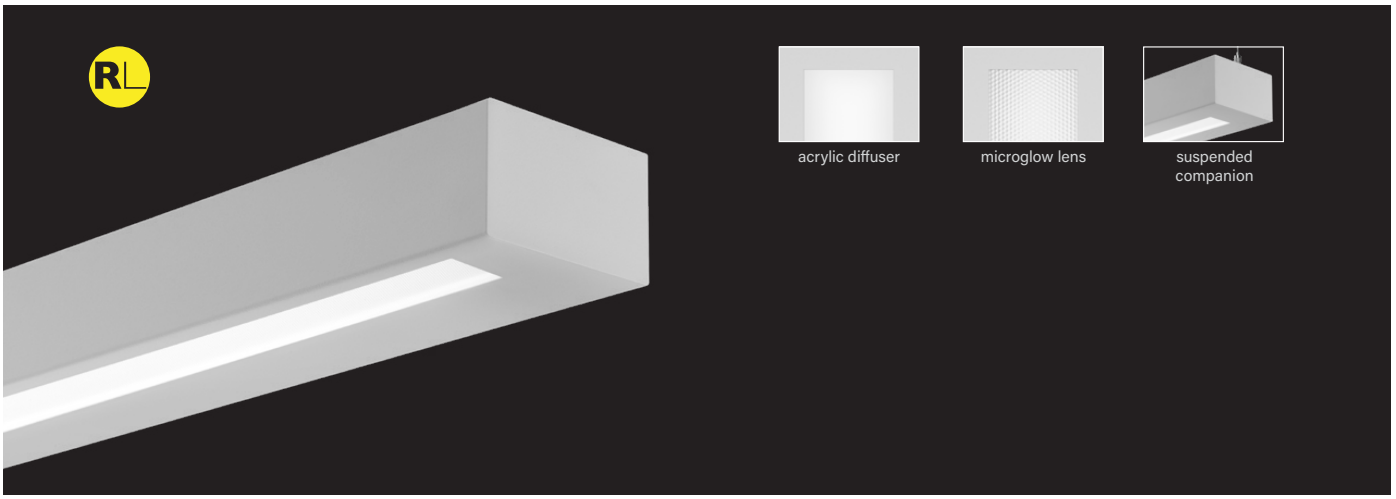
Dart™

LED WALL MOUNT

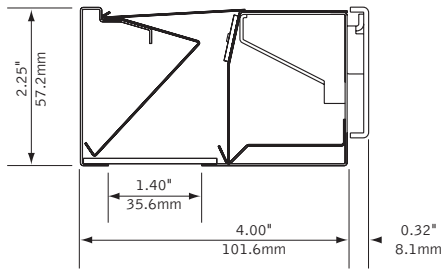
PROVIDE SPECIFIED FIXTURE BY APPROVED MANUFACTURER OR ENGINEER-APPROVED EQUAL BY:
AXIS
LEDALITE
LITECONTROL

TYPE L2
RESTROOM

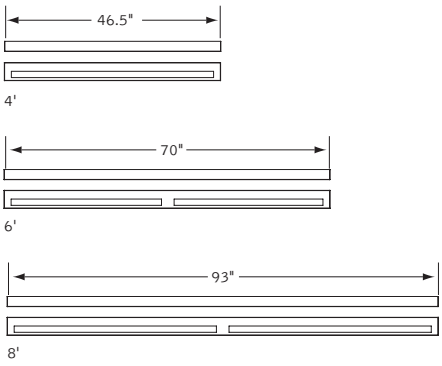
FOCAL POINT®



DIMENSIONAL DATA



fixture information



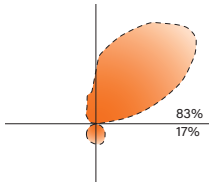
FEATURES

Miniature wall mount direct/indirect LED luminaire.

Features Gradient Optic which softens cut-off line on surrounding walls and other vertical structures. Beam Smoothing Diffuser provides additonal softening to the beam.

MicroGlow lens offers cutoff & brightness control to support comfortable environments.

PERFORMANCE



PRODUCT OVERVIEW

Lumen Output:	2500-3000lm
Wattage:	26-37W
LPW:	93-98
SDCM:	3

4' unit with Acrylic Diffuser
Nominal Output: 625 lm/ft

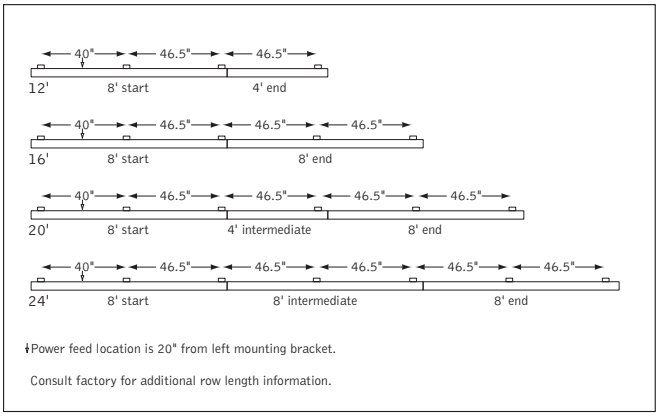
Delivered Lumens: 2500lm

Total System Watts: 26W

Photometric performance is measured in accordance with IESNA LM-79.
Visit focalpointlights.com for complete photometric data.

fixture: project:

DETAILS



Power feed location is 20" from left mounting bracket.

Consult factory for additional row length information.

SPECIFICATIONS

LED Systems

Linear LED module incorporates premium LEDs on a robust platform to achieve excellent thermal management. Available in 3000K, 3500K, 4000K with CRI>80, 3SDCM. LED boards and drivers are replaceable.

Construction

One-piece 22 Ga. steel housing. Steel end caps attach flush to housing. For row installation, internal brackets form hairline joint. All luminaires are provided with single-point suspension mounted on 48", 72" or 96" centers. 4' unit weight: 8lbs. 6' unit weight: 13lbs.
8' unit weight: 19lbs.

Optic

Reflector fabricated of low iridescent, semi specular premium grade aluminum. 0.125" thick acrylic lens. 0.42" smooth acrylic Beam Smoothing Diffuser (dust cover) standard.

Electrical

Luminaires are pre–wired with factory installed branch circuit wiring and over-molded quick connects. Standard 120-277V constant current driver includes 0-10V analog dimming.Power factor > .9.

Emergency Battery

Emergency output—12W for 90 minutes for all available models.

Labels

UL and cUL listed. Suitable for Dry or Damp Locations, indoor use only.

Finish

Polyester powder coat applied over a multi-stage pre–treatment.

Lumen Maintenance

Reported: L70 at 60,000 hours Calculated: L70 at 130,000 hours

Derived from EPA TM-21 calculator. Based on typical conditions, consult factory for additional data.

Reliability

At Focal Point, our products are designed to stand the test of time. Each luminaire is engineered using superior components, manufactured with the utmost care and rigorously tested. Contact us for reliability data.

Warranty

LED system rated for operation in ambient environments up to 25°C. 5-year limited warranty.

4' PERFORMANCE CHART

Shielding	Lumens per Foot	Delivered Lumens	System Watts	LPW
Acrylic Diffuser / MicroGlow Lens	625LF	2500	26	98
	750LF	3000	30	97
	875LF	3500	37	93

Based on 3500K. Color Temperature multipliers: 3000K - 1.035, 4000K - 0.975. *Lumen output may vary +/- 5%. Actual wattage may vary +/- 5%

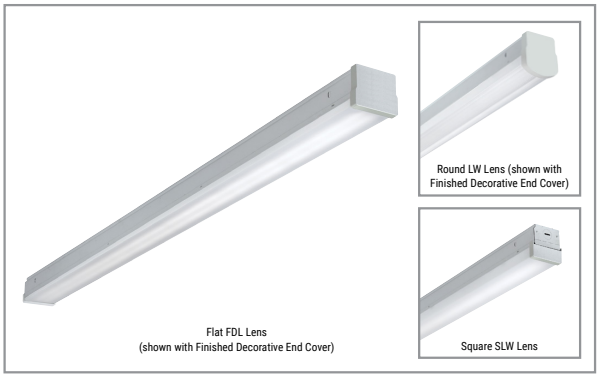
Focal Point LLC reserves the right to change specifications for product improvement without notification.

ORDERING

Fixture Series		**FDALW**
Dart LED	FDALW	
Shielding		
Acrylic Diffuser	AC	
MicroGlow Prismatic Lens	MG	
Lumen Output		
625 Lumens per foot	625LF	
750 Lumens per foot	750LF	
875 Lumens per foot	875LF	
Color Temperature		
3000K	30K	
3500K	35K	
4000K	40K	
Circuits		**1C**
Single Circuit	1C	
Voltage		
120/277 UNV Volt	UNV	
347 Volt (LD1 only)	347	
Control System & Dimming Level		
0-10V - 1% Dimming	L11	
0-10V - 10% Dimming	LD1	
Lutron Hi-Lume EcoSystem (LDE1) - 1% Dimming	LH1	
DALI - 1% Dimming	D11	
DALI - 10% Dimming	DD1	
Step Dimming (Not available with 625LF)	SD5	
Mounting		**WM**
Wall Mount	WM	
Factory Options		
Emergency Circuit (Not available in 6' units)	EC	
Emergency Battery (Not available in 6' units) (Sensor options available—consult factory)	EM	
Finish		
Titanium Silver	TS	
Matte Satin White	WH	
Fixture Run Length		
4'	4'	
6' (Can not be combined with 4' & 8' lengths to create longer run length)	6'	
8'	8'	
12' (8'+4')	12'	
16' (8'+8')	16'	
20' (8'+4'+8')	20'	
24' (8'+8'+8') (Individual units may not be field modified for continuous row mount)	24'	

For more information visit focalpointlights.com/reference or consult factory.

Project		Catalog #		Type	TYPE L3A, L3B MECH. ROOMS
Prepared by		Notes	PROVIDE SPECIFIED FIXTURE BY APPROVED MANUFACTURER OR ENGINEER-APPROVED EQUAL BY: LITHONIA COLUMBIA DAY-BRITE		



Metalux

SNX Lensed

Flat, Round and Square Lens
Linear LED Striplight

Typical Applications

Commercial • Cove • Warehouse/Distribution • Retail • Industrial • General Aisle or Open Areas • Utility/Storage Rooms

Interactive Menu

- Order Information page 2
- Photometrics page 4
- Energy and Performance Data page 5
- Product Warranty

Product Certification

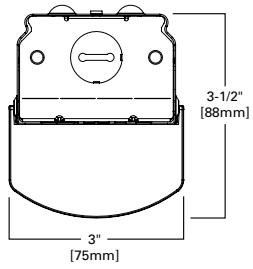
Product Features

Top Product Features

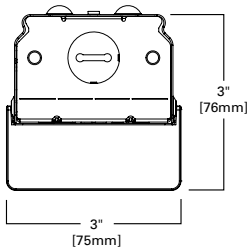
- Standard (SL) and High lumen/High Efficacy (HL) packages
- Three (3) CCT and Lumen selectable options available
- Up to 21,000 lumen and 174 LPW
- General, Narrow or Wide distributions
- Decorative end cover and multiple finishes provide a polished look
- Integral factory installed controls option allows more energy savings
- Captive lens, electrical, and channel cover assembly
- Tool-less channel cover and electrical assembly
- Options to meet Buy American and other domestic preference requirements

Dimensional Details

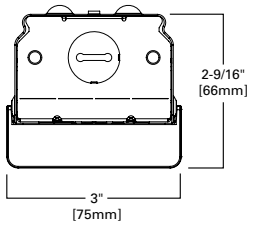
End View - Round Lens



End View - Square Lens

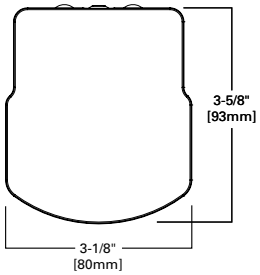


End View - Flat Lens



Finished Decorative End Covers

End View - Round Lens



additional product diagrams

Metalux — SNX Lensed

Order Information

SAMPLE ORDER NUMBERS: **4SNX-48SL-LN-UNV-L835-CD1-U or 8TSNX-180HL-SLW-UNV-EL7W-L840-CD2-U**

Domestic Preferences [1]	Length			Series
[Blank]=Standard **BAA**=Buy American Act **TAA**=Trade Agreements Act	**2**=2 ft.	**4**=4 ft. L3A	**8T**=8 ft. L3B	**SNX**=Commercial LED Striplight [2]

Standard Nominal Lumen Packages [3]

2 ft	L3A 4 ft		L3B 8 ft	
SL3	SL3	60SL	SL3 [5]	114SL [5]
19SL	20SL	63SL	40SL	120SL [5]
23SL	22SL	67SL	44SL	126SL [5]
25SL	26SL	74HL	52SL	134SL [5]
30SL	31SL	81HL	62SL	148HL [5]
40HL	33SL	84HL	66SL	162HL [5]
44HL	37SL	87HL	74SL	168HL [5]
47HL	41SL	90HL	82SL	174HL [5]
	45SL	93HL	90SL	180HL [5]
	48SL	100HL	96SL	186HL [5]
	51SL	104HL	102SL [5]	200HL [5]
	57SL			

SL denotes standard lumen output. HL denotes high lumen output. Additional LEDs to obtain lumen package.

SL3=Low/Med/High output (see performance table for lumen package).

Lens

Round
LC=Clear Lens
LN=Semi-Frost Lens - Narrow
LW=Full Frost Lens - Wide

Square
SLW=Square / Frost Lens - Wide

Flat
FDL=Flat Frost / Diffuse Lens

Voltage [4]

UNV=Universal Voltage 120-277
347=347V
480=480V [9]

Color Temp / CCT

CCT Select [6]
CC83=Switchable CCT, 80CRI, 35/4/5000K
CC93=Switchable CCT, 90CRI 35/4/5000K

CCT/CRI
L830=3000K, 80 CRI
L835=3500K, 80 CRI
L840=4000K, 80 CRI
L850=5000K, 80 CRI
L930=3000K, 90 CRI
L935=3500K, 90 CRI
L940=4000K, 90 CRI
L950=5000K, 90 CRI

Drive Type [7]

CD=0-10V Dimming Driver (10%-100% Dimming)
HCD=0-10V Dimming Driver (1%-100% Dimming)
SD=Step-dim (Bi Level)
5LTD=Fifth Light (DALI) Driver [8]

No.of Drivers

1=1 Driver
2=2 Drivers [5]

Options

Emergency [9], [10]
EL7W=7-watt 120V-277V emergency battery pack [11]
EL10W=10-watt 120V-277V emergency battery pack [11]
EL14W=14-watt 120V-277V emergency battery pack [11]
EL10WSD=10W emergency battery pack with self-diagnostic installed [11], [12]
EL14WSD=14W emergency battery pack with self-diagnostic installed [11], [12]
GTR2=Bodine Generator Transfer Relay [13]
ETRD=Emergency Transfer Relay with dimming control [13]

Wiring [14], [15]
PI=Wiring Plug-in Option [22]
CPI=Crossover Plug-in Option [22]
PC6/120=(NEMA 5-15P) 6 ft. Cord with NEMA Straight Plug
PC6/277=(NEMA L7-15P) 6 ft. Cord with NEMA Twist Plug
C6(1)=1 Circuit, 6 ft. Cord no Plug
C3(1)=1 Circuit, 3 ft. Cord no Plug

Sensor [10]
[Blank]=No Sensor
WAA=WaveLinx Wireless Integrated Sensor [A]
WAB=WaveLinx Lite Wireless Integrated Sensor [B]
SVPD2=Integrated occupancy and daylight dimming sensor, 900 sq. ft. coverage [C]
SVPD3=Integrated occupancy and daylight dimming sensor, 1200 sq. ft. coverage [C]
ZW-SWPD3=Integrated Wavelinx Wireless Sensor, 1200 sqft. coverage [21], [23], [B]
WLS4=WaveLinx Lite Wireless Integrated Sensor, 15'–40' Mounting Height [21], [23], [B]

Sensor Location
MID=Mid-row

MATCH EXISTING MOUNTING HEIGHT

Knockouts

[Blank]=Clean Channel
FKO=Full Side KOs

Paint Finish

[Blank]=Standard White
PAF=Painted after fab. (White)
BLK=PAF Black [17]
GRY=PAF Gray [17]

Packaging

U=Unit Pack

Accessories (Order Separately) [18]

AYC-CHAIN/SET-U=(2) 36" Chain Hanger (Use 1 set per fixture)
SCF=Fixed Stem Set (Specify Length) [19]
SCS=Swivel Stem Set (Specify Length) [19]
SCA=Adjustable 48" Stem Set [19]
EYE-CHAIN/SET-B=Eye Bolt Chain (Use 1 set per fixture)
WG-SNX/SN-2FT-B=2 ft Wire Guard
WG-SNX/SN-4FT-B=4 ft Wire Guard
A-1-B/SPACER-B=Spacer 1-1/2" to 2-1/2" from ceiling (Use 2 per fixture) [19]
TOGGLE=Single Toggle No. 2 (Specify Length) [19]
Y-Toggle-10-2PK=(2) Y-Toggle Cable Kits at 10FT long
GRP-SNF-U=Gripper Hanger
CLC-SNLED-EXT-B=SN/SNX Long Row Aligner Extension
ISHH-01=Integrated SVPDx Sensor Programming Remote

Round Replacement Lenses
SNX-LENS-LW-2FT-U= Replacement Lens 2 ft, Full Frost
SNX-LENS-LN-2FT-U= Replacement Lens 2 ft, Semi Frost
SNX-LENS-LC-2FT-U= Replacement Lens 2 ft, Clear
SNX-LENS-LW-4FT-U= Replacement Lens 4 ft, Full Frost
SNX-LENS-LN-4FT-U= Replacement Lens 4 ft, Semi Frost
SNX-LENS-LC-4FT-U= Replacement Lens 4 ft, Clear

Square Replacement Lenses
SNX-SQLENS-SLW-2FT-U= Replacement Lens 2 ft, Full Frost
SNX-SQLENS-SLW-4FT-U= Replacement Lens 4 ft, Full Frost

Flat Replacement Lenses
SNX-Flat Lens-FDL-2FT-U= Replacement Lens 2 ft, Full Frost
SNX-Flat Lens-FDL-4FT-U= Replacement Lens 4 ft, Full Frost

Finished End Cover [20]
DECOEND-RND PK=(2) Full end caps, SNX w/ Round Lens
DECOEND-FDL PK=(2) Full end caps, SNX w/ Flat FDL Lens
DECOEND-SLW PK=(2) Full end caps, SNX w/ Square Lens

Notes: (1) Only product configurations with these designated prefixes are built to be compliant with the Buy American Act of 1933 (BAA) or Trade Agreements Act of 1979 (TAA), respectively. Please refer to DOMESTIC PREFERENCES website for more information. Components shipped separately may be separately analyzed under domestic preference requirements. (2) DesignLights Consortium® Qualified and classified for both DLC Standard and DLC Premium, refer to www.designlights.org for details. (3) Nominal lumen values. See table for value and fixture length. (4) 347/480V max ambient temp 40C. (5) Requires two drivers. (6) SL3 to be ordered in conjunction w/CCT Select. (7) 2ft with Sensor limited to CD and HCD drivers only. (8) For a complete listing of Fifth Light products, visit www.cooperlighting.com (9) 4 ft and 8 ft only. (10) When ordering sensor or EBP option, specify UNV (for 120 or 277V), 347 or 480V. (11) Factory installed with integral test switch/indicator/laser test. For approximate delivered lumens multiply the lumens per watt of the desired fixture by the wattage of the emergency battery pack (100 lm/W x 7=700 lumens). IES-format photometry for luminaire under emergency operation available. (12) EL10WSD and EL14WSD not available with 347V. (13) Used to bypass local control during outage. Must be used in conjunction with UL 1008 device (provided by others). GTR2 include 2 relays on fixtures with dimming drivers. ETRD option only requires one relay when used on a dimming fixture. Must specify voltage as 120 or 277V when ordering GTR2. (14) Consult tech support on numerous options for this feature. (15) Most common C&P shown. Must specify location for cord. All "end" locations will be on the end with sensor installed. (16) Integral Mid-Row sensor does not apply for ZW-SVPD3. (17) Black or gray fixture and lens ends. Refer to Finish multiplier table for performance. (18) Accessories sold separately will be separately analyzed under domestic preference requirements. Consult factory for further information. (19) Order 2 per fixture. (20) Finished Deco end cover cannot be used with ZW end mount sensor or over any end mount fitting. (21) WLSx provided in separate enclosure. (22) For more information on PI/CPI options, refer to 022341_pi_tilw (cooperlighting.com) (23) Not available in Mid-Row Configuration

Integrated options must be used in conjunction with the associated system and may not be compatible with other options or accessories. Please refer to the following: (A) Consult WaveLinx system pages for additional details and compatibility. (B) WaveLinx Lite devices are not currently compatible with the WaveLinx Wireless Area Controller. Consult WaveLinx Lite system pages for additional details and compatibility. (C) Consult SVPD series system pages for additional details and compatibility.

Stock is available in the following catalog numbers:

Catalog Number	Description	Replaces Up To	Selectable CCT	Voltage	Selectable Lumens	Watts	UPC	DLC Product ID
4SNX-SL3-LW-UNV-CC83-CD1-U	4' Single Lens	2-T8 32W, 1-T5HO 54W	3500K-5000K	120-277V	2000-6100	17/33/51	080083265107	S-Z5CGBY
8TSNX-SL3-LW-UNV-CC83-CD2-U	8' Single Lens	4-T8 32W, 2-T12 75W	3500K-5000K	120-277V	4100-12000	34/67/101	080083265114	S-V503E2

COOPER Lighting Solutions

Metalux SNX Lensed

Product Specifications

Construction
- Die-formed cold rolled steel channel and cover
- Convertible end plate for continuous row alignment
- Tool-less channel/wireway cover and captive electrical assembly
- Groove for Tong Hanger
- Surface, pendant or stem mount capable. See available mounting options.

Controls
- Standard with 0-10V dimming driver (10% standard, 1% optional)
- WaveLinx wireless sensor compatible for standalone, controlled, connected, and IoT capability
- SVPD sensor compatible for out-of-the-box functionality
- DALI 2.0 and step-dimming available
- Combine with energy-saving products like occupancy sensors, daylighting controls and lighting relay panels to maximize energy savings
- For motion control, reference sensor locations for both end and middle of the row applications

Emergency Battery Pack Option
- Optional 120V-277V integral emergency battery pack available in 7W or 14W
- 90-minute backup period for code compliance
- Generator transfer options available

Electrical
- Long-life LED system with electrical driver for optimal performance
- LED's available in 3000K, 3500K, 4000K or 5000K with CRI of 80 standard or optional 90 CRI
- Three CCT select option available for 80 or 90CRI in warm to cool color temps, see ordering logic
- Lumen select option available in full, medium or low brightness, see performance table and ordering logic
- Electronic drivers available for 120-277V, 347V and 480 applications
- Operating temperature of -20°C to 50°C

Finish
- Standard baked white enamel finish with multi-stage, iron phosphate pretreatment. Baked white enamel finish is standard
- PAF option for added rust protection
- Other paint finishes available: Black (BLK) and GRAY (GR)

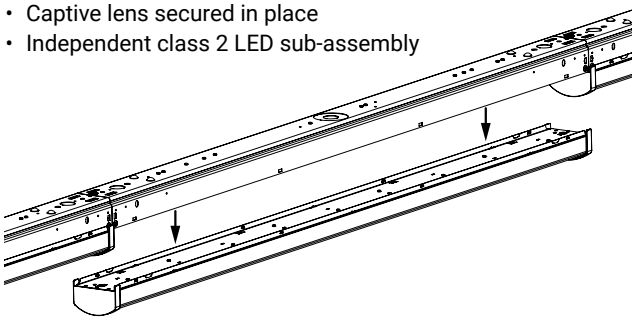
WaveLinx Lite devices are not currently compatible with the WaveLinx Pro Wireless Area Controller

Shielding
- Offered with acrylic lens and molded lens cap
- Flat lens with LED diffuse blend (FDL) for general distribution is recommended option
- Round lens offered in three distributions: Clear with linear ribs (LC), semi-frost for narrow distribution, and frost for wide distribution (LW)
- Square frost lens option for wide distribution (SLW) is available

Compliance
- cULus Listed for damp locations
- RoHS compliant
- Complies with IESNA LM-79 and LM-80 standards
- NEMA 410 compliant (drivers)
- State of California Title 24 high efficacy luminaire
- DesignLights Consortium® Qualified and classified for DLC Standard and DLC Premium (refer to www.designlights.org)
- Suitable for closet use when installed to NEC 410.16 spacings standards

Limited Warranty
- Five year limited warranty

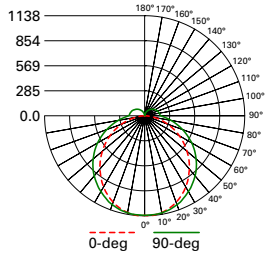
Captive Light Channel Assembly
- Tool-less removal for easy install
- Captive lens secured in place
- Independent class 2 LED sub-assembly



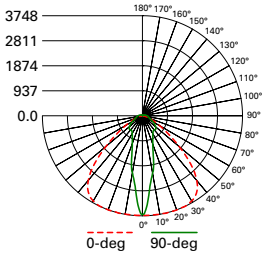
Metalux SNX Lensed

Photometric Data

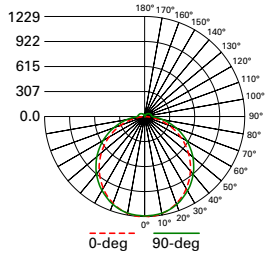
View IES files



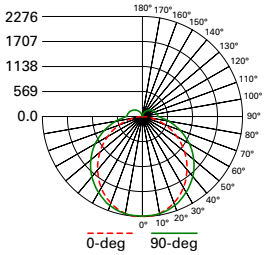
4SNX-41SL-LW-UNV-L850-CD1-U
Electronic Driver
Linear LED 5000K
Spacing criterion: (II) 1.23 x mounting height, (⊥) 1.31 x mounting height
Lumens: 4027
Input Watts: 26.3W
Efficacy: 153 LPW
Test Report: 4SNX-41SL-LW-UNV-L850-CD.IES



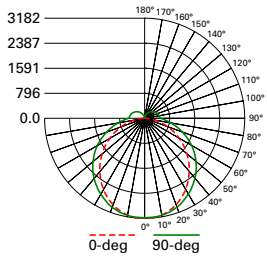
4SNX-41SL-LC-UNV-L850-CD1-U
Electronic Driver
Linear LED 5000K
Spacing criterion: (II) 1.45 x mounting height, (⊥) 0.43 x mounting height
Lumens: 4557
Input Watts: 26.3W
Efficacy: 173 LPW
Test Report: 4SNX-41SL-LC-UNV-L850-CD.IES



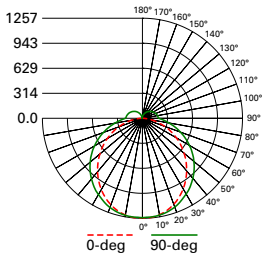
4SNX-41SL-FDL-UNV-L850-CD1-U
Electronic Driver
Linear LED 5000K
Spacing criterion: (II) 1.24 x mounting height, (⊥) 1.28 x mounting height
Lumens: 3877
Input Watts: 26.3W
Efficacy: 147 LPW
Test Report: 4SNX-41SL-FDL-UNV-L850-CD.IES



8TSNX-82SL-LW-UNV-L850-CD1-U
Electronic Driver
Linear LED 5000K
Spacing criterion: (II) 1.23 x mounting height, (⊥) 1.31 x mounting height
Lumens: 8053
Input Watts: 52.6W
Efficacy: 153 LPW
Test Report: 8SNX-82SL-LW-UNV-L850-CD.IES



8TSNX-104SL-LW-UNV-L850-CD1-U
Electronic Driver
Linear LED 5000K
Spacing criterion: (II) 1.23 x mounting height, (⊥) 1.31 x mounting height
Lumens: 11260
Input Watts: 79.4W
Efficacy: 142 LPW
Test Report: 8SNX-104SL-LW-UNV-L850-CD.IES



2SNX-47HL-LW-UNV-L850-CD1-U
Electronic Driver
Linear LED 5000K
Spacing criterion: (II) 1.24 x mounting height, (⊥) 1.28 x mounting height
Lumens: 4494
Input Watts: 33.7W
Efficacy: 133 LPW
Test Report: 2SNX-47HL-LW-UNV-L850-CD.IES

Additional Data

CCT Table

Approximate Color Temperature Multiplier	
2700K	.93
3000K	.98
3500K	1.0
4000K	1.02
5000K	1.02

CRI

Lumen multiplier (80CRI to 90CRI)			
3000K	3500K	4000K	5000K
0.805	0.840	0.846	0.901

Shipping Data

Length	Wt.
2 ft.	4.3 lbs.
4 ft.	8.2 lbs.
8 ft.	15.1 lbs.

