ADDENDUM NUMBER THREE
BID S-7-21

To: All Prospective Bidders and all others concerned
From: City of Cheyenne, Purchasing Manager, TJ Barttelbort
Date: December 18, 2020
Subject: Addendum Number Three to Bid S-7-21 for the Happy Jack Landfill Front Entrance and Scale House project

The changes, clarifications, omissions, additions, and/or alterations in, on, and to the bid information and specifications shall apply to the Invitation For Bid submitted for and to the project indicated above. Except as modified by this Addendum Number Three, all of the terms and provisions of the Invitation for Bid for the above listed project remain in full force and effect. This Addendum Number Three supersedes all previous instructions pertaining to the items listed:

REVISED PLANS & SPECIFICATIONS:

1. The City of Cheyenne is issuing revised and updated Plans & Specifications via this Addendum Three. Bidders are instructed to use these updated Plans & Specifications for their Bid Submission, and shall disregard the information found on pages 50 through 606 of the Bidding Documents. All required Proposal forms are still found on pages 14 through 20 of the Bidding Documents.

REVISED BID SCHEDULE:

1. The bid schedule has been revised & updated as follows:
   a. Pre-Bid Meeting via Zoom.
      Topic: Bid S-7-21 / Pre-Bid Meeting / Landfill Scalehouse & Admin Building
      Time: Jan 13, 2021 10:00 AM Mountain Time (US and Canada)
      https://us02web.zoom.us/j/84537458645?pwd=UzcyM0FKd3ZmZWtMZWpBaXRLS1YrQT09
      Meeting ID: 845 3745 8645  Passcode: 2101
b. Attendance is **highly recommended** for Prime Bidders. The requirement for attendance at the September 10, 2020 MANDATORY Pre-Bid Meeting is no longer required to submit a bid for this project. Due to the issuance of revised plans and specifications, and the revised bidding schedule, the City is waiving this requirement.

i. The Zoom Meeting will open approximately five (5) minutes before the meeting commences, for interested parties to join. The meeting will be limited to approximately 40 minutes. As you join the meeting, please type the following information into the chat box, so that the City may record your presence at the meeting:

1. Individual Name
2. Business you are representing
3. Phone Number
4. Email Address

2. Question Submission Deadline & Addendum Response Deadline

   a. All Questions shall be directed to the City Purchasing Manager, by e-mail at tbartelbort@cheyennecity.org

   b. Questions will be received until **5:00 pm local time on January 21, 2021**, after which no additional questions will be accepted. The City will respond via Addendum, no-later-than **5:00 pm local time on January 28, 2021**.

3. Bid Opening

   a. The Governing Body of the City of Cheyenne, Wyoming (“the Governing Body”) will receive sealed bid proposals at the Office of the City Purchasing Agent, located in Room 309 of the Municipal Building at 2101 O’Neil Avenue, Cheyenne, WY 82001, until 2:00 p.m. local time on the **10th day of February, 2021**, for the “**Happy Jack Landfill Front Entrance and Scale House**” project.

**ADDENDUM THREE ACKNOWLEDGED:**

BY________________________________________ TITLE________________________________________

(Addendum **must** be signed and returned with bid or receipt of the addendum **must** be acknowledged on the Invitation to Bid).

**REMAINDER OF PAGE INTENTIONALLY LEFT BLANK**
Front Entrance and Scale House - Happy Jack Landfill - Laramie County, Wyoming

Shall be repaired to restore the roads and pavements to their original condition to the satisfaction of the owner.

Prior to the removal of barricades and traffic control devices, the contractor shall request the owner to schedule an inspection. No roadway shall be re-opened until the owner has completed inspection and approved the re-opening of active areas.

Any damage to roads and pavements to remain due to construction equipment or traffic shall be repaired to restore the roads and pavements to their original condition to the satisfaction of the owner.
NOTES:
1. FIELD SURVEY COMPLETED BY INBERG MILLER ENGINEERS ON AUGUST 23 AND SEPTEMBER 5, 2019. CONTOURS ARE SHOWN AT AN INTERVAL OF 2 FEET.
2. THE SURVEY PROVIDED IS BASED ON THE STATE PLANE COORDINATE SYSTEM, WYOMING EAST ZONE, NAD 83. ALL LINEAR UNITS ARE DEPICTED FROM SURVEY DATA IN US SURVEY FEET.
3. UTILITY LOCATIONS SHOWN ARE AS MARKED BY THEIR OWNER, FROM THE OWNER'S RECORD, OR FROM FIELD EVIDENCE.
4. DATA PROVIDED FOR INFORMATION ONLY. CONTRACTOR SHALL FIELD VERIFY ALL FEATURES SHOWN ON THIS DRAWING.

SCALE: 1" = 100'
NOTES:

1. EXISTING SCALES SHALL BE RELOCATED TO NEW SCALE LOCATIONS SHOWN ON DRAWING CS101. CONTRACTOR SHALL COORDINATE RELOCATION SCHEDULE WITH OWNER AND SHALL MAINTAIN ONE OPERATIONAL SCALE AT ALL TIMES.

2. DEMOLITION OF SCALE FOUNDATIONS, SCALEHOUSE, AND BUILDINGS SHALL BE TO THE FULL EXTENT BELOW GRADE IN ACCORDANCE WITH SPECIFICATIONS.

Scale: 1" = 100'

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Scale: 1" = 100'
NOTE:
1. NEW POWERED LANDFILL ENTRANCE GATE TO BE LIFTMASTER MODEL SL595 WITH 1 HP MOTOR OR ENGINEER APPROVED ALTERNATIVE.

EX. STOP SIGN
LIMITS OF SPECIAL FLOOD HAZARD AREA
EXISTING SIGN (TO BE RELOCATED)
GRADE TO EXISTING FROM NEW ASPHALT AT 4:1 MAX. SLOPE
GRADE TO EXISTING FROM NEW ASPHALT AT 4:1 MAX. SLOPE

SCALE: 1" = 20'

POINT TABLE

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UNIT C503
118706CU101
SCALE IN FEET
CU101 1
20'40' 0
SCALE: 1" = 20'
INSET B
SCALE IN FEET
CU101 1
20'40' 0
SCALE: 1" = 20'
INSET B

1. CONTRACTOR TO PROVIDE A MINIMUM 5000 GALLON CISTERN DESIGN WITH INTEGRATED PUMP TO PROVIDE A MINIMUM DYNAMIC HEAD OF 155 FT AND TO ALLOW A MINIMUM OF 44 GPM FLOW TO THE SCALEHOUSE.

2. SEWER DRAIN LINE 90° BEND TO BE CONSTRUCTED USING TWO 45° BENDS.

3. SEPTIC TANK TO BE VAUGHN 1000 GALLON PRECAST CONCRETE TWO PIECE SEPTIC TANK OR ENGINEER APPROVED ALTERNATIVE.

4. NEW SEPTIC SYSTEM AND SOIL ABSORPTION BED TO BE INSTALLED IN ACCORDANCE WITH LARAMIE COUNTY SMALL WASTEWATER SYSTEM REGULATIONS. SOIL ABSORPTION SYSTEM TO BE A TWO LEGGED STANDARD TRENCH SYSTEM. TRENCHES ARE TO BE 3 FEET WIDE, WITH A MAXIMUM DEPTH OF 1 FOOT, BURIED A MINIMUM OF 12 INCHES BELOW GROUND SURFACE.

5. UTILITY CROSSING TO BE 2-INCH PVC WATERLINE INSTALLED A MINIMUM OF 44 INCHES ABOVE 4-INCH PVC SANITARY SEWER LINE.

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5. UTILITY CROSSING TO BE 2-INCH PVC WATERLINE INSTALLED A MINIMUM OF 44 INCHES ABOVE 4-INCH PVC SANITARY SEWER LINE.
NOTE:
1. PAVING AND STRIPING TO BE PERFORMED IN ACCORDANCE WITH THE US DOT MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES.
NOTE:

1. CONTRACTOR SHALL COMPACT FILL IN ACCORDANCE WITH PROJECT SPECIFICATIONS.

2. SLIGHTLY MODIFY BACKFILL OVER TRENCH TO ALLOW FOR MINOR SETTLEMENT IN NON-ROADWAY AREAS.

WHEEL CHAIR RAMP 

EXPANSION JOINTS

SECTION A-A

NOTE TO SCALE

CURB AND GUTTER DETAIL

SIDEWALK DETAIL

NOT TO SCALE
### STANDARD ABBREVIATIONS

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### MATERIAL LEGEND

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<tr>
<td>Wood</td>
<td>Wood</td>
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### SPECIAL INSPECTION REQUIREMENTS

**MATERIAL IDENTIFICATION**
- **Concrete**
  - **Material Identification**
    - Identification of Ingredients
    - Mixture of Compliance
- **Steel (Large Scale)**
  - **Material Identification**
    - Identification of ASTM Materials
- **Aluminum**
  - **Material Identification**
    - Identification of ASTM Materials

**SPECIAL INSPECTION TESTS**
- **Concrete**
  - **Special Inspection Tests**
    - Testing for Strength
- **Steel (Large Scale)**
  - **Special Inspection Tests**
    - Testing for Tensile Strength
- **Aluminum**
  - **Special Inspection Tests**
    - Testing for Strength

**SPECIAL INSPECTION APPROVAL**
- **Concrete**
  - **Special Inspection Approval**
    - Approval for Use
- **Steel (Large Scale)**
  - **Special Inspection Approval**
    - Approval for Use
- **Aluminum**
  - **Special Inspection Approval**
    - Approval for Use

**SPECIAL INSPECTION INSTALLATION**
- **Concrete**
  - **Special Inspection Installation**
    - Installation of Components
- **Steel (Large Scale)**
  - **Special Inspection Installation**
    - Installation of Components
- **Aluminum**
  - **Special Inspection Installation**
    - Installation of Components

**SPECIAL INSPECTION ACCEPTANCE**
- **Concrete**
  - **Special Inspection Acceptance**
    - Acceptance of Components
- **Steel (Large Scale)**
  - **Special Inspection Acceptance**
    - Acceptance of Components
- **Aluminum**
  - **Special Inspection Acceptance**
    - Acceptance of Components

**SPECIAL INSPECTION QUALITY CONTROL**
- **Concrete**
  - **Special Inspection Quality Control**
    - Quality Control of Components
- **Steel (Large Scale)**
  - **Special Inspection Quality Control**
    - Quality Control of Components
- **Aluminum**
  - **Special Inspection Quality Control**
    - Quality Control of Components

**SPECIAL INSPECTION COMPLIANCE**
- **Concrete**
  - **Special Inspection Compliance**
    - Compliance with Specifications
- **Steel (Large Scale)**
  - **Special Inspection Compliance**
    - Compliance with Specifications
- **Aluminum**
  - **Special Inspection Compliance**
    - Compliance with Specifications

**SPECIAL INSPECTION RECORDS**
- **Concrete**
  - **Special Inspection Records**
    - Records for Components
- **Steel (Large Scale)**
  - **Special Inspection Records**
    - Records for Components
- **Aluminum**
  - **Special Inspection Records**
    - Records for Components
GENERAL NOTES
1. CONTRACTOR SHALL COORDINATE ALL STRUCTURAL WORK WITH WORK SHOWN ON ALL OTHER DRAWINGS.
2. CONTRACTOR SHALL VERIFY THAT ALL DIMENSIONS OF CONSTRUCTION AND REPAIR ARE CORRECT. ANY DISCREPANCIES FROM THE CONTRACT DOCUMENTS MUST BE NOTIFIED TO THE ENGINEER IMMEDIATELY. DRAWINGS ARE TO THE DIMENSIONS SHOWN, UNLESS OTHERWISE NOTED. ALL DIMENSIONS ARE TO BE CHECKED WITHIN 0.25" DURING THE CONSTRUCTION PROCESS.
3. THE CONSTRUCTION SPECIFICATIONS REPRESENT THE FINISHED STRUCTURE. CONTRACTOR SHALL BE RESPONSIBLE FOR MEANS AND METHODS OF CONSTRUCTION INCLUDING, BUT NOT LIMITED TO, SHORING AND TEMPORARY BRIDGE TO PROVIDE THE CONSULTANTS WITH ACCESS TO THE SITE.
4. CONTRACTOR IS TO APPLY A 500-psi BUMP TEST TO ALL CONCRETE AS PER NAHB. CEMENT IS TO BE DETERMINED BY THE ENGINEER PRIOR TO THE CONTRACT DAVDINGS OR SPECIFICATIONS. THEIR CONSIDERATIONS OF BEING THE SAME CHARACTER AS SIMILAR CONDITIONS THAT ARE SHOWN OR CALLED FOR WITH THE APPROVAL OF THE ENGINEER, WHERE SLOPES VARY, SLOPES CAN BE MODIFIED TO SUIT THE ENGINEER'S NEEDS. THESE SLOPES CAN BE MODIFIED BY STORM WATERS.
METAL BUILDING SYSTEMS

1. THE SCALE HOUSE BUILDING IS A DEVELOPED DESIGN, PROVEN TO MEET METAL BUILDING SYSTEMS REQUIREMENTS. REFER TO PROJECT SPECIFICATION 10.34.23-14 FOR ADDITIONAL REQUIREMENTS.

2. DESIGN, SCHEDULE, AND EXECUTE THE BUILDING SYSTEM IN ACCORDANCE WITH THE CONTRACT DOCUMENTS.

3. DRAW SHOP DRAWINGS AND STRUCTURAL DESIGN ANALYSIS OF METAL BUILDING SYSTEM PREPARED AND REVIEWED BY A QUALIFIED PROFESSIONAL ENGINEER.

4. INCLUDE DEVELOPMENT OF LOADS, DESIGN OF Supports, AND SCHEDULED INSTALLATION DETAILS.

5. INCLUDE DEVELOPMENT OF LOADS, DESIGN OF Supports, AND SCHEDULED INSTALLATION DETAILS.

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11. INCLUDE DEVELOPMENT OF LOADS, DESIGN OF Supports, AND SCHEDULED INSTALLATION DETAILS.

12. INCLUDE DEVELOPMENT OF LOADS, DESIGN OF Supports, AND SCHEDULED INSTALLATION DETAILS.

NOTES:

1. SEE 001 AND 002-9 FOR ARRANGEMENTS, SPECIFICATIONS, AND GENERAL SPECIFICATIONS.

2. SEE 003 FOR TYPICAL SUBMISSIONS.

3. SEE DRAWINGS FOR LOCATION OF SCALE HOUSE BUILDING FOUNDATION.

4. SCALE FOOTING ARRANGEMENT SHOWN IS FOR 40FPC AND 100FPC SCALE HOUSE.

5. CONTRACTOR SHALL CONSULT A LOCAL, CARDINAL, AND SCALE HOUSE REPRESENTATIVE.

6. EXISTING LOAD CELLS AND OTHER INSTALLATION REQUIREMENTS.

7. CONTRACTOR SHALL CONSULT A LOCAL, CARDINAL, AND SCALE HOUSE REPRESENTATIVE.

8. CONTRACTOR SHALL CONSULT A LOCAL, CARDINAL, AND SCALE HOUSE REPRESENTATIVE.

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12. CONTRACTOR SHALL CONSULT A LOCAL, CARDINAL, AND SCALE HOUSE REPRESENTATIVE.
GENERAL NOTES

1. ALL WORK SHALL COMPLY WITH ALL APPLICABLE CODES AND STANDARDS AS LISTED OR REFERENCED ON LIFE SAFETY PLAN AND LIFE SAFETY CRITERIA.

2. ACCESSORIES SHALL COVER DETAILS SHALL COVER OVER SMALL OPENINGS AND ELEVATIONS. LARGE SCALE DETAILS OR PLANS SHALL GOVERN OVER SMALL SCALE DETAILS OR PLANS. DO NOT SCALE DRAWINGS.

3. THE GENERAL CONTRACTOR SHALL PROVIDE AND INSTALL ALL COST EMERGENCY EXIT, SAFETY SYSTEMS, ALARM SYSTEMS AND AUTOMATIC SPRINKLER SYSTEMS AS REQUIRED BY APPLICABLE CODES AND STANDARDS.

4. ALL FLOORS SHALL BE INSPECTED FOR DAMAGE, WARping OR OTHER NOTICEABLE DEVIATIONS AND PATCHED AND LEVELD PRIOR TO COVERING WITH FLOOR FINISHES.

5. THE GENERAL CONTRACTOR SHALL BE RESPONSIBLE FOR PROVIDING ALL MANUFACTURER'S RECOMMENDED MAINTENANCE PROCEDURES AND SCHEDULES.

6. ANY MANUFACTURER'S OR BRAND NAME PRODUCTS INDICATED OR SPECIFIED ARE DONE SO TO ENSURE A MINIMUM LEVEL OF QUALITY AND TO PROVIDE STANDARDS OF CONSTRUCTION. IF A CONDITION IS NOT SPECIFICALLY DETAILLED, SUBMIT A SIMILAR DETAIL FOR GUIDE AND APPROVAL.

7. ALL CONSTRUCTION MUST MEET OR EXCEED LOCAL INDUSTRY STANDARDS. DETAILS ARE PROVIDED TO INDICATE MINIMUM QUALITY AND TO GIVE STANDARDS OF CONSTRUCTION. IF A CONDITION IS NOT SPECIFICALLY DETAILED, SUBMIT A SIMILAR DETAIL FOR GUIDE AND APPROVAL.

8. THE LETTERS I, O, AND Q ARE NOT USED TO INDICATE DETAILS, SECTIONS OR ELEVATIONS.

9. PROVIDE PRESERVATIVE-TREATED WOOD AT ALL LOCATIONS WHERE WOOD IS IN DIRECT CONTACT WITH CONCRETE OR CONCRETE MASONRY.

10. PROVIDE FIRE-RATING RECOMMENDED TREATED WOOD BLOCKING FOR SECURE ANCHORAGE OF ALL SHELVES, RUNNING TRIM RAILINGS, SUSPENDED ITEMS, DOOR STOPS, GRAB BARS, AND OTHER SIMILAR WOODWORK, HARDWARE, SPECIET, ACCESSORIES, FIXTURES, OR EQUIPMENT.

11. PROVIDE CEMENT BOARD SHEATHING AT ALL AREAS WHERE A TILE SURFACE IS TO BE INSTALLED ON METAL STUD WALL.

12. PROVIDE WET-RIGHT GYPSUM BOARD AT ALL WET OR UNCONDITIONED AREAS INCLUDING, BUT NOT LIMITED TO BATHROOMS AND MOP SINS.

13. PRINT, STAIN, OR COAT ALL EXPOSED SURFACES OF CONSTRUCTION UNLESS NOTED OTHERWISE OR IF SURFACES ARE FIRE-RATED.

14. ALL OPENINGS, WINDOWS, AND DOORS SHALL BE FIELD MEASURED AND COORDINATED TO THE APPROPRIATE SUPPLIERS FOR ALL DOORS AND WINDOWS.

15. PROVIDE FITTED, PLUMBING, AIR, DUCTWORK, AND ANY EQUIPMENT EXPOSED TO VIEW SHALL BE LOCATED PARALLEL OR PERPENDICULAR TO THE STRUCTURAL FRAMEWORK.

16. PROVIDE WATER GUAGE PROTECTIONS BETWEEN OSMIAR MATERIALS WHERE REQUIRED.

17. PROVIDE CERAMIC TILE TO BE INSTALLED 4" OF ABOVE FINISH FLOOR AND 1" OF SIDE AT MOP SINK.

18. PROVIDE PROJECTUAL SPECIFICATIONS ARE APPLICABLE WHERE INDICATED BY SECTION CUT, BY NOTE, OR BY DETAIL TITLE. PROVIDE SIMILAR DETAILS AT SIMILAR CONDITIONS UNLESS NOTED OTHERWISE. THE CONTRACTOR MAY REQUEST A CLARIFICATION IF REQUIRED. OTHERWISE THE MORE STRINGENT REQUIREMENTS SHALL APPLY.

19. PROVIDE FIRE-STOPPING SYSTEMS AT TOP OF AND AT ALL PENETRATIONS THROUGH FIRE-RATED PARTITIONS.

20. PROVIDE FIRE-STOPPING SYSTEMS AT THE TOP OF AND AT ALL PENETRATIONS THROUGH FIRE-RATED PARTITIONS.

21. SEAL ALL EXTERIOR BUILDING JOINTS TO THE EXTERIOR AND INTERIOR SURFACES AGAINST MOISTURE AND AIR INFILTRATION.

22. SEAL ALL DOORS AND WINDOW FRAMES, COUNTERTOPS, WALL-MOUNTED FIXTURES AND EQUIPMENT TO ADJACENT WALL SURFACES.

23. PROVIDE FIRE-STOPPING SYSTEMS AT THE TOP OF AND AT ALL PENETRATIONS THROUGH FIRE-RATED PARTITIONS.

24. PROVIDE ARCHITECTURAL DETAILS ARE APPLICABLE WHERE INDICATED BY SECTION CUT, BY NOTE, OR BY DETAIL TITLE. PROVIDE SIMILAR DETAILS AT SIMILAR CONDITIONS THROUGHOUT.

25. PROVIDE GALVANIC PROTECTION BETWEEN DISSIMILAR MATERIALS, WHERE REQUIRED.

26. PROVIDE ALL MANUFACTURER'S RECOMMENDED MAINTENANCE INSTRUCTIONS, MAINTENANCE, AND REPAIR SYSTEMS TO THE SUBCONTRACTORS.

27. PROVIDE ALL MANUFACTURER'S RECOMMENDED MAINTENANCE INSTRUCTIONS, MAINTENANCE, AND REPAIR SYSTEMS TO THE SUBCONTRACTORS.

28. PROVIDE ALL MANUFACTURER'S RECOMMENDED MAINTENANCE INSTRUCTIONS, MAINTENANCE, AND REPAIR SYSTEMS TO THE SUBCONTRACTORS.

29. PROVIDE ALL MANUFACTURER'S RECOMMENDED MAINTENANCE INSTRUCTIONS, MAINTENANCE, AND REPAIR SYSTEMS TO THE SUBCONTRACTORS.