Lumen Maintenance

Product Model (1)	Ambient Temperature	TM-21 Lumen Maintenance (60,000 hours)	Theoretical L90 (Hours)	Theoretical L70 (Hours)
SNX-SL	25C	89	53,000	175,000
	40C and higher	89	49,000	163,000
SNX-HL	25C	89	55,000	180,000
	40C and higher	87	46,000	155,000

Notes: (1) 4ft and 8ft TM-21 data are equivalent.

Metalux SNX Lensed

Energy and Performance Data - Fixed Output

Lumen Package		Delivered Lumens					Wattage	Efficacy lm/W				
2 ft		LC	LN	LW	SLW	FDL		LC	LN	LW	SLW	FDL
19	SL	2006	1939	1773	1755	1707	12.0	167.2	161.6	147.8	146.3	142.3
23	SL	2429	2347	2146	2124	2066	14.9	163.0	157.5	144.0	142.6	138.7
25	SL	2718	2626	2401	2377	2312	17.5	155.3	150.1	137.2	135.8	132.1
30	SL	3204	3096	2831	2802	2726	21.0	152.6	147.4	134.8	133.4	129.8
40	HL	4347	4200	3727	3689	3725	27.6	157.5	152.2	135.0	133.7	135.0
44	HL	4683	4525	4015	3975	4013	31.1	150.6	145.5	129.1	127.8	129.0
47	HL	5009	4840	4295	4251	4292	33.7	148.6	143.6	127.4	126.1	127.4

Lumen Package		Delivered Lumens					Wattage	Efficacy lm/W				
4 ft		LC	LN	LW	SLW	FDL		LC	LN	LW	SLW	FDL
20	SL	2100	2029	1855	1836	1786	12.1	173.6	167.7	153.3	151.7	147.6
22	SL	2391	2311	2113	2091	2034	13.8	173.3	167.5	153.1	151.5	147.4
26	SL	2823	2728	2494	2469	2401	16.4	172.1	166.3	152.1	150.5	146.4
31	SL	3318	3206	2932	2902	2823	19.5	170.2	164.4	150.4	148.8	144.8
33	SL	3563	3443	3148	3116	3031	21.1	168.9	163.2	149.2	147.7	143.6
37	SL	4013	3877	3545	3509	3413	24.0	167.2	161.5	147.7	146.2	142.2
41	SL	4356	4209	3848	3809	3705	26.3	165.6	160.0	146.3	144.8	140.9
45	SL	4857	4693	4292	4248	4132	29.8	163.0	157.5	144.0	142.6	138.7
48	SL	5191	5015	4586	4540	4416	32.1	161.7	156.2	142.9	141.4	137.6
51	SL	5435	5252	4803	4754	4624	35.0	155.3	150.1	137.2	135.8	132.1
57	SL	6090	5884	5381	5326	5181	39.7	153.4	148.2	135.5	134.2	130.5
60	SL	6408	6192	5662	5605	5452	42.0	152.6	147.4	134.8	133.5	129.8
63	SL	6727	6500	5944	5883	5723	44.4	151.5	146.4	133.9	132.5	128.9
67	SL	7191	6948	6354	6289	6117	47.9	150.1	145.1	132.7	131.3	127.7
74	HL	8015	7745	6873	6803	6869	51.8	154.7	149.5	132.7	131.3	132.6
81	HL	8693	8400	7454	7378	7450	55.1	157.8	152.5	135.3	133.9	135.2
84	HL	9084	8777	7789	7710	7785	57.9	156.9	151.6	134.5	133.2	134.5
87	HL	9366	9050	8031	7949	8026	62.2	150.6	145.5	129.1	127.8	129.0
90	HL	9701	9373	8318	8233	8313	64.4	150.6	145.5	129.2	127.8	129.1
93	HL	10018	9680	8590	8502	8585	67.4	148.6	143.6	127.4	126.1	127.4
100	HL	10765	10402	9231	9137	9226	72.5	148.5	143.5	127.3	126.0	127.3
104	HL	11162	10786	9571	9474	9566	75.5	147.8	142.9	126.8	125.5	126.7

Metalux SNX Lensed

Energy and Performance Data - Fixed Output

Lumen Package		Delivered Lumens					Wattage	Efficacy lm/W				
8 ft		LC	LN	LW	SLW	FDL		LC	LN	LW	SLW	FDL
40	SL	4200	4058	3711	3673	3573	24.2	173.6	167.7	153.3	151.8	147.6
44	SL	4782	4621	4226	4183	4068	27.6	173.3	167.4	153.1	151.6	147.4
52	SL	5646	5455	4989	4938	4803	32.8	172.1	166.3	152.1	150.5	146.4
62	SL	6637	6413	5864	5805	5646	39.0	170.2	164.4	150.4	148.8	144.8
66	SL	7126	6885	6296	6232	6062	42.2	168.9	163.2	149.2	147.7	143.6
74	SL	8025	7754	7091	7019	6827	48.0	167.2	161.5	147.7	146.2	142.2
82	SL	8711	8417	7697	7619	7410	52.6	165.6	160.0	146.3	144.8	140.9
90	SL	9714	9386	8583	8496	8264	59.6	163.0	157.5	144.0	142.6	138.7
96	SL	10381	10031	9173	9079	8831	64.2	161.7	156.2	142.9	141.4	137.6
102	SL	10871	10504	9605	9507	9248	70.0	155.3	150.1	137.2	135.8	132.1
114	SL	12180	11769	10762	10652	10361	79.4	153.4	148.2	135.5	134.2	130.5
120	SL	12817	12384	11325	11209	10903	84.0	152.6	147.4	134.8	133.4	129.8
126	SL	13454	13000	11888	11767	11445	88.8	151.5	146.4	133.9	132.5	128.9
134	SL	14382	13897	12708	12578	12235	95.8	150.1	145.1	132.7	131.3	127.7
148	HL	16031	15490	13746	13606	13738	103.6	154.7	149.5	132.7	131.3	132.6
162	HL	17386	16800	14908	14757	14900	110.2	157.8	152.5	135.3	133.9	135.2
168	HL	18168	17555	15579	15420	15570	115.8	156.9	151.6	134.5	133.2	134.5
174	HL	18731	18099	16062	15898	16053	124.4	150.6	145.5	129.1	127.8	129.0
180	HL	19401	18747	16636	16467	16627	128.8	150.6	145.6	129.2	127.8	129.1
186	HL	20035	19359	17179	17005	17170	134.8	148.6	143.6	127.4	126.1	127.4
200	HL	21531	20804	18462	18274	18452	145.0	148.5	143.5	127.3	126.0	127.3

Energy and Performance Data - Selectable Output

Lens Type	CRI	Length	Lumen Select	Delivered Lumens			Wattage			Efficacy lm/W		
			CCT Select	3500K	4000K	5000K	3500K	4000K	5000K	3500K	4000K	5000K
LC	80	2 ft.	Low	1026	1066	1099	6.9	6.6	6.7	148.7	161.5	164.0
			Med	1990	2198	2133	13.9	13.3	13.2	143.2	165.3	161.6
			High	3016	3232	3331	21	20	20.2	143.6	161.6	164.9
		4 ft.	Low	2275	2405	2270	16.7	16.1	16.9	136.2	149.4	134.3
			Med	4665	4551	4800	33.5	32.3	33.7	139.3	140.9	142.4
			High	6957	7289	6880	50.7	48.9	51.1	137.2	149.1	134.6
		8 ft.	Low	4453	4693	4655	33.5	32.3	33.7	132.9	145.3	138.1
			Med	9383	8909	9364	66.9	64.5	67.5	140.3	138.1	138.7
			High	14575	14220	13468	101.4	97.8	102.2	143.7	145.4	131.8
	90	2 ft.	Low	842	903	904	6.9	6.6	6.7	122.0	136.8	134.9
			Med	1737	1805	1809	13.9	13.3	13.2	125.0	135.7	137.0
			High	2553	2819	2825	21	20.2	20.2	121.6	139.6	139.9
		4 ft.	Low	1944	2036	1926	16.7	16.1	16.9	116.4	126.5	114.0
			Med	3949	3852	4072	33.5	32.3	33.7	117.9	119.3	120.8
			High	5889	6169	5836	50.7	48.9	51.1	116.2	126.2	114.2
		8 ft.	Low	3770	3972	3949	33.5	32.3	33.7	112.5	123.0	117.2
			Med	7704	7540	7943	66.9	64.5	67.5	115.2	116.9	117.7
			High	12338	12035	11425	101.4	97.8	102.2	121.7	123.1	111.8

Metalux SNX Lensed

Energy and Performance Data - Selectable Output

Lens Type	CRI	Length	Lumen Select	Delivered Lumens			Wattage			Efficacy lm/W		
			CCT Select	3500K	4000K	5000K	3500K	4000K	5000K	3500K	4000K	5000K
LN	80	2 ft.	Low	991	1030	1062	6.9	6.6	6.7	143.6	156.1	158.5
			Med	1983	2124	2061	13.9	13.3	13.2	142.7	159.7	156.1
			High	2914	3122	3218	21	20	20.2	138.8	156.1	159.3
		4 ft.	Low	2218	2324	2194	16.7	16.1	16.9	132.8	144.3	129.8
			Med	4508	4398	4638	33.5	32.3	33.7	134.6	136.2	137.6
			High	6722	7043	6648	50.7	48.9	51.1	132.6	144.0	130.1
		8 ft.	Low	4647	4534	4498	33.5	32.3	33.7	138.7	140.4	133.5
			Med	8793	8608	9048	66.9	64.5	67.5	131.4	133.5	134.0
			High	14083	13740	13013	101.4	97.8	102.2	138.9	140.5	127.3
	90	2 ft.	Low	814	899	874	6.9	6.7	6.7	118.0	134.2	130.4
			Med	1679	1744	1748	13.9	13.3	13.2	120.8	131.1	132.4
			High	2467	2724	2730	21	20.2	20.2	117.5	134.9	135.1
		4 ft.	Low	1878	1967	1861	16.7	16.1	16.9	112.5	122.2	110.1
			Med	3816	3722	3934	33.5	32.3	33.7	113.9	115.2	116.7
			High	5691	5782	5639	50.7	48.9	51.1	112.2	118.2	110.4
		8 ft.	Low	3934	3838	3816	33.5	32.3	33.7	117.4	118.8	113.2
			Med	7444	7286	7675	66.9	64.5	67.5	111.3	113.0	113.7
			High	11922	11629	11039	101.4	97.8	102.2	117.6	118.9	108.0

Lens Type	CRI	Length	Lumen Select	Delivered Lumens			Wattage			Efficacy lm/W		
			CCT Select	3500K	4000K	5000K	3500K	4000K	5000K	3500K	4000K	5000K
LW	80	2 ft.	Low	907	914	971	6.9	6.6	6.7	131.4	138.5	144.9
			Med	1813	1942	1829	13.9	13.3	13.2	130.4	146.0	138.6
			High	2586	2771	2943	21	20	20.2	123.1	138.6	145.7
		4 ft.	Low	2028	2125	1947	16.7	16.1	16.9	121.4	132.0	115.2
			Med	4000	4058	4241	33.5	32.3	33.7	119.4	125.6	125.8
			High	6147	6062	5900	50.7	48.9	51.1	121.2	124.0	115.5
		8 ft.	Low	4250	4146	4137	33.5	32.3	33.7	126.9	128.4	122.8
			Med	7803	7639	8273	66.9	64.5	67.5	116.6	118.4	122.6
			High	12878	11826	11548	101.4	97.8	102.2	127.0	120.9	113.0
	90	2 ft.	Low	722	822	824	6.9	6.7	6.6	104.6	122.7	124.8
			Med	1535	1547	1551	13.9	13.3	13.2	110.4	116.3	117.5
			High	2189	2491	2497	21	20.2	20.2	104.2	123.3	123.6
		4 ft.	Low	1717	1799	1652	16.7	16.1	16.9	102.8	111.7	97.8
			Med	3386	3434	3598	33.5	32.3	33.7	101.1	106.3	106.8
			High	5204	5131	5005	50.7	48.9	51.1	102.6	104.9	97.9
		8 ft.	Low	3598	3509	3509	33.5	32.3	33.7	107.4	108.6	104.1
			Med	6606	7195	7018	66.9	64.5	67.5	98.7	111.6	104.0
			High	10902	10009	9796	101.4	97.8	102.2	107.5	102.3	95.9

Metalux SNX Lensed

Energy and Performance Data - Selectable Output

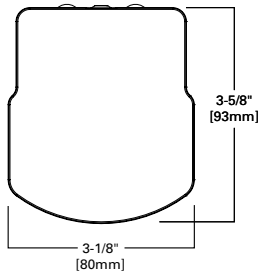
Lens Type	CRI	Length	Lumen Select	Delivered Lumens			Wattage			Efficacy		
			CCT Select	3500K	4000K	5000K	3500K	4000K	5000K	3500K	4000K	5000K
SLW	80	2 ft.	Low	845	905	905	6.9	6.6	6.7	122.5	137.1	135.1
			Med	1795	1923	1810	13.9	13.3	13.2	129.1	144.6	137.1
			High	2560	2743	2913	21	20	20.2	121.9	137.2	144.2
		4 ft.	Low	2008	1980	1927	16.7	16.1	16.9	120.2	123.0	114.0
			Med	3959	4017	4198	33.5	32.3	33.7	118.2	124.4	124.6
			High	6084	6000	5840	50.7	48.9	51.1	120.0	122.7	114.3
		8 ft.	Low	4206	4104	4095	33.5	32.3	33.7	125.6	127.1	121.5
			Med	7724	8415	8189	66.9	64.5	67.5	115.5	130.5	121.3
			High	12747	11706	11431	101.4	97.8	102.2	125.7	119.7	111.8
	90	2 ft.	Low	715	814	816	6.9	6.7	6.6	103.6	121.5	123.6
			Med	1519	1532	1536	13.9	13.3	13.2	109.3	115.2	116.4
			High	2167	2465	2326	21	20.2	20.2	103.2	122.0	115.1
		4 ft.	Low	1700	1676	1635	16.7	16.1	16.9	101.8	104.1	96.7
			Med	3352	3400	3561	33.5	32.3	33.7	100.1	105.3	105.7
			High	5151	5079	5151	50.7	48.9	51.1	101.6	103.9	100.8
		8 ft.	Low	3561	3269	3473	33.5	32.3	33.7	106.3	101.2	103.1
			Med	6539	7122	6947	66.9	64.5	67.5	97.7	110.4	102.9
			High	10791	9907	9697	101.4	97.8	102.2	106.4	101.3	94.9

Lens Type	CRI	Length	Lumen Select	Delivered Lumens			Wattage			Efficacy		
			CCT Select	3500K	4000K	5000K	3500K	4000K	5000K	3500K	4000K	5000K
FDL	80	2 ft.	Low	853	914	914	6.9	6.6	6.7	123.6	138.5	136.4
			Med	1746	1870	1828	13.9	13.3	13.2	125.6	140.6	138.5
			High	2584	2833	2833	21	20.2	20.2	123.0	140.2	140.2
		4 ft.	Low	1953	1999	1946	16.7	16.1	16.9	116.9	124.2	115.1
			Med	3998	3907	4083	33.5	32.3	33.7	119.3	121.0	121.2
			High	5918	6059	5906	50.7	48.9	51.1	116.7	123.9	115.6
		8 ft.	Low	4092	3900	3892	33.5	32.3	33.7	122.1	120.7	115.5
			Med	7799	8185	7966	66.9	64.5	67.5	116.6	126.9	118.0
			High	12399	11820	12373	101.4	97.8	102.2	122.3	120.9	121.1
	90	2 ft.	Low	722	791	793	6.9	6.7	6.6	104.6	118.1	120.2
			Med	1478	1547	1586	13.9	13.3	13.3	106.3	116.3	119.2
			High	2188	2398	2349	21	20.2	20.2	104.2	118.7	116.3
		4 ft.	Low	1653	1692	1651	16.7	16.1	16.9	99.0	105.1	97.7
			Med	3384	3307	3384	33.5	32.3	33.7	101.0	102.4	100.4
			High	5010	5128	5010	50.7	48.9	51.1	98.8	104.9	98.0
		8 ft.	Low	3464	3301	3301	33.5	32.3	33.7	103.4	102.2	98.0
			Med	6602	6927	6757	66.9	64.5	67.5	98.7	107.4	100.1
			High	10496	10004	10496	101.4	97.8	102.2	103.5	102.3	102.7

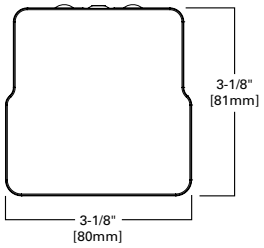
Metalux SNX Lensed

Finished Decorative End Covers

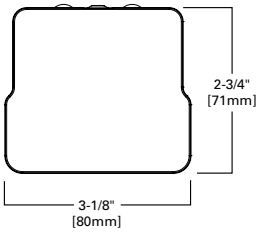
End View - Round Lens



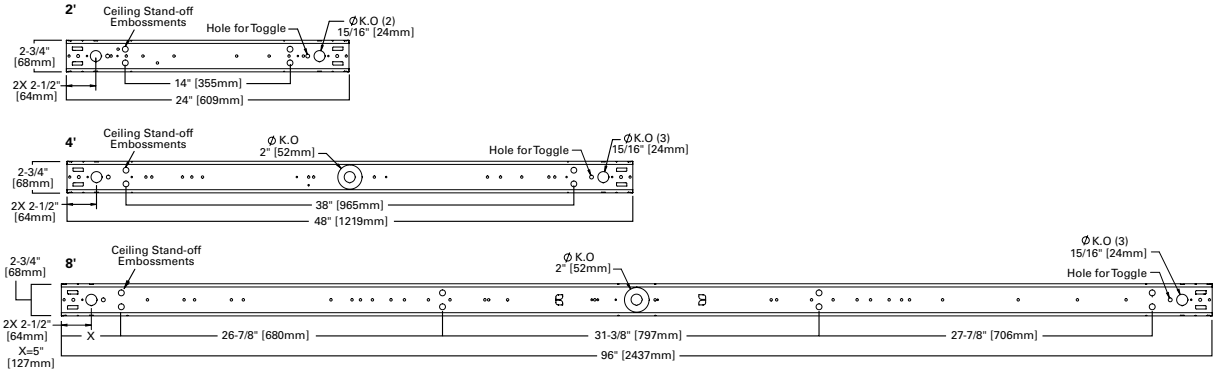
End View - Square Lens



End View - Flat Lens

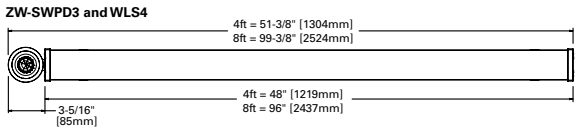


Dimensional and Mounting Details

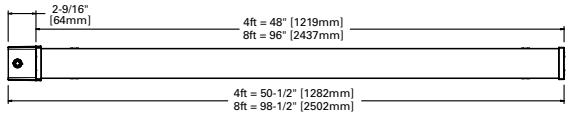


Fixture Size with Sensor

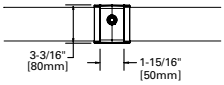
ZW-SWPD3 and WLS4



WAA or WAB



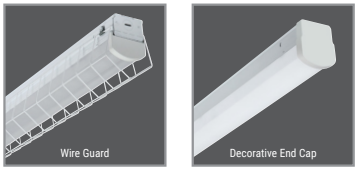
Mid-Row Sensor



Options



Accessories



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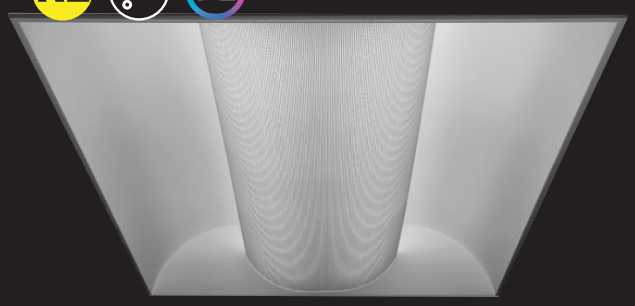
Specifications and dimensions subject to change without notice.

Luna® 2x4

LED

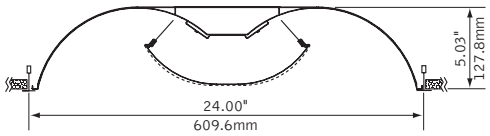
FOCAL POINT®

TYPE L4A, L4B
OFFICES

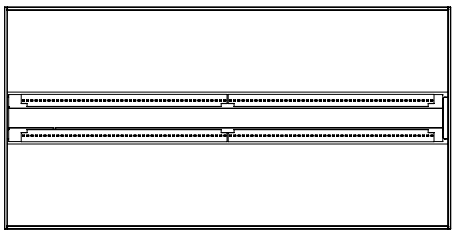


PROVIDE SPECIFIED FIXTURE BY APPROVED MANUFACTURER OR ENGINEER-APPROVED EQUAL BY:
DAY-BRITE
LITECONTROL
COLUMBIA

DIMENSIONAL DATA



Overall height of ST luminaire is 5.5"



4 LED boards

FEATURES

Architectural recessed LED luminaire with perforated center basket.

Classic style updated with the latest technology.

Reflector and end caps form seamless one-piece housing.

High reflectance, low gloss Matte White finish controls glare.

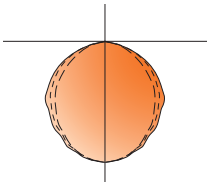
Comparable output to fluorescent versions with reduced wattage.

Luna® LED provides high angle uniform distribution ideal for comfortable general illumination.

Connected Solutions: Integrates with wired and wireless building lighting control systems.

Preferred Light: Lighting for better color rendition and human preference.

PERFORMANCE



PRODUCT OVERVIEW

Lumen Output:	3000-7000lm
Wattage:	30-83W
LPW:	83-101
SDCM:	3

Delivered Lumens: 5000lm

Total System Watts: 56W

Photometric performance is measured in accordance with IESNA LM-79.
Visit focalpointlights.com for complete photometric data.

fixture: project:

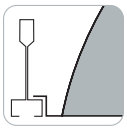
MOUNTING INFORMATION

grid

specify "G" for flat 9/16" and 15/16" tee or "ST" for 9/16" slot tee grid types.



"G" flat tee

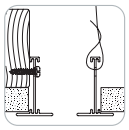


"ST" slot tee

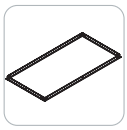
Overall height for ST luminaire is 5.50".

drywall frame kit

specify "DF" Drywall Frame Kit for drywall ceiling conditions.



Use tie–wire or screws to secure frame kit.



cut out dimensions:
2': Min: 24.25"
Max: 24.563"
4': Min: 48.25"
Max: 48.563"

SPECIFICATIONS

LED System

Proprietary linear LED module incorporates premium LEDs on a robust platform to achieve excellent thermal management. LEDs are placed to promote a uniform appearance. Available in 2700K, 3000K, 3500K or 4000K with CRI>80 or CRI>90. 0-10V dimming driver standard. LED modules and drivers are replaceable.

Construction

One-piece 20 Ga. steel reflector and housing. 20 Ga. steel ends form finished housing. LEDs are shielded by detachable 22 Ga. steel perforated shield with acrylic lens insert. LED shield is secured by four spring–pins allowing shield to hinge down for maintenance. Top access 20 Ga. steel driver compartment. Weight: 29 lbs.

Optic

One-piece 20 Ga. steel reflectors finished in Matte Satin White powder coat.

Electrical

Standard 120-277V driver includes 0-10V analog dimming, dimming range 100% - 10% Power factor > .9.

Emergency

Emergency battery output—10 watts for 90 minutes. High Output emergency battery—20 watts for 90 minutes (U.S. only). Emergency Circuit with Connected Solutions (NLT1, ENL1, CLM1, CLMZ1, DLM1) requires a UL924 compliant device, consult factory.

Labels

UL and cUL Listed. Suitable for Dry or Damp Locations, indoor use only.

Finish

Polyester powder coat applied over a multi-stage pre–treatment. Optional Anti-Microbial paint finish available.

Lumen Maintenance

Reported: L70 > 60,000 hours
L80 > 60,000 hours

Calculated: L70 at > 124,000 hours
L80 at > 78,000 hours

(Derived from EPA TM-21 calculator. Based on typical conditions, consult factory for additional data.)

Reliability

At Focal Point, our products are designed to stand the test of time. Each luminaire is engineered using superior components, manufactured with the utmost care and rigorously tested. Contact us for reliability data.

Lifetime and warranty

LED System rated for operation in ambient environments up to 25°C. 5-year limited warranty.

PERFORMANCE CHART

Lumen Output	Tested System Watts	LPW	Lumen Output	Tested System Watts	LPW
3000	30	101	5500	61	91
3500	35	100	6000	68	88
4000	43	95	6500	76	85
4500	48	94	7000	83	83
5000	56	92			

Based on 3500K, 80 CRI. Lumen multipliers: Preferred Light = 0.65, 90+ CRI = 0.87.
Lumen output may vary +/- 5%. Actual wattage may vary +/- 5%.

Focal Point LLC reserves the right to change specifications for product improvement without notification.

ORDERING

Luminaire Series		**FLUL**
Luna LED	FLUL	
Nominal Size		**24**
2' x 4'	24	
Shielding		**PS**
Perforated Shield	PS	
Lumen Output		
L4A 3000 Lumens*	3000L	
L4B 3500 Lumens*	3500L	
4000 Lumens	4000L	
4500 Lumens	4500L	
5000 Lumens	5000L	
5500 Lumens	5500L	
6000 Lumens*	6000L	
6500 Lumens*	6500L	
7000 Lumens* (*LD1 & L11 only)	7000L	
Color Temperature		
2700K, 80+ CRI **or** 90+ CRI	27K **or** 927K	
3000K, 80+ CRI **or** 90+ CRI	30K **or** 930K	
3500K, 80+ CRI **or** 90+ CRI	35K **or** 935K	
4000K, 80+ CRI **or** 90+ CRI	40K **or** 940K	
3500K, Preferred Light	P35K	
Circuit		**1C**
Single Circuit	1C	
Voltage		
UNV 120/277 Volt	UNV	
Control System & Dimming Level		
0-10V - 1% Dimming	L11	
0-10V - 10% Dimming	LD1	
Lutron Hi-Lume EcoSystem (LDE1) - 1% Dimming	LH1	
Lutron 5-Series EcoSystem (LDE5) - 5% Dimming	LU5	
Acuity nLight - 1% Dimming (Not available with CP)	NLT1	
Enlighted Smart Sensor - 1% Dimming	ENL1	
Osram Connected Lighting Module for ENCELIUM systems - 1% Dimming (Compatible with Osram ENCELIUM and ENCELIUM EDGE systems only)	CLM1	
Osram Connected Lighting Module for ZigBee Wireless Networks - 1% Dimming (Not compatible with Osram ENCELIUM systems)	CLMZ1	
Wattstopper DLM - 1% Dimming	DLM1	
Mounting		
24" Aircraft Cable	C24	
48" Aircraft Cable	C48	
96" Aircraft Cable	C96	
Drywall Frame Kit (LD1, L11, LH1 & LU5 only) (Cut out dimensions: Min: 24.25"/Max: 24.563" Min: 48.25"/Max: 48.563")	F	
Grid	G	
Slot Tee	ST	
Surface Mount (Not available with DLM1 or NLT1)	SM	
Factory Options		
Air Return (Adds 0.875" to overall height)	AR	
Chicago Plenum	CP	
Emergency Battery (Adds 3.25" to overall height)	B310	
High Output Emergency Battery (Adds 3.25" to overall height. U.S. Only)	B20	
Positional Clip	EQ	
6' New York City Flex Whip (120V)	FNY1	
6' New York City Flex Whip (277V)	FNY2	
6' Flex Whip	FW	
Finish		
Matte Satin White	WH	
Matte Satin White Anti–Microbial	WHA	

MOUNTING AS INDICATED ON PLAN

QS 5/10 DAY Options in orange qualify for the Quickship program. 5-day up to 100 pieces, 10-day up to 300 pieces. Refer to Quickship Guide for complete details.

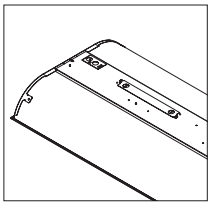
For more information visit focalpointlights.com/reference or consult factory.

CONNECTED™ SOLUTIONS

Luna® 2x4

LED

Focal Point provides flexibility in meeting the needs of each project by integrating with several building lighting control systems. A variety of sensors, drivers and other components can be specified that allow the luminaires to communicate with wired and wireless networks. All zoning can be digitally reconfigured through the application software. Daylight harvesting, occupancy sensing, integration with HVAC systems, and individual controls enable the monitoring and modulating of light levels and temperature in order to save energy, reduce costs and maximize occupants' comfort. All Connected Solutions luminaires require a compatible building control system.†





nLIGHT

nLight® provides a two-way wired digital lighting system allowing for on/off and dimming functionality, occupancy sensing, and multi-zone daylight harvesting.

Acuity nLight - 1% Dimming (NLT1)
Acuity Model #nEPS-60-IO

CAT-5 Cable provided by others.Serial labels will be provided on outside of luminaires and control unit.



enlighted A Siemens Company

Enlighted smart sensor allows for occupancy sensing, daylight harvesting, energy usage, temperature and light level control. Communicates wirelessly with the Enlighted network.

Enlighted Smart Sensor - 1% Dimming (ENL1)
Enlighted Model #SU-5E-IOT

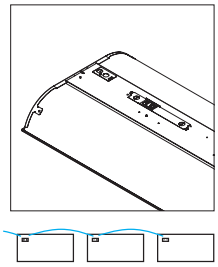


OSRAM

Connected Lighting Module (CLM) enables each luminaire to be independently controlled and configured. Communicates wirelessly with Daintree Networks®, Osram ENCELIUM®, Osram ENCELIUM EDGE™, and other networks using the ZigBee® HA communication protocol to allow for on/off and dimming functionality, occupancy sensing and multi-zone daylight harvesting.

Osram CLM - 1% Dimming (CLM1 & CLMZ1)
Osram Model #ZBHA-CLM DIM

Serial labels will be provided on outside of luminaires and control unit.

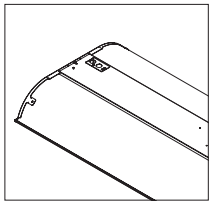


legrand® WATTSTOPPER®

A Digital Lighting Management (DLM) system that provides two-way wired communication between networked luminaires and control system to allow for on/off and dimming functionality, occupancy sensing and multi-zone daylight harvesting.

Wattstopper DLM - 1% Dimming (DLM1)
Wattstopper Model #LMFC-011

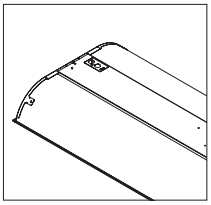
CAT-5 Cable provided by others. Serial labels will be provided on outside of luminaires and control unit.



LUTRON

A two-way digital network that enables on/off and dimming functionality, occupancy sensing, and multi-zone daylight harvesting working with Quantum®, Energi Savr Node™, and Energi TriPak® using EcoSystem® communication protocol.

Lutron Hi-Lume EcoSystem - 1% Dimming (LH1)
Lutron Model #LDE1
Lutron 5-Series EcoSystem - 5% Dimming (LU5)
Lutron Model #LDE5



CRESTRON

A two-way digital network that enables on/off and dimming functionality, occupancy sensing, and multi-zone daylight harvesting. Communicates with Zūm wireless and SpaceBuilder working with Zūm hub scheduling or FUSION management.

0-10V - 1% Dimming (L11)
Note: 0-10V is not a digital network but is compatible with Creston Zūm™ system.

CONNECTED SOLUTIONS DETAILS

Connected Solution	Model #	Protocol	Compatible Networks*	Occupancy	Daylight	Temperature Reporting	Communication to Luminaire	Drivers
Acuity nLight (NLT1)	nEPS-60-IO**	nLight	nLight	Enabled	Enabled	No	Wired	**eldoLED ECOdrive,** eldoLED SOLOdrive
Crestron (L11)	Specified Driver	0-10V	Crestron Zūm Wireless & SpaceBuilder	Enabled	Enabled	No	Wired	**Advance by Signify**
Enlighted Smart Sensor (ENL1)	SU-5E-IOT**	Enlighted RF	Enlighted	Integrated	Integrated	Yes	Wireless	**Osram Optotronic**, Advance by Signify
Legrand Wattstopper DLM (DLM1)	LMFC-011**	DLM	DLM	Enabled	Enabled	No	Wired	**Osram Optotronic**, Advance by Signify
Lutron EcoSystem (LH1 & LU5)	LDE1,** LDE5**	EcoSystem	Quantum, Energi Savr Node, Energi TriPak	Enabled	Enabled	No	Wired	**Lutron Hi-Lume Lutron 5-Series**
Osram CLM for ENCELIUM systems (CLM1)	ZBHA-CLM**	ZigBee HA	Osram ENCELIUM & ENCELIUM EDGE	Enabled	Enabled	No	Wireless	**Osram Optotronic**
Osram CLM for ZigBee Wireless Networks (CLMZ1)	ZBHA-CLM**	ZigBee HA	Daintree Networks & open ZigBee Networks	Enabled	Enabled	No	Wireless	**Osram Optotronic**

*Not all compatible networks may be listed. **For performance data and additional control system details please visit the connected solutions manufacturer websites. Primary drivers are listed in **bold.** To specify a particular driver please consult factory. †Controls systems supplied by others.

LITHONIA LIGHTING®

Catalog Number	TYPE L5 STAIRWELL
Notes	PROVIDE SPECIFIED FIXTURE BY APPROVED MANUFACTURER OR ENGINEER-APPROVED EQUAL BY: COLUMBIA METALUX DAY-BRITE
Type	

DIGITAL NAVIGATION

Ordering Tree SensorSwitch JOT nLight Platform Photometrics Performance Data

CPX LED PANEL

Configurable
1' x 4', 2' x 2'and 2' x 4'



FEATURES & SPECIFICATIONS

INTENDED USE — The CPX Series LED is a low-glare back-lit panel featuring an external driver. This cost-effective, reliable flat panel is visually comfortable and can be recessed mounted. Suitable for many applications such as schools, offices, retail, convenience stores, hospitals, healthcare facilities and other commercial spaces. A typically configured CPX features a **Unified Glare Rating (UGR)** starting at 17. Certain airborne contaminants can diminish the integrity of acrylic. **Click here for Acrylic Environmental Compatibility table for suitable uses. U.S. Patent No. 10,681,784.**

CONSTRUCTION — A metal frame with satin white lens provides excellent shielding and uniform luminance. CPX's low-profile design provides increased installation flexibility especially in restricted plenum spaces. The back plate includes integral T-bar clips for installation into T-grid ceilings.

ELECTRICAL — Direct-lit Panel with Long-Life LEDs, coupled with a high-efficiency driver, provide superior illumination for extended service life. Greater than 70% LED lumen maintenance at 60,000 hours (L80>60,000). 0-10V dimming driver. Options available for dimming to 1% or 10%. Contains non-isolated dimming leads.

Integrated Wireless Sensor (single room control) — SensorSwitch wireless dimming (JOT) or luminaire embedded occupancy sensor control (VPIR15) with JOT pairing for wall switch On/Off /Dimming control or auto off when the space is unoccupied. See page 8 for more details of the integrated wireless sensor.

Integrated Sensor (nLight® Wired Networking) — This sensor is nLight-enabled, meaning it has the ability to communicate over an nLight network. When wired, using CAT-5 cabling, with other nLight-enabled sensors, power packs, or WallPods, an nLight control zone is created. Once linked to a Gateway, directly or via a Bridge, the zone becomes capable of remote status monitoring and control via SensorView software.

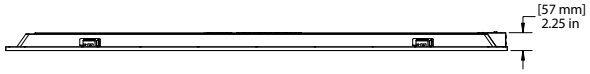
Integrated Smart Sensor (nLight Air Wireless Platform) — The RES7 sensor is nLight AIR enabled, meaning it has the ability to communicate over the wireless nLight control platform. It is available with an automatic dimming photocell, and either a digital PIR or a microphonics (PDT) dual technology occupancy sensor. It pairs to other luminaires and wall switches through our mobile app, CLAIRITY+, which allows for simple sensor adjustment.

LISTINGS — CSA certified to meet US and Canadian standards. Damp location listed. IC rated. IP5X Rated. DesignLights Consortium® (DLC) qualified product. Not all versions of this product may be DLC qualified. Please check the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified. Rated for NSF/ANSI Standard 2 - Light Fixture for Splash Zone and Non-Food Zone. NOM Certified.

BUY AMERICAN ACT — Product with the BAA option is assembled in the USA and meets the Buy America(n) government procurement requirements under FAR, DFARS and DOT regulations. Please refer to www.acuitybrands.com/buy-american for additional information.

WARRANTY — 5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

Note: Actual performance may differ as a result of end-user environment and application.
All values are design or typical values, measured under laboratory conditions at 25 °C.
Specifications subject to change without notice.



† Tested in accordance with ISO 14644-14; suitable for ISO Class 5-9 positive and negative pressure clean rooms.

Embed nLight controls today. Prepare for tomorrow.

Now	Tomorrow
User-friendly install	Scalability
Enhanced energy savings	Space configuration
Code compliance	Future-ready

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning when used with Acuity Brands controls products.

All configurations of this luminaire are calibrated and tested to meet the Acuity Brands' specifications for chromatic consistency – including color rendering, color fidelity, and color temperature tolerance around standard CIE chromaticity coordinates.

To learn more about Acuity A+ standards, specifications, and testing visit www.acuitybrands.com/aplus.

design select

Items marked by a shaded background qualify for the Design Select program and ship in 15 days or less. To learn more about Design Select, visit www.acuitybrands.com/designselect.
*See ordering tree for details

Configurable CPX LED Flat Panel

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Design Select options indicated by this color background.

Looking for Contractor Select readily available configurations? Click here to visit Contractor Select™ spec sheet or go to www.contractorselect.com

ORDERING INFORMATION

Example: CPX 2X2 3200LM 80CRI 40K SWL MIN10 ZT MVOLT E10WLCP

Series	Fixture Dimension	Lumen Output		CRI	Color Temperature	Diffuser	Minimum Dimming Level
CPX LED Panel	1X4 1' X 4'	**Standard lumens:** 2000LM 2000 Lumens 3200LM 3200 Lumens 4000LM 4000 Lumens 5000LM 5000 Lumens 6000LM 6000 Lumens	**High Efficiency lumens:** 3200LMHE 3200 Lumens 4000LMHE 4000 Lumens	80CRI 80 CRI	30K 3000K 35K 3500K 40K 4000K 50K 5000K	SWL Satin White A12 Prismatic A12 Pattern	MIN10 Dims to 10% MIN1 Dims to 1% ‡
	2X2 2' X 2'	2000LM 2000 Lumens 3200LM 3200 Lumens 4000LM 4000 Lumens 5000LM 5000 Lumens 6000LM 6000 Lumens	3200LMHE 3200 Lumens 4000LMHE 4000 Lumens				
	2X4 2' X 4'	3000LM 3000 Lumens 4000LM 4000 Lumens 5000LM 5000 Lumens 6000LM 6000 Lumens 7200LM 7200 Lumens 8500LM 8500 Lumens 10000LM 10000 Lumens ‡	4000LMHE 4000 Lumens 5000LMHE 5000 Lumens				

Dimming ‡	Voltage	Step Level Dimming	Emergency Option
(blank) If Controls are being used. ZT Generic 0-10V Dimming EZT eldoLED 0-10V Dimming ‡	MVOLT MVOLT, 120-277V 120 120V 277 277V 347 347 ‡	(blank) None SLD Step Level Dimming ‡	(blank) No battery E10WLCP EM Self-Diagnostic battery pack, 10W Constant Power, Certified in CA Title 20 MAEDBS ‡ E7W Emergency Battery Pack, 7W, CA Title 20 Noncompliant ‡ GTD Generator Transfer Device ‡

Control Input	Sensor	Options
(blank) No controls	(blank) No sensor	GLR Fast-blowing fuse ‡ GMF Slow-blowing Fuse ‡ PWS1836 6' pre-wire, 3/8" diameter, 18 gauge, 1 circuit ‡ PWS1846 6' pre-wire, 3/8" diameter, 18 gauge, 2 circuit ‡ PWS1856LV 6' pre-wire, 3/8" diameter, 18 gauge, 1 circuit w/ low voltage ‡ PWS1846 PWSLV Two cables: one 6' pre-wire, 3/8" diameter, 18 gauge, 2 circuits; one 6' pre-wire, 3/8" diameter, 18 gauge ‡ DWAM Anti-Microbial paint CP Chicago plenum ‡ NPLT Narrow Pallet BAA Buy America(n) Act Compliant
SSE Sensor Switch Embedded	APIR Occ sensing with passive infrared - on/off functionality and auto dimming photocell APDT Occ sensor dual tech (passive infrared & microphonics) and auto dimming photocell VAPIR15 Vertex low-profile on/off occupancy sensor with auto dimming photocell with VLP programming at 15ft mounting height	
NLIGHT nLight enabled NLIGHTER nLight enabled, for use with generator supply EM power NLIGHTLM nLight enabled with lumen management NLIGHTERLM nLight enabled with lumen management, for use with generator supply EM power	(blank) No sensor, Control Input function only PIR Occ sensing with passive infrared - on/off functionality PDT Occ sensor dual tech (passive infrared & microphonics) APIR Occ sensing with passive infrared - on/off functionality and auto dimming photocell APDT Occ sensor dual tech (passive and microphonics) and auto dimming photocell.	
NLTAIR2 nLight AIR Generation 2 (wireless) enabled ‡ NLTAIREM2 nLight AIR Generation 2 (wireless) enabled and UL924 Emergency Operation, via power interrupt detection. ‡	(blank) No sensor, Control Input function only APIR Occ sensing with passive infrared - on/off functionality and auto dimming photocell APDT Occ sensor dual tech (passive and microphonics) and auto dimming photocell APIREM Occ sensing with passive infrared - on/off functionality and auto dimming photocell and UL924 Emergency operation, via power interrupt detection APDTEM Occ sensing dual tech- ([passive infrared & microphonics) and auto dimming photocell and UL924 Emergency operation, via power interrupt detection	
JOT Wireless room control with "Just One Touch" pairing	(blank) No sensor, Control Input function only VAPIR15 Vertex low-profile on/off occupancy sensor with auto dimming photocell at 15ft mounting height	

NOTE: ‡ indicates option chosen has ordering restriction or note. Please reference restrictions/notes chart on next page. Restriction notes are sorted in the sequence they appear in the ordering tree.

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Configurable CPX LED Flat Panel

OPTION VALUE RESTRICTIONS/ NOTES

‡ Option Value Ordering Notes/ Restrictions	
Option value	**Restriction**
10000LM	Not available with JOT or with VAPIR15.
MIN1	Required for all Control Input Options, except JOT.
Dimming	If Control Input option selected leave this section blank.
EZT	Not available with 10000LM combined with 2X4.
347	347 not available with SLD, E10WLCP, E7W, and GTD Options.
SLD	Leave **Minimum Dimming Level** and **Dimming** option sections blank. Not available with MIN1, MIN10, EZT, ZT or GTD. Not available with any controls.
E10WLCP, E7W	Not available with 347. Configurations with E10WLCP or E7W to be used in daisy chaining or through wiring will require a Y connector not supplied. If used with CP option the contractor must verify that the Y connector is Chicago Plenum rated.
GTD	Not available with 347, SLD or in 1X4 combined with 6000LM.
NLTAIR2	See UL924 Sequence of Operation Chart below. Can be used as a normal power sensing device for nLight AIR devices and luminaires with EM emergency options .
NLTAIREM2	See UL924 Sequence of Operation Chart below. Leave Sensor option section blank, not available with APIR, APDT, APIREM, or APDTEM.
GLR, GMF	Must specify voltage, only available with 120 or 277V.
PWS1836	Not available with E10WLCP or E7W.
PWS1846	Only available with E10WLCP, E7W or SLD.
PWS1856LV	Not available with E10WLCP, E7W or Controls.
PWS1846 PWSLV	Not available with Controls or SLD.
CP	CP Not available with PWS1836, PWS1846, PWS1856LV, or PWS1846 PWSLV, NLIGHT, NLIGHTER, NLIGHTLM, NLIGHTERLM options.

ACCESSORIES

Accessories: *Order as separate catalog number.*

ILBLP CP10 HE SD A	IOTA 10 Watt Constant Power, High Efficiency LED Emergency Driver for CA Title 20 ‡
ELA PSDMT	Remote mount tray for ILBLP battery.
DGA14	Drywall grid adapter for 1x4 recessed fixture.
DGA22	Drywall grid adapter for 2x2 recessed fixture.
DGA24	Drywall grid adapter for 2x4 recessed fixture.
1X4SMKSH	Multi-Use Surface Mount Kit 1x4, Shallow Depth
2X2SMKSH	Multi-Use Surface Mount Kit 2x2, Shallow Depth
2X4SMKSH	Multi-Use Surface Mount Kit 2x4, Shallow Depth
1X4SMKSHP PAF	Multi-Use Surface Mount Kit 1X4 Post-Paint
2X2SMKSHP PAF	Multi-Use Surface Mount Kit 2X2 Post-Paint
2X4SMKSHP PAF	Multi-Use Surface Mount Kit 2X4 Post-Paint
PAC 2DNF 36	Panel Air Craft Kit, 2 cables with Y splitter, No Power Feed, 36 inches. Recommended for 2X2 or 1X4 Panel Fixture.
PAC 2DF 36	Panel Air Craft Kit, 2 cables with Y splitter, with Power Feed, 36 inches. Recommended for 2X2 or 1X4 Panel Fixture.[1]
PAC 4DNF 36	Panel Air Craft Kit, 4 cables, No Power Feed, 36 inches. Recommended for 2X4 or 2X2 or 1X4 Panel Fixtures.
PAC 4DF 36	Panel Air Craft Kit, 4 cables, with Power Feed, 36 inches. Recommended for 2X4 or 2X2 or 1X4 Panel Fixtures.[1]
PAC 2DNF 72	Panel Air Craft Kit, 2 cables with Y splitter, No Power Feed 72 inches. Recommended for 2X2 or 1X4 Panel Fixture.
PAC 2DF 72	Panel Air Craft Kit, 2 cables with Y splitter, with Power Feed, 72 inches. Recommended for 2X2 or 1X4 Panel Fixture.[1]
PAC 4DNF 72	Panel Air Craft Kit, 4 cables, No Power Feed, 72 inches. Recommended for 2X4 or 2X2 or 1X4 Panel Fixtures.
PAC 4DF 72	Panel Air Craft Kit, 4 cables, with Power Feed, 72 inches. Recommended for 2X4 or 2X2 or 1X4 Panel Fixtures.[1]
RK8BDP 2P U	Disconnect Plug (BDP), 2 Pole, Package of 1
RK8BDP 3P U	Disconnect Plug (BDP), 3 Pole, Package of 1
RK8BDP 2P J10	Disconnect Plug (BDP), 2 Pole, Package of 10
RK8BDP 2P J40	Disconnect Plug (BDP), 2 Pole, Package of 40

Emergency Battery Delivered Lumens

Use the formula below to determine the delivered lumens in emergency mode

Delivered Lumens = 1.25 x P x LPW

P = Output power of emergency driver (10W for PS1055)

LPW = Lumen per watt rating of the luminaire.

Notes
1 For MVOLT only, not available with 347V.

UL924 Sequence of Operation

The below information applies to all nLight AIR devices with an EM option.

- EM devices will remain at their high-end trim and ignore wireless lighting control commands, unless a normal-power-sensed (NPS) broadcast is received at least every 8 seconds.
- Using the CL**AIR**ITY+ mobile app, EM devices must be associated with a group that includes a normal power sensing device to receive NPS broadcasts.
- Only non-emergency rPP20, rLSXR, rSBOR, rSDGR, and nLight AIR luminaires with version 3.4 or later firmware can provide normal power sensing for EM devices. See specification sheets for control devices and luminaires for more information on options that support normal power sensing.

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Configurable CPX LED Flat Panel

Emergency Battery Pack Options - Field Installable

Battery Model Number	Wattage	Runtime (Minutes)	Lumen Output* @ 120 Lumens/Watt	Other
ILB CP07 2H A	7W	120	840	Storm Shelter/ 2-hour Runtime
ILB CP10 A	10W	90	1200	
ILBLP CP10 HE SD A	10W	90	1200	Title 20, Self Diagnostic
ILB CP10 HE AELR A	10W	90	1200	Title 20; Enabled with Self Testing, Automated Reporting (STAR)
ILBLP CP15 HE SD A	15W	90	1800	Title 20, Self Diagnostic
ILB CP20 HE A	20W	90	2400	Title 20
ILB CP20 HE SD A	20W	90	2400	Title 20, Self Diagnostic

All the above are UL Listed products that are certified for field install external/remote to the fixture.
*Minimum delivered lumen output to assist in product selection for increased fixture mounting height.
The CP10 delivered emergency illumination outperforms legacy 1400 lumen fluorescent emergency ballast.
Please contact us at techsupport@iotaengineering.com for any Emergency Battery related questions.

star
SELF-TESTING AUTOMATED REPORTING

+

Field Installed Emergency LED Driver



ILB CP10 HE AELR A

Compliance Just Got Easier!