30. PROVIDE ALL MANUFACTURER'S RECOMMENDED MAINTENANCE INSTRUCTIONS, MAINTENANCE, AND REPAIR SYSTEMS TO THE SUBCONTRACTORS.
NOTES:
1. DIMENSIONS SHOWN ARE TO FINISHED FACE OF WALL. CONTRACTOR TO VERIFY FINISH MATERIAL THICKNESS.
2. SEE A104 FOR REFLECTED CEILING PLAN.
3. SEE A111 FOR DOOR AND WINDOW SCHEDULE AND DETAILS.
4. SEE A113 FOR FINISH SCHEDULE.
5. DOOR LOCATIONS NOT DIMENSIONED ARE 6" FROM FINISHED FACE OF WALL TO JAMB FACE. VERIFY PULL SIDE CLEARANCE OF 18" FROM STRIKE TO INTERSECTING FINISH FACE OF WALL. NOTIFY OWNER FOR NON-COMPLIANCE PRIOR TO SETTING DOOR FRAME.

LEGEND:
- WALL TYPE, SEE A110
- DOOR TAG, SEE A111
- WINDOW TAG, SEE A111
- RECEPT/SWITCH/DATA, SEE ELEC DRAWINGS

FINISHED FLOOR PLAN

SCALE IN FEET
0 2' 4' 8'
KEY NOTES:
1. BASALITE 8X8X16 SPLIT FACE, S-SCORE CMU, RUNNING BOND, COLOR #5656
2. BASALITE 8X8X16 PRECISION CMU, RUNNING BOND, COLOR #5656
3. PREFINISHED ALUMINUM COPING, DARK BRONZE ANODIZED
4. PREFINISHED ALUMINUM SCUPPER AND DOWNSPOUT, DARK BRONZE ANODIZED, PRECAST SPLASH BLOCK
5. EXTERIOR LIGHTING, SEE ELECTRICAL DWGS.
6. CANOPY, SEE A107
7. OUTDOOR RECEPT. SEE ELECTRICAL DWGS.
8. OUTDOOR SPGOT. SEE PLUMBING DWGS.
9. 8" CAST ALUMINUM LETTERING EXACT WORDING TO BE SELECTED BY OWNER.
KEY NOTES:
1. BASALITE 8X8X16 SPLIT FACE, 5 SCORE CMU. RUNNING BOND, COLOR #5656R
2. BASALITE 8X8X16 PRECISION CMU. RUNNING BOND, COLOR #5656R
3. PREFINISHED ALUMINUM COPING. DARK BRONZE ANODIZED.
4. PREFINISHED ALUMINUM SCUPPER AND DOWNSPOUT. DARK BRONZE ANODIZED, PRECAST SPLASH BLOCK.
5. EXTERIOR LIGHTING. SEE ELECTRICAL DWGS.
6. CANOPY. SEE A107.
7. OUTDOOR RECEPT. SEE ELECTRICAL DWGS.
8. OUTDOOR SPIGOT. SEE PLUMBING DWGS.
9. 8" CAST ALUMINUM LETTERING. EXACT WORDING TO BE SELECTED BY OWNER.
### Door Schedule

<table>
<thead>
<tr>
<th>Door Number</th>
<th>Door Pair</th>
<th>Frame Width</th>
<th>Frame Height</th>
<th>Type</th>
<th>Material</th>
<th>Finish</th>
<th>Fire Rating</th>
<th>Head</th>
<th>Jamb</th>
<th>Sill</th>
<th>Detail (A12)</th>
<th>Hardware</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>101</td>
<td>3'-0&quot;</td>
<td>7'-0&quot;</td>
<td>SL</td>
<td>IN</td>
<td>HM</td>
<td>PAINT</td>
<td>F1</td>
<td></td>
<td></td>
<td></td>
<td>-</td>
<td>HM PAINT</td>
<td>-</td>
</tr>
<tr>
<td>102</td>
<td>3'-0&quot;</td>
<td>7'-0&quot;</td>
<td>SL</td>
<td>IN</td>
<td>HM</td>
<td>PAINT</td>
<td>F1</td>
<td></td>
<td></td>
<td></td>
<td>-</td>
<td>HM PAINT</td>
<td>-</td>
</tr>
<tr>
<td>103</td>
<td>3'-0&quot;</td>
<td>7'-0&quot;</td>
<td>SL</td>
<td>IN</td>
<td>HM</td>
<td>PAINT</td>
<td>F2</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>HM PAINT</td>
<td>01 2,3</td>
</tr>
<tr>
<td>104</td>
<td>3'-0&quot;</td>
<td>7'-0&quot;</td>
<td>HL</td>
<td>WOOD</td>
<td>HM</td>
<td>PAINT</td>
<td>F1</td>
<td></td>
<td></td>
<td></td>
<td>-</td>
<td>HM PAINT</td>
<td>-</td>
</tr>
<tr>
<td>105</td>
<td>3'-0&quot;</td>
<td>7'-0&quot;</td>
<td>HL</td>
<td>WOOD</td>
<td>HM</td>
<td>PAINT</td>
<td>F1</td>
<td></td>
<td></td>
<td></td>
<td>-</td>
<td>HM PAINT</td>
<td>-</td>
</tr>
<tr>
<td>106</td>
<td>3'-0&quot;</td>
<td>7'-0&quot;</td>
<td>HL</td>
<td>WOOD</td>
<td>HM</td>
<td>PAINT</td>
<td>F3</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>HM PAINT</td>
<td>01 2,3</td>
</tr>
<tr>
<td>107</td>
<td>3'-0&quot;</td>
<td>7'-0&quot;</td>
<td>HL</td>
<td>WOOD</td>
<td>HM</td>
<td>PAINT</td>
<td>F1</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>HM PAINT</td>
<td>-</td>
</tr>
</tbody>
</table>

### Window Schedule

<table>
<thead>
<tr>
<th>Window Type</th>
<th>Quantity</th>
<th>Size Width</th>
<th>Height</th>
<th>Head</th>
<th>Jamb</th>
<th>Sill</th>
<th>Detail</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Operable Window</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Remarks:
1. Operable Window
2. Provide ADA push button each side of Door, mount per detail on A004.
3. Overhead doors are located at the existing garage to the south of the primary construction site. Contractor to field verify dimensions of existing doors prior to ordering. See spec section 08 33 23 for additional overhead door requirements.
4. See spec section 08 700 00 for finish hardware sets.

---

**City of Cheyenne**

**Addendum Three / Bid S-7-21 for the Happy Jack Landfill Front Entrance and Scale House**

**JULY 2020**

**Design:**
- R. THURMAN

**Detail:**
- R. LANG

**Drawn:**
- M. AHRON

**Project:**
- Happy Jack Landfill

**Location:**
- 9715 Mountain Circle, Suite 500
  - Centennial, CO 80112
  - 303-731-6126

**City of Cheyenne Landfill:**
- 118706 Admin Building Door & Window Schedules and Details
1

2

3

5

4

6

7

8

9

10

11

12

13

FURNITURE SCHEDULE

ROOM FINISH SCHEDULE
WALLS
ROOM
NUMBER
ROOM NAME
FLOOR
BASE
NORTH
SOUTH
EAST
WEST
CEILING
REMARKS
101
OFFICE
13
23
31
31
31
31
42
102
OFFICE
13
23
31
31
31
31
42
103
OFFICE
11
21
31
31
31
31
42
104
CONFERENCE ROOM
13
23
31
31
31
31
42
105
BREAK ROOM
11
21
31
31
31
31
42
106
MENS LOCKER ROOM
12
22
33
33
33
33
41
107
WOMENS LOCKER ROOM
12
22
33
33
33
33
41
108
PUBLIC RESTROOM
12
22
32
32
31
32
41
109
ENTRY HALL
11
21
31
31
31
31
42
110
UTILITY ROOM
10
20
31
32
31
31
40
111
ELEC ROOM
10
20
34
34
34
34
40
112
VESTIBULE
11
21
31
31
31
31
43
113
STORAGE
13
23
31
31
31
31
43
114
STORAGE
13
23
31
31
31
31
43
115
STORAGE
11
21
31
31
31
31
43
REMARKS:
1.
SEE SPEC DIVISION 9 FOR FLOOR, WALL, AND CEILING FINISHES. WALL AND FLOOR FINISHES TO BE APPROVED BY ARCHITECT PRIOR TO INSTALLATION.
2.
ADMINISTRATION BUILDING SLAB-ON-GRADE TO HAVE STEEL TROWEL CONCRETE FINISH.
3.
PAINT ALL UNFINISHED SURFACES THAT ARE EXPOSED TO VIEW.
ROOM FINISH LEGEND:
FLOOR
10 - HARD TROWEL CONCRETE FINISH - SEALED
11 - RUBBER TILE
12 - CERAMIC TILE
13 - CARPET TILE
BASE
20 - NO BASE
21 - RUBBER COVE BASE
22 - CERAMIC TILE COVE BASE
23 - RUBBER STRAIGHT BASE
WALL
30 - EXPOSED CONCRETE (NO FINISH)
31 - GYP. BOARD - PAINTED
32 - PAINT ON CMU
33 - CERAMIC TILE
34 - PLYWOOD PANELS - PAINTED WHITE
CEILING
40 - EXPOSED STRUCTURE
41 - MOISTURE RESISTANT GYPBOARD CEILING
42 - ACOUSTIC CEILING TILE
43 - GYP. BOARD CEILING

MARK
F1
F2
F3
F4
F5

QT
Y
8
2
2
3
31

F6
F7
F10
F11
F12
F13
F14
F20
F21
F22
F30

DESCRIPTION
CONFERENCE TABLE
BREAKROOM TABLE
OFFICE TABLE
SIT/STAND DESK
CONFERENCE AND SIDE
CHAIRS
10 BREAKROOM CHAIRS
3 OFFICE CHAIR
3 FILE CABINET
3 BOOKCASE
3 DESK DRAWERS
5 FILE CABINET
3 UPPER STORAGE
3 MODESTY PANEL
7 SUPPORT PANEL
1 SUPPORT PANEL
1 WORK SURFACE

F31
F32
F33
F34
F40
F41

1
2
1
1
4
3

F42

3

F43
F44

3
3

F50

1

F51
F52

1
1

WORK SURFACE
WORK SURFACE
LAMINATE TOP
LAMINATE TOP
DRY ERASE BOARD
WALL MOUNT
TACKBOARD
UNDERMOUNT TASK
LIGHT
KEYBOARD TRAY
DESK MOUNT MONITOR
ARM
25 CU. FT. SIDE BY SIDE
REFIGERATOR
MICROWAVE
SMART BOARD 6000 PRO
SERIES

MODEL
TARA-3060-LJSNYH4
TARA-3660-LJSNYH4
TARN-3030-LJSNXG4A
TS00-2H7S
SCS-34-31E

MANUFACTURER
Haworth
Haworth
Haworth
Haworth
Haworth

SCC-34-12E
SJT-30-711A1A
JLPD-0230-SJA
JBCS-0230
JPAH-24-SJ
JLPD-0330-SJ
UUFS-1648-PWL
TA0M-1354-LF

WURA-24B4-LJSA

Haworth
Haworth
Haworth
Haworth
Haworth
Haworth
Haworth
Haworth
Haworth
Haworth
Haworth

WURA-2484-LJSA
WURA-24A8-LJSA
JTPL-1890-JYJYS
JTPL-1860-JYJYS
52676/28326
KUAF-1648

Haworth
Haworth
Haworth
Haworth
Staples
Haworth

LUTN-0031-19ULDN

Haworth

6FB259-S12
M21CMSBTB

Humanscale
Humanscale

WRS315SNHM

Whirlpool

NN-SN686S
6375P

Panasonic
SMARTBoard®

no.

date

by

0

7/10/20

ckd

description

KDT RPL ISSUED FOR BID

REMARKS
30"X60"
36"X60"
WITH MODESTY PANEL F20

A

B

COLOR TO MATCH WORKSURFACE
COLOR TO MATCH WORKSURFACE
2'-0" X 9'-8", WUAR-7200-PHS SUPPORT
BAR
2'-0" X 7'-0"
2'-0" X 9'-0"
1'-6" X 7'-6"
1'-6" X 5'-0"
3'-0" x 5'-0"

C

D

SCHEDULE REMARKS:
1.
PRODUCTS PROVIDED ARE A BASIS OF DESIGN TO SET A MINIMUM STANDARD.
SUBSTITUTIONS ARE PERMITTED ONLY WITH PRIOR APPROVAL OF THE
ARCHITECT OR OWNER.
2.
FURNITURE CONTACT:
ENCOMPAS
SUSAN KIDD
816.285.6467
susan@encompas.com

E

CASEWORK SCHEDULE
MARK
K1
K2
K3
K4
K5
K6
K7
K8
K9
K10
K11
K20
K21
K22
S1

QTY
1
3
1
1
1
1
2
1
1
1
1
1
1
1
3

DESCRIPTION
2 DOOR/DRAWER BASE
2 DOOR/DRAWER BASE
4 DRAWER BASE
2 DOOR SINK BASE
PULL OUT TRASH BASE
2 DOOR/DRAWER CORNER BASE
2 DOOR WALL CABINET
CORNER WALL SHELVING
CORNER WALL SHELVING
2 DOOR WALL CABINET
2 DOOR WALL CABINET
SOLID SURFACE COUNTERTOP
SOLID SURFACE COUNTERTOP
SOLID SURFACE COUNTERTOP
HARDWOOD SHELVING

WIDTH
4'-0"
3'-0"
1'-6"
3'-0"
1'-0"
3'-0"
3'-0"
3'-0"
6'-0"
3'-0"
3'-0"

6'-0"

DEPTH
2'-0"
2'-0"
2'-0"
2'-0"
2'-0"
2'-0"
1'-0"
1'-0"
1'-3"
1'-3"
1'-3"
2'-1"
2'-1"
2'-1"
1'-6"

HEIGHT
2'-9"
2'-9"
2'-9"
2'-9"
2'-9"
2'-9"
2'-6"
2'-6"
2'-6"
2'-6"
2'-6"
2'-10"
2'-10"
2'-10"
7'-0"

REMARKS
1, 2
1, 2
1, 2
1, 2
1, 4
1, 2
2
2
2
2
3
6
6
6
7

F

9785 Maroon Circle, Suite 400
Centennial, CO 80112
303-721-9292

date

detailed
N. ARYAN

JULY 2020

designed
K. THURMAN

CASEWORK REMARKS:
1. ADA HEIGHT COUNTER TOP.
2. PROVIDE ADJUSTABLE SHELVING, MINIMUM OF (2) SHELVES.
3. PROVIDE CONCEALED DISH DRYING RACK. DRIP DRY® MODEL DDC28 OR APPROVED EQUAL, thedripdry.com
4. SIZE FOR (2)-27QT TRASH CANS.
5. EQUAL SPACED SHELVES AT 18" OC, WITH FIRST SHELF AT 30" AFF.
6. CONTINUOUS BACKSPASH. PROVIDE LENGTHS AS REQUIRED TO FIT CABINETRY.
7. PROVIDE SHELVING AT ALL STORAGE CLOSETS. CONFIGURATION TO BE COORDINATED WITH OWNER.

G

checked
R. LANG

H

LARAMIE COUNTY, WYOMING
HAPPY JACK LANDFILL
FRONT ENTRANCE AND SCALE HOUSE

ADMINISTRATION BUILDING ROOM FINISH
SCHEDULE AND DETAILS
project

contract

7/9/2020 5:20:15 PM

118706

drawing

sheet
file
City of Cheyenne / Addendum Three / Bid S-7-21 for the Happy Jack Landfill Front Entrance and Scale House
Page 44 of 549

rev.

A113

0

of

sheets

I


NOTE:
USE CLOSED FACE WHERE DOWNSPOUT IS NOT VERTICAL AND A MIN OF 12" BEYOND TRANSITION.
<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Glazing</strong></td>
<td>Sealed Insulating Glass</td>
</tr>
<tr>
<td><strong>Window</strong></td>
<td>Size 48&quot; x 44&quot;</td>
</tr>
<tr>
<td><strong>Window</strong></td>
<td>Quantity: 2; Material: Type 3 Aluminum Frame</td>
</tr>
<tr>
<td><strong>Water Closet</strong></td>
<td>Floor Mount, Vitreous China low-flow Water Closet with exposed flushometer (1.28 gpf maximum) and open front</td>
</tr>
<tr>
<td><strong>Building Exterior Finishes</strong></td>
<td>6&quot; x 12&quot; Ironcraft porcelain cove tile, Casper Gray or Architect approved equal</td>
</tr>
<tr>
<td><strong>Fixed Windows</strong></td>
<td>U-0.36, SHGC 0.40</td>
</tr>
<tr>
<td><strong>Windows</strong></td>
<td>Size 48&quot; x 48&quot;</td>
</tr>
<tr>
<td><strong>Lavatory</strong></td>
<td>Wall mount, deep single bowl, white vitreous china lavatory with chrome single handle manual faucet, with 0.5 GPM aerator</td>
</tr>
<tr>
<td><strong>Water Meter and Backflow Prevention</strong></td>
<td>Provide code approved backflow preventer on domestic water entrance piping, and compound series water meter</td>
</tr>
<tr>
<td><strong>HVAC</strong></td>
<td>Exterior Wall Mount Unit Constant Volume Air Conditioner with individual thermostat</td>
</tr>
<tr>
<td><strong>Electrical</strong></td>
<td>参照Electrical, Mechanical, and Plumbing sections to size the building service ampacity. Size shall allow for all loads</td>
</tr>
<tr>
<td><strong>Lighting</strong></td>
<td>Indoor lights shall be a 60W medium based fluorescent fixture with a minimum of 85 CRI and 800 lumens at 1-foot from fixture</td>
</tr>
<tr>
<td><strong>Stair and Access Ramp</strong></td>
<td>Provide prefabricated aluminum stair and ADA access ramp. Design per IBC requirements</td>
</tr>
<tr>
<td><strong>Mechanical/HVAC Equipment</strong></td>
<td>Coordinate and provide all power requirements with Mechanical section</td>
</tr>
<tr>
<td><strong>Electrical Panel</strong></td>
<td>락스house panel shall be located in a convenient location and shall be accessible to Building Service’s coming service</td>
</tr>
<tr>
<td><strong>Electrical System</strong></td>
<td>Power See Electrical for power service</td>
</tr>
<tr>
<td><strong>Cooling Capacity</strong></td>
<td>As required to maintain 75 degree indoor temperature with 95 degree ambient outdoor temperature. Provide with epoxy coated condenser coil</td>
</tr>
<tr>
<td><strong>Heating Capacity</strong></td>
<td>Electric strip heat as required to maintain 70 degree indoor temperature with 0 degree ambient outdoor temperature</td>
</tr>
<tr>
<td><strong>Refrigerator(s)</strong></td>
<td>(1) 20A-120V receptacle each</td>
</tr>
<tr>
<td><strong>Microwave(s)</strong></td>
<td>(1) dedicated 20A circuit, with 20A-120V receptacle each</td>
</tr>
<tr>
<td><strong>HOP Table(s)</strong></td>
<td>(1) quad receptacle each</td>
</tr>
<tr>
<td><strong>Water Cooler</strong></td>
<td>(1) 20A-120V receptacle each</td>
</tr>
</tbody>
</table>

**NOTES:**
1. SEE STRUCTURAL DRAWINGS AND SPECIFICATION REQUIREMENTS SECTION 1.24.23.19 FOR ADDITIONAL DESIGN REQUIREMENTS
GENERAL FLOOR PLAN NOTES:

1. BUILDING MANUFACTURER TO PROVIDE ALL ITEMS SHOWN ON THIS FLOOR PLAN INCLUDING CONNECTION TO ELECTRICAL EQUIPMENT AND DEVICES, MECHANICAL EQUIPMENT, AND PLUMBING EQUIPMENT UNLESS NOTED N.I.C.

2. DOOR LOCATIONS NOT DIMENSIONED ARE 6" FROM FINISHED FACE OF WALL TO JAMB FACE. VERIFY FULL SIDE CLEARANCE OF DOOR TO INTERSECTING FINISH FACE OF WALL. NOTIFY OWNER FOR NON-COMPLIANCE PRIOR TO SETTING DOOR FRAME.

3. ALL WORK SHALL COMPLY WITH ALL APPLICABLE CODES AND STANDARDS AS LISTED OR REFERENCED IN THE PERFORMANCE CRITERIA OR AS REQUIRED BY THE AUTHORITY HAVING JURISDICTION.

4. ALL WALL ENCLOSURES ARE 1-1/2" METAL STUD FRAMING @ 16" OC W/ ONE LAYER OF 5/8" GYPSUM WALL BOARD ON BOTH SIDES OF FRAMING. TERMINATE AT STRUCTURE ABOVE.

5. PROVIDE MOISTURE RESISTANT GYPSUM BOARD IN RESTROOMS AND AT ALL SINK LOCATIONS.

6. PROVIDE 9" X 9" ADA COMPLIANT PLAQUE SIGNS AT ALL CODE REQUIRED SPACES.

7. FURNITURE, TV'S, WHITEBOARDS, CASEWORK, AND APPLIANCES SHOWN SHALL BE PROVIDED BY CONTRACTOR. LOCATIONS PROVIDED TO ALLOW FOR COORDINATION. BUILDING MANUFACTURER TO PROVIDE ALL REQUIRED UTILITIES AND BLOCKING AT THESE LOCATIONS.

8. FURNITURE SHOWN IS THE BASIS OF DESIGN. ACTUAL FURNITURE WILL BE SELECTED BY CLIENT IN COMPLIANCE WITH THE FURNITURE ALLOWANCE PROVIDED IN THE CONTRACT.
NOTES:
1. SEE PERFORMANCE CRITERIA FOR FINISHES.
2. PRODUCTS PROVIDED ARE A BASIS OF DESIGN TO SET A MINIMUM STANDARD. SUBSTITUTIONS ARE PERMITTED ONLY WITH PRIOR APPROVAL OF THE ARCHITECT OR OWNER.
3. FURNITURE CONTACT: ENCOMPAS SUSAN KIDD 816.285.6467 susan@encompas.com

FURNITURE & EQUIPMENT SCHEDULE

<table>
<thead>
<tr>
<th>MARK</th>
<th>QTY</th>
<th>DESCRIPTION</th>
<th>MODEL</th>
<th>MANUFACTURER</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH1</td>
<td>1</td>
<td>AUTOMATIC WALL MOUNTED SOAP DISPENSER</td>
<td>B-4814</td>
<td>Bobrick Washroom Equipment Inc.</td>
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<tr>
<td>CH2</td>
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<td>2-STAY GLASS WELDED FRAME MIRROR</td>
<td>B-6940</td>
<td>Bobrick Washroom Equipment Inc.</td>
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<td>CH3</td>
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<td>ADA GRAB BARS</td>
<td>B-6300</td>
<td>Bobrick Washroom Equipment Inc.</td>
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<td>CH4</td>
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<td>SHELF, TOILET PAPER Holder</td>
<td>B-3491</td>
<td>Bobrick Washroom Equipment Inc.</td>
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<tr>
<td>CH5</td>
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<td>DOUBLE DOOR TRIM</td>
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<tr>
<td>CH6</td>
<td>2</td>
<td>DOOR SURFACE COURTESY FR/GR/TOC/EL</td>
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<td>CH7</td>
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<td>EXTERIOR DESK</td>
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<td>CH8</td>
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<td>CH9</td>
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<td>CH12</td>
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<tr>
<td>CH13</td>
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<td>CH18</td>
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<td>GUARD RAIL</td>
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<td>CH19</td>
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<tr>
<td>CH20</td>
<td>1</td>
<td>ALUMINUM GUTTER</td>
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<tr>
<td>CH21</td>
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<td>DOWNSPOUT BY CONTRACTOR</td>
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</table>

A202 INTERIOR ELEVATION

A201 INTERIOR ELEVATION

A203 INTERIOR ELEVATION

A204 INTERIOR ELEVATION

SCALE IN FEET

0 2' 4' 8'

SCALE IN FEET

0 2' 4' 8'

SCALE IN FEET

0 2' 4' 8'

SCALE IN FEET

0 2' 4' 8'

LAKE COUNTY, WYOMING
FRONT ENTRANCE AND SCALE HOUSE
SCALE HOUSE ELEVATIONS

BURNS & McdONELLL
9715 Walnut Circle, Suite 400
Cincinnati, OH 45242
303-721-9292

K. THURMAN
R. LANG

JULY 2020

SCHEDULE
MARK  | QTY  | DESCRIPTION                               | MODEL | MANUFACTURER                               | COMMENTS |
------|------|-------------------------------------------|-------|--------------------------------------------|----------|
CH1   | 1    | AUTOMATIC WALL MOUNTED SOAP DISPENSER     | B-4814| Bobrick Washroom Equipment Inc.            |          |
CH2   | 1    | 2-STAY GLASS WELDED FRAME MIRROR          | B-6940| Bobrick Washroom Equipment Inc.            |          |
CH3   | 1    | ADA GRAB BARS                             | B-6300| Bobrick Washroom Equipment Inc.            |          |
CH4   | 1    | SHELF, TOILET PAPER Holder               | B-3491| Bobrick Washroom Equipment Inc.            |          |
CH5   | 1    | DOUBLE DOOR TRIM                         |       |                                            |          |
CH6   | 2    | DOOR SURFACE COURTESY FR/GR/TOC/EL       |       |                                            |          |
CH7   | 2    | EXTERIOR DESK                            |       |                                            |          |
CH8   | 1    | OFFICE COAT HOOK                         |       |                                            |          |
CH9   | 1    | FILE CABINET                             |       |                                            |          |
CH10  | 1    | BATH CABINET                             |       |                                            |          |
CH11  | 1    | WOOD SURFACE                             |       |                                            |          |
CH12  | 1    | ADJUSTABLE TRAYS                         |       |                                            |          |
CH13  | 2    | REST ENSO CR INT ABD                     |       |                                            |          |
CH14  | 1    | UNDERCOUNTER REFRIGERATOR                |       |                                            |          |
CH15  | 1    | LIGHT FIXTURE                            |       |                                            |          |
CH16  | 1    | ALUMINUM GUTTER                          |       |                                            |          |
CH17  | 1    | DOWNSPOUT BY CONTRACTOR                  |       |                                            |          |
CH18  | 1    | GUARD RAIL                                |       |                                            |          |
CH19  | 2    | DOUBLE DOOR TRIM                         |       |                                            |          |
CH20  | 1    | ALUMINUM GUTTER                          |       |                                            |          |
CH21  | 1    | DOWNSPOUT BY CONTRACTOR                  |       |                                            |          |
1. LEGEND IS GENERAL IN NATURE AND MAY INDICATE MORE INFORMATION THAN IS APPLICABLE TO PROJECT. SEE PLANS FOR SPECIFIC SYMBOLS AND ABBREVIATIONS.

2. PROVIDE ALL MATERIALS, VALUES, HANGERS, ETC. AND EQUIPMENT AND PERFORMANCE SPECIFICATIONS REQUIRED TO INSTALL, COMPLETE AND OPERATE MECHANICAL SYSTEMS AS SHOWN AS INDICATED ON THE DRAWINGS. AS SPECIFIED, AND AS REQUIRED BY CODE.

3. INSTALL ALL MECHANICAL EQUIPMENT AND APPURTEANCES IN ACCORDANCE WITH MANUFACTURERS RECOMMENDATIONS, CONTRACT DOCUMENTS, AND APPLICABLE CODES AND REGULATIONS.

4. COORDINATE CONSTRUCTION OF ALL MECHANICAL WORK WITH STRUCTURAL, CIVIL, ELECTRICAL, WORK, ETC. SHOWN ON OTHER CONTRACT DOCUMENTS.

5. UNLESS OTHERWISE INDICATED MAINTAIN A MINIMUM OF 6'-0" CLEARANCE TO UNDERSIDE OF PIPES, CONDUITS, ETC. THROUGHOUT ACCESS ROUTES AND MECHANICAL ROOMS.

6. LOCATE ALL MECHANICAL EQUIPMENT FOR UNOBSERVED ACCESS TO UNIT ACCESS PANELS AND VALVES.

7. VERIFY DIMENSIONS AND CONNECTION SIZE WITH FURNISHED EQUIPMENT.

8. ALL ELEVATIONS ARE ABOVE FINISHED FLOOR TO BOTTOM OF DUCT, PIPE, OR PIPE SUPPORT UNLESS NOTED OTHERS.

9. DUCT STATIC PRESSURE CLASSIFICATION:  UNLESS OTHERWISE INDICATED, DUCTS SHALL BE AIR BALANCED TO A STATIC PRESSURE PLUS OR MINUS THE TOLERANCE OF THE DUCTLESS DEVICE INSTALLED. AIR DUCTS USED IN A RETURN DUCT SYSTEM AND SHEET METAL SIZE SHALL BE THE SAME.

10. DUCT STATIC PRESSURE CLASSIFICATION UNLESS OTHERWISE INDICATED CONSTRUCT DUCTS ON THE DISCHARGE SIDE OF FANS AND VAV BOXES TO HAVE 1.0 IN. W.C. POSITIVE PRESSURE AND DUCTS ON THE INLET SIDE OF EQUIPMENT TO HAVE 1.0 IN. W.C. NEGATIVE PRESSURE CLASSIFICATIONS. DUCTS ON OUTSIDE SIDE OF AHU'S SHALL HAVE 3.0 INCH POSITIVE PRESSURE CLASS DUCT.

11. LOCATE TRANSFER AIR DUCTS AND OPENINGS 24" ABOVE HIGHEST CEILING ELEVATION UNLESS OTHERWISE NOTED.

12. COORDINATE ALL WALL AND ROOF PENETRATIONS WITH STRUCTURAL AND ARCHITECTURAL DRAWINGS.

13. INSTALL TEMPERATURE CONTROL AT 48" ABOVE FINISHED FLOOR AND COORDINATE WITH OTHER DEVICES LOCATED ON WALLS, ROOFS, OIL AND FUEL STORAGE.

14. CONTRACTOR SHALL BALANCE ALL GRILLES TO CFM'S SHOWN ON PLANS.

15. MOTOR ALL OVERTIME MECHANICAL EQUIPMENT AND AIRMOVING EQUIPMENT AND FURNISH 1-2 POUNDS OR MORE TO SUPPORTS THAT SHALL RESIST FORCES OF 0.5 TIMES THE EQUIPMENT WEIGHT IN ANY HORIZONTAL OR 1.5 TIMES THE EQUIPMENT WEIGHT IN THE DOWNWARD DIRECTION.

16. LOCATE THE AIR DISTRIBUTION DEVICE IDENTIFICATION SYSTEM TYPE.

17. DETERMINE AIR DISTRIBUTION DEVICE IDENTIFICATION SYSTEM TYPE.

18. VERIFY DIMENSIONS AND CONNECTION SIZE WITH FURNISHED EQUIPMENT.

19. CHECK DIMENSIONS AND CONNECTION SIZE WITH FURNISHED EQUIPMENT.

20. LOCATE TRANSFER AIR DUCTS AND OPENINGS 24" ABOVE HIGHEST CEILING ELEVATION UNLESS OTHERWISE NOTED.

21. LOCATE ALL MECHANICAL EQUIPMENT FOR UNOBSERVED ACCESS TO UNIT ACCESS PANELS AND VALVES.

22. VERIFY DIMENSIONS AND CONNECTION SIZE WITH FURNISHED EQUIPMENT.

23. COORDINATE CONSTRUCTION OF ALL MECHANICAL WORK WITH STRUCTURAL, CIVIL, ELECTRICAL, WORK, ETC. SHOWN ON OTHER CONTRACT DOCUMENTS.

24. INSTALL ALL MECHANICAL EQUIPMENT AND APPURTEANCES IN ACCORDANCE WITH MANUFACTURERS RECOMMENDATIONS, CONTRACT DOCUMENTS, AND APPLICABLE CODES AND REGULATIONS.

25. COORDINATE CONSTRUCTION OF ALL MECHANICAL WORK WITH STRUCTURAL, CIVIL, ELECTRICAL, WORK, ETC. SHOWN ON OTHER CONTRACT DOCUMENTS.

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27. CONTRACTOR SHALL BALANCE ALL GRILLES TO CFM'S SHOWN ON PLANS.
GENERAL NOTES:
1. FOR MECHANICAL SYMBOLS & ABBREVIATIONS, SEE M-001.
2. BRANCH RUNOUT SIZES TO SUPPLY DIFFUSERS ARE THE SAME SIZE AS THE DIFFUSER NECK SIZE INDICATED ON THE DIFFUSER TAG, UNLESS OTHERWISE NOTED.
3. INSTALL THERMOSTATS AT 48" A.F.F. UNLESS NOTED OTHERWISE.

REVIEWED NOTES:
1. 12" X 10" SA DUCT UP TO EF-1 MOUNTED ON ROOF ABOVE, SEE M-110.
2. DRENGER PIPING SIZES AND ROUTING SHALL BE PROVIDED BY CRU/ACCU EQUIPMENT MANUFACTURERS.
3. ROUTE PUMPED CONDENSATE FROM DSS-1 TO UTILITY ROOM 110 AND SPILL INTO MOP BASIN 6" ABOVE BARN RIM. DO NOT ROUTE WATER PIPING OVER ELECTRICAL ROOM.
4. EXTEND FULL SIZE SUPPLY AND RETURN AIR DUCTS DOWN INTO PLENUM SPACE. COORDINATE FINAL ROOF OPENING SIZES AND LOCATIONS WITH STRUCTURAL DRAWINGS.
5. TERMINATE RETURN AIR DUCT BELOW DECK WITH BELLMOUTH RETURN AIR OPENING COVERED WITH 1/2" X 1/2" STEEL MESH.

KEYED NOTES:
1. 12" X 10" EA DUCT UP TO EF-1 MOUNTED ON ROOF ABOVE, SEE M-110.
2. DRENGER PIPING SIZES AND ROUTING SHALL BE PROVIDED BY CRU/ACCU EQUIPMENT MANUFACTURERS.
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5. TERMINATE RETURN AIR DUCT BELOW DECK WITH BELLMOUTH RETURN AIR OPENING COVERED WITH 1/2" X 1/2" STEEL MESH.
GENERAL NOTES:
1. FOR MECHANICAL SYMBOLS & ABBREVIATIONS, SEE M-001.
2. COORDINATE EQUIPMENT ROOF OPENINGS WITH EXISTING STRUCTURAL STEEL. LOCATE OPENINGS BETWEEN JOISTS.
3. SEE ARCHITECTURAL AND STRUCTURAL DETAILS FOR ROOF OPENINGS.
4. MAINTAIN MINIMUM CODE REQUIRED DISTANCES BETWEEN AIR INTAKES AND EXHAUST AIR OPENINGS.

REVIEWED NOTES:
1. MOUNT RTU ON MANUFACTURER'S ROOF CURB.
2. SPILL COOLING COIL CONDENSATE TO SPLASH BLOCK ON ROOF.

GENERAL NOTES:
1. FOR MECHANICAL SYMBOLS & ABBREVIATIONS, SEE M-001.
2. COORDINATE EQUIPMENT ROOF OPENINGS WITH EXISTING STRUCTURAL STEEL. LOCATE OPENINGS BETWEEN JOISTS.
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REVIEWED NOTES:
1. MOUNT RTU ON MANUFACTURER'S ROOF CURB.
2. SPILL COOLING COIL CONDENSATE TO SPLASH BLOCK ON ROOF.
DUCT & PIPE HANGERS

- Strap hangers may be used as reinforcement if strap is placed under a bottom reinforcement.
- Screws may be omitted if hanger loops are secured as a hangar strap.
- One half-round may be used if duct shape is maintained.
- Load-rated fasteners should be used.

TRAPEZE HANGERS

- Strap or angle rod hangers may be used.
- Size bolt(s) for load should be used.
- Intermediate support may be used for attachment if it qualifies for both duties, do not exceed allowable load limits.

LOAD RATED FASTENERS

- Nuts must be used.
- Screws may be omitted if hanger loops secure wire.

REINFORCEMENT MAY BE USED FOR ATTACHMENT IF IT QUALIFIES FOR BOTH DUTIES DO NOT EXCEED ALLOWABLE LOAD LIMITS

ONE HALF-ROUND MAY BE USED IF DUCT SHAPE IS MAINTAINED.

DUCT CONNECTION TO DIFFUSER

- Balancing damper with lockout quadrant. Provide 2" duct extension to allow operation of damper without damage to insulation.

NOTES:

1. Provide intermediate support, where required, to prevent sagging and kinking and to keep flexible ductwork off surrounding objects.
2. Provide 2" duct extension to allow operation of damper without damage to insulation.

LINEAR SLOT DIFFUSER

- See plans and schedule for length, number of slots and connection size.

RECTANGULAR DUCT WITH 2 DIFFUSER TAKE-OFFS

- Take-off on both sides or single side as required by plans.
- Rigid duct connection to duct shall have corner seals (see Smacna manual).
- Extractors, scoops, reflectors or dampers that protrude into the main duct shall not be used. Balancing dampers shall be located to prevent protrusion into the main duct and to provide stable air flow and minimal noise when adjusted.

- Duct transition should be used.

- Supply duct size should be used.

- Rectangular tap-in (Note 2 and 3)

- Diffuser connection size, see plans.

- Rectangular duct size, see plans.

NOTES:

1. Take-off on both sides or single side as required by plans.
2. Cling lock connection to duct shall have corner seals (see Smacna manual).
3. Extractors, scoops, reflectors or dampers that protrude into the main duct shall not be used. Balancing dampers shall be located to prevent protrusion into the main duct and to provide stable air flow and minimal noise when adjusted.

SPRING IN FITTING OR 45° BOOT AS INDICATED WITH DAMPER

- Insulate diffuser plenum.
- Insulate supply duct and diffuser elbow.

- See plans and schedule for length, number of slots and connection size.
1. USE THIS DESIGN WHERE SQUARE 90° ELBOWS ARE SHOWN ON DRAWINGS OR IF SPACE DOES NOT PERMIT ROUND 90° ELBOWS.

2. USE THIS DESIGN WHERE SQUARE 90° ELBOWS ARE SHOWN ON DRAWINGS OR IF SPACE DOES NOT PERMIT ROUND 90° ELBOWS.

3. USE THIS DESIGN FOR RECTANGULAR DUCT ELBOWS TURNING VANES.

4. USE THIS DESIGN FOR RECTANGULAR DUCT STANDARD CURVE.

NOTE:
- TURNING VANES DETAIL
- RECTANGULAR TRANSITION
- RECTANGULAR TO ROUND TRANSITION
- SQUARE 90° ELBOW
- ROUND 90° ELBOW
- MAX. SLOPE 1" IN 4'
- DIMENSION IS EQUAL TO DIMENSIONS, SEE PLANS FOR SIZES.

TURNING VANES @ 45° (TYP.)

DIMENSIONS, SEE PLANS FOR SIZES
DIMENSION IS EQUAL TO C = D

S = D/6 (MIN. 2")
W/S = NO. OF SPACES
R = 1 1/4 S
L = 3/4 S

BLADES IN TRANSITION ELBOWS SHALL BE DETERMINED ACCORDING TO SMALLEST WIDTH OF ELBOW.

STANDARD RADIUS ELBOW
R/W: CENTERLINE R = 1 1/2 W
ALSO CALLED FULL RADIUS ELBOW.

BEAD OR CROSSBREAK IF REQUIRED
BEADS ON ALL CORNERS

TURNING VANES @ 45° (TYP.)
NOTES:
1. CONTRACTOR IS RESPONSIBLE FOR COORDINATING REFRIGERANT LIQUID AND SUCTION PIPING, SIZES, ROUTING, AND ALL ACCESSORIES WITH EQUIPMENT MANUFACTURER. MAINTAIN UNIFORM SLOPE TO PREVENT OIL FROM POOLING IN LOW POINTS IN THE REFRIGERANT PIPING SYSTEM.
1. Roof mounted with manufacturer’s insulated 12” curb and downturned weatherhood.
2. Provide with low leakage dampers.
3. Provide single point electrical connection.
4. Provide with Kynar finish. Final equipment color to be coordinated with architect.
5. Full economizer with power exhaust.
6. Provide with MERV 8 filters.

NOTES:

RTU-2 Roof Admin Bldg 260 990 0.8 0.5 D/X 17.8 17.4 77.8 61.1 55 55 ELEC 10 47.7 82.2 240/1/60 DIV. 23 TRANE 4TCY030 418 1-6

RTU-1 Roof Admin Bldg 220 1350 0.8 0.5 D/X 22.4 22.4 76.8 61.6 55 55 ELEC 10 55.9 81.2 240/1/60 DIV. 23 TRANE 4TCY036 422 1-6

EF-1 Roof Restrooms Upblast Centrifugal 480 0.5 1550 4413 7.9 0.09 1550 ODP 120/1/60 DIV. 23 GREENHECK CUE-095-D 38 1, 2, 3

TAG LOCATION SERVING TYPE AIRFLOW CFM ESP (IN) SOUND (Sones) HP RPM ENCLOSURE V/PH/HZ MFR MODEL WEIGHT (LBS) NOTES

ACCU-1 Roof DSS-1 Heat Pump 95 18 14.48 18 230/1/60 18.3 DIV. 23 DAIKIN RX18NMVJU 1, 2, 3, 4

CUH-3 111 - Elec Room Accu-1 Heat Pump R-410A 713 80 67 18 14.48 230/1/60 18.3 DIV. 23 DAIKIN FTX18NMVJU 1, 2

CUH-2 108 - Public Restroom Vertical Recessed 3 68 95 240/1/60 DIV. 23 REZNOR EHC 24 1, 2

CUH-1 109 - Entry Hall Vertical Recessed 2 68 95 240/1/60 DIV. 23 REZNOR EHC 24 1, 2

CUH-4 107 - Women’s Locker Room Vertical Recessed 3 68 95 240/1/60 DIV. 23 REZNOR EHC 24 1, 2
PIPE LINE DESIGNATIONS

- VENT
- STORM (ABOVE GRADE)
- STORM (BELOW GRADE)
- STORM OVERFLOW
- DOMESTIC COLD WATER
- DOMESTIC HOT WATER
- SHAR
- SANITARY SEWER (ABOVE GRADE)
- SANITARY SEWER (BELOW GRADE)
- COND
- COMPRESSED AIR
- NATURAL GAS
- OD
- FCO
- WCO
- WFO
- FO
- SSD
- PLUG VALVE
- ANGLE VALVE
- SELF CONTAINED PRESSURE REDUCING (REGULATING) VALVE
- AUTOMATIC AIR VENT
- MANUAL AIR VENT ASSEMBLY
- FLEX CONNECTION
- PLUMBING ACCESSORIES

- PIPE LINE ACCESSORIES
  - OUTSIDE SLEEVE & YOKE VALVE
  - BUTTERFLY VALVE
  - CHECK VALVE
  - 2-WAY VALVE
  - BALL VALVE
  - BALANCING VALVE / CIRCUIT SIZER
  - RELIEF VALVE
  - METERED CONTROL VALVE
  - HOSE GATE VALVE
  - GLOBE VALVE
  - SPRING RETURN CLOSED VALVE
  - DRY SEAL
  - SELF CONTAINED PRESSURE REDUCING (REGULATING) VALVE
  - AUTOMATIC AIR VENT
  - MANUAL AIR VENT ASSEMBLY
  - INSULATING FLANGE
  - PIPE WITH HEAT TRACE
  - FLEX CONNECTION

PLUMBING SYMBOLS LEGEND

- WO-1 WATER CLOSET
- WC-2 WATER CLOSET - ACCESSIBLE
- U-1 URINAL
- U-2 URINAL, ACCESSIBLE
- LA-1 LAVATORY, COUNTER MOUNTED
- LA-2 LAVATORY, WALL MOUNTED
- JS-1 JANTANK SINK
- NB-1 MOP BASIN
- SK-1 KITCHEN
- SK-2 SAN
- SK-3 UNDER MOUNT SAN
- EWC-1 DUAL ELECTRIC WATER-COOLER
- EEWG-1 EMERGENCY EVERKASH / SHOWER
- 4" FD-A SIZE - FLOOR DRAIN
- HB HOSE BibB
- WH WALL HYDRANT

PLUMBING ABBREVIATIONS

- AC AIR COCK
- AFF ABOVE FINISHED FLOOR
- AG AIR GAP
- ARV AIR RELEASE VALVE
- BF BLIND FLANGE
- BOP BOTTOM OF PIPE
- SW BUTT WELD
- CHG CHAIN WHEEL OPERATOR
- CONC CONCENTRIC
- CORP STOP CORPORATION STOP
- CPVC CHLORETHYLENE POLYVINYL CHLORIDE
- D DRAIN
- D IL DUCTILE IRON
- DN DOWN
- DWI DOMESTIC WATER HEATER
- ELL ELL
- EXIST EXISTING
- FCA FLANGED COUPLING ADAPTER
- FCD FLOOR CLEANOUT
- FD FLOOR DRAIN
- FE FLANGED END
- FI FLAT IACED
- FI FLOW INDICATOR
- FLG FLANGED
- FM FLOW METER
- FOA FLAT ON ALL
- FOT FLAT ON TOP
- FTP FLOAT OPERATED VALVE
- FRR FIBERGLASS REINFORCED PIPE
- FW FIELD WELD
- HD HUB DRAIN
- IE INSULATED FLANGE
- LC LOCK CLOSED
- LO LOCK OPEN
- LR LONG RADIUS
- NPSH NET POSITIVE SUCTION HEAD
- NWS NON-WATERING STEM
- NML NORMAL WATER LEVEL
- PSA POUNDS PER SQUARE INCH ABSOLUTE
- PSQ POUNDS PER SQUARE INCH GAUGE
- PVD POLYVINYL CHLORIDE
- RED REDUCER-REDUCING
- RE REDUCER-REDUCING
- RE RISING STEM
- SCH SCHEDULE
- SCR SCREWED
- ST SHORT RADIUS
- TD TRENCH DRAIN
- TOG TOP OF CONCRETE
- TOP TOP OF PIPE
- TOS TOP OF STEEL
- TP TRAP PRIMER
- VTR VENT THROUGH ROOF
- WCO WASTE CLEANOUT
- WCO-1 WATER CLOSET
- WC-2 WALL CLEANOUT
- WO-1 WALL DRAIN

SECTION CUT SYMBOL

- INDICATES PERSPECTIVE AND LIMITS OF SECTION
- SECTION DESIGNATOR
- DRAWING WHERE SECTION IS SHOWN

CONSTRUCTION INTERFACE

- EXISTING
- NEW
- DEMOLITION

DETAIL/SECTION TITLE

- LOCATION WHERE DETAIL/SECTION IS SHOWN ON SHEET
- DETAIL/SECTION DESIGNATOR
- SHEET WHERE DETAIL/SECTION IS SHOWN

PIPE SYMBOLS

- PIPE ELBOW
- PIPE DRAIN
- PIPE UP
- PIPE CONTINUATION

PLUMBING NOTES, LEGEND, SYMBOLS & ABBREVIATIONS
NOTES:
1. TRAP PRIMER VALVE SHOULD BE MOUNTED ONE FOOT ABOVE THE FINISHED FLOOR FOR EVERY 20 FOOT OF PRIME LINE.
2. A METERED AMOUNT OF WATER FROM THE FLOOR DRAIN TRAP PRIMER IS DISTRIBUTED TO AS MANY AS (8) INDIVIDUAL FLOOR DRAIN TRAPS.
3. INSTALL ASSEMBLY WITH ACCESS FOR PERIODIC INSPECTION.