Emergency Lighting with Self Testing Automated Reporting (STAR), enables self-testing and automated reporting to aid in life safety code compliance. Emergency lighting equipment enabled with STAR, automatically conducts the required monthly and annual tests, logs results within the units, and wirelessly communicates test data on demand to the CLARITY+ mobile app. **Leave the ladders, disruptions and written records behind with emergency lighting solutions with STAR!**





DOWNLOAD CLAIRTY™+

Available on the App Store
ANDROID APP ON Google play

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Configurable CPX LED Flat Panel

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PERFORMANCE DATA

Model #	Lumens	LPW	Watts
CPX 2X2 2000LM 80CRI 30K SWL	2092	134.1	15.6
CPX 2X2 2000LM 80CRI 30K A12	2013	129.1	15.6
CPX 2X2 2000LM 80CRI 35K SWL	2167	138.9	15.6
CPX 2X2 2000LM 80CRI 35K A12	2085	133.7	15.6
CPX 2X2 2000LM 80CRI 40K SWL	2206	141.4	15.6
CPX 2X2 2000LM 80CRI 40K A12	2122	136.1	15.6
CPX 2X2 2000LM 80CRI 50K SWL	2212	141.8	15.6
CPX 2X2 2000LM 80CRI 50K A12	2128	136.4	15.6
CPX 2X2 3200LM 80CRI 30K SWL	3542	117.7	30.1
CPX 2X2 3200LM 80CRI 30K A12	3408	113.2	30.1
CPX 2X2 3200LM 80CRI 35K SWL	3669	121.9	30.1
CPX 2X2 3200LM 80CRI 35K A12	3530	117.3	30.1
CPX 2X2 3200LM 80CRI 40K SWL	3734	124.1	30.1
CPX 2X2 3200LM 80CRI 40K A12	3593	119.4	30.1
CPX 2X2 3200LM 80CRI 50K SWL	3744	124.4	30.1
CPX 2X2 3200LM 80CRI 50K A12	3603	119.7	30.1
CPX 2X2 3200LMHE 80CRI 30K SWL	3542	127.1	27.9
CPX 2X2 3200LMHE 80CRI 30K A12	3408	122.3	27.9
CPX 2X2 3200LMHE 80CRI 35K SWL	3669	131.7	27.9
CPX 2X2 3200LMHE 80CRI 35K A12	3530	126.7	27.9
CPX 2X2 3200LMHE 80CRI 40K SWL	3734	134.0	27.9
CPX 2X2 3200LMHE 80CRI 40K A12	3593	129.0	27.9
CPX 2X2 3200LMHE 80CRI 50K SWL	3744	134.4	27.9
CPX 2X2 3200LMHE 80CRI 50K A12	3603	129.3	27.9
CPX 2X2 4000LM 80CRI 30K SWL	4272	117.7	36.3
CPX 2X2 4000LM 80CRI 30K A12	4111	113.2	36.3
CPX 2X2 4000LM 80CRI 35K SWL	4425	121.9	36.3
CPX 2X2 4000LM 80CRI 35K A12	4257	117.3	36.3
CPX 2X2 4000LM 80CRI 40K SWL	4504	124.1	36.3
CPX 2X2 4000LM 80CRI 40K A12	4334	119.4	36.3
CPX 2X2 4000LM 80CRI 50K SWL	4516	124.4	36.3
CPX 2X2 4000LM 80CRI 50K A12	4346	119.7	36.3
CPX 2X2 4000LMHE 80CRI 30K SWL	4272	123.7	34.5
CPX 2X2 4000LMHE 80CRI 30K A12	4111	119.0	34.5
CPX 2X2 4000LMHE 80CRI 35K SWL	4425	128.1	34.5
CPX 2X2 4000LMHE 80CRI 35K A12	4257	123.3	34.5
CPX 2X2 4000LMHE 80CRI 40K SWL	4504	130.4	34.5
CPX 2X2 4000LMHE 80CRI 40K A12	4334	125.5	34.5
CPX 2X2 4000LMHE 80CRI 50K SWL	4516	130.8	34.5
CPX 2X2 4000LMHE 80CRI 50K A12	4346	125.8	34.5
CPX 2X2 5000LM 80CRI 30K SWL	5186	124.1	41.8
CPX 2X2 5000LM 80CRI 30K A12	4990	119.4	41.8
CPX 2X2 5000LM 80CRI 35K SWL	5371	128.5	41.8
CPX 2X2 5000LM 80CRI 35K A12	5168	123.6	41.8
CPX 2X2 5000LM 80CRI 40K SWL	5468	130.8	41.8
CPX 2X2 5000LM 80CRI 40K A12	5261	125.9	41.8
CPX 2X2 5000LM 80CRI 50K SWL	5482	131.2	41.8
CPX 2X2 5000LM 80CRI 50K A12	5275	126.2	41.8
CPX 2X2 6000LM 80CRI 30K SWL	6354	117.4	54.1
CPX 2X2 6000LM 80CRI 30K A12	6114	113.0	54.1
CPX 2X2 6000LM 80CRI 35K SWL	6581	121.6	54.1
CPX 2X2 6000LM 80CRI 35K A12	6332	117.0	54.1
CPX 2X2 6000LM 80CRI 40K SWL	6699	123.8	54.1
CPX 2X2 6000LM 80CRI 40K A12	6446	119.1	54.1
CPX 2X2 6000LM 80CRI 50K SWL	6717	124.1	54.1
CPX 2X2 6000LM 80CRI 50K A12	6463	119.4	54.1

Model #	Lumens	LPW	Watts
CPX 2X4 3000LM 80CRI 30K SWL	3207	130.5	24.6
CPX 2X4 3000LM 80CRI 30K A12	3102	126.3	24.6
CPX 2X4 3000LM 80CRI 35K SWL	3287	133.8	24.6
CPX 2X4 3000LM 80CRI 35K A12	3180	129.4	24.6
CPX 2X4 3000LM 80CRI 40K SWL	3368	137.1	24.6
CPX 2X4 3000LM 80CRI 40K A12	3258	132.6	24.6
CPX 2X4 3000LM 80CRI 50K SWL	3412	138.9	24.6
CPX 2X4 3000LM 80CRI 50K A12	3300	134.3	24.6
CPX 2X4 4000LM 80CRI 30K SWL	4700	128.1	36.7
CPX 2X4 4000LM 80CRI 30K A12	4546	123.9	36.7
CPX 2X4 4000LM 80CRI 35K SWL	4818	131.3	36.7
CPX 2X4 4000LM 80CRI 35K A12	4660	127.0	36.7
CPX 2X4 4000LM 80CRI 40K SWL	4936	134.5	36.7
CPX 2X4 4000LM 80CRI 40K A12	4775	130.1	36.7
CPX 2X4 4000LM 80CRI 50K SWL	5000	136.3	36.7
CPX 2X4 4000LM 80CRI 50K A12	4837	131.8	36.7
CPX 2X4 4000LMHE 80CRI 30K SWL	4814	138.3	34.8
CPX 2X4 4000LMHE 80CRI 30K A12	4657	133.8	34.8
CPX 2X4 4000LMHE 80CRI 35K SWL	4986	143.3	34.8
CPX 2X4 4000LMHE 80CRI 35K A12	4823	138.6	34.8
CPX 2X4 4000LMHE 80CRI 40K SWL	5075	145.8	34.8
CPX 2X4 4000LMHE 80CRI 40K A12	4910	141.1	34.8
CPX 2X4 4000LMHE 80CRI 50K SWL	5089	146.2	34.8
CPX 2X4 4000LMHE 80CRI 50K A12	4923	141.4	34.8
CPX 2X4 5000LM 80CRI 30K SWL	4945	123.6	40.0
CPX 2X4 5000LM 80CRI 30K A12	4783	119.6	40.0
CPX 2X4 5000LM 80CRI 35K SWL	5069	126.7	40.0
CPX 2X4 5000LM 80CRI 35K A12	4904	122.6	40.0
CPX 2X4 5000LM 80CRI 40K SWL	5193	129.8	40.0
CPX 2X4 5000LM 80CRI 40K A12	5024	125.6	40.0
CPX 2X4 5000LM 80CRI 50K SWL	5261	131.5	40.0
CPX 2X4 5000LM 80CRI 50K A12	5089	127.2	40.0
CPX 2X4 5000LMHE 80CRI 30K SWL	5437	136.6	39.8
CPX 2X4 5000LMHE 80CRI 30K A12	5260	132.1	39.8
CPX 2X4 5000LMHE 80CRI 35K SWL	5631	141.5	39.8
CPX 2X4 5000LMHE 80CRI 35K A12	5447	136.8	39.8
CPX 2X4 5000LMHE 80CRI 40K SWL	5732	144.0	39.8
CPX 2X4 5000LMHE 80CRI 40K A12	5545	139.3	39.8
CPX 2X4 5000LMHE 80CRI 50K SWL	5748	144.4	39.8
CPX 2X4 5000LMHE 80CRI 50K A12	5560	139.7	39.8
CPX 2X4 6000LM 80CRI 30K SWL	5777	138.3	41.8
CPX 2X4 6000LM 80CRI 30K A12	5588	133.8	41.8
CPX 2X4 6000LM 80CRI 35K SWL	5983	143.2	41.8
CPX 2X4 6000LM 80CRI 35K A12	5788	138.6	41.8
CPX 2X4 6000LM 80CRI 40K SWL	6091	145.8	41.8
CPX 2X4 6000LM 80CRI 40K A12	5892	141.1	41.8
CPX 2X4 6000LM 80CRI 50K SWL	6107	146.2	41.8
CPX 2X4 6000LM 80CRI 50K A12	5908	141.4	41.8
CPX 2X4 7200LM 80CRI 30K SWL	7405	130.9	56.6
CPX 2X4 7200LM 80CRI 30K A12	7163	126.6	56.6
CPX 2X4 7200LM 80CRI 35K SWL	7669	135.6	56.6
CPX 2X4 7200LM 80CRI 35K A12	7419	131.2	56.6
CPX 2X4 7200LM 80CRI 40K SWL	7807	138.0	56.6
CPX 2X4 7200LM 80CRI 40K A12	7552	133.5	56.6
CPX 2X4 7200LM 80CRI 50K SWL	7828	138.4	56.6
CPX 2X4 7200LM 80CRI 50K A12	7573	133.9	56.6
CPX 2X4 8500LM 80CRI 30K SWL	8831	124.6	70.9
CPX 2X4 8500LM 80CRI 30K A12	8543	120.5	70.9
CPX 2X4 8500LM 80CRI 35K SWL	9146	129.0	70.9
CPX 2X4 8500LM 80CRI 35K A12	8848	124.8	70.9
CPX 2X4 8500LM 80CRI 40K SWL	9310	131.4	70.9
CPX 2X4 8500LM 80CRI 40K A12	9007	127.1	70.9
CPX 2X4 8500LM 80CRI 50K SWL	9336	131.7	70.9
CPX 2X4 8500LM 80CRI 50K A12	9031	127.4	70.9
CPX 2X4 10000LM 80CRI 30K SWL	10422	119.0	87.6
CPX 2X4 10000LM 80CRI 30K A12	10082	115.1	87.6
CPX 2X4 10000LM 80CRI 35K SWL	10794	123.3	87.6
CPX 2X4 10000LM 80CRI 35K A12	10442	119.3	87.6
CPX 2X4 10000LM 80CRI 40K SWL	10988	125.5	87.6
CPX 2X4 10000LM 80CRI 40K A12	10629	121.4	87.6
CPX 2X4 10000LM 80CRI 50K SWL	11018	125.8	87.6
CPX 2X4 10000LM 80CRI 50K A12	10658	121.7	87.6

Model #	Lumens	LPW	Watts
CPX 1X4 2000LM 80CRI 30K SWL	2048	119.2	17.2
CPX 1X4 2000LM 80CRI 30K A12	2010	117.0	17.2
CPX 1X4 2000LM 80CRI 35K SWL	2100	122.2	17.2
CPX 1X4 2000LM 80CRI 35K A12	2061	120.0	17.2
CPX 1X4 2000LM 80CRI 40K SWL	2151	125.2	17.2
CPX 1X4 2000LM 80CRI 40K A12	2111	122.9	17.2
CPX 1X4 2000LM 80CRI 50K SWL	2179	126.9	17.2
CPX 1X4 2000LM 80CRI 50K A12	2139	124.5	17.2
CPX 1X4 3200LM 80CRI 30K SWL	3232	110.3	29.3
CPX 1X4 3200LM 80CRI 30K A12	3172	108.2	29.3
CPX 1X4 3200LM 80CRI 35K SWL	3313	113.1	29.3
CPX 1X4 3200LM 80CRI 35K A12	3251	111.0	29.3
CPX 1X4 3200LM 80CRI 40K SWL	3394	115.8	29.3
CPX 1X4 3200LM 80CRI 40K A12	3331	113.7	29.3
CPX 1X4 3200LM 80CRI 50K SWL	3439	117.3	29.3
CPX 1X4 3200LM 80CRI 50K A12	3375	115.2	29.3
CPX 1X4 3200LMHE 80CRI 30K SWL	3353	124.3	27.0
CPX 1X4 3200LMHE 80CRI 30K A12	3291	122.0	27.0
CPX 1X4 3200LMHE 80CRI 35K SWL	3473	128.8	27.0
CPX 1X4 3200LMHE 80CRI 35K A12	3408	126.4	27.0
CPX 1X4 3200LMHE 80CRI 40K SWL	3535	131.1	27.0
CPX 1X4 3200LMHE 80CRI 40K A12	3469	128.6	27.0
CPX 1X4 3200LMHE 80CRI 50K SWL	3545	131.4	27.0
CPX 1X4 3200LMHE 80CRI 50K A12	3479	129.0	27.0
CPX 1X4 4000LM 80CRI 30K SWL	4069	114.6	35.5
CPX 1X4 4000LM 80CRI 30K A12	3994	112.4	35.5
CPX 1X4 4000LM 80CRI 35K SWL	4172	117.4	35.5
CPX 1X4 4000LM 80CRI 35K A12	4094	115.3	35.5
CPX 1X4 4000LM 80CRI 40K SWL	4274	120.3	35.5
CPX 1X4 4000LM 80CRI 40K A12	4194	118.1	35.5
CPX 1X4 4000LM 80CRI 50K SWL	4330	121.9	35.5
CPX 1X4 4000LM 80CRI 50K A12	4249	119.6	35.5
CPX 1X4 4000LMHE 80CRI 30K SWL	4154	123.8	33.5
CPX 1X4 4000LMHE 80CRI 30K A12	4077	121.5	33.5
CPX 1X4 4000LMHE 80CRI 35K SWL	4302	128.2	33.5
CPX 1X4 4000LMHE 80CRI 35K A12	4222	125.9	33.5
CPX 1X4 4000LMHE 80CRI 40K SWL	4380	130.5	33.5
CPX 1X4 4000LMHE 80CRI 40K A12	4298	128.1	33.5
CPX 1X4 4000LMHE 80CRI 50K SWL	4391	130.9	33.5
CPX 1X4 4000LMHE 80CRI 50K A12	4310	128.5	33.5
CPX 1X4 5000LM 80CRI 30K SWL	4988	118.1	42.2
CPX 1X4 5000LM 80CRI 30K A12	4895	115.9	42.2
CPX 1X4 5000LM 80CRI 35K SWL	5166	122.3	42.2
CPX 1X4 5000LM 80CRI 35K A12	5070	120.0	42.2
CPX 1X4 5000LM 80CRI 40K SWL	5259	124.5	42.2
CPX 1X4 5000LM 80CRI 40K A12	5161	122.2	42.2
CPX 1X4 5000LM 80CRI 50K SWL	5273	124.8	42.2
CPX 1X4 5000LM 80CRI 50K A12	5175	122.5	42.2
CPX 1X4 6000LM 80CRI 30K SWL	6373	114.9	55.4
CPX 1X4 6000LM 80CRI 30K A12	6254	112.8	55.4
CPX 1X4 6000LM 80CRI 35K SWL	6601	119.0	55.4
CPX 1X4 6000LM 80CRI 35K A12	6478	116.8	55.4
CPX 1X4 6000LM 80CRI 40K SWL	6719	121.2	55.4
CPX 1X4 6000LM 80CRI 40K A12	6594	118.9	55.4
CPX 1X4 6000LM 80CRI 50K SWL	6737	121.5	55.4
CPX 1X4 6000LM 80CRI 50K A12	6612	119.2	55.4

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Configurable CPX LED Flat Panel

DIGITAL NAVIGATION | Home | Ordering | SensorSwitch JOT | nLight Platform | Photometrics | Performance Data

Optical Performance

UGR Values of CPX 1x4 @ **80CRI** and 3500K (70% 50% 20% reflectance using a 4H x 8H room size)				
Lumen Package	A12		SWL	
	Crosswise	Endwise	Crosswise	Endwise
2000LM	17.5	17.6	19.8	19.5
3200LM	19.1	19.2	21.4	21.1
3200LMHE	19.3	19.3	21.5	21.3
4000LM	19.9	20	22.2	21.9
4000LMHE	20	20.1	22.3	22
5000LM	20.6	20.7	22.9	22.6
6000LM	21.5	21.6	23.8	23.5

UGR Values of CPX 2x2 @ **80CRI** and 3500K (70% 50% 20% reflectance using a 4H x 8H room size)				
Lumen Package	A12		SWL	
	Crosswise	Endwise	Crosswise	Endwise
2000LM	17.3	17.6	19.7	19.5
3200LM	19.1	19.4	21.5	21.3
3200LMHE	19.1	19.4	21.5	21.3
4000LM	19.7	20.1	22.2	22
4000LMHE	19.7	20.1	22.2	22
5000LM	20.4	20.8	22.9	22.6
6000LM	21.1	21.5	23.6	23.3

UGR Values of CPX 2x4 @ **80CRI** and 3500K (70% 50% 20% reflectance using a 4H x 8H room size)				
Lumen Package	A12		SWL	
	Crosswise	Endwise	Crosswise	Endwise
3000LM	16.2	16.4	18.5	18.4
4000LM	17.4	17.8	19.9	19.7
4000LMHE	17.6	17.9	20	19.9
5000LM	17.7	17.9	20	19.9
5000LMHE	18	18.3	20.4	20.3
6000LM	18.2	18.5	20.6	20.5
7200LM	19.1	19.4	21.5	21.4
8500LM	19.7	20	22.1	22
10000LM	20.3	20.6	22.7	22.5

*UGR varies based on luminaire options and is affected by application dependent parameters. Numbers depicted here are considered "Luminaire-UGR and/or "Point-UGR" values. To determine a more precise maximum UGR value ("Application-UGR"), a full lighting design layout should be completed with the selected luminaire configuration for each application.

Lumen Maintenance

Reported Lumen Maintenance	Forecasted Lumen Maintenance
L90 @ 37k Hrs / L80 @ >60k Hrs / L70 @ > 60k Hrs	L90 @ 37k Hrs / L80 @ 76k Hrs / L70 @ 120k Hrs

*Note - Reported LM based on IES standard 6X test period for LM-80 report. Forecasted LM based on TM-21 report extrapolation past 6X LM-80 testing.

CPX compatible with Sensor Switch™ WSX-D and SPOD wall switches.



WSX-D



SPOD

PHOTOMETRICS

See www.lithonia.com for photometry reports.

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Configurable CPX LED Flat Panel

DIGITAL NAVIGATION | Home | Ordering | SensorSwitch JOT | nLight Platform | Photometrics | Performance Data

Intelligent Luminaire Technology Guide

Choose nomenclature from these columns

Control/ Sensor Configurations

Control Input		Sensor		Sensor	Notes
SSE	+	APIR	=	MSD 7 ADCX	Individual fixture control only. PIR integral occupancy sensor with automatic dimming control photocell.
SSE	+	APDT	=	MSD PDT 7 ADCX	Individual fixture control only. PDT integral occupancy sensor with automatic dimming control photocell.
SSE	+	VPIR15	=	VERTEX 15F EZ VLP	Vertex low-profile on/off occupancy sensor with auto dimming photocell with VLP programming at 15ft mounting height.
JOT	+	(blank)	=	BTRM JOT BTA	Wireless room control with "Just One Touch" pairing.
JOT	+	VPIR15	=	BTRM JOT BTA + VERTEX 15F EZ VLP GSKT	Wireless room control with "Just One Touch" pairing.
NLIGHT	+	(blank)	=	nIO EZ PH	nLight enabled only. No onboard sensor.
NLIGHT	+	PIR	=	nIO EZ PH + nES 7	nLight enabled with PIR integral occupancy sensor.
NLIGHT	+	PDT	=	nIO EZ PH + nES PDT 7	nLight enabled with dual technology occupancy control sensor.
NLIGHT	+	APIR	=	nIO EZ PH + nES 7 ADCX	nLight enabled with PIR integral occupancy sensor with automatic dimming photocell.
NLIGHT	+	APDT	=	nIO EZ PH + nES PDT 7 ADCX	nLight enabled with dual technology occupancy controls sensor with automatic dimming photocell.
NLIGHTER	+	(blank)	=	nIO EZ PH ER	Emergency nLight enabled only. No onboard sensor.
NLIGHTER	+	PIR	=	nIO EZ PH ER + nES 7	Emergency nLight enabled with PIR integral occupancy sensor.
NLIGHTER	+	PDT	=	nIO EZ PH ER + nES PDT 7	Emergency nLight enabled with dual technology occupancy control sensor.
NLIGHTER	+	APIR	=	nIO EZ PH ER + nES 7 ADCX	Emergency nLight enabled with PIR integral occupancy sensor with automatic dimming photocell.
NLIGHTER	+	APDT	=	nIO EZ PH ER + nES PDT 7 ADCX	Emergency nLight enabled with dual technology occupancy controls sensor with automatic dimming photocell.
NLIGHTLM	+	(blank)	=	nIO EZ PH N80	nLight enabled only with 80% constant lumen managment. No onboard sensor.
NLIGHTLM	+	PIR	=	nIO EZ PH N80 + nES 7	nLight enabled with 80% contstant lumen managment with PIR integral occupancy sensor.
NLIGHTLM	+	PDT	=	nIO EZ PH N80 + nES PDT 7	nLight enabled with 80% contstant lumen management with dual technology occupancy control sensor.
NLIGHTLM	+	APIR	=	nIO EZ PH N80 + nES 7 ADCX	nLight enabled with 80% contstant lumen management with PIR integral occupancy sensor with automatic dimming photocell.
NLIGHTLM	+	APDT	=	nIO EZ PH N80 + nES PDT 7 ADCX	nLight enabled with 80% contstant lumen managmentwith dual technology occupancy controls sensor with automatic dimming photocell.
NLIGHTERLM	+	(blank)	=	nIO EZ PH ER N80	Emergency nLight enabled only with 80% contstant lumen managment. No onboard sensor.
NLIGHTERLM	+	PIR	=	nIO EZ PH ER N80 + nES 7	Emergency nLight enabled with 80% contstant lumen managment with PIR integral occupancy sensor.
NLIGHTERLM	+	PDT	=	nIO EZ PH ER N80 + nES PDT 7	Emergency nLight enabled with 80% contstant lumen management with dual technology occupancy control sensor.
NLIGHTERLM	+	APIR	=	nIO EZ PH ER N80 + nES 7 ADCX	Emergency nLight enabled with 80% contstant lumen management with PIR integral occupancy sensor with automatic dimming photocell.
NLIGHTERLM	+	APDT	=	nIO EZ PH ER N80 + nES PDT 7 ADCX	Emergency nLight enabled with 80% contstant lumen management with dual technology occupancy controls sensor with automatic dimming photocell.
NLTAIR2	+	(blank)	=	RIO EZ PH 180D G2	nLight AIR Generation 2 enabled.
NLTAIREM2	+	(blank)	=	RIO EZ PH ER 180D G2	nLight AIR Generation 2 enabled
NLTAIR2	+	APIR	=	RES7 G2	nLight AIR Generation 2 enabled.
NLTAIR2	+	APDT	=	RES7 PDT 90D G2	nLight AIR Generation 2 enabled.
NLTAIR2	+	APIREM	=	RES7 EM 90D G2	nLight AIR Generation 2 enabled.
NLTAIR2	+	APDTEM	=	RES7 PDT EM 90D G2	nLight AIR Generation 2 enabled.

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Configurable CPX LED Flat Panel

nLight Platform

nLight AIR Wireless



Simple as 1,2,3

1. Install the nLight® AIR fixtures with embedded smart sensor
2. Install the wireless battery-powered wall switch
3. With the CLAIRITY+ Pro app, pair the fixtures with the wall switch and if desired, customize the sensor settings for the desired outcome



nLight Wired Networking



Simple as 1,2,3

1. Install the nLight® Wired fixtures with embedded control
2. Install the nLight Wired wall switch
3. Connect the fixtures using standard CAT5e cables and the devices will automatically discover each other and work (plug and play)



nLight embedded fixtures offer:	Customers get:
Manual Dimming	Convenience and visual comfort for occupants
Motion Sensing and/or Daylight Harvesting	Energy savings and code compliance
Fixture or Group Level Control	Ability to configure lighting to the space requirements
Flexibility	Ease of fixture moves, adds and changes
Wireless Wall Switch (nLight AIR Only)	Ease and flexibility of placement
Astronomical and Time of Day Scheduling	Energy savings and building security
Scalable Solution	nLight controls to grow with your business
Future-Ready	nLight platform to set foundation for future upgrades and capabilities

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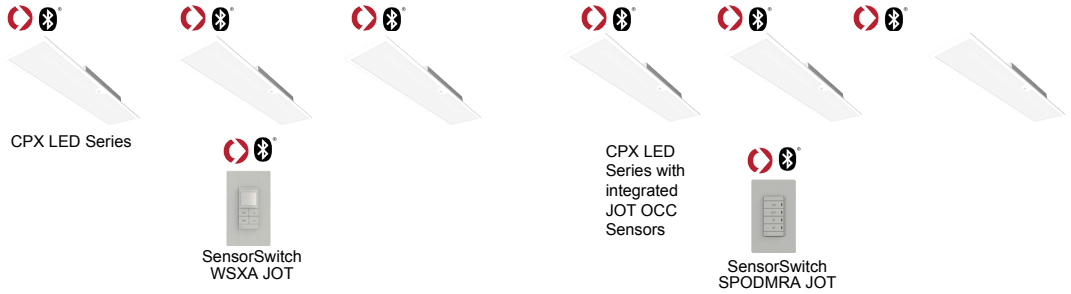
Configurable CPX LED Flat Panel

JOT WIRELESS

JOT
Just One Touch

SensorSwitch JOT Enabled Wireless Solution
Designed with contractors in mind, the SensorSwitch JOT enabled wireless solution offers a straightforward approach to the installation and pairing of lighting fixtures and controls. Absolutely no 0-10V control wires and no mobile apps are needed with JOT enabled products, allowing for lightning speed installation right out of the box.

1. Power: Install JOT enabled fixtures and controls as instructed.
2. Pair: Insert the pairing tool into the pinhole on the wall switch; press and hold any button for 6 seconds.
3. Play: Once paired, each fixture will individually dim down to 10% brightness. All products will be fully functional.