NOTES:
1. PROVIDE PIPE SIZES SEE FLOOR PLAN.
2. FOR HEATER SELECTION SEE SCHEDULE AND SPECIFICATIONS.

NOTES:
1. PROVIDE WATER HAMMER ARRESTERS. INSTALL IN HORIZONTAL OR VERTICAL POSITION, BUT NEVER UPRIGHT. INSTALL IN LINE WITH WATER FLOW IN EACH WATER SYSTEM, OR IN alternate WATER SYSTEM UNITS AS SHOWN ON THE DRAWINGS AND/OR PER THE TABLES SHOWN.
### PLUMBING FIXTURE SCHEDULE

<table>
<thead>
<tr>
<th>TAG NO.</th>
<th>DESCRIPTION</th>
<th>TYPE</th>
<th>LOCATION</th>
<th>SYSTEM</th>
<th>MIN. TANK VOLUME (GAL)</th>
<th>MAX. TANK VOLUME (GAL)</th>
<th>MIN. TANK PRESS. (PSI)</th>
<th>MAX. TANK PRESS. (PSI)</th>
<th>FULL WEIGHT (LBS)</th>
<th>BASE OF DESIGN</th>
</tr>
</thead>
<tbody>
<tr>
<td>FB-1</td>
<td>HOSE BIBB</td>
<td>INTERIOR HOSE BIBB</td>
<td>N/A</td>
<td>N/A</td>
<td>BRASS SWIVEL SPRING VALVE, LEVER HANDLE, AND HOSE CONNECTION</td>
<td>1/2&quot;</td>
<td>1/2&quot;</td>
<td>N/A</td>
<td>N/A</td>
<td>WALL MOUNTED WITH LOCKANDLESS CONNECTORS</td>
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<td>JS-1</td>
<td>WALL MOUNTED</td>
<td>CEILING MOUNT</td>
<td>N/A</td>
<td>N/A</td>
<td>PROCEED SS BASKET STANDARDS AND PLUMBING ACCESSORIES</td>
<td>1-1/4&quot;</td>
<td>1&quot;</td>
<td>1/2&quot;</td>
<td>1/2&quot;</td>
<td>REFER TO ASBC, WALL ELEVATIONS</td>
</tr>
<tr>
<td>LA-1</td>
<td>UNDERCOUNTER</td>
<td>UNDERCOUNTER MOUNTED</td>
<td>N/A</td>
<td>N/A</td>
<td>4&quot; CENTERFIRE DOUBLE BOLT HANDLES, MANEUVER 3/4&quot; GPM FAUCET AND PERFORATED GRID STRAINER</td>
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<td>MB-1</td>
<td>CORNER MAP BASIN</td>
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<td>N/A</td>
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<td>BACK DISCHARGE WHITE VITREOUS CHINA</td>
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### WATER HEATER SCHEDULE (WH)

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<th>DESIGN TEMP.</th>
<th>CAPACITY</th>
<th>MAX. TANK</th>
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<td>120°</td>
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### FLOOR DRAIN SCHEDULE (FD)

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<th>NOTES</th>
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<td>CLOSET DRAIN</td>
<td>UNDERGROUND</td>
<td>DIAMETER</td>
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<td>30&quot; 22&quot; 12&quot;</td>
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### CLEANOUT SCHEDULE (CD)

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<tr>
<td>C-1</td>
<td>FLOOR</td>
<td>BOX LID MICHEL</td>
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### EXPANSION TANK SCHEDULE (ET)

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### FLOOR DRAIN SCHEDULE (FD)

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<th>MAX. TANK VOLUME (GAL)</th>
<th>MAX. TANK PRESS. (PSI)</th>
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</table>
SANITARY WASTE & VENT RISER DIAGRAM
DOMESTIC WATER RISER DIAGRAM

GENERAL NOTES:
1. FOR PLUMBING NOTES, LEGEND, SYMBOLS & ABBREVIATIONS, SEE P-001.
2. FINISHED FLOOR ELEVATION IS 100.0'.
3. WATER SHUTOFF VALVES SHALL BE LOCATED WHERE ACCESS PANELS ARE AVAILABLE. COORDINATE ACCESS PANELS FOR SHUTOFF VALVES WITH ARCHITECTURAL DRAWINGS.
4. ROUTE DOMESTIC COLD WATER LINE TO TRAP PRIMER CONNECTION AT ALL FLOOR DRAINS.

KEYED NOTES:
- PRESSURE REDUCING VALVE SHALL BE SET TO 50 PSI.

KEY:
- WH-1: MAIN SHUT-OFF VALVE
- WC-2: WATER CONNECTION WITH INLINE BFP
- MB-1: WATER CONNECTION
- LAV-2: Lavatory
- WC-1: WC
- MB-1: Refrigerator Water Connection
- TRAP PIPER ASSEMBLY

NOTES:
1. FOR PLUMBING NOTES, LEGEND, SYMBOLS & ABBREVIATIONS, SEE P-001.
2. FINISHED FLOOR ELEVATION IS 100.0'.
3. WATER SHUTOFF VALVES SHALL BE LOCATED WHERE ACCESS PANELS ARE AVAILABLE. COORDINATE ACCESS PANELS FOR SHUTOFF VALVES WITH ARCHITECTURAL DRAWINGS.
4. ROUTE DOMESTIC COLD WATER LINE TO TRAP PRIMER CONNECTION AT ALL FLOOR DRAINS.
GENERAL NOTES:

1. REFER TO EGIS FOR ELECTRICAL NOTES, SYMBOLS, LEGENDS, AND ABBREVIATIONS.

2. REFER TO DRAWING 50600 FOR DETAILS.

3. GROUND CONDUCTOR PASSING THROUGH CONCRETE WALLS OR SLAB TO BE MADE OF COPPER CONDUCT OR BARE GALVANIZED STEEL WITH GROUND RGINGS.

4. PROVIDE GROUND CONNECTION TO BUILDING STEEL, MAIN WATER LINE PIPS AND MAIN GROUND WIRE/MAIN GROUND WIRE (WHERE REQUIRED) IN ELECTRICAL ROOM.

5. SOME LIGHTNING PROTECTION SYSTEM TO THE STRUCTURAL STEEL WHERE REQUIRED.

6. THE DRAWING IS PROVISED FOR PLANNING PURPOSES ONLY. CONTRACTOR SHALL LOCATE GROUND WIRE/MAIN GROUND WIRE WHERE REQUIRED.

REVISED NOTES:

1. BOND TO BUILDING STEEL, REFER TO DETAIL SED501.
NOTES:
1. COORDINATES WITH POWER AND TELECOM DRAWINGS FOR COMBINATION COMPARISON FLOOR BOX LOCATION; SEE SHEET E I-1 FOR ELECTRICAL AND TELECOM.
2. ROUTE ALL CONDUITS "TIGHT" FROM BOX AT MINIMUM OF 3" BELOW SLAB, AVOID ROUTING CONDUITS HORIZONTALLY TOWARD SLAB. COORDINATE WITH STRUCTURAL DRAWING FOR SLAB DEPTHS.
3. CAST IN PLACE AND PORE, SURFACE MOUNT BOX MUST MAINTAIN FIRE RATING OF FLOOR ASSEMBLY.
4. PROVIDE SPOUTS AS REQUIRED.
5. PROVIDE INFORMATION TO COORDINATE WITH USE.
6. PROVIDE RACK WAVES AS REQUIRED TO MATCH ARCHITECTURAL FINISHES.

JUNCTION BOX TYPE:
1. OUTLET BOX AT 18" AFF. LON.
2. SINGLE GANG PLATE (SEE DETAILS FOR SPECIFIC CONFIGURATIONS).

TELECOMMUNICATIONS:
1. LIGHT FIXTURE, TYPE AS INDICATED.
2. ROUND TAPERED POLE FINISH TO MATCH LAYOUT LENGTH AS INDICATED.
3. PROVIDE POLE BASE COVERS.
4. PROVIDE SPOUTS AS REQUIRED BY POLICE.

TELEPHONE INSTALLATION:
1. WALL MOUNTED TYP.
2. MODULAR CAT 5 COMM MODULE.
3. PAVING OR FINISHED GRADE.

CONCRETE:
1. USE POLY PRO CONCRETE AT 8" OF PD.
<table>
<thead>
<tr>
<th>No.</th>
<th>Type</th>
<th>Description</th>
<th>Manufacturer</th>
<th>Catalog Number</th>
<th>Lamp Type</th>
<th>Lumens</th>
<th>CCT</th>
<th>Voltage</th>
<th>Wattage</th>
<th>Design Load</th>
<th>Mounting</th>
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<td>A</td>
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<td>Lithonia</td>
<td>SLC-2X-2X30W-A19-4000</td>
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<td>2 x 2 Volumentric Troffers, Minimum 85% Optical Efficiency, Acrylic Lamp Shield With Ten 8-Watt Emergency Battery Pack</td>
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<td>24 W</td>
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<td>E</td>
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**Notes:**
- Electrical contractor to furnish and install fixture with Lithonia T-401 LED, Catalog Number: 23-50-0114-0443-0003

**City of Cheyenne / Addendum Three / Bid S-7-21 for the Happy Jack Landfill Front Entrance and Scale House**
### PANELBOARD: LA1

**Location:** LA1 Panel

**Volume:** Two Copy Single

**All References:** V.A.C.

**Sheet:** 11

**Material:** 30A

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### PANELBOARD: LB1

**Location:** LB1 Panel

**Volume:** Two Copy Single

**All References:** V.A.C.

**Sheet:** 11

**Material:** 30A

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DOCUMENT 00 01 07 – INDEX AND CERTIFICATION PAGE

SPECIFICATION INDEX

| DOCUMENT/| DESCRIPTION |
| DIVISION | |
| ___ | City of Cheyenne Construction Specifications |
| 02 | City of Cheyenne Traffic Control Manual |
| 03 | Existing Conditions |
| 04 | Concrete |
| 05 | Masonry |
| 06 | Metals |
| 07 | Woods, Plastics and Composites |
| 08 | Thermal and Moisture Protection |
| 09 | Openings |
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CERTIFICATION(S)

DIV 02

DIV 03, 04, 05, 13

DIV 06, 07, 08, 09, 10, 12

DIV 22, 23

DIV 26, 27, 48
SECTION 02 41 16 - STRUCTURE DEMOLITION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary
      Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. This Section includes:
      1. Demolition and removal of buildings and site improvements.
      2. Disconnecting, capping or sealing, and abandoning in-place site utilities.
      3. Salvaging items for reuse by Owner.

1.03 RELATED REQUIREMENTS:

1.04 REFERENCE STANDARDS:
   A. The American Society of Safety Engineers
      1. ASSE A10.6-2006: Safety Requirements for Demolition Operations (ANSI)
   B. Code of Federal Regulations
      1. 40 CFR 82-2012: Protection of Stratospheric Ozone
   C. NFPA
      1. NFPA 241-2013: Safeguarding Construction, Alteration, and Demolition Operations

1.05 DEFINITIONS:
   A. Remove: Detach items from existing construction and dispose of them off-site unless indicated
      to be salvaged.

1.06 MATERIALS OWNERSHIP:
   A. Unless otherwise indicated, demolition waste becomes property of Contractor.
   B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones
      and their contents, commemorative plaques and tablets, and other items of interest or value to
      Owner that may be uncovered during demolition remain the property of Owner.
      1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.07 PREINSTALLATION MEETINGS:
   A. Predemolition Conference: Conduct conference at Project SITE.
      1. Inspect and discuss condition of construction to be demolished.
      2. Review structural load limitations of existing structures.
      3. Review and finalize building demolition schedule and verify availability of demolition
         personnel, equipment, and facilities needed to make progress and avoid delays.
      4. Review and finalize protection requirements.
      5. Review procedures for dust control.
      6. Review procedures for protection of adjacent buildings.
      7. Review items to be salvaged and returned to Owner.

1.08 SUBMITTALS:
   A. Qualification Data: For refrigerant recovery technician.
C. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, and for dust control. Indicate proposed locations and construction of barriers.

D. Schedule of Building Demolition Activities: Indicate the following:
   1. Detailed sequence of demolition work, with starting and ending dates for each activity.
   2. Temporary interruption of utility services.
   3. Shutoff and capping of utility services.

E. Predemolition Photographs or Video: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by demolition operations. Submit before the Work begins.

F. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

G. Inventory: Submit a list of items that have been removed and salvaged.

1.09 QUALITY ASSURANCE:
   A. Refrigerant Recovery Technician Qualifications: Certified by EPA-approved certification program.

1.10 FIELD CONDITIONS:
   A. Buildings to be demolished will be vacated and their use discontinued before start of the Work.
   B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
   C. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
      1. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Engineer and Owner. Hazardous materials will be removed by Owner under a separate contract.

1.11 COORDINATION:
   A. Arrange demolition schedule so as not to interfere with Owner's on-site operations.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:
   A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
   B. Standards: Comply with ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.01 EXAMINATION:
   A. Verify that utilities have been disconnected and capped before starting demolition operations.

3.02 PREPARATION:
   A. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction.
3.03 **UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS:**
   A. Existing Utilities to be Disconnected: Locate, identify, disconnect, and seal or cap off utilities serving buildings and structures to be demolished.
      1. Arrange to shut off utilities with utility companies.
      2. If removal, relocation, or abandonment of utility services will affect adjacent occupied buildings, then provide temporary utilities that bypass buildings and structures to be demolished and that maintain continuity of service to other buildings and structures.
      3. Cut off pipe or conduit a minimum of 24 inches below grade. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing according to requirements of authorities having jurisdiction.
      4. Do not start demolition work until utility disconnecting and sealing have been completed and verified in writing.

3.04 **PROTECTION:**
   A. Existing Facilities: Protect adjacent walkways, loading docks, building entries, and other building facilities during demolition operations. Maintain exits from existing buildings.
   B. Temporary Shoring: Provide and maintain interior and exterior shoring, bracing, or structural support to preserve stability and prevent unexpected movement or collapse of construction being demolished.
      1. Strengthen or add new supports when required during progress of demolition.
   C. Existing Utilities to Remain: Maintain utility services to remain and protect from damage during demolition operations.

3.05 **DEMOLITION, GENERAL:**
   A. General: Demolish indicated buildings and site improvements completely. Use methods required to complete the Work within limitations of governing regulations and as follows:
      1. Do not use cutting torches until work area is cleared of flammable materials. Maintain portable fire-suppression devices during flame-cutting operations.
      2. Maintain fire watch during and for at least four hours after flame-cutting operations.
      3. Maintain adequate ventilation when using cutting torches.
      4. Locate building demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
   B. Site Access and Temporary Controls: Conduct building demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
      1. Do not close or obstruct streets, walks, walkways, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed trafficways if required by authorities having jurisdiction.
      2. Use water mist and other suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations. Do not use water when it may damage adjacent construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.

3.06 **DEMOLITION BY MECHANICAL MEANS:**
   A. Proceed with demolition of structural framing members systematically, from higher to lower level. Complete building demolition operations above each floor or tier before disturbing supporting members on the next lower level.
B. Remove debris from elevated portions of the building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
   1. Remove structural framing members and lower to ground by method suitable to minimize ground impact and dust generation.
C. Below-Grade Construction: Abandon foundation walls and other below-grade construction. Cut below-grade construction flush with grade.
D. Below-Grade Construction: Demolish foundation walls and other below-grade construction that are within footprint of new construction and extending 5 feet outside footprint indicated for new construction. Abandon below-grade construction outside this area.
   1. Remove below-grade construction, including foundation walls and footings completely.
E. Existing Utilities: Abandon existing utilities and below-grade utility structures. Cut utilities flush with grade.
F. Existing Utilities: Demolish existing utilities and below-grade utility structures that are within 5 feet outside footprint indicated for new construction. Abandon utilities outside this area.
   1. Fill abandoned utility structures with satisfactory soil materials.
G. Existing Utilities: Demolish and remove existing utilities and below-grade utility structures.

3.07 SITE RESTORATION:
   A. Below-Grade Areas: Rough grade below-grade areas ready for further excavation or new construction.
   B. Below-Grade Areas: Completely fill below-grade areas and voids resulting from building demolition operations with satisfactory soil materials according to backfill requirements in specifications.
   C. Site Grading: Uniformly rough grade area of demolished construction to a smooth surface, free from irregular surface changes. Provide a smooth transition between adjacent existing grades and new grades.

3.08 REPAIRS:
   A. Promptly repair damage to adjacent buildings caused by demolition operations.

3.09 DISPOSAL OF DEMOLISHED MATERIALS:
   A. Remove demolition waste materials from Project Site and dispose of them in the Owner’s construction and demolition waste landfill.
      1. Do not allow demolished materials to accumulate on-site.
      2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
   B. Do not burn demolished materials.

3.10 CLEANING:
   A. Clean adjacent structures and improvements of dust, dirt, and debris caused by building demolition operations. Return adjacent areas to condition existing before building demolition operations began.
      1. Clean roadways of debris caused by debris transport.

END OF SECTION 02 41 16
SECTION 03 10 00 – CONCRETE FORMWORK

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. This Section includes formwork for cast-in-place concrete.

1.03 RELATED REQUIREMENTS:
   A. Section 03 23 00 – Concrete Reinforcement.
   B. Section 03 30 00 – Concrete.

1.04 REFERENCE STANDARDS:
   A. Applicable Standards:
      1. American Concrete Institute (ACI):
         a. ACI 117 - Specifications for Tolerances for Concrete Construction and Materials.
         b. ACI 301 - Specifications for Structural Concrete.
         c. ACI 318 - Building Code Requirements for Reinforced Concrete.
         d. ACI 347R - Guide to Formwork for Concrete.
      2. ASTM International (ASTM):
         c. ASTM C1077 - Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation.

PART 2 - PRODUCTS

2.01 MATERIALS FOR FACING:
   A. Where concrete will be exposed to view after construction:
      1. Use exterior grade plywood at least 5/8-inch-thick or steel forms capable of producing a smooth, uniform appearance.
      2. Do not use form-facing materials with raised grain, torn surfaces, worn edges, dents, or other defects that will impair the texture of concrete surfaces.
   B. Where concrete will not be exposed to view after construction:
      1. Exterior grade plywood at least 5/8 inch thick.
      2. Steel.
      3. Wood fiberboard.
      4. Dressed lumber free of loose knots.
   C. Treat forms with commercially available form releasing agents that will not bond with, stain, or adversely affect concrete surfaces. Agents shall not impair subsequent treatment of concrete surfaces depending upon bond or adhesion, nor shall it impede the wetting of surfaces to be cured with water or curing compounds. Form releasing agents shall be VOC compliant with a maximum VOC content of 3.8 lbs./gal. (450 g/L), or less where area restrictions are more stringent.
   D. Clean forms of sawdust, dust, dirt, and other foreign materials.
SECTION 03 10 00 – CONCRETE FORMWORK: continued

2.02 FORM TIES:
A. Break back, coil, or screw type, except where otherwise specified.
B. Use water-seal coil type in walls below grade and in walls of water bearing structures.
C. Coil type shall leave conical depression in concrete.
D. Space as required against pressure of fresh concrete.
E. The portion of the form tie remaining in place shall provide for a clearance of two times the minimum dimension of the tie, but not less than 3/4 inch, from the formed surface.

2.03 CHAMFER STRIPS:
A. Chamfer: 3/4 inch except where otherwise indicated.
B. Place in all forms to provide chamfer where concrete will have exposed projecting corners.

PART 3 - EXECUTION

3.01 FORM CONSTRUCTION:
A. Conform to ACI 301, 318, and 347R, except Shop Drawings for formwork, shoring, and reshoring shall not be submitted for approval.
B. Adequately brace, stiffen, and support forms to prevent perceptible deflection or settlement, and to hold plumb, level, and true to line.
C. Construct and maintain forms to the tolerances given in ACI 117.
D. Construct sufficiently tight to prevent mortar leakage.
E. Avoid offsets between adjacent forms and construct so that shores, braces, and stiffening members are in line with those below.
F. Space studs and stringers as required to support facing against concrete pressure, but not more than 12 inches for 5/8-inch plywood or 16 inches for 3/4-inch plywood. Maximum deflection of facing materials reflected on concrete surfaces exposed to view shall be 1/240 of the span between structural members of the formwork.
G. Use wales, strongbacks, shores, and bracing as required.
H. Form all necessary openings or chases for piping, ductwork, and similar items where indicated or as required for the Work.
I. Construct forms to be removable in sections without marring concrete surface.
J. Surface of forms shall provide a smooth, dense, plane surface to finished concrete where exposed to view.
K. Contractor shall be responsible for structural adequacy, design, engineering, and construction of the formwork.
L. Stay-in-place metal forms shall not be used.