CPX 2X4 with JOT Vertex Sensor



CPX 1X4 with JOT Vertex sensor

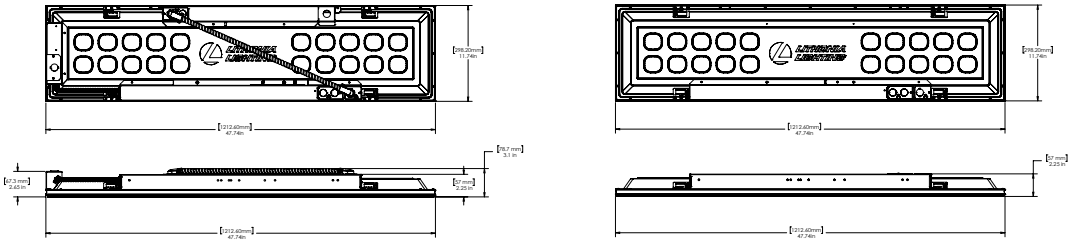
CPX 2X2 with JOT Vertex Sensor

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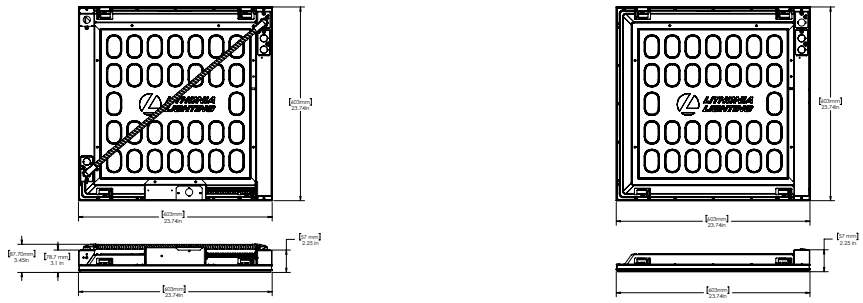
Configurable CPX LED Flat Panel

DIMENSIONS

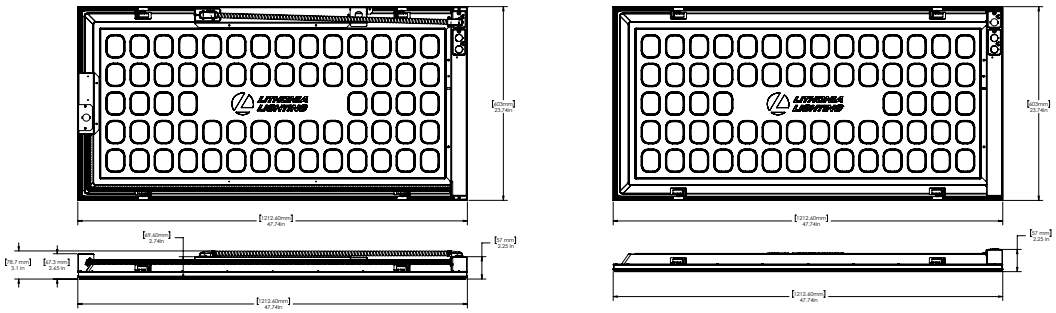
Length: 47.8" 121.4cm
Width: 11.8" 30.0cm
Depth: 2.3" 5.7cm
Weight:
Unit: 9.25 lbs
Unit Carton: 10.25 lbs



Length: 23.8" 60.5cm
Width: 23.8" 60.5cm
Depth: 2.3" 5.7cm
Weight:
Unit: 9.45lbs
Unit Carton: 10.45lbs



Length: 47.8" (121.4cm)
Width: 23.8" 60.5cm
Depth: 2.3" 5.7cm
Weight:
Unit: 17.25 lbs
Unit Carton: 19.25 lbs



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Project		Catalog #		Type	TYPE OE
Prepared by		Notes		PROVIDE SPECIFIED FIXTURE BY APPROVED MANUFACTURER OR ENGINEER-APPROVED EQUAL BY: LITHONIA LIGHTING GARDCO	



Streetworks

GLAN Galleon II

Area / Site Luminaire

Product Features

Light ARchitect™

BAA

Interactive Menu

- Ordering Information page 2
- Mounting Details page 3
- Optical Distributions page 5
- Product Specifications page 5
- Energy and Performance Data page 6
- Control Options page 11

Product Certifications

ISO CERTIFIED · DLC LISTED [1] · DLC LISTED PREMIUM [1] · 3G VIB · IP66 · UL CERTIFIED · ida DARK SKY APPROVED [2] · 5 YEAR LIMITED WARRANTY

Quick Facts

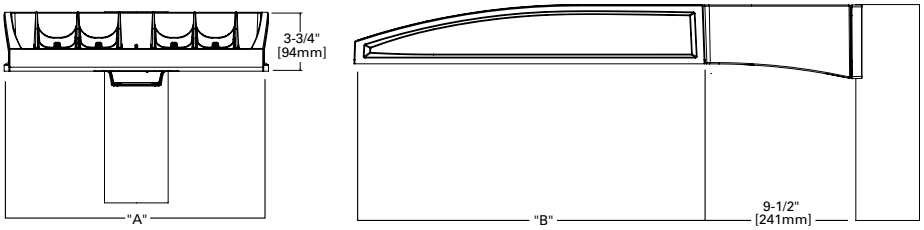
- Lumen packages range from 3,300 - 73,500 (33W - 552W)
- 17 optical distributions
- Efficacy up to 159 lumens per watt
- Options to meet Buy American and other domestic preference requirements

Connected Systems

- WaveLinx Lite
- WaveLinx

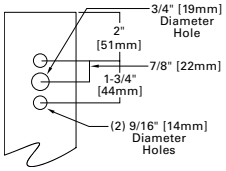
Dimensional Details

Standard Pole Mount Arm



Pole Drilling Patterns

Type "N"



Number of Light Squares	Width "A"	Housing Length "B"	Weight with Standard or QM Arm	EPA with Standard or QM Arm
1-4	16"	22"	29 lb	0.95
5-6	22"	22"	39 lb	0.95
7-9	22"	28-1/8"	48 lb	1.1

NOTES:
For arm selection requirements and additional line art, see Mounting Details section.

NOTES:
1. Visit https://www.designlights.org/search/ to confirm qualification. Not all product variations are DLC qualified.
2. IDA Certified for 3000K CCT and warmer only.

Streetworks — GLAN Galleon II

Ordering Information

SAMPLE NUMBER: **GLAN-SA4C-740-U-T4FT-GM**

PROVIDE KIT WITH INSTRUCTIONS FOR INSTALLATION TO EXISTING POLES -VERIFY POLE TYPE IN FIELD.

Product Family [1, 2]	Light Engine		Color Temperature	Voltage	Distribution	Mounting	Finish
	Configuration	Drive Current					
GLAN=Galleon II **BAA-GLAN**= Galleon II Buy American Act Compliant [30] **TAA-GLAN**= Galleon II Trade Agreements Act Compliant [30]	**SA1**=1 Square **SA2**=2 Squares **SA3**=3 Squares **SA4**=4 Squares **SA5**=5 Squares **SA6**=6 Squares **SA7**=7 Squares **SA8**=8 Squares **SA9**=9 Squares	**A**=600mA **B**=800mA **C**=1000mA **D**=1200mA [4, 17] **Z**=Configured [34]	**722**=70CRI, 2200K **727**=70CRI, 2700K **730**=70CRI, 3000K **735**=70CRI, 3500K **740**=70CRI, 4000K **750**=70CRI, 5000K **760**=70CRI, 6000K **827**=80CRI, 2700K **830**=80CRI, 3000K **835**=80CRI, 3500K **840**=80CRI, 4000K **930**=90CRI, 3000K **935**=90CRI, 3500K **940**=90CRI, 4000K **950**=90CRI, 5000K **AMB**=Amber, 590nm [15, 17]	**U**=120-277V **H**=347V-480V [7, 29] **1**=120V **2**=208V **3**=240V **4**=277V **8**=480V [7, 29] **9**=347V [7] **DV**=277V-480V DuraVolt Drivers [27, 28, 29]	**T1**=Type I **T2**=Type II **T2R**=Type II Roadway **T3**=Type III **T3R**=Type III Roadway **T4FT**=Type IV Forward Throw **T4W**=Type IV Wide **5NQ**=Type V Narrow **5MQ**=Type V Square Medium **5WQ**=Type V Square Wide **SLZ**=Type II w/Spill Control **SL3**=Type III w/Spill Control **SL4**=Type IV w/Spill Control **SLL**=90° Spill Light Eliminator Left **SLR**=90° Spill Light Eliminator Right **RW**=Rectangular Wide Type I **AFL**=Automotive Frontline	**[Blank]**=Standard Pole Mount Arm **QU**=Quick Mount Universal Arm **QM**=Pole Mount Arm with Quick Mount Adaptor **PA**=Pole Mount, Adjustable **SP**=3" Slipfitter, Adjustable [8] **SP2**=2-3/8" Slipfitter, Adjustable [8] **QMA**=Quick Mount Mast Arm, Fixed **MA**=Mast Arm, Fixed **WM**=Wall Mount, Fixed **WA**=Wall Mount, Adjustable **UP**=Upswept Arm	**AP**=Grey **BZ**=Bronze **BK**=Black **DP**=Dark Platinum **GM**=Graphite Metallic **WH**=White **RALXX**=Custom Color

MATCH EXISTING POLE EXISTING POLES

Options (Add as Suffix)	Controls and Systems Options (Add as Suffix)	Accessories (Order Separately) [31]
DIM=External 0-10V Dimming Leads [20] **F**=Single Fuse (120, 277 or 347V Specify Voltage) **FF**=Double Fuse (208, 240 or 480V Specify Voltage) **20K**=20kV UL 1449 fused surge protective device [10] **2L**=Two Circuits [10] **TB**=3-Position Terminal Block **HA**=50°C High Ambient **HSS**=Installed House Side Shield [18] **GRSBK**=Glare Reducing Shield, Black [23] **GRSWH**=Glare Reducing Shield, White [23] **LCF**=Light Square Trim Painted to Match Housing [26] **TH**=Tool-less Door Hardware [5] **CC**=Coastal Construction finish [3] **L90**=Optics Rotated 90° Left **R90**=Optics Rotated 90° Right **AHD145**=After Hours Dim, 5 Hours [22] **AHD245**=After Hours Dim, 6 Hours [22] **AHD255**=After Hours Dim, 7 Hours [22] **AHD355**=After Hours Dim, 8 Hours [22] **DALI**=DALI Drivers **DXXXXX**=Department of Transportation - Customer specific details [33] **UXXXXX**=Utility - Customer specific details [33]	**BPC**=Button Type Photocontrol. Must specify voltage 120V, 208V, 240V or 277V [6] **PR**=NEMA 3-PIN Photocontrol Receptacle **PR7**=NEMA 7-PIN Photocontrol Receptacle [21] **FADC**=Field Adjustable Dimming Controller [32] **PSC**=Photocontrol Shorting Cap **SPB2**=Dimming Motion Sensor, 9'-20' mounting [24] **SPB4**=Dimming Motion Sensor, 21'-40' mounting [24] **SPB2/X**=Dimming Motion Sensor, limited square count, 9'-20' mounting [24] **SPB4/X**=Dimming Motion Sensor, limited square count, 21'-40' mounting [24] **MS/DIM-L20**=Motion Sensor for Dimming Operation, 9'-20' mounting [35] **MS/DIM-L40**=Motion Sensor for Dimming Operation, 21'-40' mounting [35] **ZW**=WaveLinx-enabled 4-PIN Twistlock Receptacle [19] **ZD**=SR Driver-enabled 4-PIN Twistlock Receptacle [19] **ZW-WOBXX**=WaveLinx Lite, Dimming Motion and Daylight, Bluetooth Programmable, 7' - 15' Mounting [19,12,13] **ZW-WOFXX**=WaveLinx Lite, Dimming Motion and Daylight, Bluetooth Programmable, 15' - 40' Mounting [19,12,13] **ZD-WOBXX**=WaveLinx Lite, SR Driver, Dimming Motion and Daylight, Bluetooth Programmable, 7' - 15' Mounting [19,12,13] **ZD-WOFXX**=WaveLinx Lite, SR Driver, Dimming Motion and Daylight, Bluetooth Programmable, 15' - 40' Mounting [19,12,13] **ZW-SWPD4XX**=WaveLinx Pro, Dimming Motion and Daylight, WAC Programmable, 7' - 15' Mounting [19,12,13] **ZW-SWPD5XX**=WaveLinx Pro, Dimming Motion and Daylight, WAC Programmable, 15' - 40' Mounting [19,12,13] **ZD-SWPD4XX**=WaveLinx Pro, SR Driver, Dimming Motion and Daylight, WAC Programmable, 7' - 15' Mounting [19, 12,13] **ZD-SWPD5XX**=WaveLinx Pro, SR Driver, Dimming Motion and Daylight, WAC Programmable, 15' - 40' Mounting [19,12,13] **DIM10-L20**=Synapse Occupancy Sensor (9'-20' Mounting) [19] **DIM10-L40**=Synapse Occupancy Sensor (21'-40' Mounting) [19]	**OA/RA1016**=NEMA Photocontrol Multi-Tap - 105-285V **OA/RA1027**=NEMA Photocontrol - 480V **OA/RA1201**=NEMA Photocontrol - 347V **OA/RA1013**=Photocontrol Shorting Cap **OA/RA1014**=120V Photocontrol **MA1252**=10kV Surge Module Replacement **MA1036-XX**=Single Tenon Adapter for 2-3/8" O.D. Tenon **MA1037-XX**=2@180° Tenon Adapter for 2-3/8" O.D. Tenon **MA1197-XX**=3@120° Tenon Adapter for 2-3/8" O.D. Tenon **MA1188-XX**=4@90° Tenon Adapter for 2-3/8" O.D. Tenon **MA1189-XX**=2@90° Tenon Adapter for 2-3/8" O.D. Tenon **MA1190-XX**=3@90° Tenon Adapter for 2-3/8" O.D. Tenon **MA1191-XX**=2@120° Tenon Adapter for 2-3/8" O.D. Tenon **MA1038-XX**=Single Tenon Adapter for 3-1/2" O.D. Tenon **MA1039-XX**=2@180° Tenon Adapter for 3-1/2" O.D. Tenon **MA1192-XX**=3@120° Tenon Adapter for 3-1/2" O.D. Tenon **MA1193-XX**=4@90° Tenon Adapter for 3-1/2" O.D. Tenon **MA1194-XX**=2@90° Tenon Adapter for 3-1/2" O.D. Tenon **MA1195-XX**=3@90° Tenon Adapter for 3-1/2" O.D. Tenon **SRA238**=Adapter kit for mounting to 2-3/8" O.D. Tenon **FSIR-100**=Wireless Configuration Tool for Occupancy Sensor [35] **LS/HSS**=Field Installed House Side Shield [9, 18] **LS/GRSBK-2PK** =Glare Reducing Shield, Black [9, 23] **LS/GRSWH-2PK** =Glare Reducing Shield, White [9, 23] **LS/PFS**=Perimeter Shield, Black [16] **WOLC-7P-10A**=WaveLinx Outdoor Control Module [11, 19] **WOB-XX**= WaveLinx Lite Sensor, Dimming Motion and Daylight, Bluetooth Programmable, 7' - 15' Mounting [12,13,14,19] **WOF-XX**= WaveLinx Lite Sensor, Dimming Motion and Daylight, Bluetooth Programmable, 15' - 40' Mounting [12,13,14,19] **SWPD4-XX**= WaveLinx Sensor, Dimming Motion and Daylight, WAC Programmable, 7' - 15' Mounting [12,13,14,19] **SWPD5-XX**= WaveLinx Sensor, Dimming Motion and Daylight, WAC Programmable, 15' - 40' Mounting [12,13,14,19]

FOR LUMINAIRES NOTED AS EM, INCLUDE INTEGRAL UL924 LISTED EMERGENCY BYPASS.

NOTES:

1. Customer is responsible for engineering analysis to confirm pole and fixture compatibility for all applications. Refer to our white paper WP513001EN for additional support information.
2. DesignLights Consortium® Qualified. Refer to www.designlights.org Qualified Products List under Family Models for details.
3. Coastal construction finish salt spray tested to over 5,000-hours per ASTM B117, with a scribe rating of 9 per ASTM D1654. Not available with TH option.
4. Drive current 1200mA not available with color temperatures 722, 727 or 830 when either HA or HSS options are selected.
5. TH option not 3G rated. Not available with Coastal Construction (CC) option.
6. Not available with voltage options H, 8 or 9.
7. Requires the use of an internal step down transformer when combined with sensor options. Not available in combination with the HA high ambient and sensor options at 1A.
8. SP arm limited to 3" O.D. vertical tenon. SP2 limited to 2-3/8" O.D. vertical tenon.
9. One required for each Light Square.
10. 2L is not available with SPB at 347V or 480V. Not available with WaveLinx or Enlighted sensors, or 20kV surge option.
11. Requires PR7.
12. Replace XX with sensor color (WH, BZ or BK.)
13. WAC Gateway required to enable field-configurability: Order WAC-PoE and WPOE-120 (10V to PoE injector) power supply if needed. WAC not required for LC Bluetooth sensors.
14. Requires ZW or ZD receptacle.
15. Narrow-band 590nm +/- 5nm for wildlife and observatory use. Choose drive current A; supplied at 500mA drive current only. Exact luminaire wattage available in IES files. Available with 5WQ, 5MQ, SL2, SL3 and SL4 distributions. Can be used with HSS option.
16. Set of 4 pcs. One set required per Light Square.
17. Not available with HA option.
18. Not for use with 5NQ, 5MQ, 5WQ or RW optics. A black trim plate is used when HSS is selected.
19. Cannot be used with other control options.
20. Low voltage control lead brought out 18" outside fixture. Not available with DALI or integrated controls options
21. Not available if any SPB, LWR, or WaveLinx sensor is selected. Motion sensor has an integral photocell.
22. Requires the use of BPC photocontrol or the PR7 or PR photocontrol receptacle with photocontrol accessory.
23. Not for use with T4FT, T4W or SL4 optics. See IES files for details.
24. Sensor configuration mobile application required for configuration. See controls page for details.
25. Replace X with number of Light Squares controlled by the SPB, referencing the "SPB/X Availability Table" on the controls page.
26. Not available with HSS, GRSWH or GRSBK.
27. DuraVolt drivers feature added protection from power quality issues such as loss of neutral, transients and voltage fluctuations. Visit www.signify.com/duravolt for more information.
28. Not available in 1 square configuration at 800mA and below. Not available with any control option except SPB.
29. 480V not to be used with ungrounded or impedance grounded systems.
30. Only product configurations with these designated prefixes are built to be compliant with the Buy American Act of 1933 (BAA) or Trade Agreements Act of 1979 (TAA), respectively. Please refer to DOMESTIC PREFERENCES website for more information. Components shipped separately may be separately analyzed under domestic preference requirements.
31. Accessories sold separately will be separately analyzed under domestic preference requirements. Consult factory for further information.
32. Cannot be used with PR7 or other motion response control options.
33. Customer specific specifications utilizes standard products with small adjustments to meet unique requirements such as packaging, labels, wattage adjustments, etc.
34. Use GLAN Product Configurator to specify lumen output, drive current and wattage. Not available with AMB.
35. Uses the FSP-211 motion sensor. The FSIR-100 configuration tool is required to adjust parameters including high and low modes, sensitivity, time delay, cutoff and more. Consult your lighting representative at Cooper Lighting Solutions for more information.

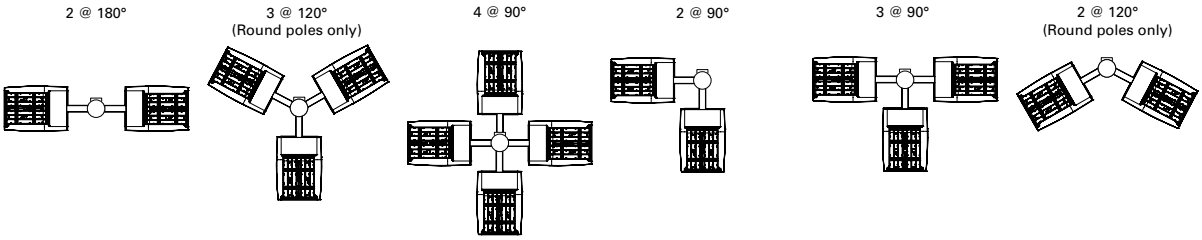
LumenSafe Integrated Network Security Camera Technology Options (Add as Suffix)

Product Family	Camera Type	Data Backhaul	
L=LumenSafe Technology	**D**=Standard Dome Camera **H**=Hi-Res Dome Camera **Z**=Remote PTZ Camera	**C**=Cellular, No SIM **A**=Cellular, AT&T **V**=Cellular, Verizon **S**=Cellular, Sprint	**R**=Cellular, Rogers **W**=Wi-Fi Networking w/ Omni-Directional Antenna **E**=Ethernet Networking

Streetworks GLAN Galleon II

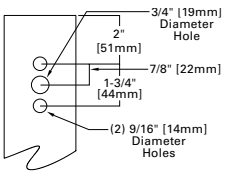
Mounting Details

Pole Configuration Options

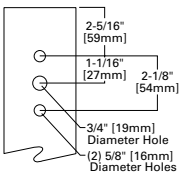


Pole Drilling Patterns

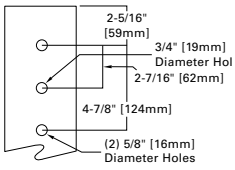
Type "N"



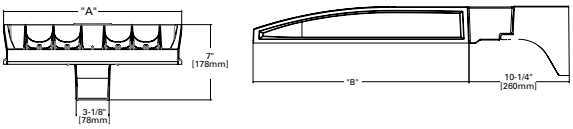
Type "R"



Type "M"

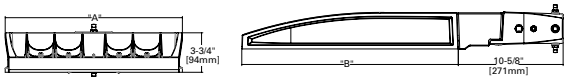


Quick Mount Universal Arm (QU)



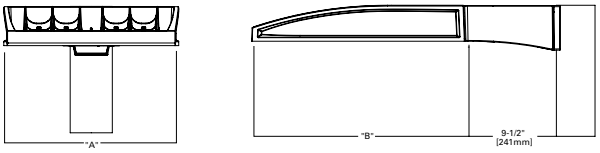
*NOTE: Universal bolt pattern compatible with Type N through Type M drilling patterns

Quick Mount Mast Arm (QMA)



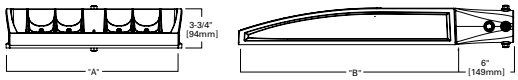
*NOTE: Fits 2-3/8" O.D. tenon

Pole Mount Arm with Quick Mount Adaptor (QM)



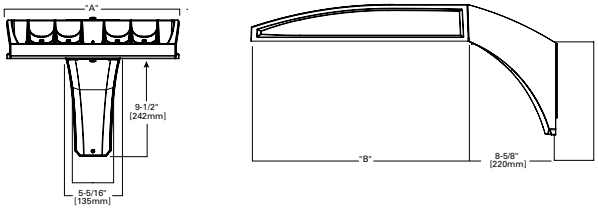
*NOTE: Use Type N drilling pattern

Mast Arm, Fixed (MA)



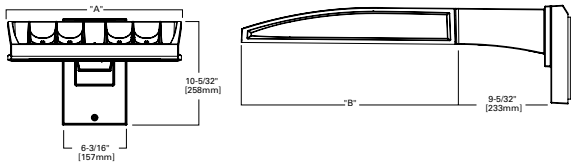
*NOTE: Fits 2-3/8" O.D. tenon

Upswept Arm (UP)



*NOTE: Universal bolt pattern compatible with Type N through Type M drilling patterns

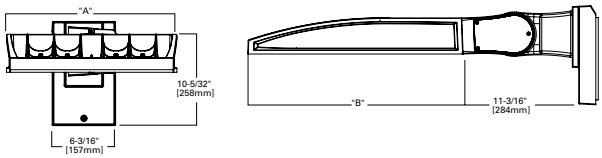
Wall Mount, Fixed (WM)



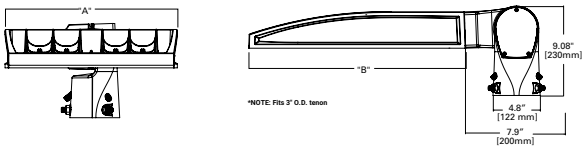
Streetworks GLAN Galleon II

Mounting Details

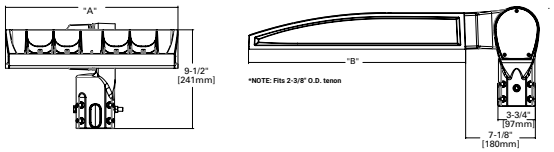
Wall Mount, Adjustable (WA)



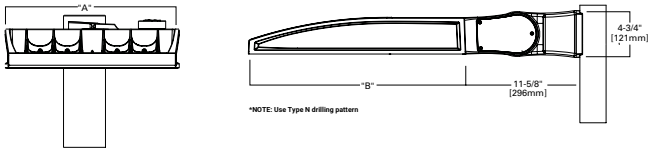
3" Slipfitter, Adjustable (SP)



2-3/8" Slipfitter, Adjustable (SP2)

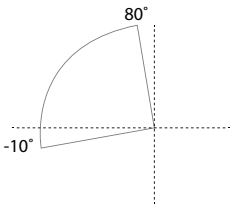


Pole Mount, Adjustable Arm (PA)



Adjustable Arm Range of Motion

- Includes WA, SP, SP2 and PA mounting options
- Adjustable in increments of 5°
- Must maintain downward facing orientation

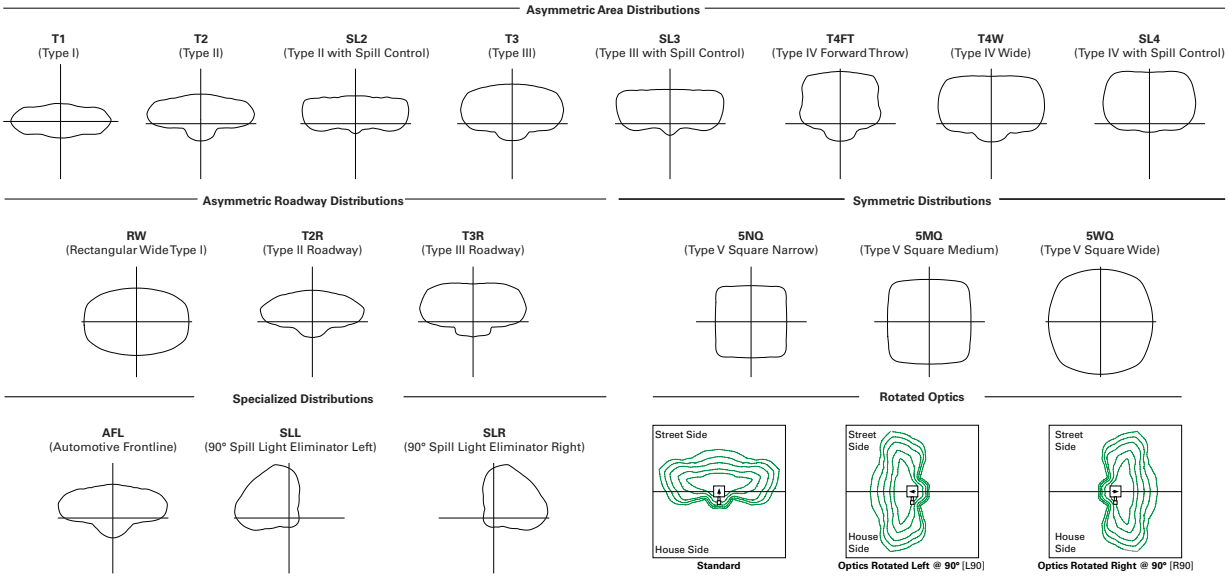


Fixture Weights and EPAs

Tilt Angle (Degrees)	Number of Light Squares	Weight	1 @ 90°	2 @ 180°	2 @ 90°	2 @ 120°	3 @ 90°	3 @ 120°	4 @ 90°
0°	1-4	33.5 lb (15.2 kg)	0.85	1.70	1.46	1.66	2.31	2.25	2.35
	5-6	43.5 lb (19.7 kg)	0.86	1.71	1.62	1.80	2.49	2.35	2.50
	7-9	52.5 lb (23.8 kg)	0.98	1.95	1.75	1.98	2.73	2.55	2.76
15°	1-4	33.5 lb (15.2 kg)	1.10	1.71	1.95	2.26	2.81	3.30	2.87
	5-6	43.5 lb (19.7 kg)	1.42	1.71	2.27	2.72	3.13	3.63	3.15
	7-9	52.5 lb (23.8 kg)	1.69	1.96	2.67	3.22	3.65	4.38	3.72
30°	1-4	33.5 lb (15.2 kg)	1.72	1.81	2.58	3.21	3.44	4.59	3.53
	5-6	43.5 lb (19.7 kg)	2.26	2.29	3.11	4.00	3.97	5.27	4.00
	7-9	52.5 lb (23.8 kg)	2.75	2.85	3.73	4.83	4.71	6.45	4.81
45°	1-4	33.5 lb (15.2 kg)	2.25	2.36	3.10	4.00	3.96	5.63	4.08
	5-6	43.5 lb (19.7 kg)	2.96	2.99	3.81	5.06	4.67	6.49	4.71
	7-9	52.5 lb (23.8 kg)	3.63	3.76	3.73	6.17	5.59	8.03	5.73
60°	1-4	33.5 lb (15.2 kg)	2.63	2.77	3.49	4.58	4.34	6.21	4.48
	5-6	43.5 lb (19.7 kg)	3.46	3.51	4.32	5.84	5.19	7.01	5.22
	7-9	52.5 lb (23.8 kg)	4.27	4.44	5.25	7.15	6.23	8.80	6.40

Streetworks GLAN Galleon II

Optical Distributions



Product Specifications

Construction
- Die-cast aluminum housing and heat sink
- Three housing sizes, using 1 to 9 light squares
- Driver compartment utilizes hinged door with captive fasteners

Optics
- High-efficiency injection-molded AccuLED Optics technology
- 17 optical distributions for area site and roadway applications
- 3 shielding options include HSS, GRS and PFS
- IDA certified (3000K CCT and warmer only, arms at 0° tilt)

Electrical
- Removable power tray assembly includes drivers, surge modules and control modules for ease of maintenance and serviceability
- Standard with 0-10V dimming
- Standard with 10kV surge module, optional 20kV surge module
- Suitable for operation in -40°C to 40°C ambient environments. Optional 50°C high ambient (HA) configuration

Mounting
- Arms are factory installed, enabling closed-housing installation
- All arms suitable for round or square pole installation
- All arms provide clearance for multiple fixture installations at 90°

Finish
- 6 standard finishes use super durable TGIC polyester powder coat paint, providing 2.5 mil nominal thickness and salt-spray tested to 3,000 hours per ASTM B117
- RAL and custom color matches available
- Coastal Construction (CC) option salt-spray tested to 5,000 hours per ASTM B117, achieving a scribe rating of 9 per ASTM D1654

Typical Applications
- Outdoor, Parking Lots, Walkways, Roadways

Warranty
- Five year limited warranty

Streetworks GLAN Galleon II

Energy and Performance Data

Lumen Maintenance (TM-21)

Drive Current	Ambient Temperature	25,000 hours*	50,000 hours*	60,000 hours*	100,000 hours**	Theoretical L70 hours**
Up to 1A	25°C	99.4%	99.0%	98.9%	98.3%	> 2.4M
	40°C	98.7%	98.3%	98.1%	97.4%	> 1.9M
	50°C	98.2%	97.2%	96.8%	95.2%	> 851,000
1.2A	25°C	99.4%	99.0%	98.9%	98.3%	> 2.4M
	40°C	98.5%	97.9%	97.7%	96.7%	> 1.3M

* Supported by IES TM-21 standards
** Theoretical values represent estimations commonly used; however, refer to the IES position on LED Product Lifetime Prediction, IES PS-10-18, explaining proper use of IES TM-21 and LM-80.

Lumen Multiplier

Ambient Temperature	Lumen Multiplier
0ºC	1.02
10ºC	1.01
25ºC	1.00
40ºC	0.99
50ºC	0.97

FADC Settings
SA1-SA3 (A, B, C, D Drive Current)

FADC Position	Percent of Typical Lumen Output
1	25%
2	48%
3	56%
4	65%
5	75%
6	80%
7	85%
8	90%
9	95%
10	100%

FADC Settings
SA4-SA6 (A, B, C, D Drive Current)

FADC Position	Percent of Typical Lumen Output
1	14%
2	25%
3	32%
4	43%
5	49%
6	57%
7	65%
8	72%
9	80%
10	100%

FADC Settings
SA7-SA9 (A, B, C, D Drive Current)

FADC Position	Percent of Typical Lumen Output
1	19%
2	38%
3	47%
4	63%
5	74%
6	85%
7	95%
8	97%
9	100%
10	100%

Streetworks — GLAN Galleon II

Performance Table, Drive Current "A" (615mA)

Number of Light Squares		1	2	3	4	5	6	7	8	9
Nominal Power (Watts)		33	63	93	121	154	182	215	244	274
Input Current @ 120V		0.283	0.529	0.778	1.058	1.310	1.556	1.839	2.089	2.335
Input Current @ 208V		0.165	0.309	0.460	0.618	0.771	0.919	1.082	1.240	1.379
Input Current @ 240V		0.143	0.270	0.398	0.540	0.671	0.796	0.944	1.078	1.194
Input Current @ 277V		0.125	0.237	0.352	0.473	0.581	0.705	0.818	0.962	1.057
Input Current @ 347V		0.098	0.181	0.272	0.362	0.454	0.544	0.636	0.738	0.816
Input Current @ 480V		0.073	0.133	0.200	0.267	0.335	0.400	0.470	0.554	0.600
Optics										
T1	4000K Lumens	4,619	9,180	13,628	18,059	22,861	27,070	31,796	36,863	41,385
	BUG Rating	B2-U0-G1	B3-U0-G1	B3-U0-G2	B4-U0-G2	B4-U0-G2	B4-U0-G2	B5-U0-G3	B5-U0-G3	B5-U0-G3
	Lumens per Watt	140	146	147	149	148	149	148	151	151
T2	4000K Lumens	4,654	9,249	13,730	18,194	23,032	27,273	32,034	37,138	41,694
	BUG Rating	B1-U0-G1	B1-U0-G2	B2-U0-G2	B2-U0-G3	B3-U0-G4	B3-U0-G4	B3-U0-G4	B3-U0-G5	B3-U0-G5
	Lumens per Watt	141	147	148	150	150	150	149	152	152
T2R	4000K Lumens	4,716	9,372	13,913	18,437	23,340	27,637	32,462	37,634	42,251
	BUG Rating	B1-U0-G1	B1-U0-G2	B2-U0-G2	B2-U0-G2	B3-U0-G3	B3-U0-G3	B3-U0-G4	B3-U0-G4	B3-U0-G4
	Lumens per Watt	143	149	150	152	152	152	151	154	154
T3	4000K Lumens	4,589	9,120	13,538	17,940	22,711	26,892	31,587	36,620	41,112
	BUG Rating	B1-U0-G1	B2-U0-G2	B2-U0-G2	B3-U0-G3	B3-U0-G3	B3-U0-G4	B3-U0-G4	B3-U0-G4	B4-U0-G4
	Lumens per Watt	139	145	146	148	147	148	147	150	150
T3R	4000K Lumens	4,735	9,411	13,970	18,513	23,436	27,751	32,596	37,790	42,425
	BUG Rating	B1-U0-G1	B1-U0-G2	B2-U0-G3	B2-U0-G3	B3-U0-G4	B3-U0-G4	B3-U0-G4	B3-U0-G5	B3-U0-G5
	Lumens per Watt	143	149	150	153	152	152	152	155	155
T4FT	4000K Lumens	4,617	9,176	13,622	18,051	22,851	27,058	31,782	36,847	41,366
	BUG Rating	B1-U0-G2	B2-U0-G2	B2-U0-G3	B3-U0-G3	B3-U0-G4	B3-U0-G4	B3-U0-G5	B3-U0-G5	B3-U0-G5
	Lumens per Watt	140	146	146	149	148	149	148	151	151
T4W	4000K Lumens	4,631	9,203	13,662	18,104	22,918	27,138	31,876	36,955	41,488
	BUG Rating	B1-U0-G2	B2-U0-G2	B2-U0-G3	B3-U0-G3	B3-U0-G4	B3-U0-G4	B3-U0-G5	B3-U0-G5	B4-U0-G5
	Lumens per Watt	140	146	147	150	149	149	148	151	151
SL2	4000K Lumens	4,619	9,180	13,627	18,058	22,860	27,069	31,795	36,861	41,383
	BUG Rating	B1-U0-G2	B2-U0-G2	B2-U0-G3	B3-U0-G3	B3-U0-G4	B3-U0-G4	B3-U0-G4	B3-U0-G5	B4-U0-G5
	Lumens per Watt	140	146	147	149	148	149	148	151	151
SL3	4000K Lumens	4,586	9,115	13,531	17,931	22,699	26,879	31,571	36,602	41,091
	BUG Rating	B1-U0-G1	B1-U0-G2	B2-U0-G3	B2-U0-G3	B3-U0-G4	B3-U0-G4	B3-U0-G4	B3-U0-G5	B3-U0-G5
	Lumens per Watt	139	145	145	148	147	148	147	150	150
SL4	4000K Lumens	4,529	9,002	13,363	17,708	22,417	26,544	31,178	36,146	40,580
	BUG Rating	B1-U0-G2	B1-U0-G3	B2-U0-G3	B2-U0-G4	B2-U0-G4	B3-U0-G5	B3-U0-G5	B3-U0-G5	B3-U0-G5
	Lumens per Watt	137	143	144	146	146	146	145	148	148
5NQ	4000K Lumens	4,829	9,598	14,247	18,880	23,901	28,301	33,242	38,539	43,266
	BUG Rating	B2-U0-G1	B3-U0-G1	B3-U0-G2	B4-U0-G2	B4-U0-G2	B4-U0-G2	B5-U0-G2	B5-U0-G3	B5-U0-G3
	Lumens per Watt	146	152	153	156	155	155	155	158	158
5MQ	4000K Lumens	4,853	9,645	14,318	18,974	24,020	28,442	33,407	38,731	43,482
	BUG Rating	B3-U0-G1	B3-U0-G2	B4-U0-G2	B4-U0-G2	B5-U0-G3	B5-U0-G3	B5-U0-G4	B5-U0-G4	B5-U0-G4
	Lumens per Watt	147	153	154	157	156	156	155	159	159
5WQ	4000K Lumens	4,843	9,625	14,288	18,934	23,969	28,382	33,337	38,649	43,390
	BUG Rating	B3-U0-G1	B4-U0-G2	B4-U0-G2	B5-U0-G3	B5-U0-G3	B5-U0-G4	B5-U0-G4	B5-U0-G4	B5-U0-G5
	Lumens per Watt	147	153	154	156	156	156	155	158	158
SLL/ SLR	4000K Lumens	3,989	7,927	11,768	15,594	19,741	23,375	27,456	31,831	35,736
	BUG Rating	B1-U0-G2	B1-U0-G2	B2-U0-G3	B2-U0-G3	B2-U0-G4	B3-U0-G4	B3-U0-G4	B3-U0-G5	B3-U0-G5
	Lumens per Watt	121	126	127	129	128	128	128	130	130
RW	4000K Lumens	4,774	9,488	14,085	18,665	23,628	27,979	32,863	38,100	42,774
	BUG Rating	B2-U0-G1	B3-U0-G1	B3-U0-G2	B4-U0-G2	B4-U0-G2	B4-U0-G2	B5-U0-G3	B5-U0-G3	B5-U0-G3
	Lumens per Watt	145	151	151	154	153	154	153	156	156
AFL	4000K Lumens	4,673	9,286	13,785	18,268	23,126	27,384	32,164	37,290	41,864
	BUG Rating	B1-U0-G1	B1-U0-G1	B2-U0-G2	B2-U0-G2	B3-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B3-U0-G3
	Lumens per Watt	142	147	148	151	150	150	150	153	153

* Nominal data for 70 CRI. ** For additional performance data, please reference the Galleon Supplemental Performance Guide.

Streetworks — GLAN Galleon II

Performance Table, Drive Current "B" (800mA)

Number of Light Squares		1	2	3	4	5	6	7	8	9
Nominal Power (Watts)		44	82	121	164	204	243	286	325	364
Input Current @ 120V		0.367	0.689	1.014	1.378	1.704	2.027	2.393	2.716	3.041
Input Current @ 208V		0.213	0.401	0.594	0.802	0.997	1.188	1.400	1.605	1.782
Input Current @ 240V		0.184	0.347	0.510	0.694	0.860	1.021	1.210	1.386	1.531
Input Current @ 277V		0.160	0.303	0.449	0.605	0.757	0.898	1.065	1.242	1.347
Input Current @ 347V		0.125	0.235	0.355	0.471	0.592	0.710	0.828	0.958	1.065
Input Current @ 480V		0.092	0.172	0.258	0.344	0.432	0.517	0.605	0.706	0.775
Optics										
T1	4000K Lumens	5,748	11,423	16,957	22,470	28,446	33,683	39,563	45,867	51,494
	BUG Rating	B2-U0-G1	B3-U0-G2	B4-U0-G2	B4-U0-G2	B4-U0-G2	B5-U0-G3	B5-U0-G3	B5-U0-G4	B5-U0-G4
	Lumens per Watt	131	139	140	137	139	139	138	141	141
T2	4000K Lumens	5,790	11,508	17,083	22,638	28,658	33,935	39,859	46,210	51,879
	BUG Rating	B1-U0-G2	B2-U0-G2	B2-U0-G3	B3-U0-G4	B3-U0-G4	B3-U0-G4	B3-U0-G5	B3-U0-G5	B4-U0-G5
	Lumens per Watt	132	140	141	138	140	140	139	142	143
T2R	4000K Lumens	5,868	11,662	17,311	22,941	29,041	34,388	40,391	46,827	52,572
	BUG Rating	B1-U0-G1	B2-U0-G2	B2-U0-G2	B3-U0-G3	B3-U0-G3	B3-U0-G4	B3-U0-G4	B3-U0-G4	B3-U0-G5
	Lumens per Watt	133	142	143	140	142	142	141	144	144
T3	4000K Lumens	5,710	11,347	16,845	22,322	28,258	33,461	39,303	45,565	51,155
	BUG Rating	B1-U0-G1	B2-U0-G2	B3-U0-G3	B3-U0-G3	B3-U0-G4	B3-U0-G4	B4-U0-G4	B4-U0-G5	B4-U0-G5
	Lumens per Watt	130	138	139	136	139	138	137	140	141
T3R	4000K Lumens	5,892	11,710	17,383	23,035	29,161	34,530	40,558	47,020	52,788
	BUG Rating	B1-U0-G2	B2-U0-G2	B2-U0-G3	B3-U0-G4	B3-U0-G4	B3-U0-G5	B3-U0-G5	B3-U0-G5	B4-U0-G5
	Lumens per Watt	134	143	144	140	143	142	142	145	145
T4FT	4000K Lumens	5,745	11,418	16,949	22,460	28,433	33,668	39,546	45,847	51,471
	BUG Rating	B1-U0-G2	B2-U0-G3	B2-U0-G3	B3-U0-G4	B3-U0-G4	B3-U0-G5	B3-U0-G5	B4-U0-G5	B4-U0-G5
	Lumens per Watt	131	139	140	137	139	139	138	141	141
T4W	4000K Lumens	5,762	11,451	16,999	22,526	28,517	33,767	39,662	45,982	51,622
	BUG Rating	B1-U0-G2	B2-U0-G2	B3-U0-G3	B3-U0-G4	B3-U0-G4	B3-U0-G5	B4-U0-G5	B4-U0-G5	B4-U0-G5
	Lumens per Watt	131	140	140	137	140	139	139	141	142
SL2	4000K Lumens	5,747	11,422	16,956	22,469	28,444	33,681	39,561	45,865	51,491
	BUG Rating	B1-U0-G2	B2-U0-G3	B3-U0-G3	B3-U0-G4	B3-U0-G4	B3-U0-G4	B4-U0-G5	B4-U0-G5	B4-U0-G5
	Lumens per Watt	131	139	140	137	139	139	138	141	141
SL3	4000K Lumens	5,707	11,342	16,836	22,311	28,244	33,444	39,283	45,542	51,129
	BUG Rating	B1-U0-G2	B2-U0-G3	B2-U0-G3	B3-U0-G4	B3-U0-G4	B3-U0-G5	B3-U0-G5	B3-U0-G5	B3-U0-G5
	Lumens per Watt	130	138	139	136	138	138	137	140	140
SL4	4000K Lumens	5,636	11,201	16,627	22,034	27,893	33,028	38,794	44,976	50,493
	BUG Rating	B1-U0-G2	B1-U0-G3	B2-U0-G4	B2-U0-G4	B3-U0-G5	B3-U0-G5	B3-U0-G5	B3-U0-G5	B3-U0-G5
	Lumens per Watt	128	137	137	134	137	136	136	138	139
5NQ	4000K Lumens	6,009	11,942	17,727	23,492	29,739	35,214	41,362	47,953	53,835
	BUG Rating	B2-U0-G1	B3-U0-G1	B4-U0-G2	B4-U0-G2	B5-U0-G2	B5-U0-G2	B5-U0-G3	B5-U0-G3	B5-U0-G3
	Lumens per Watt	137	146	147	143	146	145	145	148	148
5MQ	4000K Lumens	6,039	12,001	17,816	23,609	29,887	35,389	41,568	48,191	54,103
	BUG Rating	B3-U0-G1	B4-U0-G2	B4-U0-G2	B5-U0-G3	B5-U0-G3	B5-U0-G4	B5-U0-G4	B5-U0-G4	B5-U0-G5
	Lumens per Watt	137	146	147	144	147	146	145	148	149
5WQ	4000K Lumens	6,026	11,976	17,778	23,559	29,824	35,315	41,480	48,090	53,989
	BUG Rating	B3-U0-G1	B4-U0-G2	B5-U0-G3	B5-U0-G3	B5-U0-G4	B5-U0-G4	B5-U0-G4	B5-U0-G5	B5-U0-G5
	Lumens per Watt	137	146	147	144	146	145	145	148	148
SLL/ SLR	4000K Lumens	4,963	9,863	14,642	19,403	24,563	29,085	34,163	39,607	44,465
	BUG Rating	B1-U0-G2	B1-U0-G3	B2-U0-G3	B2-U0-G4	B3-U0-G4	B3-U0-G5	B3-U0-G5	B3-U0-G5	B3-U0-G5
	Lumens per Watt	113	120	121	118	120	120	119	122	122
RW	4000K Lumens	5,940	11,806	17,526	23,224	29,400	34,813	40,891	47,407	53,222
	BUG Rating	B3-U0-G1	B3-U0-G2	B4-U0-G2	B4-U0-G2	B5-U0-G3	B5-U0-G3	B5-U0-G3	B5-U0-G4	B5-U0-G4
	Lumens per Watt	135	144	145	142	144	143	143	146	146
AFL	4000K Lumens	5,814	11,555	17,153	22,730	28,775	34,073	40,021	46,398	52,090
	BUG Rating	B1-U0-G1	B2-U0-G1	B2-U0-G2	B2-U0-G2	B3-U0-G3	B3-U0-G3	B3-U0-G3	B3-U0-G3	B3-U0-G4
	Lumens per Watt	132	141	142	139	141	140	140	143	143

* Nominal data for 70 CRI. ** For additional performance data, please reference the Galleon Supplemental Performance Guide.

Streetworks — GLAN Galleon II

Performance Table, Drive Current "C" (1050mA)

Number of Light Squares		1	2	3	4	5	6	7	8	9
Nominal Power (Watts)		57	108	160	213	269	321	377	429	481
Input Current @ 120V		0.478	0.905	1.338	1.810	2.244	2.675	3.150	3.584	4.013
Input Current @ 208V		0.279	0.532	0.780	1.064	1.313	1.559	1.845	2.093	2.339
Input Current @ 240V		0.243	0.458	0.664	0.916	1.123	1.328	1.582	1.788	1.991
Input Current @ 277V		0.213	0.404	0.582	0.808	0.997	1.164	1.401	1.589	1.745
Input Current @ 347V		0.164	0.322	0.471	0.644	0.795	0.943	1.117	1.269	1.414
Input Current @ 480V		0.121	0.235	0.341	0.469	0.579	0.681	0.814	0.923	1.022
Optics										
T1	4000K Lumens	7,101	14,113	20,950	27,763	35,146	41,616	48,882	56,671	63,623
	BUG Rating	B3-U0-G1	B3-U0-G2	B4-U0-G2	B4-U0-G2	B5-U0-G3	B5-U0-G3	B5-U0-G4	B5-U0-G4	B5-U0-G4
	Lumens per Watt	125	131	131	130	131	130	130	132	132
T2	4000K Lumens	7,154	14,219	21,107	27,970	35,408	41,927	49,247	57,094	64,098
	BUG Rating	B1-U0-G2	B2-U0-G2	B3-U0-G3	B3-U0-G4	B3-U0-G4	B3-U0-G5	B4-U0-G5	B4-U0-G5	B4-U0-G5
	Lumens per Watt	126	132	132	131	132	131	131	133	133
T2R	4000K Lumens	7,250	14,408	21,389	28,344	35,881	42,487	49,905	57,857	64,954
	BUG Rating	B1-U0-G1	B2-U0-G2	B2-U0-G3	B3-U0-G3	B3-U0-G4	B3-U0-G4	B3-U0-G5	B4-U0-G5	B4-U0-G5
	Lumens per Watt	127	133	134	133	133	132	132	135	135
T3	4000K Lumens	7,054	14,020	20,812	27,580	34,914	41,342	48,560	56,297	63,203
	BUG Rating	B1-U0-G2	B2-U0-G2	B3-U0-G3	B3-U0-G4	B3-U0-G4	B4-U0-G4	B4-U0-G5	B4-U0-G5	B4-U0-G5
	Lumens per Watt	124	130	130	129	130	129	129	131	131
T3R	4000K Lumens	7,280	14,468	21,477	28,461	36,029	42,663	50,111	58,096	65,222
	BUG Rating	B1-U0-G2	B2-U0-G3	B3-U0-G4	B3-U0-G4	B3-U0-G5	B3-U0-G5	B3-U0-G5	B4-U0-G5	B4-U0-G5
	Lumens per Watt	128	134	134	134	134	133	133	135	136
T4FT	4000K Lumens	7,098	14,107	20,941	27,751	35,130	41,598	48,860	56,646	63,594
	BUG Rating	B1-U0-G2	B2-U0-G3	B3-U0-G4	B3-U0-G4	B3-U0-G5	B3-U0-G5	B4-U0-G5	B4-U0-G5	B4-U0-G5
	Lumens per Watt	125	131	131	130	131	130	130	132	132
T4W	4000K Lumens	7,119	14,148	21,003	27,832	35,233	41,720	49,004	56,812	63,781
	BUG Rating	B1-U0-G2	B2-U0-G3	B3-U0-G4	B3-U0-G4	B3-U0-G5	B4-U0-G5	B4-U0-G5	B4-U0-G5	B4-U0-G5
	Lumens per Watt	125	131	131	131	131	130	130	132	133
SL2	4000K Lumens	7,101	14,112	20,949	27,761	35,144	41,614	48,879	56,668	63,619
	BUG Rating	B1-U0-G2	B2-U0-G3	B3-U0-G3	B3-U0-G4	B3-U0-G5	B4-U0-G5	B4-U0-G5	B4-U0-G5	B4-U0-G5
	Lumens per Watt	125	131	131	130	131	130	130	132	132
SL3	4000K Lumens	7,051	14,013	20,802	27,566	34,897	41,321	48,535	56,269	63,172
	BUG Rating	B1-U0-G2	B2-U0-G3	B2-U0-G4	B3-U0-G4	B3-U0-G5	B3-U0-G5	B3-U0-G5	B4-U0-G5	B4-U0-G5
	Lumens per Watt	124	130	130	129	130	129	129	131	131
SL4	4000K Lumens	6,963	13,839	20,543	27,223	34,463	40,808	47,932	55,569	62,386
	BUG Rating	B1-U0-G2	B2-U0-G3	B2-U0-G4	B3-U0-G5	B3-U0-G5	B3-U0-G5	B3-U0-G5	B3-U0-G5	B3-U0-G5
	Lumens per Watt	122	128	128	128	128	127	127	130	130
5NQ	4000K Lumens	7,424	14,755	21,903	29,025	36,743	43,508	51,104	59,247	66,515
	BUG Rating	B3-U0-G1	B3-U0-G2	B4-U0-G2	B5-U0-G2	B5-U0-G3	B5-U0-G3	B5-U0-G3	B5-U0-G4	B5-U0-G4
	Lumens per Watt	130	137	137	136	137	136	136	138	138
5MQ	4000K Lumens	7,461	14,828	22,012	29,169	36,926	43,725	51,359	59,542	66,846
	BUG Rating	B3-U0-G1	B4-U0-G2	B5-U0-G3	B5-U0-G3	B5-U0-G4	B5-U0-G4	B5-U0-G4	B5-U0-G5	B5-U0-G5
	Lumens per Watt	131	137	138	137	137	136	136	139	139
5WQ	4000K Lumens	7,445	14,797	21,966	29,108	36,849	43,633	51,250	59,417	66,705
	BUG Rating	B3-U0-G2	B4-U0-G2	B5-U0-G3	B5-U0-G4	B5-U0-G4	B5-U0-G5	B5-U0-G5	B5-U0-G5	B5-U0-G5
	Lumens per Watt	131	137	137	137	137	136	136	139	139
SLL/ SLR	4000K Lumens	6,132	12,187	18,091	23,973	30,348	35,936	42,210	48,935	54,938
	BUG Rating	B1-U0-G2	B2-U0-G3	B2-U0-G3	B3-U0-G4	B3-U0-G5	B3-U0-G5	B3-U0-G5	B3-U0-G5	B3-U0-G5
	Lumens per Watt	108	113	113	113	113	112	112	114	114
RW	4000K Lumens	7,340	14,587	21,653	28,694	36,325	43,013	50,522	58,573	65,757
	BUG Rating	B3-U0-G1	B3-U0-G2	B4-U0-G2	B4-U0-G2	B5-U0-G3	B5-U0-G3	B5-U0-G4	B5-U0-G4	B5-U0-G4
	Lumens per Watt	129	135	135	135	135	134	134	137	137
AFL	4000K Lumens	7,183	14,276	21,193	28,084	35,552	42,098	49,448	57,327	64,359
	BUG Rating	B1-U0-G1	B2-U0-G2	B2-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B3-U0-G4	B3-U0-G4	B4-U0-G4
	Lumens per Watt	126	132	132	132	132	131	131	134	134

* Nominal data for 70 CRI. ** For additional performance data, please reference the Galleon Supplemental Performance Guide.