3.02 TIME-IN-PLACE FOR FORMS:
A. It is the responsibility of Contractor to consider all applicable factors and leave the formwork in place until it is safe to remove them.
B. All removal shall be performed in a manner which will prevent damage to the concrete and ensure the complete safety of the structure.
C. Where forms support more than one element, the forms shall not be removed until the form removal criteria are met by all supported elements.
D. Evidence that concrete has gained sufficient strength to permit removal of forms shall be determined by tests on control cylinders. All control cylinders shall be stored in the structure or as near the structure as possible, so they receive the same curing conditions and protection methods as given those portions of the structure they represent. Control cylinders shall be removed from the molds at an age of no more than 24 hours. All control cylinders shall be
prepared and tested in accordance with ASTM C31/C31M REV A and ASTM C39/C39M at the expense of Contractor by an independent laboratory that complies with ASTM C1077. Control cylinders shall be tested within 4 hours after removal from the Site.

E. Forms shall not be removed unless the minimum time or minimum compressive strength requirements below are met.

1. Formwork Not Supporting Weight of Concrete:
   a. Formwork for walls, columns, sides of beams, gravity structures, slabs-on-ground and other vertical type formwork not supporting the weight of concrete shall remain in place 24-hours minimum after concrete placement is completed.

2. Formwork Supporting Weight of Concrete:
   a. Formwork supporting weight of concrete and shoring shall not be removed until structural members have acquired sufficient strength to safely support their own weight and any construction or other superimposed loads to which the supported concrete may be subjected. As a minimum, no forms or shoring shall be loosened or removed until control concrete test cylinders indicate the concrete has attained the following compressive strengths for the respective structural members:

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<th>Structural Member</th>
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<th>Compressive Strength</th>
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<td>Unshored slab and beam forms or forms which can be removed without disturbing shores</td>
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<td>Slab or beam shoring</td>
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END OF SECTION 03 10 00
SECTION 03 15 50 – VAPOR RETARDER

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary
      Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. This Section includes vapor retarder under concrete slabs on grade.

1.03 RELATED WORK SPECIFIED ELSEWHERE:
   A. Section 03 30 00 - Concrete.

1.04 REFERENCE STANDARDS:
   A. Applicable Standards:
      1. American Concrete Institute (ACI):
         a. 302.1R - Guide to Concrete Floor and Slab Construction
         b. 302.2R - Guide for Slabs that Receive Moisture-Sensitive Flooring Materials
         b. E154 - Test Methods for Water Vapor Retarders Used in Contact with Earth Under
            Concrete Slabs, on Walls, or as Ground Cover.
         c. E1643 - Standard Practice for Selection, Design, Installation, and Inspection of
            Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete
            Slabs
         d. E1745 - Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill
            Under Concrete Slabs.

1.05 SUBMITTALS:
   A. Submit as specified in DIVISION 01.
   B. Include, but not limited to, the following:
      1. Product specification and data.
      2. Installation instructions.

PART 2 - PRODUCTS

2.01 VAPOR RETARDER:
   A. Flexible, preformed sheet membrane material conforming to ASTM E1745, Class A or B
      having a minimum thickness of 15 mils.

PART 3 - EXECUTION

3.01 INSTALLATION:
   A. Install in accordance with ASTM E1643 and the following.
   B. Remove sharp edges, projecting materials, and roughness which might penetrate vapor
      retarder.
   C. Level and tamp or roll granular base.
   D. Place vapor retarder sheeting with the longest dimension parallel with the direction of the
      concrete pour.
SECTION 03 15 50 – VAPOR RETARDER: continued

E. Lap vapor retarder over footing or seal to foundation wall, or both, and seal around penetrations such as utilities and columns in order to create a monolithic membrane between the surface of the slab and moisture sources below the slab and at the slab perimeter.

F. Lap joints 6 inches, or as instructed by the manufacturer, and seal with the manufacturer's recommended adhesive or pressure sensitive tape, or both.

G. Take precaution to protect vapor retarder from damage during installation of reinforcing steel and utilities and during placement of concrete.

H. Use only concrete brick type reinforcing bar supports, or provide 6-inch by 6-inch protective pads of asphaltic hardboard or other material recommended by the vapor retarder manufacturer to protect the vapor retarder from puncture.

I. Do not drive stakes through the vapor retarder.

J. Repair vapor retarder damaged during placement of reinforcing or concrete as instructed by manufacturer.

END OF SECTION 03 15 50
SECTION 03 20 00 – CONCRETE REINFORCEMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
A. This Section includes steel reinforcement bars, ties, welded wire fabric, bolsters, chair supports, and accessories.

1.03 RELATED WORK SPECIFIED ELSEWHERE:
A. Section 03 10 00 - Concrete Formwork.
B. Section 03 30 00 - Concrete.

1.04 REFERENCE STANDARDS:
A. Applicable Standards:
      a. A615/A615M - Deformed and Plain Carbon Steel Bars for Concrete Reinforcement.
      b. A706/A706M - Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
      c. A1064/A1064M – Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
   2. American Concrete Institute (ACI):
      a. 301 - Specifications for Structural Concrete.
      b. SP 66 - Detailing Manual.
      c. 318 - Building Code Requirements for Structural Concrete.
      d. 117 - Specifications for Tolerances for Concrete Construction and Materials.
   3. American Welding Society (AWS):
      a. A5.5 - Low Alloy Steel Electrodes for Shielded Metal Arc Welding.
      c. D1.4 - Structural Welding Code Reinforcing Steel.
   4. Concrete Reinforcing Steel Institute (CRSI):

1.05 SUBMITTALS:
A. Submit as specified in DIVISION 01.
B. Include, but not limited to, the following:
   1. Complete bar schedule, bar details, and erection drawings to conform to ACI SP 66.
   2. Drawing with each type of bent bar marked with identification mark. Straight bars shall have mark number or be identified by size and length.
   3. Erection drawings shall be clear, easily legible, and to a minimum scale of:
      a. 1/4 inch = 1 foot (1:50).
      b. 1/8 inch = 1 foot (1:100) if bars in each face are shown in separate views.
   4. Size and location of all openings.
   5. Concrete protective cover.
   6. Grade of steel.
   7. Lap splice lengths.
SECTION 03 20 00 – CONCRETE REINFORCEMENT:  continued

1.06  DELIVERY, STORAGE, AND HANDLING:
   A. Store steel reinforcement blocked up off the ground and in orderly stacks.
   B. Store only bars with the same identifying label in the same stack.

1.07  TESTING:
   A. Perform at the mill for each heat.
   B. Submit certified test results upon request.

PART 2 - PRODUCTS

2.01  REINFORCEMENT BARS, TIES, AND STIRRUPS:
   A. Materials:
      1. Conform to ASTM A615, Grade 60, except as otherwise specified.
      2. Cold-drawn wire for spiral column ties shall conform to ASTM A82.
      3. Reinforcement indicated or specified to be welded shall conform to ASTM A706.
   B. Fabrication of Bars:
      1. Fabricate with cold bends conforming to the recommended dimensions shown in ACI 318.
      2. Fabricate bars according to the tolerances given in ACI 117.
      3. Field fabrication will be allowed only if Contractor has equipment to properly fabricate steel.
      4. Attach metal or plastic tags with identifying mark or length corresponding to mark number or length on Drawing. Straight bars shall have mark number or size and length. Bent bars shall have mark number.
      5. Contractor may, at his option, continue steel reinforcement through openings in walls and slabs, then field-cut the opening so that there will be the required concrete cover between ends of bars and edge of opening.

2.02  WELDED WIRE REINFORCEMENT:
   A. Conform to ASTM 1064.
   B. Wire sizes W1.4 and smaller shall be galvanized.
   C. Provide mats only. Rolled fabric is not acceptable.

2.03  BOLSTERS, CHAIRS, AND ACCESSORIES:
   A. Conform to ACI SP 66 and the CRSI Manual of Standard Practice.
   B. Provide all spacers, bolsters, chairs, ties, and other devices necessary to properly space, place, support, and fasten steel reinforcement in place during the concrete placement.
   C. Metal accessories shall be galvanized or plastic-coated where legs will be exposed in finished concrete surfaces.
   D. Do not use rocks, broken bricks, wood blocks, or concrete fragments for support of steel reinforcement.

2.04  PRECAST CONCRETE BLOCK BAR SUPPORTS:
   A. May be used only for bar supports in slabs on ground.
   C. Each block shall have a minimum of 9 square inches (5800 square millimeters) of bearing area. Space as required by the particular condition of weight, bearing surface, and rigidity of the steel reinforcement.
PART 3 - EXECUTION

3.01 PLACEMENT OF STEEL REINFORCEMENT:
   A. Place all steel reinforcement before concrete is cast in accordance with approved erection drawings, ACI 117, ACI 318, and the CRSI Manual of Standard Practice.
   B. Remove oil, mill scale, pitting, mud, loose rust, ice, and other materials that would reduce bond from bars before placing.
   C. Tie securely with 16 gage (1.6 mm) or larger annealed iron wire.
   D. Place to maintain concrete cover to conform to ACI 117 and ACI 318, unless otherwise indicated.
   E. Splice steel where indicated. Splices shall be in full contact and shall conform to ACI 318.
      1. Unless otherwise indicated, lap splices shall be Class B as defined by ACI 318.
      2. Splice steel using Cadweld Series T-splices where indicated or approved.
         a. Provide a manufacturer's representative to give on site instructions to all welders who will perform the splices in the field.
         b. Contractor shall have the manufacturer's representative instruct, observe, and approve in writing those persons doing the welding.
         c. Contractor shall arrange for the manufacturer's representative to return at the request of the Engineer.
   3. Lenton Mechanical Splices:
      a. Lenton mechanical splices shall be used where indicated or approved by Engineer.
      b. The Lenton mechanical splices shall develop in tension and compression at least 125% of the yield strength (Fy) of the bar spliced.
      c. Lenton mechanical splices shall be positive locking, taper threaded type coupler.
   4. Any additional Contractor-proposed splice shall be submitted for acceptance of location and splice length.
   F. Lap welded wire reinforcement in accordance with ACI 318, but not less than the length of one mesh plus 2 inches (50 mm).
   G. Connection of reinforcement bars to steel shapes or plate shall be with a Cadweld Series B-splice.
   H. Do not bend bars embedded in hardened or partially hardened concrete without approval from Engineer. If bending is permitted, conform to procedures of ACI 301 unless otherwise prescribed by the governing building code.
   I. Do not weld reinforcing bars unless specifically indicated. Where welding is indicated, provide bars conforming to ASTM A706/A706M and comply with AWS D1.4.

END OF SECTION 03 20 00
SECTION 03 30 00 – CONCRETE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
A. This Section includes concrete and related items.

1.03 RELATED REQUIREMENTS:
A. Section 03 10 00 – Concrete Formwork.
B. Section 03 15 50 – Vapor Retarder.
C. Section 03 20 00 – Concrete Reinforcement.
D. Section 05 50 00 – Embedded Steel.
E. Section 07 12 00 – Insulation.
F. Section 09 90 00 – Protective Coatings.

1.04 REFERENCE STANDARDS:
A. Comply with the provisions of the following codes, specifications, and standards, except as otherwise indicated.
B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
1. American Concrete Institute (ACI):
   b. ACI 301 - Specifications for Structural Concrete.
   c. ACI 302.1R - Guide for Concrete Floor and Slab Construction.
   d. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete.
   e. ACI 305.1 – Specification for Hot Weather Concreting.
   g. ACI 306.1 – Specification for Cold Weather Concreting.
   i. ACI 308.1 - Specification for Curing Concrete.
   j. ACI 309R - Guide for Consolidation of Concrete.
   k. ACI 318 - Building Code Requirements for Structural Concrete.
   l. ACI 506.2 - Specification for Shotcrete.
2. ASTM International (ASTM):
   b. ASTM C33/C33M - Standard Specification for Concrete Aggregates.
   e. ASTM C42/C42M – Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
   f. ASTM C78/C78M REV B - Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading).
g. ASTM C88 – Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.


o. ASTM C172/AC172M REV A – Standard Practice for Sampling Freshly Mixed Concrete.

p. ASTM C192/C192M – Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.

q. ASTM C231/C231M – Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.


w. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete.


z. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.


dd. ASTM C1218/C1218M - Standard Test Method for Water-Soluble Chloride in Mortar and Concrete.


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ii. ASTM E1155 - Standard Test Method for Determining FF Floor Flatness and FL Floor Levelness Numbers.
3. Concrete Plant Manufacturers Bureau (CPMB):
   a. 100 - Concrete Plant Standards.
   b. 102 - Recommended Guide Specifications for Batching Equipment and Control Systems in Concrete Batch Plants.
4. Plant Mixer Manufacturers Division (PMMD):
   a. 100 - Concrete Plant Mixer Standards.
5. Federal Specification (FS):
   a. SS-S-200 - Sealants, Joint: Two-Component, Jet-Blast-Resistant, Cold-Applied, for Portland Cement Concrete Pavement.
   b. TT-S-227 - Sealing Compound: Elastomeric Type, Multi-Component (for Calking, Sealing, and Glazing in Buildings and Other Structures).
7. Truck Mixer Manufacturers Bureau (TMMB):
   a. Truck Mixer, Agitator and Front Discharge Concrete Carrier Standards.

1.05 SUBMITTALS:
   A. Submit as specified in Division 01.
   B. Include, but not limited to, product data and Shop Drawings of the following:
      1. Nonshrink grouts.
      2. Admixtures.
      5. Concrete floor hardeners, sealers, and coloring compounds.
      7. Joint sealants.
      8. Aggregate Concrete Floor Hardener.
   C. Mill Certificates:
      1. Submit to Engineer a minimum of one copy for each cement shipment.
   D. Concrete Mix Design Proportions:
      1. Submit as specified in PART 2, Paragraph 2.01.D - Mix Proportions, this Section.
      2. Submit for each mix design, including aggregate gradation data.
      3. Resubmit for any change in each mix design.
   E. Production Test Reports: Submit as specified in Division 01 and PART 2, Paragraph 2.01.E. - Measurement of Materials, this Section.
   F. Laboratory Test Reports: Submit as specified in Division 01 and PART 2, Paragraph 3.08. C – Laboratory Testing of Aggregates and Concrete During Construction, this Section.

1.06 QUALITY ASSURANCE:
   A. Field Testing: Shall be performed by an ACI Concrete Field-Testing Technician Grade 1.
   B. Submit qualification records of field testing and finishing technicians prior to placing concrete.
PART 2 - PRODUCTS

2.01 CONCRETE:

A. Materials:

1. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
   a. Portland cement: ASTM C150, Type I/II
      (1) Fly ash: ASTM C618, Class F or C.
      (2) Ground Granulated Blast-Furnace Slag: ASTM C989, Grade 100 or 120.
   b. The maximum amount retained on the No. 325 sieve shall be 10% as determined in accordance with ASTM C430.
   c. The maximum amount of alkalis (\( \text{Na}_2\text{O} + 0.658 \text{K}_2\text{O} \)) shall be 0.60% determined in accordance with ASTM C114. A running average of three Samples shall not exceed a maximum of 0.50%.

2. Fine Aggregate:
   a. Conform to ASTM C33.
   b. Approved service record of 3 years with a history indicating that the fine aggregate is not chemically reactive.
   c. For a new fine aggregate source, or when 3 years' approved service records are not available, or when the service records are unacceptable; the aggregate shall be evaluated for potential reactivity. Aggregate must be considered innocuous in accordance with petrographic examination by ASTM C295.
   d. Fine aggregate considered deleterious or potentially deleterious shall not be used without approval.
   e. Maintain fine aggregate free of ice and frozen lumps.
   f. Fineness modulus shall be between 2.3 and 3.1.

3. Coarse Aggregate:
   a. Conform to ASTM C33.
      (1) Limits for deleterious substances and physical property requirements shall conform to Table 3 and applicable class designation 5S, 5M, or 1N.
   b. Approved service record of 3 years with a history indicating that the coarse aggregate is not chemically reactive.
   c. For a new coarse-aggregate source, when 3 years' approved service records are not available, or when the service records are unacceptable; the aggregate shall be evaluated for potential reactivity. Aggregate must be considered innocuous in accordance with petrographic examination by ASTM C295 and tests conforming to ASTM C1260.
   d. Coarse aggregate considered deleterious or potentially deleterious shall not be used without approval.
   e. Blast furnace slag will not be permitted.
   f. Maintain coarse aggregate free of ice and frozen lumps.
   g. Grading Requirements:
      (1) Size No. 57, from 1-inch (25-mm) to No. 4 (4.75-mm) sieve for all concrete unless otherwise specified.

4. Mixing Water:
   a. Only potable water will be acceptable.

5. Admixtures:
   a. Water-Reducing Type:
      (1) Conform to ASTM C494, Type A.
(2) Conform to manufacturer's recommendations for use.
(3) Technical assistance of the manufacturer's field representative shall be furnished upon request.

b. Air-Entraining Type:
   (1) Conform to ASTM C260.
   (2) Conform to manufacturer's recommendations for use.
   (3) Technical assistance of the manufacturer's field representative shall be furnished upon request.
   (4) Testing of air-entraining admixtures shall conform to ASTM C233.

c. Other Admixtures: Use only with Engineer's written concurrence.
   (1) Water-Reducing, Retarding Type: Conform to ASTM C494, Type D.

d. Admixtures shall not contain any chloride ions.

e. Storage: Admixtures shall be stored in such a manner as to avoid contamination, evaporation, freezing, temperature changes, settling, or any damage which would adversely affect their characteristics.

B. Laboratory Testing of Materials for Use in Concrete:
1. An approved independent testing laboratory shall be selected and paid by Contractor to perform all required laboratory tests of materials proposed for use in the production of concrete and to determine mix proportions when laboratory trial batches are required.
2. Contractor shall deliver representative Samples of all proposed concrete materials to the laboratory for the following testing:
   a. Fine Aggregate:
      (1) ASTM C33 (as amended by PART 2, Paragraph 2.01.A. - Materials, this Section).
      (2) ASTM C40.
      (3) ASTM C88.
      (4) ASTM C117.
      (5) ASTM C136.
      (6) ASTM C142.
      (7) Fineness modulus.
   b. Coarse Aggregate:
      (1) ASTM C33 (as amended by PART 2, Paragraph 2.01.A. - Materials, this Section).
      (2) ASTM C88.
      (3) ASTM C136.
      (4) ASTM C142.
   c. Air-entraining admixture shall be tested conforming to ASTM C233.
   d. Mixing water: if other than potable water is proposed for use and in the opinion of Engineer there is reason to suspect its acceptability:
      (1) With the design mix the laboratory shall make two concrete test cylinders using proposed water and two concrete test cylinders using potable water conforming to ASTM C192.
      (2) All cylinders shall be tested conforming to ASTM C39. Age of cylinders at test shall be 28 days unless an earlier age is authorized.
      (3) Concrete made with nonpotable water shall attain at least 95% of the compressive strength of similar specimens of the same mix design made with potable water.
   
3. The laboratory test results shall be part of the design mix submittal specified in this PART 2, Paragraph 2.01.D. - Mix Proportions.
C. Concrete Qualities Required:
1. Minimum 28-day compressive strength:
   a. 4,500 psi (31,026 kPa) for all construction unless otherwise indicated.
   b. 2,000 psi (13,789 kPa) for fill concrete and seal slabs.
   c. 4,000 psi for Electrical Duct Banks and Site Concrete.
   d. Compressive-strength determinations shall be made from 6-inch (150-mm) diameter by 12-inch (300-mm) long concrete cylinders tested in accordance with ASTM C39.
2. Slump of concrete shall be between 4 inches (50 mm) and 6 inches (100 mm) as tested in accordance with ASTM C143.
3. Air Content:
   a. 6% ±1.5% unless otherwise indicated or specified.
   b. 3% maximum for all concrete receiving steel-troweled finish.
   c. Testing shall be in accordance with ASTM C231.
4. Water-Cementitious Materials Ratio:
   a. In addition to the aforementioned requirements, maximum water-cementitious materials ratio shall be limited as follows:
      (1) 0.45 for all concrete unless otherwise specified.
          (a) Includes Administration Building foundation and slab.
      (2) 0.40 for concrete exposed to freezing and thawing in a moist condition or to deicing chemicals.
          (a) Includes Scale House and Scale foundations and approach slabs.
5. Chloride Ion Content:
   a. Maximum water-soluble chloride ion content, in percent by weight of cement:
      (1) 0.30 for all concrete unless otherwise specified.
   b. Testing shall be in accordance with ASTM C1218.
D. Mix Proportions:
1. Concrete shall be homogeneous, readily placeable, uniformly workable, and finishable; proportioned to conform to ACI 211.1.
2. Mix proportions for all concrete, unless otherwise specified, shall be selected preferably on the basis of field experience; but in the case where sufficient or suitable strength test data is not available, concrete shall be proportioned on the basis of laboratory trial mix design.
   a. Field experience using test results within the preceding year, with the materials and plant to be employed may be the basis of mix proportioning, provided that not less than 30 consecutive satisfactory compressive-strength tests on concrete using the proposed materials with a similar mix are available. A compressive-strength test is defined as the average 28-day compressive strength of two companion cylinders made conforming to ASTM C172 and ASTM C31 and tested conforming to ASTM C39.
      (1) The standard deviation of compressive-strength tests shall be computed as a basis for design of the mix. The design average compressive strength shall exceed the specified strength by at least:
          (a) 400 psi (2760 kPa) if standard deviation is less than 300 psi (2070 kPa).
          (b) 550 psi (3800 kPa) if standard deviation is 300 to 400 psi (2070 to 2760 kPa).
          (c) 700 psi (4830 kPa) if standard deviation is 400 to 500 psi (2760 to 3450 kPa).
SECTION 03 30 00 – CONCRETE:  continued

(d) 900 psi (6200 kPa) if standard deviation is 500 to 600 psi (3450 to 4140 kPa).
(e) 1,200 psi (8275 kPa) if standard deviation is greater than 600 psi (4140 kPa).

(2) Submit the following test data to Engineer for approval prior to placing concrete:

(a) Fine Aggregate:
1). ASTM C33.
2). ASTM C40.
3). ASTM C88.
4). ASTM C117.
6). ASTM C142.
7). Fineness modulus.