Streetworks — GLAN Galleon II

Performance Table, Drive Current "D" (1200mA)

Number of Light Squares		1	2	3	4	5	6	7	8	9
Nominal Power (Watts)		65	125	184	245	309	368	433	493	552
Input Current @ 120V		0.546	1.041	1.535	2.082	2.578	3.070	3.619	4.114	4.605
Input Current @ 208V		0.318	0.610	0.893	1.219	1.504	1.786	2.113	2.397	2.679
Input Current @ 240V		0.276	0.523	0.758	1.046	1.282	1.516	1.806	2.041	2.274
Input Current @ 277V		0.241	0.460	0.662	0.920	1.133	1.325	1.593	1.807	1.987
Input Current @ 347V		0.187	0.370	0.543	0.740	0.915	1.085	1.285	1.459	1.628
Input Current @ 480V		0.138	0.269	0.391	0.537	0.663	0.782	0.932	1.057	1.173
Optics										
T1	4000K Lumens	7,814	15,529	23,053	30,549	38,672	45,793	53,787	62,358	70,007
	BUG Rating	B3-U0-G1	B4-U0-G2	B4-U0-G2	B5-U0-G3	B5-U0-G3	B5-U0-G4	B5-U0-G4	B5-U0-G4	B5-U0-G4
	Lumens per Watt	120	124	125	125	125	124	124	126	127
T2	4000K Lumens	7,872	15,645	23,225	30,777	38,962	46,135	54,189	62,824	70,530
	BUG Rating	B1-U0-G2	B2-U0-G3	B3-U0-G4	B3-U0-G4	B3-U0-G5	B3-U0-G5	B4-U0-G5	B4-U0-G5	B4-U0-G5
	Lumens per Watt	121	125	126	126	126	125	125	127	128
T2R	4000K Lumens	7,977	15,854	23,535	31,188	39,482	46,751	54,913	63,663	71,472
	BUG Rating	B1-U0-G2	B2-U0-G2	B3-U0-G3	B3-U0-G4	B3-U0-G4	B3-U0-G4	B4-U0-G5	B4-U0-G5	B4-U0-G5
	Lumens per Watt	123	127	128	127	128	127	127	129	129
T3	4000K Lumens	7,762	15,427	22,901	30,348	38,418	45,491	53,433	61,947	69,546
	BUG Rating	B2-U0-G2	B3-U0-G3	B3-U0-G3	B3-U0-G4	B4-U0-G4	B4-U0-G5	B4-U0-G5	B4-U0-G5	B4-U0-G5
	Lumens per Watt	119	123	124	124	124	124	123	126	126
T3R	4000K Lumens	8,010	15,920	23,632	31,317	39,645	46,944	55,139	63,925	71,767
	BUG Rating	B1-U0-G2	B2-U0-G3	B3-U0-G4	B3-U0-G4	B3-U0-G5	B3-U0-G5	B4-U0-G5	B4-U0-G5	B4-U0-G5
	Lumens per Watt	123	127	128	128	128	128	127	130	130
T4FT	4000K Lumens	7,810	15,522	23,043	30,535	38,655	45,772	53,763	62,330	69,976
	BUG Rating	B1-U0-G2	B2-U0-G3	B3-U0-G4	B3-U0-G4	B3-U0-G5	B4-U0-G5	B4-U0-G5	B4-U0-G5	B4-U0-G5
	Lumens per Watt	120	124	125	125	125	124	124	126	127
T4W	4000K Lumens	7,833	15,568	23,110	30,625	38,769	45,907	53,921	62,513	70,182
	BUG Rating	B2-U0-G2	B3-U0-G3	B3-U0-G4	B3-U0-G5	B4-U0-G5	B4-U0-G5	B4-U0-G5	B4-U0-G5	B4-U0-G5
	Lumens per Watt	121	125	126	125	125	125	125	127	127
SL2	4000K Lumens	7,813	15,528	23,052	30,547	38,670	45,790	53,784	62,354	70,003
	BUG Rating	B2-U0-G2	B3-U0-G3	B3-U0-G4	B3-U0-G4	B4-U0-G5	B4-U0-G5	B4-U0-G5	B4-U0-G5	B4-U0-G5
	Lumens per Watt	120	124	125	125	125	124	124	126	127
SL3	4000K Lumens	7,758	15,419	22,889	30,332	38,398	45,468	53,406	61,916	69,511
	BUG Rating	B1-U0-G2	B2-U0-G3	B3-U0-G4	B3-U0-G4	B3-U0-G5	B3-U0-G5	B3-U0-G5	B4-U0-G5	B4-U0-G5
	Lumens per Watt	119	123	124	124	124	124	123	126	126
SL4	4000K Lumens	7,662	15,228	22,605	29,955	37,921	44,903	52,742	61,146	68,646
	BUG Rating	B1-U0-G3	B2-U0-G3	B2-U0-G4	B3-U0-G5	B3-U0-G5	B3-U0-G5	B3-U0-G5	B3-U0-G5	B4-U0-G5
	Lumens per Watt	118	122	123	122	123	122	122	124	124
5NQ	4000K Lumens	8,169	16,235	24,101	31,938	40,431	47,874	56,232	65,193	73,190
	BUG Rating	B3-U0-G1	B3-U0-G2	B4-U0-G2	B5-U0-G2	B5-U0-G3	B5-U0-G3	B5-U0-G4	B5-U0-G4	B5-U0-G4
	Lumens per Watt	126	130	131	130	131	130	130	132	133
5MQ	4000K Lumens	8,210	16,316	24,221	32,097	40,632	48,113	56,512	65,517	73,554
	BUG Rating	B3-U0-G2	B4-U0-G2	B5-U0-G3	B5-U0-G3	B5-U0-G4	B5-U0-G4	B5-U0-G5	B5-U0-G5	B5-U0-G5
	Lumens per Watt	126	131	132	131	131	131	131	133	133
5WQ	4000K Lumens	8,192	16,282	24,170	32,029	40,546	48,011	56,393	65,379	73,399
	BUG Rating	B3-U0-G2	B4-U0-G2	B5-U0-G3	B5-U0-G4	B5-U0-G4	B5-U0-G5	B5-U0-G5	B5-U0-G5	B5-U0-G5
	Lumens per Watt	126	130	131	131	131	130	130	133	133
SLL/ SLR	4000K Lumens	6,747	13,410	19,906	26,379	33,394	39,542	46,445	53,846	60,451
	BUG Rating	B1-U0-G2	B2-U0-G3	B2-U0-G4	B3-U0-G4	B3-U0-G5	B3-U0-G5	B3-U0-G5	B3-U0-G5	B4-U0-G5
	Lumens per Watt	104	107	108	108	108	107	107	109	110
RW	4000K Lumens	8,076	16,050	23,826	31,574	39,970	47,329	55,592	64,450	72,356
	BUG Rating	B3-U0-G1	B4-U0-G2	B4-U0-G2	B5-U0-G3	B5-U0-G3	B5-U0-G4	B5-U0-G4	B5-U0-G4	B5-U0-G5
	Lumens per Watt	124	128	129	129	129	129	128	131	131
AFL	4000K Lumens	7,904	15,709	23,320	30,902	39,120	46,323	54,410	63,079	70,817
	BUG Rating	B1-U0-G1	B2-U0-G2	B3-U0-G2	B3-U0-G3	B3-U0-G3	B3-U0-G3	B3-U0-G4	B4-U0-G4	B4-U0-G4
	Lumens per Watt	122	126	127	126	127	126	126	128	128

* Nominal data for 70 CRI. ** For additional performance data, please reference the Galleon Supplemental Performance Guide.

Streetworks GLAN Galleon II

Control Options

0-10V (DIM)
This fixture is offered standard with 0-10V dimming driver(s). The DIM option provides 0-10V dimming wire leads for use with a lighting control panel or other control method.

Photocontrol (BPC, PR and PR7)
Optional button-type photocontrol (BPC) and photocontrol receptacles (PR and PR7) provide a flexible solution to enable "dusk-to-dawn" lighting by sensing light levels. Advanced control systems compatible with NEMA 7-pin standards can be utilized with the PR7 receptacle.

After Hours Dim (AHD)
This feature allows photocontrol-enabled luminaires to achieve additional energy savings by dimming during scheduled portions of the night. The dimming profile will automatically take effect after a "dusk-to-dawn" period has been calculated from the photocontrol input. Specify the desired dimming profile for a simple, factory-shipped dimming solution requiring no external control wiring. Reference the After Hours Dim supplemental guide for additional information.

Dimming Occupancy Sensor (SPB and MS/DIM-LXX)
These passive infrared (PIR) sensors are factory installed in the luminaire housing. When the SPB (FSP-321 or FSP-311) or MS/DIM (FSP-211) sensor options are selected, the occupancy sensor is connected to a dimming driver and the luminaire dims when no motion is detected. After a set period of time, the luminaire turns off, and when motion is detected, the luminaire returns to full light output. Both sensors are factory preset to dim down to approximately 10% power with a time delay of five minutes. The MS/DIM sensor requires the FSIR-100 programming tool to adjust factory defaults. The SPB sensor default parameters are listed in the table below and can be configured utilizing the Sensor Configuration mobile application for iOS and Android devices. The SPB/X is configured to control only the specified number of light squares (See SPB/X Availability Table below.) An integral photocontrol can be activated with the app for "dusk-to-dawn" control or daylight harvesting - the factory default is off. Four sensor colors are available; Bronze, Black, Gray and White, and are automatically selected based on the luminaire finish as indicated by the table below.

SPB sensor finish matched to luminaire finish		
Luminaire Finish		SPB Sensor Finish*
WH	White	White
BK	Black	Black
GM	Graphite Metallic	Black
BZ	Bronze	Bronze
AP	Gray	Gray
DP	Dark Platinum	Gray

*SPB bezel color automatically selected based on luminaire finish

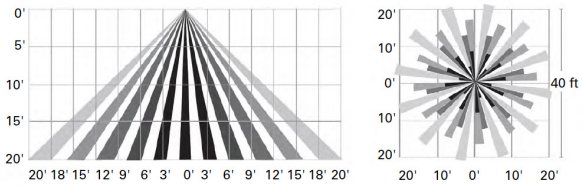
SPB/X Availability Table	
Fixture Square Count	Available SPB/X Square Count
1	Not Available
2	Not Available
3	Not Available
4	2
5	2 or 3
6	3
7	2, 3, 4 or 5
8	2, 3, 5 or 6
9	3 or 6

Default Program Settings (Out of the Box Functionality)

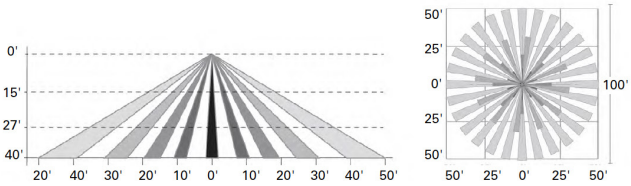
Occupancy Sensor				
Setting	MS/DIM	SPB	WaveLinx Lite (WOF / WOB)	WaveLinx (SWPD)
High Mode %	100%	100%	100%	100%
Low Mode %	10%	10%	50%	50%
Time Delay	5 min	5 min	15 min	15 min
Cut Off Delay	1 hr	1 hr	Disabled	Disabled
Photocell Enabled	No	No	Yes	Yes

WaveLinx Wireless Control and Monitoring System
Operates on a wireless mesh network based on IEEE 802.15.4 standards enabling wireless control of outdoor lighting. WaveLinx and WaveLinx Lite sensors utilize the Zhaga Book 18 compliant 4-PIN receptacle (ZD or ZW), while the WOLC control module utilizes a 7-PIN receptacle. ZW option provides 4-PIN receptacle and control module to enable future installation of WaveLinx sensors. ZD option provides 4-PIN receptacle and sensor-ready (SR) driver to enable future installation of WaveLinx sensors, power monitoring, and advanced functionality. WaveLinx (SWPD4 to SWPD5) outdoor wireless sensors offer passive infrared (PIR) occupancy and photocell for closed loop daylight harvesting, and can be factory or field-installed. Sensors are factory preset to dim down to 50% after 15 minutes of no motion detected. Two lens options are available for mounting heights of 7' to 40'. Use the WaveLinx mobile application for set-up and configuration. At least one Wireless Area Controller (WAC) is required for full functionality and remote communication (including adjustment of any factory pre-sets). WaveLinx Lite (WOF and WOB) outdoor wireless sensors provide PIR occupancy and photocell for closed loop daylight harvesting, and can be factory or field-installed. Sensors are factory preset to dim down to 50% after 15 minutes of no motion detected. Two lens options are available for mounting heights of 7' to 40'. Use the WaveLinx Lite mobile application for set-up and configuration. WAC not required. WaveLinx Outdoor Control Module (WOLC-7P-10A) accessory provides a photocontrol enabling astronomic or time-based schedules to provide ON, OFF and dimming control of fixtures utilizing a 7-PIN receptacle. The out-of-box functionality is ON at dusk and OFF at dawn.

For mounting heights up to 15' (SWPD4 and WOB)



For mounting heights up to 40' (SWPD5 and WOF)



LumenSafe Integrated Network Security Camera (LD)
Cooper Lighting Solutions brings ease of camera deployment to a whole new level. No additional wiring is needed beyond providing line power to the luminaire. A variety of networking options allows security integrators to design the optimal solution for active surveillance. As the ideal solution to meet the needs for active surveillance, the LumenSafe integrated network camera is a streamlined, outdoor-ready fixed dome that provides HDTV 1080p video. This IP camera is optimally designed for deployment in the video management system or security software platform of choice.

Synapse (DIM10)
SimplySNAP integrated wireless controls system by Synapse. Includes factory installed DIM10 Synapse control module and FSP-201 motion sensor; requires additional Synapse system components for operation. Contact Synapse at www.synapsewireless.com for product support, warranty and terms and conditions.

COOPER Lighting Solutions
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1121 Highway 74 South
Peachtree City, GA 30269
P: 770-486-4800
www.cooperlighting.com

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Specifications and dimensions
subject to change without notice.

ULEW-30021

Leeds 3 Large Surface Wedge Downlight

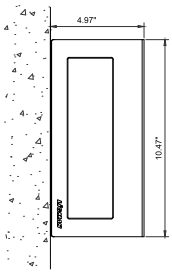
microVos TECHNOLOGY

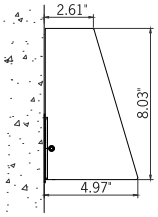
LIGMAN LIGHTING USA

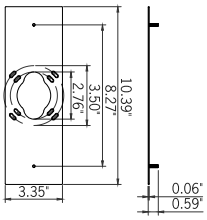
TYPE OG1



20w LED 2422 Lumens • 28w LED 3200 Lumens
IP65 • Suitable For Wet Locations
IK07 • Impact Resistant
Weight 18 lbs



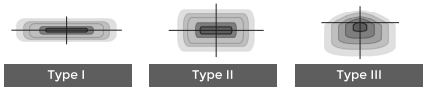




Mounting Detail

microVos TECHNOLOGY

Ligman's micro Variable Optical System provides the ability to interchange, mix & rotate optics to provide specific light distributions for optimized spacing and uniformity.

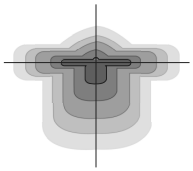


Type I | Type II | Type III



Type IV | Type V

The variable optic system allows for the designer to create hybrid distributions for precise lighting requirements.



HYBRID
TYPE I & TYPE IV

Construction

Aluminum
Less than 0.1% copper content – Marine Grade 6060 extruded & LM6 Aluminum High Pressure die casting provides excellent mechanical strength , clean detailed product lines and excellent heat dissipation.

Pre paint
8 step degrease and phosphate process that includes deoxidizing and etching as well as a zinc and nickel phosphate process before product painting.

Memory Retentive -Silicon Gasket
Provided with special injection molded "fit for purpose" long life high temperature memory retentive silicon gaskets. Maintains the gaskets exact profile and seal over years of use and compression.

Thermal management
LM6 Aluminum is used for its excellent mechanical strength and thermal dissipation properties in low and high ambient temperatures. The superior thermal heat sink design by Ligman used in conjunction with the driver, controls thermals below critical temperature range to ensure maximum luminous flux output, as well as providing long LED service life and ensuring less than 10% lumen depreciation at 50,000 hours.

Surge Suppression
Standard 10kv surge suppressor provided with all fixtures.

BUG Rating
B1 - U0 - G0

Finishing
All Ligman products go through an extensive finishing process that includes fettling to improve paint adherence.

Paint
UV Stabilized 4.9Mil thick powder coat paint and baked at 200 Deg C. This process ensures that Ligman products can withstand harsh environments. Rated for use in natatoriums.

Inspired by Nature Finishes
The Inspired by nature Finishing is a unique system of decorative powder coating. Our metal decoration process can easily transform the appearance of metal or aluminum product into a wood grain finish.

This patented technology enables the simulation of wood grain, and even marble or granite finish through the use of decorative powder coating.

The wood grain finish is so realistic that it's almost undistinguishable from real wood, even from a close visual inspection. The system of coating permeates the entire thickness of the coat and as a result, the coating cannot be removed by normal rubbing, chipping, or scratching.

The Coating Process
After pre-treatment the prepared parts are powder coated with a specially formulated polyurethane powder. This powder provides protection against wear, abrasion, impact and corrosion and acts as the relief base color for the finalized metal decoration.

The component is then wrapped with a sheet of non-porous film with the selected decoration pattern printed on it using special high temperature inks.

This printed film transfer is vacuum-sealed to the surface for a complete thermo print and then transferred into a customized oven. The oven transforms the ink into different forms within the paint layer before it becomes solid. Finally, the film is removed, and a vivid timber look on aluminum remains.

Wood grain coating can create beautiful wood-looking products of any sort. There are over 300 combinations of designs currently in use. Wood grains can be made with different colors, designs, etc.

Our powder coatings are certified for indoor and outdoor applications and are backed by a comprehensive warranty. These coatings rise to the highest conceivable standard of performance excellence and design innovation.

Added Benefits
- Resistance to salt-acid room, accelerated aging
- Boiling water, lime and condensed water resistant
- Anti-Graffiti, Anti-Slip, Anti-Microbial, Anti-Scratch
- Super durable (UV resistant)
- TGIC free (non-toxic)

Hardware
Provided Hardware is Marine grade 316 Stainless steel.

Anti Seize Screw Holes
Tapped holes are infused with a special anti seize compound designed to prevent seizure of threaded connections, due to electrolysis from heat, corrosive atmospheres and moisture.

Crystal Clear Low Iron Glass Lens
Provided with tempered, impact resistant crystal clear low iron glass ensuring no green glass tinge.

Optics & LED
Precise optic design provides exceptional light control and precise distribution of light. LED CRI > 80

Lumen - Maintenance Life
L80 /B10 at 50,000 hours (This means that at least 90% of the LED still achieve 80% of their original flux)

Clean, beautiful, surface wall fix… leading performance. Minimalis… most powerful and flexible lighting tool of its type, offering packages up to 2,400 lumens and microVos technology.

A range of small, square and rectangular, ADA compliant wall mounted luminaires with options of upward or downward light distributions. Ideally suited to illuminate the wall and surfaces in front of wall and for light accents on vertical surfaces using high efficiency LED's. The Leeds is suitable for indoor and outdoor applications and provides a clean, visually appealing solution for small, unobtrusive wall mounted luminaires.

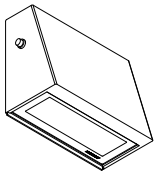
This luminaire is available in 3 different sizes and in combinations of down, up or up/down light distributions.

This fixture utilizes microVos technology, meaning the ability to do Type I,II,III,IV & V distributions as well as hybrid distributions to suit the designer's requirements.

Using the microVos optics allows for very wide spacing to mounting height ratios, while still providing perfect uniformity and code compliant light levels.

To meet International Dark Sky criteria, 3000k or warmer LEDs must be selected and luminaire fix mounted (+/- 15˚ allowable to permit leveling).

Additional Options (Consult Factory For Pricing)



BPC
Button Photocell

Ligman Lighting USA reserves the right to change specifications without prior notice, please contact factory for latest information. Due to the continual improvements in LED technology data and components may change without notice.

ULEW-30021

Leeds 3 Large Surface Wedge Downlight

microVOS TECHNOLOGY

LIGMAN LIGHTING USA

PROJECT		DATE	
QUANTITY		TYPE		NOTE	

ORDERING EXAMPLE || ULEW - 30021 - 20w - T2 - W30 - 02 - 120/277v - Options

ULEW-30021	LAMP	BEAM	LED COLOR	FINISH COLOR	VOLTAGE
	20w LED 2422 Lumens 28w LED 3200 Lumens	T1 - Type I Distribution T2 - Type II Distribution T3 - Type III Distribution T4 - Type IV Distribution M - Medium 30˚ W - Wide 56˚ EW - Extra Wide 99˚x102˚	W27 - 2700K W30 - 3000K W35 - 3500K W40 - 4000K	01 - BLACK RAL 9011 02 - DARK GREY RAL 7043 03 - WHITE RAL 9003 04 - METALLIC SILVER RAL 9006 05 - MATTE SILVER RAL 9006 06 - LIGMAN BRONZE 07 - CUSTOM RAL	120/277v Other - Specify

ADDITIONAL OPTIONS

NAT - Natatorium Rated
SCE - Surface Conduit Decorative Trim
F - Frosted Lens
BPC - Button Photocell
AMB - Turtle Friendly Amber LED

PROVIDE IF REQUIRED TO MATCH EXISTING INSTALLATION

INSPIRED BY NATURE FINISHES

SW01 - OAK FINISH
SW02 - WALNUT FINISH
SW03- PINE FINISH
DF - DOUGLAS FIR FINISH
CW - CHERRY WOOD FINISH
NW - NATIONAL WALNUT FINISH
SU01 - CONCRETE FINISH
SU02 - SOFTSCAPE FINISH
SU03 - STONE FINISH
SU04 - CORTEN FINISH

THERE IS AN ADDITIONAL COST FOR THESE FINISHES

More Custom Finishes Available Upon Request

Consult factory for pricing and lead times

Oak, Cherry, Beech, Carbon
Walnut, Chestnut, Bamboo, Galvanized
Pine, Mahogany, Birch, Steel



Example: Inspired by Nature Finish

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Intertek

Leeds Product Family



Leeds 1 - Up/Down

- ULEE-30031-2x5.5w-2x570lm



Leeds 2 - Down

- ULEE-30001-5.5w-570lm



Leeds 3 - Up/Down

- ULEE-30041-2x14w-2x1660lm



Leeds 4 - Down

- ULEE-30011-14w-1660lm



Leeds 5 - Up/Down

- ULD-30051-2x20w-2x2422lm



Leeds 6 - Down

- ULEE-30021-20w-2422lm

Leeds Wedge Product Family



Leeds Wedge 1

- ULEW-30001-5.5w-570lm



Leeds Wedge 2

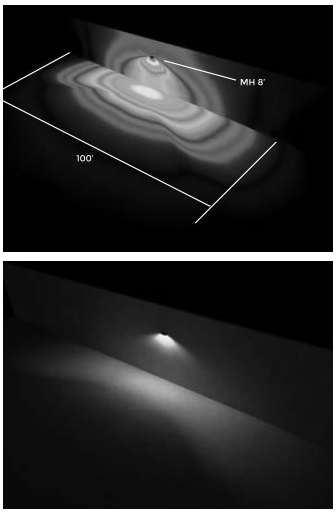
- ULEW-30011-14w-1660lm



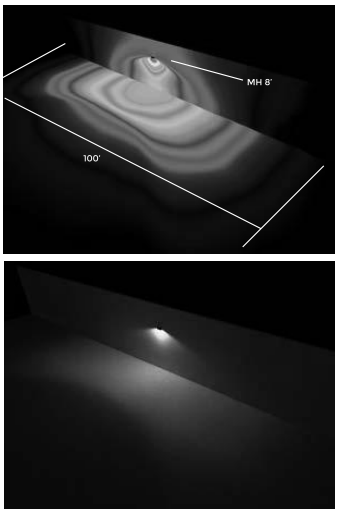
Leeds Wedge 3

- ULEW-30021-20w-2422lm

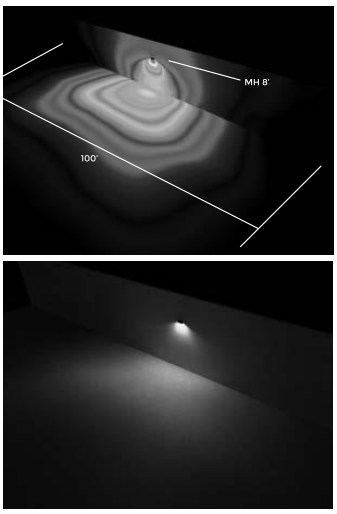
Type II Distribution



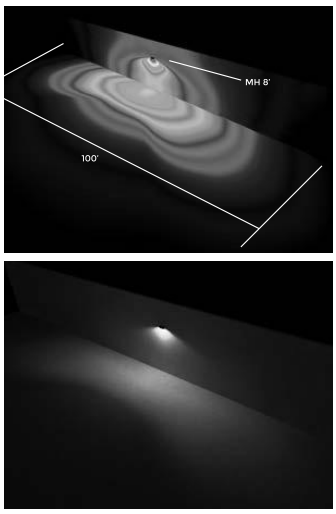
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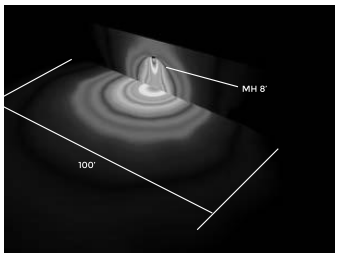
Type IV Distribution



Type ME Distribution

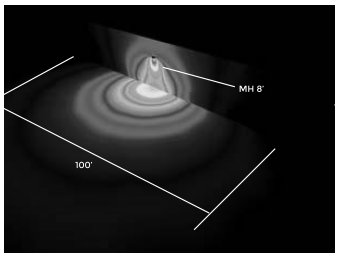


Medium Beam - 30˚



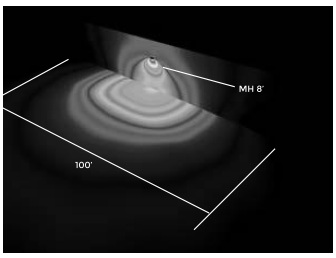


Wide Beam - 56˚





Extra Wide Beam - 99˚ x 102˚





ULEW-30001

Leeds 1 Small Surface Wedge Downlight

microVos TECHNOLOGY

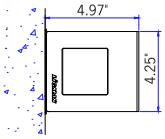
LIGMAN LIGHTING USA

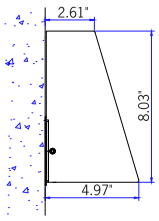
TYPE OG3

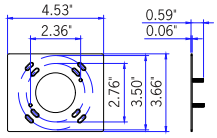


TURTLE FRIENDLY

5.5w LED 570 Lumens
IP65 • Suitable For Wet Locations
IK07 • Impact Resistant
Weight 5 lbs



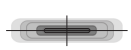


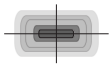


Mounting Detail

microVos TECHNOLOGY

Ligman's micro Variable Optical System provides the ability to interchange, mix & rotate optics to provide specific light distributions for optimized spacing and uniformity.