(b) Coarse Aggregate:
1). ASTM C33.
2). ASTM C88.
4). ASTM C142.
5). ASTM C295 and ASTM C1260 or approved service records.

(c) Cement:
1). Mill certificate.
2). ASTM C430.

(d) Concrete:
1). Fine and coarse aggregate, water and cement sources.
2). Mix proportions, slump and air content.
3). Data on 30 consecutive satisfactory compressive strength tests and standard deviation calculations.

b. Laboratory Trial Batch: When laboratory trial batches are used as a basis for determining mix proportions, all such Work shall be performed by the laboratory as specified in PART 2, Paragraph 2.01.B. - Laboratory Testing of Materials for Use in Concrete, this Section.

(1) Laboratory trial batches shall be used to establish a water-cement ratio, compression-strength curve with at least three points, each representing the strength of a separate trial batch. At least one point shall be above and one below the strength required. Each point on the curve shall represent the average of at least three cylinders tested at 28 days or an earlier age when approved by Engineer. The slump and air content shall be at the maximum limits specified in PART 2, Paragraph 2.01.C. - Concrete Qualities Required, this Section.

(2) A point on the water-cement ratio, compressive-strength curve shall be selected that will provide an average compressive strength at least 1,200 psi (8275 kPa) greater than the specified minimum strength.

(3) Submit the following test data to Engineer for approval prior to placing concrete.

(a) Fine Aggregate:
1). ASTM C33.
2). ASTM C40.
3). ASTM C88.
SECTION 03 30 00 – CONCRETE: continued

4). ASTM C117.
6). ASTM C142.
7). Fineness modulus.
8). ASTM C295 and ASTM C1260 or approved service records.

(b) Coarse Aggregate:
1). ASTM C33.
2). ASTM C88.
4). ASTM C142.
5). ASTM C295 and ASTM C1260 or approved service records.

(c) Cement:
1). Mill certificate.
2). ASTM C430.

(d) Concrete:
1). Fine and coarse aggregate, water and cement sources.
2). Laboratory mix proportions, slump and air content.
3). Water-cement ratio, compressive-strength curve.

3. Prior to placing any concrete, the laboratory selected by Contractor shall report the results of the testing and mix designs to the following:
   a. Engineer, Denver Office one copy.
   b. Contractor (copies as required).
   c. Concrete Supplier (copies as required).

E. Measurement of Materials:
1. General Requirements:
   a. Conform to ACI 304R.

F. Mixing and Delivery:
1. Conform to ACI 304R.
2. Cement temperature, when added to mix, shall not exceed 170°F (77°C).
3. Adjust the amount of mix water to compensate for the moisture content of the aggregates.
4. Concrete Plant:
   a. Conform to "Concrete Plant Mixer Standards" of the Plant Mixer Manufacturers Division, Concrete Plant Manufacturers Bureau, and "Concrete Plant Standards" of the Concrete Plant Manufacturers Bureau.
   b. Water added to concrete having a slump below the specified minimum shall be at Contractor's risk. If the water added produces a slump greater than the specified maximum, the concrete will be rejected. If water is added, the concrete shall be remixed for a minimum of 25 revolutions. Water shall not be added after the truck mixer has begun to discharge concrete.
   c. Truck mixer shall conform to "Truck Mixer, Agitator, and Front Discharge Concrete Carrier Standards" of the Truck Mixer Manufacturers Bureau.
   d. Ready-mixed concrete shall be produced and delivered conforming to ASTM C94 as applicable.
   e. Contractor shall furnish Owner with a concrete delivery ticket for each load of concrete. The ticket shall have the following information recorded:
      (1) Serial number of ticket.
      (2) Time batched.
      (3) Time arrived on jobsite.
(4) Amount of concrete (by volume).
(5) Mix number.
(6) Amount of all water added at jobsite by Contractor.
(7) Name of ready-mix batch plant.
(8) Date.
(9) Truck number.
(10) Name of purchaser.

5. Plant and truck mixer uniformity shall be tested according to ASTM C94. Frequency of tests shall be as specified in PART 3, this Section.

2.02 **GROUT:**

A. Grout for Dry Packing:
   1. Volume: 1 part Portland cement to 2 parts sand.
   2. Keep water to a minimum as required for placing by the dry packing method.
   3. Place after the mixed grout has been allowed to stand for 2 hours.
   4. The sand and cement shall be as specified for concrete.

B. Flowable Nonshrinking Grout:
   1. Required for setting handrail posts, for setting equipment recommended by the manufacturer to be set with nonshrinking grout, and in other places indicated.
   2. Grout shall be nonmetallic and conform to ASTM C1107.
   3. Prepare and place conforming to manufacturer's printed instructions.
   4. For equipment bases, the concrete surfaces shall be grit blasted or roughened with a chipping hammer prior to grouting. The foundation plates shall be cleaned of any grease, oil, paint, primers, or epoxy coatings.

C. Grout for Bonding:
   1. Proportion (by weight): 1 part cement to 1-1/2 parts sand.
   2. Keep water to a minimum.

2.03 **BONDING AGENT:**

A. Provide moisture-insensitive, epoxy-resin bonding agent conforming to ASTM C881, Type V.

2.04 **CONCRETE ACCESSORIES:**

A. Expansion Joints:
   2. Bond Breaker: Polyethylene tape or other plastic tape as recommended by sealant manufacturer.
   3. Sealant Backer Rod: Provide closed cell backer rod or other backing material as recommended by sealant manufacturer.
   4. Joint Sealants:
      a. Multi-component sealant as follows:
         (1) Joint Sealant - General Use:
            (a) BASF Building Systems: Sonneborn Sonolastic NP 2 (vertical use) and Sonolastic SL 2 (horizontal use).
            (b) Epoxy Systems Products Company: Product #11.
            (c) Euclid Chemical Company: Eucolastic II.
            (d) Pecora Corporation: NR-200, Dynatred.
         (2) Joint Sealant - Traffic Grade (conforming to FS TT-S-227):
            (a) BASF Building Systems: Sonneborn Sonolastic SL 2.
SECTION 03 30 00 – CONCRETE: continued

(b) Epoxy Systems Products Company: Product #913.
(c) Pecora Corporation: Dynatrol II SG.
(d) Sika Corporation: Sikaflex-2c NS TG.

B. Preformed Contraction Joints: Zip Joint T-shaped plastic strip as manufactured by BoMetals, Inc., Powder Springs, Georgia. Depth of preformed construction joint shall exceed 1/4 of the slab thickness.

2.05 CURING AGENT:
A. Apply to all concrete surfaces unless otherwise indicated or specified.
B. Curing agent shall conform as follows:
   1. ASTM C309, Type 1: Use where concrete surface is not exposed to direct sunlight after placement.
   2. ASTM C309, Type 1-D: Use where slabs are exposed to direct sunlight for a period of seven days minimum after placement. Curing and sealing agent with fugitive dye shall be readily distinguishable upon the concrete surface for at least four hours after application but shall be inconspicuous within seven days after application.
   3. ASTM C309, Type 2: Use as specified in PART 3, Article 3.05 - Hot Weather Concreting, this Section.
C. Curing compound used on floors to be sealed, painted, tiled, topped, dampproofed, waterproofed, or covered with resilient floor covering shall be guaranteed not to interfere with application of sealer, paint, tile mortar, or tile adhesive after a 28-day curing period.
D. Curing compound shall be VOC compliant with a maximum VOC content of 2.9 lbs./gal (350 g/L), or less where Project location regulations are more stringent.

2.06 CONCRETE FLOOR CURING AND SEALING AGENT:
A. Apply to all interior concrete floor surfaces subject to vehicle or pedestrian traffic.
B. Curing and sealing agent shall conform as follows:
   1. ASTM C1315, Type I, Class A: Use where slabs are not exposed to direct sunlight after placement.
   2. ASTM C1315, Type I, Class A with Fugitive Dye: Use where slabs are exposed to direct sunlight for a period of seven days minimum after placement. Curing and sealing agent with fugitive dye shall be readily distinguishable upon the concrete surface for at least four hours after application but shall be inconspicuous within seven days after application.
   3. ASTM C1315, Type II, Class A: Use as specified in PART 3, Article 3.05 - Hot Weather Concreting, this Section.
C. Apply as soon as possible and in conformance with manufacturer's written instructions.

PART 3 - EXECUTION

3.01 PREPARATION FOR CONCRETE PLACEMENT:
A. Openings Through Concrete: Provide openings through concrete as indicated and for the proper installation of all equipment, piping, wiring, ductwork and similar items, installed under this Contract.
B. Installation of Embedded Items:
   1. Provide for accurate installation of embedded items installed under this Contract.
   2. Securely fix floor drains in place to prevent flotation while placing concrete. Uniformly and accurately slope finish floor slab toward the drains.
3. Embedded items shall be as indicated or specified, or as selected by Contractor and approved by Engineer.

4. During cold weather, protect pipe sleeves, shear pockets, and blockouts from moisture which may freeze, expand, and crack the sleeve, pocket or blockout and concrete structure.

5. Grease or tape anchor bolt threads to protect from concrete splatter.

C. Installation of Joints:

1. Construction Joints:
   a. Location:
      (1) Locate joints, which are not indicated or specified, in conformance with ACI 318.
      (2) Locate joints to limit the length of all concrete placements to not more than 40 feet.
      (3) Obtain Engineer's approval of joints located by Contractor prior to preparation of reinforcing steel drawings.
   b. Preparation and Installation:
      (1) Clean and break laitance or other foreign material from bonding surface.
      (2) Tighten forms remaining in place (where applicable) to prevent seepage between forms and hardened concrete.

2. Expansion Joints:
   a. Install filler, backer rod and sealant in strict conformance with manufacturer's written instructions.
   b. Reinforcing steel shall not extend through expansion joints unless indicated otherwise.
   c. Attach rigid joint filler to the face of the joint prior to placing adjacent concrete. The filler shall occupy the entire width of the joint.
   d. Install sealant backer rod for sealant except where indicated to be omitted. Install bond breaker where indicated.
   e. Clean joints surface immediately before application of sealant.
   f. Install joint sealants to conform to ASTM C1193. Tool sealants to provide smooth, uniform bead with a slightly concave surface, eliminate air pockets, and insure sealant contact and adhesion with sides of joint.
   g. Protect joints from moisture and ice during freezing.

3. Contraction Joints: As specified in this PART 3, Article 3.03 - Finishing, this Section.

3.02 PLACING OF CONCRETE:
A. Conventional Placing:

1. General Requirements:
   a. Conform to ACI 304R.
   b. Bonding surfaces, including reinforcement, shall be clean, free of laitance and foreign materials.
   c. Face horizontal bonding surfaces with 1-inch (25-mm) thick coat of fresh "grout for bonding." Wet all other surfaces.
   d. Place concrete on properly prepared and unfrozen subgrade and only in dewatered excavation and forms.
   e. Use forms for all concrete except where otherwise indicated or specified. Footings entirely below grade may be earth formed.
   f. Do not place concrete that has partially hardened or has been contaminated by foreign materials.
g. Prevent mud or foreign materials from entering the concrete or forms during placement operations.

2. Conveying:
   a. Convey concrete from the mixer and deposit in place by methods which will prevent the segregation or loss of materials.
   b. Equipment for chuting, pumping, and pneumatically conveying concrete shall be of such size and design as to provide a practically continuous flow of concrete at the delivery end.
   c. Aluminum conveying equipment shall not be used.

3. Depositing:
   a. Place concrete in continuous horizontal lifts not to exceed 2 feet (600 mm), and place concrete against bulkheads and keyways at vertical joints.
   b. Maximum free drop of concrete and grout for bonding shall be 5 feet (1.5 meters), in walls 10 inches (250 mm) or less in thickness, with 1-foot (300-mm) additional drop allowed for each inch (25 mm) of wall thickness over 10 inches (250 mm), with a maximum drop of 10 feet (3 meters).
   c. When vapor barrier is used, keep lapped joints closed and take precautions to avoid puncturing the barrier.

4. Consolidation of Concrete:
   a. Consolidate concrete in conformance with ACI 309R. Characteristics and application of concrete vibrators shall be as set forth in Table 5.1.5.
   b. Provide an adequate number of vibrators of sufficient capacity to keep up with the maximum rate of concrete placement. Keep on hand adequate standby equipment in good operating condition.
   c. Vibrate concrete only until the concrete is thoroughly consolidated and the voids filled, as evidenced by the leveled appearance of the concrete at the exposed surface and the embedment of the surface aggregate.
   d. Insert internal vibrators vertically to the full depth of the layer being placed and into the previous layer. Do not drag vibrators through the concrete. Insert and withdraw vibrator slowly with the vibrator running continuously so that no hole will be left in the concrete. Do not flow concrete from one location to another by use of a vibrator.
   e. Consolidate concrete layer to full depth when using a surface vibrator. Use thinner layers or a more powerful vibrator if necessary, to achieve complete consolidation.
   f. Use form vibrators only where sections are too thin or where sections are inaccessible for internal vibrators.

5. Time Requirements:
   a. Place concrete at a sufficient rate to assure that lifts below have not taken initial set before fresh concrete is deposited.
   b. Place concrete within 45 minutes after mixing. This period may be extended to 1 hour and 30 minutes provided that the combined air temperature, relative humidity, and wind velocity are such that the plasticity of the fresh concrete is satisfactory for placement and consolidation, and that the specified mixing water is not exceeded. Concrete which has partially set shall not be retempered but shall be discarded.

B. Placing Concrete at Joints:
   1. Take precautions to ensure tight, well-bonded construction joints with no air pockets or voids.
SECTION 03 30 00 – CONCRETE: continued

2. Delay construction at a joint a minimum of 16 hours where placement is continued past joint, except where otherwise indicated.

3.03 FINISHING:
   A. Unformed Surfaces:
      1. Screed Finish:
         a. Use as first stage for all concrete finishes.
         b. Use as final finish on surfaces that will be covered by additional concrete, grout placement, or mortar setting bed except as otherwise specified.
         c. Immediately after screeding, use a wood float, darby, or bullfloat to eliminate high and low spots and to embed large aggregate. This shall be done in a manner to produce even, uniform surfaces so that surface irregularities do not exceed 3/8 inch in 10 feet (9 mm in 3 meters) when used as final finish.

2. Floated Finish:
   a. Use as second stage of broomed, troweled, or magnesium-troweled finish.
   b. Use as final finish on all areas to receive quarry or ceramic tile with mortar setting bed.
   c. Float with mechanical float. Hand floating will be permitted only in areas inaccessible to mechanical float.
   d. On surfaces not to receive troweled or magnesium-troweled finish, finish with wood or cork float after mechanical floating to a true uniform surface so that surface irregularities do not exceed 1/8 inch in 10 feet (3 mm in 3 meters), except at floor drains.

3. Broomed Finish:
   a. Use as final finish on all outdoor slabs including pavements, sidewalks and approach slabs.
   b. After floated finish, draw a stiff bristle broom across the surface making uniform corrugations, perpendicular to the direction of traffic, not more than 1/16 inch (1.6 mm) deep.

4. Troweled Finish:
   a. Use as final finish on inside floors and on all other unformed surfaces not otherwise indicated or specified.
   b. Trowel with mechanical steel trowel to obtain a smooth, dense finish. Hand steel trowel shall be used in areas not accessible by mechanical trowel. The final troweling shall be done after the concrete has become hard enough so that no mortar adheres to the edge of trowel and a ringing sound is produced as the trowel passes over the surface.
   c. Do not trowel before surface water has evaporated or has been removed with a squeegee.
   d. Finish to a true uniform surface so that surface irregularities do not exceed 1/8 inch in 10 feet (3 mm in 3 meters), except at floor drains.
   e. Do not add sand or cement to the floor surface.

5. Contraction Joints:
   a. Locate as indicated.
   b. Maintain true alignment with straightedge.
   c. Slab on grade joints shall be sawed.
   d. Sawed Joints:
SECTION 03 30 00 – CONCRETE: continued

(1) Cut joints with power blade as soon as concrete surface is firm enough to resist tearing or damage by the blade and before random shrinkage cracks can occur. (Usually required 4 to 12 hours after finishing.)

(2) Make joints approximately 1/8 inch (3 mm) wide with depth equal to 1/4 the slab thickness unless otherwise indicated.

(3) Seal where indicated with the same type sealant specified for expansion joint sealant.

6. Floor Flatness and Levelness:
   a. Applicable for steel and magnesium troweled finish floors, and other floors as indicated or specified.
   b. Finish to a true uniform surface. Contractor shall engage an independent testing agency to conduct floor tolerance tests (floor flatness and floor levelness tests) in accordance with ASTM E1155. Floor tolerance tests shall be made in the presence of Owner and Contractor within 16 hours after completion of the final troweling operation, and before floor forms and shores have been removed. Floor tolerance tests shall be conducted with an electronic floor profiler instrument equal to a Dipstick Floor Profiler as manufactured by the Edward W. Face Company, Inc. The minimum acceptable ACI F-number tolerances are:
   c. All slabs on grade not meeting the above minimum tolerance tests shall be removed and replaced at Contractor's expense.

B. Formed Surfaces:
   1. Repair surface defects as specified in PART 3, Paragraph 3.03.C. - Repair of Defective Surfaces, this Section.
   2. Burlap Finish:
      a. Apply burlap surface treatment to the following formed surfaces:
         (1) Scale House walls above finished grade.
      b. Remove forms as soon as permitted in accordance with Section 03 10 00.
      c. Wet and fill all voids using mortar with the same sand-cement ratio as original concrete. Blend with white cement to match concrete color.
      d. Strike off all excess mortar flush with the surface using a burlap or canvas cloth with a circular motion.
      e. Remove all rough spots and rub with cloth to leave a surface of uniform texture and appearance.
      f. Finish shall result in a coating of mortar that will fill all small voids and air holes, leaving a smooth surface.
      g. Cure as specified in this PART 3, Article 3.04 - Curing, this Section.

C. Repair of Defective Surfaces:
   1. Defined as any concrete surface showing misalignment, rock pockets, poor joints, holes from ties, voids, honeycomb, or any other defective area.
   2. Repairing:
      a. Repair as soon as forms have been removed.
      b. Chip surface back to minimum depth of 1/2 inch (13 mm), chip edges perpendicular to surface, prewet depression and brush with neat cement immediately before patching.
      c. Patch surfaces using stiff mortar with same sand-cement ratio as original concrete and with minimum water for placing. Blend with white cement to match concrete color.
d. Compact mortar into depressions so that after curing, hole is filled and mortar is flush with surface. Use hammer and ramming rod for compacting the holes.
e. Moist-cure for 3 days or use curing compound.
f. Engineer shall be notified of areas containing defects or where reinforcing steel is exposed, prior to determination of repair method.

3.04 CURING:
A. Cure concrete by one of the following methods in accordance with ACI 308.1:
   1. Leaving in forms for a minimum of 7 days. Keep formwork wet to prevent drying of concrete surfaces.
   2. Using one coat of a liquid membrane forming compound as specified. Apply immediately after removal of forms (which have been continuously wet); or in case of a slab, after the concrete has been finished and is hardened sufficiently to walk on.
   3. Curing of concrete during hot or cold weather shall conform to PART 3 - Hot Weather Concreting and Cold Weather Concreting, this Section.

3.05 HOT WEATHER CONCRETING:
A. Follow the recommendations of ACI Specification 305.1 if any of the following conditions occur:
   1. When the temperature is 90°F (32°C) or above.
   2. When the temperature is likely to rise above 90°F (32°C) within the 24-hour period after concrete placement.
   3. When there is any combination of high air temperature, low relative humidity, and wind velocity which would impair either concrete strength or quality.
B. Concrete shall have a maximum temperature of 85°F (29°C) during placement.
C. Dampen subgrade and forms with cool water immediately prior to placement of concrete.
D. Protect freshly placed concrete immediately after placement so that the rate of evaporation as determined by ACI 305.1 Equations 3.1.3 does not exceed 0.2 pound per square foot (1.0 kg per square meter) per hour.
E. Protect concrete with suitable insulation if rapidly decreasing nighttime temperatures occur, which would cause thermal shock to concrete placed during warm daytime temperatures.
F. Protect the concrete with temporary wet covering during any appreciable delay between placement and finishing.
G. Begin curing unformed surfaces immediately after finishing and continue for 24 hours. Curing shall consist of application and maintenance of water-saturated material to all exposed surfaces; horizontal, vertical, and otherwise. After the 24-hour interval, continue curing using one of the following methods:
   1. Moist curing for 6 days.
   2. Application of one coat of curing compound as specified.
   3. Application and maintenance of curing paper or heat-reflecting plastic sheets for 6 more days.
H. Begin curing formed concrete immediately after placing. Curing shall consist of keeping forms continuously wet for 24 hours. Thereafter, continue curing using one of the following methods:
   1. Loosen forms and position soaker hose so that water runs down along concrete surfaces. Continue for 6 days.
   2. Strip forms and apply curing compound as specified. Do not allow concrete surfaces to dry prior to application of curing compound.
SECTION 03 30 00 – CONCRETE: continued

3.06 COLD WEATHER CONCRETING:
   A. Work shall conform to all requirements of ACI 306.1, Standard Specification for Cold Weather Concreting, except as modified by the requirements of these Contract Documents.
      1. Modification to Section 3.2.2: Temperature shall be measured twice per day until protection may be terminated.
      2. Modification to Section 3.4.5: Refer to Section 03 10 00 to determine when forms may be removed.
   B. When the temperature is 40°F (4.4°C) or is likely to fall below 40°F (4.4°C) during the 24-hour period after concrete placement, follow the recommendations of ACI 306.1 to prevent loss of concrete strength or quality.
   C. Minimum temperature for concrete as mixed shall be as indicated in Table 3.2.1 of ACI 306.1. Maximum temperature for concrete as mixed shall be 10°F (5.6°C) greater than the corresponding minimum temperature.
   D. Place and maintain concrete so that its temperature is never less than the temperature indicated on line 1 of Table 5.1 of ACI 306R. Maintain the required temperature for the time duration indicated on Tables 5.1 and 7.1 of ACI 306R.
   E. Monitor temperature of concrete in place at corners or edges of formwork as applicable.
   F. Air Heaters:
      1. Do not expose concrete to carbon monoxide or carbon dioxide fumes from heaters or engines.
      2. Oil- or coke-burning salamanders will not be permitted.
      3. Heaters shall be ultramatic portable heaters made by the Union Chill Mat Company or Engineer approved equal.
      4. Personnel shall be present at all times to maintain safe, continuous operation of heating system.
   G. Control temperature and humidity of protected concrete so that excessive drying of concrete surfaces does not occur.
   H. Calcium chloride will not be permitted as a concrete accelerator or to thaw frozen subgrade prior to concrete placement.
   I. The maximum allowable temperature drop during the first 24-hour period after protection is discontinued shall be as indicated on line 1 of Table 5.1 of ACI 306R.
   J. Cure the concrete in accordance with Chapter 10 of ACI 306R.

3.07 LOW-STRENGTH CONCRETE:
   A. Low-Strength Concrete:
      1. Defined as either:
         a. Concrete where the average, of any sets of three consecutive 28-day compressive strength tests, is below the required 28-day strength.
         b. Concrete where the individual 28-day strength test (average of two cylinders) is more than 500 psi (3450 kPa) below the required 28-day strength.
      2. Should concrete meet either definition of low-strength concrete as a minimum, the Contractor shall take the following steps:
         a. Increase the cement content. The increase shall be based on a statistical evaluation of the strength data, the design water-cement ratio, compressive-strength curve, and acceptable mix-design literature as follows:
            (1) If sufficient concrete has been furnished to accumulate 30 tests, these should be used to establish a new target average strength in accordance with ACI 318, Section 5.3.
(2) If less than 30 tests have been made, the new target average strength should be at least as great as the average strength used in the initial selection of the mix proportions. Increase the target average strength based on a statistical evaluation of the available strength data, the design water-cement ratio, compressive-strength curve, and acceptable mix-design literature. If the statistical average equals or exceeds the initial mix-design level, a further increase in the average level is required.

b. Remove and replace with acceptable concrete when the quality and location of the low-strength concrete is such that Engineer considers the strength or durability of the structure is impaired and so orders.

3. Low-strength concrete shall be considered defective Work as defined in General Conditions.

B. Potentially Low-Strength Concrete: Defined as concrete whose 7-day test (average of two cylinders) is less than 70% of the specified minimum 28-day compressive strength.

C. Construction delays caused by low-strength or potentially low-strength concrete shall not relieve Contractor from responsibility for late completion even though extensions of time may be granted.

3.08 TESTING:

A. Field Testing of Concrete Plant and Mixing Trucks:
   1. The concrete plant shall be inspected and tested to ensure conformance with ACI 304R and the "Concrete Plant Standards of the Concrete Plant Manufacturers Bureau." The scales shall be calibrated at the initial setup and at 3-month intervals thereafter.
   2. Mixing trucks shall be inspected and tested to ensure conformance with ACI 304R and "Truck Mixer and Agitator Standards of the Truck Mixer Manufacturers Bureau" of the National Ready-Mix Concrete Association. Tests shall be done at initial setup and every 3 months thereafter.
   3. Submit test reports when requested.

B. Field Testing of Concrete and Making of Concrete Test Cylinders:
   1. Contractor shall furnish test equipment, test cylinder molds, and certified personnel to perform all required field tests, make the required concrete test cylinders, and deliver test cylinders to the testing laboratory. The prescribed tests shall be made in the presence of or with the concurrence of the Owner.
   2. Field testing personnel shall be on Site throughout placement of concrete.
   3. Concrete sampling for tests and cylinder making shall be done conforming to ASTM C172. Samples shall be taken at random and at the point of truck discharge.
   4. Perform the following tests:
      a. Prepare test cylinders conforming to ASTM C31, with not less than one set of cylinders (four cylinders) from each day's placement for each 100 cubic yards (75 cubic meters) or fraction thereof.
      b. Slump test conforming to ASTM C143. Perform tests on the first batch produced each day, for every 50 cubic yards (38 cubic meters) or fraction thereafter, and with every set of test cylinders. Additional tests shall be run when directed by Engineer.
      c. Air content test conforming to ASTM C231. Perform for first batch of day and with each set of test cylinders.
      d. The batch of concrete being tested for slump or air content shall not be placed until acceptable results are obtained.
      e. Discard concrete used for slump and air tests.
f. Perform concrete and air temperature tests for first batch of day and with each set of test cylinders. Additional readings shall be taken when directed by Engineer.
g. Any batch of concrete with slump or air content not in conformance with Specifications shall be rejected.
h. Furnish slump, air content, and temperature test results to the testing laboratory for inclusion in the cylinder test reports.

C. Laboratory Testing of Aggregates and Concrete During Construction:
   1. An independent testing laboratory shall be selected and paid by Contractor to perform the required laboratory tests and statistical evaluations of aggregates and concrete being used in the Work.
      a. Laboratory shall cure and test concrete cylinders conforming to ASTM C192 and C39, testing two cylinders at 7 days of age and two at 28 days of age.
      b. Engineer shall have the right to observe all phases of concrete cylinder curing and testing.
      c. Should the test results indicate low strength concrete as defined in PART 3, Article 3.07- Low-Strength Concrete, this Section, Contractor shall take immediate corrective action.
      d. Should the material tests taken during construction indicate nonconformance with the Specifications, Contractor shall take immediate corrective action.

3.09 REPAIR, REPLACEMENT, AND FIELD MODIFICATIONS:
   A. Embedded items and concrete that are misplaced or damaged during construction shall not be repaired, replaced, or field-modified without approval of Engineer.

END OF SECTION 03 30 00
SECTION 04 22 00 - CONCRETE UNIT MASONRY

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. This Section Includes:
      1. Concrete masonry units.
      2. Decorative concrete masonry units.
      3. Mortar and grout.
      4. Steel reinforcing bars.
      5. Masonry-joint reinforcement.
      6. Embedded flashing.
      7. Miscellaneous masonry accessories.

1.03 RELATED REQUIREMENTS:
   A. Section 05 21 00 - Structural Joist Framing for installing anchor sections for connecting to structural joists.
   B. Section 07 62 00 - Sheet Metal Flashing and Trim for sheet metal flashing and for furnishing manufactured reglets installed in masonry joints.

1.04 REFERENCED STANDARDS:
   A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
   B. American Concrete Institute (ACI):
      1. 315: Details and Detailing of Concrete Reinforcement.
   C. ASTM International (ASTM):
      2. A82/A82M - Specification for Steel Wire, Plain, for Concrete Reinforcement.
      5. A615/A615M - Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
      7. A653/A653 - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
      8. A666 - Specification for Annealed or Cold-Worked Austenitic Stainless-Steel Sheet, Strip, Plate, and Flat Bar.
     10. A1008/A1008M - Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
     12. C90 - Specification for Loadbearing Concrete Masonry Units.
16. C140 - Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
22. C331/C331M - Specification for Lightweight Aggregates for Concrete Masonry Units.
28. C979/C979M - Specification for Pigments for Integrally Colored Concrete.
30. C1093 - Practice for Accreditation of Testing Agencies for Unit Masonry.
35. C1623 - Specification for Manufactured Concrete Masonry Lintels.

D. The Masonry Society (TMS), American Concrete Institute (ACI), and American Society of Civil Engineers (ASCE):
   1. TMS 402 – Building Code Requirements for Masonry Structures.
   2. TMS 602 – Specification for Masonry Structures.
E. National Concrete Masonry Association (NCMA):
   1. NCMA TEK 8-4A - Cleaning Concrete Masonry.
F. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):

1.05 DEFINITIONS:
A. CMU(s): Concrete masonry unit(s).
B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.06 PREINSTALLATION MEETINGS:
A. Preinstallation Conference: Conduct conference at Project Site.

1.07 SUBMITTALS:
A. Product Data: For each type of product.
B. Shop Drawings: For the following:
   1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
SECTION 04 22 00 – CONCRETE UNIT MASONRY: continued

2. Reinforcing Steel: Detail bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 315. Show elevations of reinforced walls.

3. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.

C. Samples for Initial Selection:
   1. Decorative CMUs, in the form of small-scale units.
   2. Colored mortar.
   3. Weep holes/vents.

D. Qualification Data: For testing agency.

E. Material Certificates: For each type and size of the following:
   1. Masonry units.
      a. Include material test reports substantiating compliance with requirements.
      b. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.
   2. Integral water repellant used in CMUs.
   3. Cementitious materials. Include name of manufacturer, brand name, and type.
   5. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
   6. Grout mixes. Include description of type and proportions of ingredients.
   7. Reinforcing bars.
   8. Joint reinforcement.
   9. Anchors, ties, and metal accessories.

F. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
   1. Include test reports for mortar mixes required to comply with Property Specification. Test according to ASTM C109/C109M for compressive strength, ASTM C1506 for water retention, and ASTM C91/C91M for air content.
   2. Include test reports, according to ASTM C1019, for grout mixes required to comply with compressive strength requirement.

G. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to TMS 602/ACI 530.1/ASCE 6.

H. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.08 QUALITY ASSURANCE:

A. Testing Agency Qualifications: Qualified according to ASTM C1093 for testing indicated.

B. Sample Panels: Build sample panels to verify selections made under Sample submittals and to demonstrate aesthetic effects.
   1. Build sample panels for typical exterior wall in sizes approximately 48 inches (1200 mm) long by 48 inches (1200 mm) high by full thickness.
   2. Build sample panels facing south.
   3. Protect approved sample panels from the elements with weather-resistant membrane.
   4. Approval of sample panels is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; aesthetic qualities of workmanship; and other material and construction qualities specifically approved by Architect in writing.
a. Approval of sample panels does not constitute approval of deviations from the Contract Documents contained in sample panels unless Architect specifically approves such deviations in writing.

1.09 DELIVERY, STORAGE, AND HANDLING:

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.

C. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.10 FIELD CONDITIONS:

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

1. Extend cover a minimum of 24 inches (600 mm) down both sides of walls, and hold cover securely in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.

1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.

2. Protect sills, ledges, and projections from mortar droppings.

3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.

4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40°F (4°C) and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.

E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.
B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

2.02 PERFORMANCE REQUIREMENTS:
A. Provide structural unit masonry that develops indicated net-area compressive strengths at 28 days.
   1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) according to TMS 602.

2.03 UNIT MASONRY, GENERAL:
A. Masonry Standard: Comply with TMS 602 except as modified by requirements in the Contract Documents.
B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work and will be within 20 feet (6 m) vertically and horizontally of a walking surface.

2.04 CONCRETE MASONRY UNITS:
A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.
   1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
   2. Provide square-edged units for outside corners unless otherwise indicated.
B. Integral Water Repellent: Provide units made with integral water repellent for exposed units.
   1. Integral Water Repellent: Liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested according to ASTM E514/E514M as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive, with test period extended to 24 hours, shall show no visible water or leaks on the back of test specimen.
C. CMUs: ASTM C90.
   1. Density Classification: Lightweight
   2. Size (Width): Manufactured to dimensions 3/8 inch (10 mm) less-than-nominal dimensions.
   3. Exposed Faces: Provide color and texture matching the range represented by Architect's sample.
D. Decorative CMUs: ASTM C90.
   1. Density Classification: Lightweight.
   2. Size (Width): Manufactured to dimensions specified in "CMUs" Paragraph.
   3. Pattern and Texture as indicated on Drawings.
   4. Colors: As indicated on Drawings.

2.05 MASONRY LINTELS:
A. General: Provide one of the following:
B. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from solid bottom lintel unit CMUs matching adjacent CMUs in color, texture, and density classification, with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.
2.06 MORTAR AND GROUT MATERIALS:
A. Portland Cement: ASTM C150/C150M, 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.
   1. Alkali content shall not be more than 0.1% when tested according to ASTM C114.
B. Hydrated Lime: ASTM C207, Type S.
C. Portland Cement-Lime Mix: Packaged blend of Portland cement and hydrated lime containing no other ingredients.
D. Masonry Cement: ASTM C91/C91M.
E. Mortar Cement: ASTM C1329/C1329M.
F. Aggregate for Mortar: ASTM C144.
   1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
   2. For joints less than 1/4-inch (6 mm) thick, use aggregate graded with 100% passing the No. 16 (1.18-mm) sieve.
   3. White-Mortar Aggregates: Natural white sand or crushed white stone.
H. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs containing integral water repellent from same manufacturer.
I. Water: Potable.
J. Field addition of admixtures into self-consolidating grout is not permitted.

2.07 REINFORCEMENT:
A. Uncoated Steel Reinforcing Bars: ASTM A615/A615M or ASTM A996/A996M, Grade 60 (Grade 420).
B. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and to hold reinforcing bars in center of cells. Units are formed from 0.148-inch (3.77-mm) steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.
C. Masonry-Joint Reinforcement, General: Ladder type complying with ASTM A951/A951M.
   1. Interior Walls: Hot-dip galvanized carbon steel.
   2. Exterior Walls: Hot-dip galvanized carbon steel.
   3. Wire Size for Side Rods: 0.148-inch (3.77-mm) diameter.
   4. Wire Size for Cross Rods: 0.148-inch (3.77-mm) diameter.
   5. Spacing of Cross Rods: Not more than 16 inches (407 mm) o.c.
   6. Provide in lengths of not less than 10 feet (3 m), with prefabricated corner and tee units.

2.08 TIES AND ANCHORS:
A. General: Ties and anchors shall extend at least 1-1/2 inches (38 mm) into masonry but with at least a 5/8-inch (16-mm) cover on outside face.
B. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:
5. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

C. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

D. Rigid Anchors: Fabricate from steel bars 1-1/2 inches (38 mm) wide by 1/4 inch (6.35 mm) thick by 24 inches (610 mm) long, with ends turned up 2 inches (51 mm) or with cross pins unless otherwise indicated.
   1. Corrosion Protection: Hot-dip galvanized to comply with ASTM A153/A153M.

2.09 EMBEDDED FLASHING MATERIALS:

A. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual" and as follows:
   1. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304, 0.016 inch (0.40 mm) thick.
   2. Copper: ASTM B370, Temper H00, cold-rolled copper sheet, 16-oz./sq. ft. (4.9-kg/sq. m) weight or 0.0216 inch (0.55 mm) thick or ASTM B370, Temper H01, high-yield copper sheet, 12 oz./sq. ft. (3.7-kg/sq. m) weight or 0.0162 inch (0.41 mm) thick.
   3. Fabricate continuous flashings in sections 96 inches (2400 mm) long minimum, but not exceeding 12 feet (3.7 m). Provide splice plates at joints of formed, smooth metal flashing.
   4. Fabricate through-wall metal flashing embedded in masonry from stainless steel, with ribs at 3-inch (76-mm) intervals along length of flashing to provide an integral mortar bond.
   5. Fabricate through-wall flashing with snaplock receiver on exterior face where indicated to receive counterflashing.
   6. Fabricate through-wall flashing with drip edge unless otherwise indicated. Fabricate by extending flashing 1/2 inch (13 mm) out from wall, with outer edge bent down 30 degrees and hemmed.
   7. Fabricate through-wall flashing with sealant stop unless otherwise indicated. Fabricate by bending metal back on itself 3/4 inch (19 mm) at exterior face of wall and down into joint 1/4 inch (6 mm) to form a stop for retaining sealant backer rod.
   8. Fabricate metal drip edges and sealant stops for ribbed metal flashing from plain metal flashing of same metal as ribbed flashing and extending at least 3 inches (76 mm) into wall with hemmed inner edge to receive ribbed flashing and form a hooked seam. Form hem on upper surface of metal so that completed seam sheds water.
   9. Fabricate metal drip edges from stainless steel. Extend at least 3 inches (76 mm) into wall and 1/2 inch (13 mm) out from wall, with outer edge bent down 30 degrees and hemmed.
  10. Fabricate metal sealant stops from stainless steel. Extend at least 3 inches (76 mm) into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for 3/4 inch (19 mm) and down into joint 1/4 inch (6 mm) to form a stop for retaining sealant backer rod.
  11. Fabricate metal expansion-joint strips from stainless steel to shapes indicated.
  12. Solder metal items at corners.

B. Flexible Flashing: Use one of the following unless otherwise indicated:
   1. Copper-Laminated Flashing: 5-oz./sq. ft. (1.5-kg/sq. m) copper sheet bonded between two layers of glass-fiber cloth. Use only where flashing is fully concealed in masonry.
SECTION 04 22 00 – CONCRETE UNIT MASONRY: continued

2. EPDM Flashing: Sheet flashing product made from ethylene-propylene-diene terpolymer, complying with ASTM D4637/D4637M, 0.040 inch (1.02 mm) thick.

C. Application: Unless otherwise indicated, use the following:
   1. Where flashing is indicated to receive counterflashing, use metal flashing.
   2. Where flashing is indicated to be turned down at or beyond the wall face, use metal flashing.
   3. Where flashing is partly exposed and is indicated to terminate at the wall face, use metal flashing with a drip edge.
   4. Where flashing is fully concealed, use flexible flashing.

D. Single-Wythe CMU Flashing System: System of CMU cell flashing pans and interlocking CMU web covers made from UV-resistant, high-density polyethylene. Cell flashing pans have integral weep spouts designed to be built into mortar bed joints and that extend into the cell to prevent clogging with mortar.

E. Solder and Sealants for Sheet Metal Flashings:
   1. Solder for Stainless Steel: ASTM B32, Grade Sn96 with acid flux of type recommended by stainless-steel sheet manufacturer.
   2. Solder for Copper: ASTM B32, with maximum lead content of 0.2%.
   3. Elastomeric Sealant: ASTM C920, chemically curing silicone sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and remain watertight.

F. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

2.10 MISCELLANEOUS MASONRY ACCESSORIES:

A. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35%; of width and thickness indicated; formulated from neoprene.

B. Preformed Control-Joint Gaskets: Made from PVC, complying with ASTM D2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips: Asphalt-saturated felt complying with ASTM D226/D226M, Type I (No. 15 asphalt felt).

2.11 MASONRY CLEANERS:

A. Use ProSoCo, Inc. or approved equal masonry cleaners as recommended by manufacturer.

2.12 MORTAR AND GROUT 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 or grout.
   2. Use Portland cement-lime mortar unless otherwise indicated.
   3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project Site.

C. Mortar for Unit Masonry: Comply with ASTM C270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated.
SECTION 04 22 00 – CONCRETE UNIT MASONRY: continued

1. For reinforced masonry, use Type S.

D. Pigmented Mortar: Use colored cement product.
   1. Pigments shall not exceed 10% of Portland cement by weight.
   2. Mix to match Architect’s sample.
   3. Application: Use pigmented mortar for exposed mortar joints with the following units:
      a. Decorative CMUs.

E. Grout for Unit Masonry: Comply with ASTM C476.
   1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will
      comply with TMS 602 for dimensions of grout spaces and pour height.
   2. Proportion grout in accordance with ASTM C476, paragraph 4.2.2 for specified 28-day
      compressive strength indicated, but not less than 2,000 psi (14 MPa).
   3. Provide grout with a slump of 10 to 11 inches (250 to 280 mm) as measured according to
      ASTM C143/C143M.
   4. Proportioning of self-consolidating grout at the project site is not permitted. Do not add
      water at the project site except in accordance with the self-consolidating grout
      manufacturer’s recommendations.

PART 3 - EXECUTION

3.01 EXAMINATION:
   A. Examine conditions, with Installer present, for compliance with requirements for installation
      tolerances and other conditions affecting performance of the Work.
      1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental
         to performance of the Work.
      2. Verify that foundations are within tolerances specified.
      3. Verify that reinforcing dowels are properly placed.
      4. Verify that substrates are free of substances that would impair mortar bond.
   B. Before installation, examine rough-in and built-in construction for piping systems to verify
      actual locations of piping.
   C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION, GENERAL:
   A. Build chases and recesses to accommodate items specified in this and other Sections.
   B. Leave openings for equipment to be installed before completing masonry. After installing
      equipment, complete masonry to match construction immediately adjacent to opening.
   C. Use full-size units without cutting if possible. If cutting is required to provide a continuous
      pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp,
      unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install
      cut units with cut surfaces and, where possible, cut edges concealed.

3.03 TOLERANCES:
   A. Dimensions and Locations of Elements:
      1. For dimensions in cross section or elevation, do not vary by more than +1/2 inch (12 mm)
         or -1/4 inch (6 mm).
      2. For location of elements in plan, do not vary from that indicated by more than ±1/2 inch
         (12 mm).
      3. For location of elements in elevation, do not vary from that indicated by more than
         ±1/4 inch (6 mm) in a story height or 1/2 inch (12 mm) total.
   B. Lines and Levels:
SECTION 04 22 00 – CONCRETE UNIT MASONRY: continued

1. For bed joints and top surfaces of bearing walls, do not vary from level by more than 1/4 inch in 10 feet (6 mm in 3 m), or 1/2-inch (12-mm) maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2-inch (12-mm) maximum.
3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2-inch (12-mm) maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2-inch (12-mm) maximum.
5. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2-inch (12-mm) maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), or 1/2-inch (12-mm) maximum.
7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch (1.5 mm).

C. Joints:
1. For bed joints, do not vary from thickness indicated by more than ±1/8 inch (3 mm), with a maximum thickness limited to 1/2 inch (12 mm).
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch (3 mm).
3. For head and collar joints, do not vary from thickness indicated by more than +3/8 inch (9 mm) or -1/4 inch (6 mm).
4. For exposed head joints, do not vary from thickness indicated by more than ±1/8 inch (3 mm).

3.04 LAYING MASONRY WALLS:
A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less-than-nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.
C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4 inches (100 mm). Bond and interlock each course of each wythe at corners. Do not use units with less-than-nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.
D. Stopping and Resuming Work: Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.
E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.
G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below, and rod mortar or grout into core.

3.05 MORTAR BEDDING AND JOINTING:
A. Lay hollow CMUs as follows:
SECTION 04 22 00 – CONCRETE UNIT MASONRY: continued

1. Bed face shells in mortar and make head joints of depth equal to bed joints.
2. Bed webs in mortar in all courses of piers, columns, and pilasters.
3. Bed webs in mortar in grouted masonry, including starting course on footings.
4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.

B. Lay solid CMUs with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

D. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

E. Cut joints flush where indicated to receive waterproofing unless otherwise indicated.

3.06 MASONRY-JOINT REINFORCEMENT:
A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch (16 mm) on exterior side of walls, 1/2 inch (13 mm) elsewhere. Lap reinforcement a minimum of 6 inches (150 mm).

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at corners by using prefabricated L-shaped units.

3.07 CONTROL AND EXPANSION JOINTS:
A. General: Install control- and expansion-joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.

B. Form control joints in concrete masonry as follows:
   1. Install preformed control-joint gaskets designed to fit standard sash block.

3.08 LINTELS:
A. Provide masonry lintels where shown and where openings of more than 24 inches (610 mm) for block-size units are shown without structural steel or other supporting lintels.