Type I


Type II


Type III


Type IV


Type V

Construction

Aluminum
Less than 0.1% copper content – Marine Grade 6060 extruded & LM6 Aluminum High Pressure die casting provides excellent mechanical strength , clean detailed product lines and excellent heat dissipation.

Pre paint
8 step degrease and phosphate process that includes deoxidizing and etching as well as a zinc and nickel phosphate process before product painting.

Memory Retentive -Silicon Gasket
Provided with special injection molded "fit for purpose" long life high temperature memory retentive silicon gaskets. Maintains the gaskets exact profile and seal over years of use and compression.

Thermal management
LM6 Aluminum is used for its excellent mechanical strength and thermal dissipation properties in low and high ambient temperatures. The superior thermal heat sink design by Ligman used in conjunction with the driver, controls thermals below critical temperature range to ensure maximum luminous flux output, as well as providing long LED service life and ensuring less than 10% lumen depreciation at 50,000 hours.

Surge Suppression
Standard 10kv surge suppressor provided with all fixtures.

BUG Rating
Contact Factory

Finishing
All Ligman products go through an extensive finishing process that includes fettling to improve paint adherence.

Paint
UV Stabilized 4.9Mil thick powder coat paint and baked at 200 Deg C. This process ensures that Ligman products can withstand harsh environments. Rated for use in natatoriums.

Inspired by Nature Finishes
The Inspired by nature Finishing is a unique system of decorative powder coating. Our metal decoration process can easily transform the appearance of metal or aluminum product into a wood grain finish.

This patented technology enables the simulation of wood grain, and even marble or granite finish through the use of decorative powder coating.

The wood grain finish is so realistic that it's almost undistinguishable from real wood, even from a close visual inspection. The system of coating permeates the entire thickness of the coat and as a result, the coating cannot be removed by normal rubbing, chipping, or scratching.

The Coating Process
After pre-treatment the prepared parts are powder coated with a specially formulated polyurethane powder. This powder provides protection against wear, abrasion, impact and corrosion and acts as the relief base color for the finalized metal decoration.

The component is then wrapped with a sheet of non-porous film with the selected decoration pattern printed on it using special high temperature inks.

This printed film transfer is vacuum-sealed to the surface for a complete thermo print and then transferred into a customized oven. The oven transforms the ink into different forms within the paint layer before it becomes solid. Finally, the film is removed, and a vivid timber look on aluminum remains.

Wood grain coating can create beautiful wood-looking products of any sort. There are over 300 combinations of designs currently in use. Wood grains can be made with different colors, designs, etc.

Our powder coatings are certified for indoor and outdoor applications and are backed by a comprehensive warranty. These coatings rise to the highest conceivable standard of performance excellence and design innovation.

Added Benefits
• Resistance to salt-acid room, accelerated aging
• Boiling water, lime and condensed water resistant
• Anti-Graffiti, Anti-Slip, Anti-Microbial, Anti-Scratch
• Super durable (UV resistant)
• TGIC free (non-toxic)

Hardware
Provided Hardware is Marine grade 316 Stainless steel.

Anti Seize Screw Holes
Tapped holes are infused with a special anti seize compound designed to prevent seizure of threaded connections, due to electrolysis from heat, corrosive atmospheres and moisture.

Crystal Clear Low Iron Glass Lens
Provided with tempered, impact resistant crystal clear low iron glass ensuring no green glass tinge.

Optics & LED
Precise optic design provides exceptional light control and precise distribution of light. LED CRI > 80

Lumen - Maintenance Life
L80 /B10 at 50,000 hours (This means that at least 90% of the LED still achieve 80% of their original flux)

Clean, beautiful, surface wall fixtu[illegible] leading performance. Minimalist form, yet the most powerful and flexible lighting tool of its type, offering packages up to 2,400 lumens and microVos technology.

A range of small, square and rectangular, ADA compliant wall mounted luminaires with options of upward or downward light distributions. Ideally suited to illuminate the wall and surfaces in front of wall and for light accents on vertical surfaces using high efficiency LED's. The Leeds is suitable for indoor and outdoor applications and provides a clean, visually appealing solution for small, unobtrusive wall mounted luminaires.

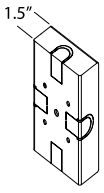
This luminaire is available in 3 different sizes and in combinations of down, up or up/down light distributions.

This fixture utilizes microVos technology, meaning the ability to do Type I,II,III,IV & V distributions as well as hybrid distributions to suit the designer's requirements.

Using the microVos optics allows for very wide spacing to mounting height ratios, while still providing perfect uniformity and code compliant light levels.

To meet International Dark Sky criteria, 3000k or warmer LEDs must be selected and luminaire fix mounted (+/- 15˚ allowable to permit leveling).

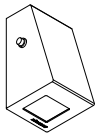
Additional Options (Consult Factory For Pricing)





SCDT
Surface Conduit Decorative Trim

NOTE: This decorative trim does not function as a junction box. Wire connections should be made inside the luminaire



BPC
Button Photocell

Ligman Lighting USA reserves the right to change specifications without prior notice, please contact factory for latest information. Due to the continual improvements in LED technology data and components may change without notice.

ULEW-30001

Leeds 1 Small Surface Downlight

microVOS TECHNOLOGY

LIGMAN LIGHTING USA

TYPE OG3

PROJECT		DATE	
QUANTITY		TYPE		NOTE	

ORDERING EXAMPLE || ULEW - 30001 - 5.5w - T2 - W30 - 02 - 120/277v - Options

ULEW-30001					
	LAMP	BEAM	LED COLOR	FINISH COLOR	VOLTAGE
	5.5w LED 570 Lumens	T1 - Type I Distribution T2 - Type II Distribution T3 - Type III Distribution T4 - Type IV Distribution M - Medium 30˚ W - Wide 56˚ EW - Extra Wide 99˚x102˚	W27 - 2700K W30 - 3000K W35 - 3500K W40 - 4000K	01 - BLACK RAL 9011 02 - DARK GREY RAL 7043 03 - WHITE RAL 9003 04 - METALLIC SILVER RAL 9006 05 - MATTE SILVER RAL 9006 06 - LIGMAN BRONZE 07 - CUSTOM RAL	120/277v Other - Specify

ADDITIONAL OPTIONS		
NAT - Natatorium Rated	BPC - Button Photocell	
SCE - Surface Conduit Decorative Trim	AMB - Turtle Friendly Amber LED	
F - Frosted Lens	SCDT - Surface Conduit Decorative Trim	

PROVIDE IF REQUIRED TO MATCH EXISTING INSTALLATION

INSPIRED BY NATURE FINISHES

- SW01 - OAK FINISH
- SW02 - WALNUT FINISH
- SW03- PINE FINISH
- DF - DOUGLAS FIR FINISH
- CW - CHERRY WOOD FINISH
- NW - NATIONAL WALNUT FINISH
- SU01 - CONCRETE FINISH
- SU02 - SOFTSCAPE FINISH
- SU03 - STONE FINISH
- SU04 - CORTEN FINISH

THERE IS AN ADDITIONAL COST FOR THESE FINISHES

More Custom Finishes Available Upon Request

Consult factory for pricing and lead times

Oak	Cherry	Beech	Carbon
Walnut	Chestnut	Bamboo	Galvanized
Pine	Mahogany	Birch	Steel



Example: Inspired by Nature Finish

Ligman Lighting USA reserves the right to change specifications without prior notice, please contact factory for latest information. Due to the continual improvements in LED technology data and components may change without notice.

Intertek

Leeds Product Family



Leeds 1 - Up/Down

• ULEE-30031-2x5.5w-2x570lm



Leeds 2 - Down

• ULEE-30001-5.5w-570lm



Leeds 3 - Up/Down

• ULEE-30041-2x14w-2x1660lm



Leeds 4 - Down

• ULEE-30011-14w-1660lm



Leeds 5 - Up/Down

• ULD-30051-2x20w-2x2422lm



Leeds 6 - Down

• ULEE-30021-20w-2422lm

Leeds Wedge Product Family



Leeds Wedge 1

• ULEW-30001-5.5w-570lm



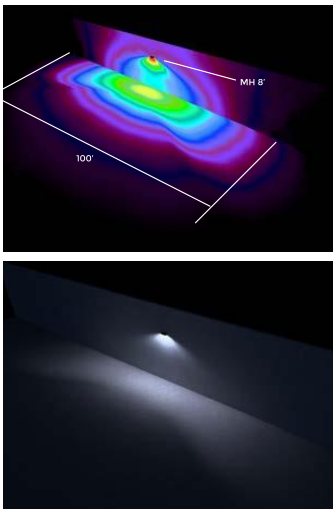
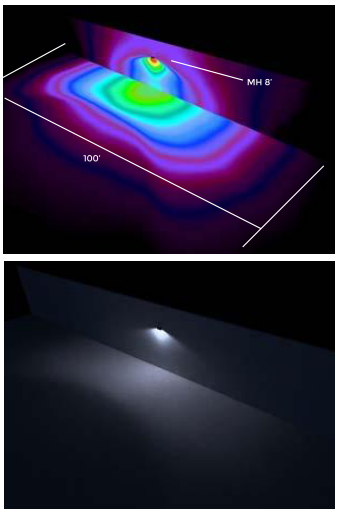
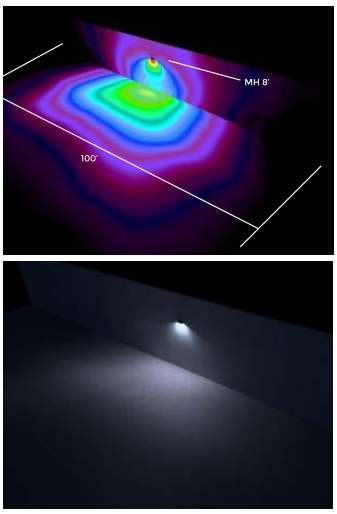
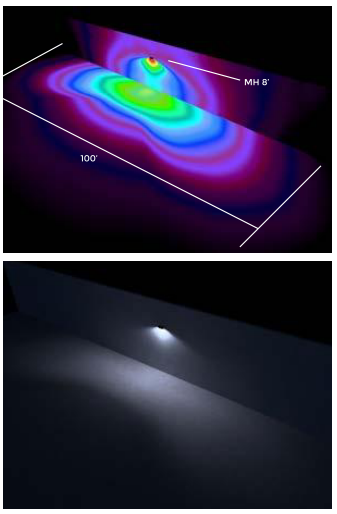
Leeds Wedge 2

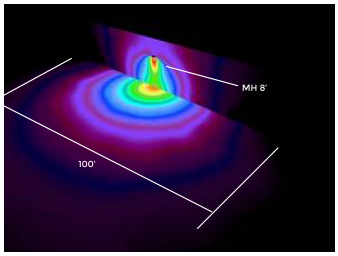
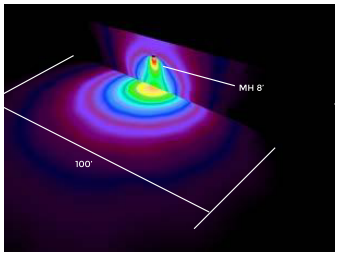
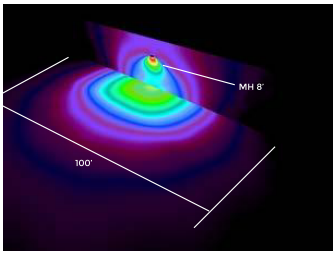
• ULEW-30011-14w-1660lm



Leeds Wedge 3

• ULEW-30021-20w-2422lm

Type II Distribution	Type III Distribution	Type IV Distribution	Type ME Distribution
			

Medium Beam - 30˚	Wide Beam - 56˚	Extra Wide Beam - 99˚ x 102˚
		
		

Project		Catalog #		Type	Type X PARKING DECK USE
Prepared by		Notes			

PROVIDE SPECIFIED FIXTURE BY APPROVED MANUFACTURER OR ENGINEER-APPROVED EQUAL BY:
DUAL LITE
LITHONIA
LSI



Sure-Lites

LPX Series

LED polycarbonate Exit with 90 minutes of run time

Typical Applications

Office • Education • Healthcare • Hospitality • Retail • Industrial • Manufacturing

Interactive Menu

- Order Information page 2
- Product Warranty

Product Certification

CERTIFIED · T20 Certified to California Title 20 Appliance Database · OSHA

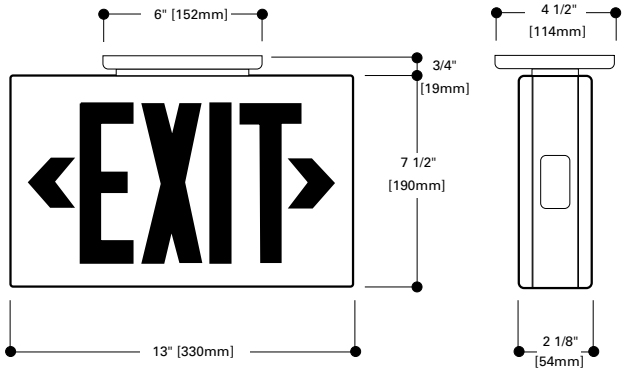
Product Features

damp location · selectable faces

Top Product Features

- LED Polycarbonate Exit available in white or black housings
- UL 924 damp location certified
- Field selectable for Red or Green illumination and single or double faces
- 90 minutes of emergency run time with self-powered (battery backup) models
- Maintenance free nickel cadmium battery
- Self-diagnostic and remote capacity options
- DLVP option

Dimensional Details



Sure-Lites LPX Series

Ordering Information

SAMPLE ORDER NUMBER: **LPX6, LPX6BK, LPX7SD, LPX7BKSD**

Family	Series	Face Options	Housing Finish	Options	Accessories
LPX=Polycarbonate Exit, LED	**6**=AC Only **7**=Self-Powered	**[Blank]**=Single and Double	**[Blank]**=White Housing **BK**=Black Housing (available with AC series and self-powered, self-diagnostics only)	**[Blank]**=No additional options SD=self-diagnostics/LPX7 only	**WG10**=Wall mount wire guard **WGS11**=Ceiling or End **VS1**=Polycarbonate Vandal Shield **VS1WP**=Polycarbonate Vandal Shield, Weather Proof **Pendant Kit** **LPX18PKWH**=18" Pendant Kit, White **LPX18PKHTWH**=18" Hang True Pendant Kit, White **LPX18PKBK**=18" Pendant Kit, Black **LPX18PKHTBK**=18" Hang True Pendant Kit, Black

FACE AS INDICATED ON PLANS

Notes (1) Self-powered units have battery backup to provide 90 minutes of run time when A/C power is lost. Units must be connected to A/C power for standard operation. (2) LPX7 (no self-diagnostics) units are not available in black. LPX7BKSD (self-diagnostics) units are available in black. (3) For 2 circuit capability on the LPX6 series, order the SL2CPK in addition to the exit sign. The 2 circuit kit does not accept two hot circuits.

LPXR5SD Ordering Information

INDICATORS AS SHOWN ON PLAN

MOUNTING AS SHOWN ON PLANS

Family	Coverage	Remote Capability	Color	Self-Diagnostics	Full Catalog Logic
LPX=LED Polycarbonate Exit	non-applicable	**R5**=5 watts	**[Blank]**=White **BK**=Black	**SD**=Self-diagnostic (standard)	**LPXR5SD, LPXR5BXSD**

Remote Logic for LPXR5SD Only

		SEL Series Outdoor Capable Remotes					
Series		**Single Head Remotes**			**Double Head Remotes**		
Catalog number		**SRP/SRM13**	**SRP/SRM25**	**SRP/SRM30**	**SRP25D/SRM25D**	**SRP50D/SRM50D**	**SRP60D/SRM60D**
Watts Consumed		**1.25**	**2.5**	**4.1**	**2.5**	**5**	**8.2**
Catalog Number	Remote Watts Available	# of SRP/SRM13 remotes fixture will power	# of SRP/SRM25 remotes fixture will power	# of SRP/SRM30 remotes fixture will power	# of SRP25D/ SRM25D remotes fixture will power	# of SRP50D/ SRM50D remotes fixture will power	# of SRP60D/ SRM60D remotes fixture will power
LPXR5SD	5	4	2	1	2	1	NA

DLVP Options

Family	Series	Face Options	Color	Options	DLVP	Full Catalog Logic
LPX=LED Polycarbonate Exit	**6**=AC Only **7**=Self-Powered	**[Blank]**=Single and Double	**[Blank]**=White **BK**=Black	**SD**=Self-diagnostics (standard for LPX7, not available for LPX6)	**DLVP**=DLVP	**LPX6DLVP, LPX6BKDLVP, LPX7SDDLVP, LPX7BKSDDLVP**

Energy and Performance Data

Maximum power consumption under all charge conditions:

AC Only

Input Voltage	Input Amps	Input Watts
120 Volts	0.07	1.02
277 Volts	0.07	1.12

Self-Powered

Input Voltage	Input Amps
120 Volts	0.07
277 Volts	0.07

Self-Powered, LPX5R Only

Input Voltage	Input Watts
120 Volts	2.2
240 Volts	2.5
277 Volts	3.2

AC Only, DLVP (57 Vdc)

Input Voltage	Input Amps	Input Watts
57Vdc	0.02	1.2

Self-Powered, DLVP (57 Vdc)

Input Voltage	Input Amps
57Vdc	0.07

Sure-Lites LPX Series

Product Specifications

Electrical
- Field selectable red and green sign capability standard on all units (units shipped red, field convert to green with supplied parts)
- Dual Voltage Input 120/277 VAC, 60Hz
- 2C capability enabled with the SL2CPK kit. Note: 2 circuit kit does not accept two hot circuits.
- Self-powered units have battery backup to provide 90 minutes of run time when A/C power is lost
- Sure-Lites EZ Key patented external battery disconnect feature - prevents unnecessary battery drainage, saves on installation time
- Solid-state Voltage Limited Charger
- Brownout Circuit
- Low-Voltage Disconnect
- Test Switch/Power Indicator Light
- Standard 24 hour recharge time (max)
- Self-Diagnostic feature available as option
- DLVP enabled with field installable kit

Housing Construction
- All components are injection molded, color stable, high impact UL 94-5VA rated, polycarbonate material
- White or black textured finish standard
- Faces can be field selectable as single or double faced
- Snap-out or snap-in chevron directional indicators have full 3/4" stroke
- Components are of snap-fit construction to facilitate under 5-minute installation
- Reinforcing ribs throughout to provide maximum strength
- Molded-in wireways facilitate internal wire routing and connections
- All components including battery and electronics are located inside the exit housing
- Knockout provided on housing for surface conduit attachment
- Snap-fit canopy with captive mounting screws included with all exits
- Exit can be ceiling, wall, or end mounted
- Universal J-box mounting pattern

Lamp Data
- AC LED: Red and green LED lamps provide uniform diffused illumination
- DC: Red and green LED DC lamps (Brighter in emergency mode)

Code Compliance
- UL 924 Listed
- UL Damp Location (0-40° C)
- Life Safety NFPA 101
- NEC/OSHA
- Most State and Local Codes
- Suitable for Floor Proximity Installation
- UL Listed for 2C (FTBR)

Warranty
- 5 year product warranty
- 7 year pro-rated battery warranty

Technical Data

Lamps
- Long life, red and green LEDs, provide uniform diffuse illumination of the exit face
- Low operating costs and no maintenance required
- Consumes on average less than one watt

Housing Construction
- Rugged, durable, injection molded polycarbonate
- Structural components designed with reinforcing ribs for additional rigidity and structural integrity
- Impact and scratch resistant
- UV stabilized to resist discoloration due to age and ultraviolet radiation
- Snap-fit construction (no mechanical fasteners) to facilitate installation in under five minutes
- Installation components included (wire nuts, wire leads, universal metal J-box bracket, etc.)
- Universal design enables exit to be field selectable as single face or double face
- Wall, ceiling or end mounting
- Rugged, snap-fit, low-profile canopy with captive screws included for ceiling and end mounting
- Housing color available in white or black

Lens
- Durable, impact-resistant polycarbonate
- Field selectable red or green; ships with red lenses installed and green lenses included
- Full 3/4" stroke snap-out or snap-in chevron directional indicators ensure maximum visibility and code compliances

Sure-Lites EZ Key External Battery Disconnect (Self Powered Only*)
- The Patented EZ key is an external battery disconnect that allows the product to be shipped with the battery connected internally.
- This prevents battery drain during the construction cycle to insure that the battery isn't damaged and is fully charged for inspection.
- EZ Key also saves the labor of internally connecting the battery after construction is complete.

* Self-powered units have battery backup to provide 90 minutes of run time when A/C power is lost. Units must be connected to A/C power for standard operation.

Brownout Circuit (Self Powered Only*)
- Monitors the flow of AC current
- Activates the emergency lighting system when a predetermined reduction/dip of AC power occurs (a dip in voltage will cause most ballasted products to extinguish, causing loss of normal lighting even though a total power failure has not occurred)

Low Voltage Disconnect (Self Powered Only*)
- Low-voltage circuitry disconnects the lighting load when battery's terminal voltage falls
- Disconnect remains in effect until normal utility power is restored, preventing deep battery discharge

Test Switch/Power Indicator Light (Self Powered Only*)
- Switch located on the side of the exit permits the activation of the emergency circuit for complete operational systems check
- Indicator light provides visual assurance that the AC power is on
- LPXR5SD only - switch located on bottom of the exit

Self-Diagnostics Option (Self Powered Only*)
- Automatically performs all tests required by UL924 and NFPA 101
- Indicates the status of the exit at all times using the LED indicator near the test switch on the side of the unit
- 90-minute battery power (emergency mode) simulation test occurs randomly once every 12 months
- 30-second battery power simulation test occurs every 30 days

Photocell Test Switch for LPXR5SD Model Only
- Allows verification of proper operation of the transfer circuit and emergency lamps with a laser pointer (laser is sold as an accessory). The emergency lamps will test for 30 seconds when activated.
- Located on bottom of the unit



Laser tester
Part Number=LASER
(sold separately)

"2C" Option (AC Only)
Note: "2C" cannot accept 2 active hots
- Enables the exits to operate per the requirements of UL 924 when connected simultaneously to both normal and emergency power circuits (two circuit operation–UL Category FTBR–Emergency Lighting and Power Equipment)
- The "2C" Option alters the standard Exit such that it complies with and is UL Listed under the FTBR Category
- This option should only be used for exits which are intended to be connected simultaneously to normal and emergency power circuits, but cannot support two hot inputs. Only one of the normal or emergency circuits can be powered. If both are powered simultaneously, it will make the Exit inoperable.
- Both circuits have universal 120/277 VAC standard

Sealed Nickel Cadmium Battery
- Sealed, maintenance-free nickel cadmium battery with 10-year typical life expectancy
- Rechargeable battery offers high discharge rates and stable performance over a wide range of temperatures from 0°C to 40°C

Warranty
- Five-year warranty against defects in material and workmanship
- Nickel cadmium battery has a seven-year prorated warranty

COOPER Lighting Solutions

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www.cooperlighting.com

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Specifications and dimensions subject to change without notice.