3.09 FLASHING:
A. General: Install embedded flashing at ledges and other obstructions to downward flow of water in wall where indicated.

B. Install flashing as follows unless otherwise indicated:
   1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
   2. At lintels, extend flashing a minimum of 6 inches (150 mm) into masonry at each end. At heads and sills, extend flashing 6 inches (150 mm) at ends and turn up not less than 2 inches (50 mm) to form end dams.
   3. Interlock end joints of ribbed sheet metal flashing by overlapping ribs not less than 1-1/2 inches (38 mm) or as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Section 07 92 00 - Joint Sealants for application indicated.
SECTION 04 22 00 – CONCRETE UNIT MASONRY: continued

4. Install metal drip edges and sealant stops with ribbed sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Section 07 92 00 - Joint Sealants for application indicated.

5. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch (13 mm) back from outside face of wall, and adhere flexible flashing to top of metal drip edge.

C. Install single-wythe CMU flashing system in bed joints of CMU walls where indicated to comply with manufacturer’s written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.

3.10 REINFORCED UNIT MASONRY INSTALLATION:

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
   1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
   2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in TMS 602.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
   1. Comply with requirements in TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
   2. Limit height of vertical grout pours to not more than 64 inches.

3.11 FIELD QUALITY CONTROL:

A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.

B. Inspections: Special inspections according to Level 2 in TMS 402.
   1. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
   2. Place grout only after inspectors have verified proportions of site-prepared grout.

C. Testing Prior to Construction: One set of tests.

D. Testing Frequency: One set of tests for each 5,000 sq. ft. (464 sq. m) of wall area or portion thereof.

E. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C140 for compressive strength.

F. Prism Test: For each type of construction provided, according to ASTM C1314 at [7 days and at ]28 days.
3.12 REPAIRING, POINTING, AND CLEANING:
   A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise
damaged or that do not match adjoining units. Install new units to match adjoining units;
install in fresh mortar, pointed to eliminate evidence of replacement.
   B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and
completely fill with mortar. Point up joints, including corners, openings, and adjacent
construction, to provide a neat, uniform appearance. Prepare joints for sealant application,
where indicated.
   C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove
mortar fins and smears before tooling joints.
   D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
   1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes
or chisels.
   2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for
comparison purposes. Obtain Architect's approval of sample cleaning before proceeding
with cleaning of masonry.
   3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering
them with liquid strippable masking agent or polyethylene film and waterproof masking
tape.
   4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by
      rinsing surfaces thoroughly with clear water.
   5. Clean concrete masonry by applicable cleaning methods indicated in NCMA TEK 8-4A.

3.13 MASONRY WASTE DISPOSAL:
   A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's
property. At completion of unit masonry work, remove from Project Site.
SECTION 05 05 19 – POST-INSTALLED ANCHORS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. This section includes post installed adhesive anchors, mechanical anchors and epoxy anchorage of rebar in hardened concrete.

1.03 RELATED WORK SPECIFIED ELSEWHERE:
   1. Concrete Reinforcement: SECTION 03 20 00
   2. Concrete: SECTION 03 30 00
   3. Division 22 Hangers and Supports Section.

1.04 REFERENCE STANDARDS:
   A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
   2. American Concrete Institute (ACI):
      a. 318 – Building Code Requirements for Reinforced Concrete.
      b. 355.2 – Qualification of Post-Installed Mechanical Anchors in Concrete.
      c. 355.4 – Qualification of Post-Installed Adhesive Anchors in Concrete
      a. AC01 – Acceptance Criteria for Expansion Anchors in Masonry Elements
      b. AC58 – Acceptance Criteria for Adhesive Anchors in Masonry Elements
      c. AC60 - Acceptance Criteria for Anchors in Unreinforced Masonry Elements
      d. AC193 – Acceptance Criteria for Mechanical Anchors in Concrete Elements
      e. AC308 – Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements
   4. International Association of Plumbing and Mechanical Officials (IAPMO)

1.05 SUBMITALS:
   A. Submit as specified in DIVISION 1.
   B. Include but not limited to, the following:
      1. Product specification data with recommended design values and physical characteristics for epoxy dowels, expansion and undercut anchors.
      2. Quality Assurance Submittals:
         a. Test Reports: Certified test reports showing compliance with specified performance characteristics and physical properties.
         b. Certificates:
            (1) ICC ES Evaluation Reports.
      3. Manufacturer’s installation instructions.
      4. Installer Qualifications & Procedures: Submit installer qualifications as stated in Section 1.06.B. Submit a letter of procedure stating method of drilling, the product proposed for use, the complete installation procedure, manufacturer training date, and a list of the personnel to be trained on anchor installation.
   C. Closeout Submittals: Submit the following:
1. Record Documents: Project record documents for installed materials in accordance with Division 1 Closeout Submittals Section.

1.06 QUALITY ASSURANCE
   A. Installer Qualifications:
      1. Drilled-in anchors shall be installed by a contractor with at least three years of experience performing similar installations.
      2. All personnel installing adhesive anchors shall be ACI adhesive anchor certified.
   B. Installer Training: Conduct a thorough training with the manufacturer or the manufacturer’s representative for the contractor on the project. Training to consist of a review of the complete installation process for drilled-in anchors, to include but not limited to:
      1. hole drilling procedure
      2. hole preparation & cleaning technique
      3. adhesive injection technique & dispenser training / maintenance
      4. rebar dowel preparation and installation
      5. proof loading/torquing
   C. Certifications: Unless otherwise authorized by the Engineer, anchors shall have one of the following certifications:
      2. IAPMO UES Evaluation Report indicating conformance with current applicable acceptance criteria.

1.07 DELIVERY, STORAGE, AND HANDLING
   A. Deliver products to job site in manufacturer’s clearly labeled unopened packaging, complete with installation instructions.
   B. Protect and handle materials in accordance with manufactures recommendations to prevent damage or deterioration.

PART 2 - PRODUCTS:

2.01 MATERIALS
   A. Fasteners and Anchors:
      1. Bolts and Studs: ASTM A307; ASTM A449 where “high strength” is indicated on the Drawings.
      4. Carbon Steel Threaded Rod: ASTM A36; or ASTM A193 Grade B7; or ISO 898 Class 5.8.
     10. Reinforcing Dowels: ASTM A615

2.02 MECHANICAL ANCHORS
   A. Mechanical anchors shall meet the qualification criteria of ACI 355.2, ICC-ES AC01 (masonry) or AC193 (concrete).
SECTION 05 05 19 – CONCRETE ANCHORS: CONTINUED

B. Use of mechanical anchors in permanently submerged conditions shall not be permitted.

C. Interior Use: Unless otherwise indicated on the Drawings, provide carbon steel anchors with zinc plating in accordance with ASTM B633, Type III Fe/Zn 5 (SC1).

D. Exterior Use: Unless otherwise indicated on the Drawings, provide stainless steel anchors. Stainless steel anchors shall be AISI Type 304 stainless steel provided with stainless steel nuts and washers of matching alloy group and minimum proof stress equal to or greater than the specified minimum full-size tensile strength of the externally threaded fastener. Stainless steel nuts shall conform to ASTM F594 unless otherwise specified. Avoid installing stainless steel anchors in contact with galvanically dissimilar metals.

E. The type of anchors shall be as follows:
   1. Wedge type, torque-controlled, with impact section to prevent thread damage complete with required nuts and washers. –
      a. Life safety applications (Including but not limited to handrail and direct tension hangers)
         (1) Simpson Strong Tie – Strong Bolt 2
         (2) Hilti Kwik Bolt TZ
         (3) Powers – Power-Stud SD2
      b. Low risk to life safety (small pipe stands, Unistrut, etc)
         (1) Simpson Strong Tie – Wedge All
         (2) Hilti Kwik Bolt 3
         (3) Powers – Power-Stud SD1
   2. Screw Anchors: screw type. Pre-drilling of the hole requires a standard ANSI drill bit with the same diameter as the anchor and installing the anchor will be done with an impact wrench. Provide anchors with a diameter and anchor length marking on the head. Type and size as indicated on Drawings.
      a. Hilti Kwik-HUS-EZ
      b. Simpson Titen HD
   3. Heavy Duty Undercut Anchors: Bearing type. Installed anchor shall have a minimum tension bearing area in the concrete, measured as the horizontal projection of the bearing surface, not less than two times the net tensile area of the anchor bolt. The installed anchor shall exhibit a form fit between the bearing elements and the undercut in the concrete. Type and size as indicated on Drawings.
      a. Simpson Strong Tie – Torq-Cut
      b. Hilti HDA Undercut Anchor
      c. Powers – Atomic+ Undercut
      d. Use only where specifically called for on drawings

2.03 ADHESIVE ANCHORS

A. Adhesive anchors shall meet the qualification criteria of ACI 355.4, ICC-ES A58 (masonry) or A308 (concrete).

B. Adhesive anchors shall not be installed in concrete less than 21 days of age.

C. Interior Use: Unless otherwise indicated on the Drawings, provide carbon steel threaded rods conforming to ASTM A36, ASTM A 193 Type B7 or ISO 898 Class 5.8 with zinc plating in accordance with ASTM B633, Type III Fe/Zn 5 (SC1).

D. Exterior Use: Unless otherwise indicated on the Drawings, provide stainless steel anchors. Stainless steel anchors shall be AISI Type 304 stainless steel provided with stainless steel nuts and washers of matching alloy group and minimum proof stress equal to or greater than the specified minimum full-size tensile strength of the externally threaded fastener. All nuts shall
SECTION 05 05 19 – CONCRETE ANCHORS: CONTINUED

conform to ASTM F594 unless otherwise specified. Avoid installing stainless steel anchors in contact with galvanically dissimilar metals.

E. Reinforcing dowels shall be A615 Grade 60.

F. The type of anchors shall be as follows:
   1. Epoxy Anchors – Life safety applications.
      a. Simpson Strong Tie – SET XP
      b. Hilti HIT-RE500 V3
      c. Hilti HIT-HY200
      d. Powers PE1000
   2. Adhesive Anchors: (Used for non-vibrating equipment anchorage and other non-life safety attachments)
      a. Simpson Strong Tie - AT
      b. Hilti HIT-HY200
      c. Powers – AC100+ Gold
   3. Epoxy Rebar Dowels:
      a. Simpson Strong Tie – SET
      b. Hilti HIT-RE500 V3
   4. Anchorage to Masonry, ICC-ES AC58 & AC60:
      a. Hilti HIT-HY270
         (1) Provide Hilti HIT-SC mesh sleeve when anchoring to hollow masonry.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Drilled-In Anchors:
   1. Drill holes with rotary impact hammer drills using carbide-tipped bits or hollow drill bit system. Drill bits shall be of diameters as specified by the anchor manufacturer. Unless otherwise shown on the Drawings, all holes shall be drilled perpendicular to the concrete surface.
      a. Cored Holes: Where anchors are permitted to be installed in cored holes, use core bits with matched tolerances as specified by the manufacturer. Properly clean cored hole per manufacturer’s instructions.
      b. Embedded Items: Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Exercise care in coring or drilling to avoid damaging existing reinforcing or embedded items. Take precautions as necessary to avoid damaging prestressing tendons, electrical and telecommunications conduit, and gas lines.
         (1) Notify the Engineer prior to abandoning and relocating anchor holes if reinforcing steel or other embedded items are encountered during drilling and the specified embedment depth has not been met.
      c. Base Material Strength: Unless otherwise specified, do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
   2. Perform anchor installation in accordance with manufacturer instructions.
   3. Wedge Anchors, Heavy-Duty Sleeve Anchors, and Undercut Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in part to be fastened. Set anchors to manufacturer’s recommended torque, using a torque wrench. Following attainment of 10% of the specified torque, 100% of the specified torque shall be reached within 7 or fewer
SECTION 05 05 19 – CONCRETE ANCHORS: CONTINUED

complete turns of the nut. If the specified torque is not achieved within the required number of turns, the anchor shall be removed and replaced unless otherwise directed by the Engineer.

4. Cartridge Injection Adhesive Anchors: Clean all holes per manufacturer instructions to remove loose material and drilling dust prior to installation of adhesive. Inject adhesive into holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive. Follow manufacturer recommendations to ensure proper mixing of adhesive components. Sufficient adhesive shall be injected in the hole to ensure that the annular gap is filled to the surface. Remove excess adhesive from the surface. Shim anchors with suitable device to center the anchor in the hole. Do not disturb or load anchors before manufacturer specified cure time has elapsed.

5. Capsule Anchors: Perform drilling and setting operations in accordance with manufacturer instructions. Clean all holes to remove loose material and drilling dust prior to installation of adhesive. Remove water from drilled holes in such a manner as to achieve a surface dry condition. Capsule anchors shall be installed with equipment conforming to manufacturer recommendations. Do not disturb or load anchors before manufacturer specified cure time has elapsed.

6. Observe manufacturer recommendations with respect to installation temperatures for cartridge injection adhesive anchors and capsule anchors.

3.02 REPAIR OF DEFECTIVE WORK

A. Remove and replace misplaced or malfunctioning anchors. Fill empty anchor holes and patch failed anchor locations with high-strength non-shrink, nonmetallic grout. Anchors that fail to meet proof load or installation torque requirements shall be regarded as malfunctioning.

3.03 FIELD QUALITY CONTROL

A. Mechanical anchor installation shall have periodic special inspection per IBC.

B. Adhesive anchors installed in horizontally or upwardly inclined orientations to resist sustained tensions loads shall have continuous special inspection per IBC.

1. All other adhesive anchors not described above shall have periodic special inspection per IBC.

C. Minimum anchor embedments, proof loads and torques shall be as shown on the Drawings.

END OF SECTION 05 05 19
SECTION 05 21 00 – STEEL JOIST FRAMING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. This Section includes:
      2. Joist accessories.
   B. Related Requirements:
      1. DIVISION 04, Section "Unit Masonry" for installing bearing plates in unit masonry.
      2. DIVISION 05, Section "Metal Fabrications" for bearing plates.
      3. DIVISION 09, Section “Protective Coatings” for prime and paint of joists.

1.03 REFERENCE STANDARDS:
   A. Comply with the provisions of the following codes, specifications, and standards, except as otherwise indicated.
   B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
   C. American Welding Society:
      1. AWS D1.1/D1.1M - Structural Welding Code - Steel.
   D. ASTM International:
      1. ASTM A36/A36M - Specification for Carbon Structural Steel.
      4. ASTM A307 - Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.
      5. ASTM A325 - Specification for Structural Bolts Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
      7. ASTM A780 - Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
      10. ASTM E164 - Practice for Ultrasonic Contact Examination of Weldment.
   E. California Department of Health Services:
   F. Occupational Safety and Health Administration:
      1. OSHA regulations, including, but not limited to, 29 CFR 1926 Subpart R - Steel Erection.
   G. Research Council on Structural Connections:
      1. RCSC Specification for Structural Joints Using High-Strength Bolts.
H. SSPC - The Society for Protective Coatings:
   1. SSPC-Paint 15 - Paint Specification No. 15 - Steel Joist Shop Primer/Metal Building Primer.
   2. SSPC-SP 2 - Surface Preparation Specification No. 2 - Hand Tool Cleaning.
   3. SSPC-SP 3 - Surface Preparation Specification No. 3 - Power Tool Cleaning.
I. Steel Joist Institute:

1.04 DEFINITIONS:
   A. SJI's "Specifications": Steel Joist Institute's "Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders."
   B. Special Joists: Steel joists or joist girders requiring modification by manufacturer to support nonuniform, unequal, or special loading conditions that invalidate load tables in SJI's "Specifications."

1.05 SUBMITTALS:
   A. Product Data: For each type of joist, accessory, and product.
   B. Shop Drawings:
      1. Include layout, designation, number, type, location, and spacing of joists.
      2. Include joining and anchorage details, bracing, bridging, and joist accessories; splice and connection locations and details; and attachments to other construction.
      3. Indicate locations and details of bearing plates to be embedded in other construction.
   C. Qualification Data: For manufacturer and professional engineer.
   D. Two certified copies of all mill reports or laboratory reports covering chemical and physical properties of steel used if requested by Engineer.
   E. Welding certificates if requested by Engineer.
   F. Manufacturer certificates.
   G. Mill Certificates: For each type of bolt.
   H. Comprehensive engineering analysis of special joists sealed and signed by the qualified professional engineer responsible for its preparation.

1.06 QUALITY ASSURANCE:
   A. Manufacturer Qualifications: A member of SJI certified by SJI to manufacture joists complying with applicable standard specifications and load tables in SJI's "Specifications".
      1. Manufacturer's responsibilities include providing professional engineering services for designing special joists to comply with performance requirements.
   B. Welding Qualifications: Qualify field-welding procedures and personnel according to AWS D1.1/D1.1M.
   C. Inspection and Tests:
      1. Materials to be furnished shall be subject to inspection in the mill, shop, and field.
      2. Joists shall be inspected by the manufacturer before shipment to ensure compliance of materials and workmanship with the specifications.

1.07 DELIVERY, STORAGE, AND HANDLING:
   A. Deliver, store, and handle joists as recommended in SJI's "Specifications."
   B. Protect joists from corrosion, deformation, and other damage during delivery, storage, and handling.
1.08 **SEQUENCING:**
   
   A. Deliver steel bearing plates to be built into masonry construction.

**PART 2 - PRODUCTS**

2.01 **GENERAL REQUIREMENTS:**

   A. Structural Performance: Provide special joists and connections capable of withstanding design loads indicated.
      1. Use ASD; data are given at service-load level.
      2. Design special joists to withstand design loads with live-load deflections no greater than the following:
   
   B. All joists shall be fabricated from new materials.
   
   C. Comply with all applicable OSHA regulations, including, but not limited to, 29 CFR 1926 Subpart R - Steel Erection.

2.02 **K-SERIES STEEL JOISTS:**

   
   B. Provide holes in chord members for connecting and securing other construction to joists. Holes shall not be made or enlarged by burning.
   
   C. Do not camber joists.
   
   D. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches (1:48).

2.03 **PRIMERS:**

   A. Primer: SSPC-Paint 15, or manufacturer's standard shop primer complying with performance requirements in SSPC-Paint 15. Coordinate with Section 09 90 00.

2.04 **JOIST ACCESSORIES:**

   A. Bridging: Schematically indicated. Detail and fabricate according to SJI's "Specifications." Furnish additional bridging as necessary where net uplift is indicated, and additional erection bridging if required for stability.
   
   B. Fabricate steel bearing plates from ASTM A36/A36M steel with integral anchorages of sizes and thicknesses indicated. Shop prime paint.
   
   C. Furnish ceiling extensions, either extended bottom-chord elements or a separate extension unit of enough strength to support ceiling construction. Extend ends to within 1/2 inch (13 mm) of finished wall surface unless otherwise indicated.
   
   D. Carbon-Steel Bolts and Threaded Fasteners: ASTM A307, Grade A (ASTM F568M, Property Class 4.6), carbon-steel, hex-head bolts and threaded fasteners; carbon-steel nuts; and flat, unhardened steel washers.
      1. Finish: Plain, uncoated.
   
   E. Welding Electrodes: Comply with AWS standards.
   
   F. Furnish miscellaneous accessories including splice plates and bolts required by joist manufacturer to complete joist assembly.
SECTION 05 21 00 – STEEL JOIST FRAMING: continued

2.05 CLEANING AND SHOP PAINTING:
   A. Clean and remove loose scale, heavy rust, and other foreign materials from fabricated joists and accessories by hand-tool cleaning, SSPC-SP 2 or power-tool cleaning, SSPC-SP 3.
   B. Apply one coat of shop primer to joists and joist accessories to be primed to provide a continuous, dry paint film not less than 1 mil (0.025 mm) thick.

PART 3 - EXECUTION

3.01 EXAMINATION:
   A. Examine supporting substrates, embedded bearing plates, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance.
   B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:
   A. Do not install joists until supporting construction is in place and secured.
   B. Install joists and accessories plumb, square, and true to line; securely fasten to supporting construction according to SJI's "Specifications," joist manufacturer's written recommendations, and requirements in this Section, before construction loads are applied.
      1. Before installation, splice joists delivered to Project Site in more than one piece.
      2. Space, adjust, and align joists accurately in location before permanently fastening.
      3. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.
   C. Field weld joists to supporting steel bearing plates. Coordinate welding sequence and procedure with placement of joists. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
   D. Install and connect bridging concurrently with joist erection, before construction loads are applied.
      1. Bridging shall support the top chords against lateral movement and shall hold the steel joists in the plane indicated.
      2. Anchor bridging to steel joists by welding or bolting. Welds for attachment of bridging shall not damage the joist members.
      3. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.
   E. During the construction period, exercise care to avoid excessive concentrated loads. Distribute temporary loads so as not to exceed carrying capacity of steel joists. Do not apply loads to bridging.
   F. Comply with all applicable OSHA regulations, including, but not limited to, 29 CFR 1926 Subpart R - Steel Erection.

3.03 FIELD QUALITY CONTROL:
   A. Testing Agency: Contractor shall engage a qualified independent testing and inspecting agency to inspect field welds and to perform field tests and inspections and prepare test and inspection reports.
   B. Visually inspect field welds according to AWS D1.1/D1.1M.
   C. Visually inspect bolted connections.
   D. Correct deficiencies in Work that test and inspection reports have indicated are not in compliance with specified requirements.
   E. Perform additional testing to determine compliance of corrected Work with specified requirements.
3.04 PROTECTION:
   A. Touchup Painting: After installation, promptly clean, prepare, and prime or re-prime field connections, rust spots, and abraded surfaces of prime-painted joists, bearing plates and accessories.
      1. Clean and prepare surfaces by hand-tool cleaning according to SSPC-SP 2 or power-tool cleaning according to SSPC-SP 3.
      2. Apply a compatible primer of same type as primer used on adjacent surfaces.
   B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer, that ensure that joists and accessories are without damage or deterioration at time of Substantial Completion.

END OF SECTION 05 21 00
SECTION 05 31 00 – STEEL DECKING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary
      Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. This Section includes:
      1. Roof deck.
   B. Related Requirements:
      1. DIVISION 05, Section "Metal Fabrications" for framing deck openings with
         miscellaneous steel shapes.
      2. DIVISION 09 Painting Sections for repair painting of primed deck and finish painting of
         deck.

1.03 REFERENCE STANDARDS:
   A. Publication Dates: Comply with standards in effect as of date of the Contract Documents
      unless otherwise indicated.
   B. American Iron and Steel Institute:
      1. AISI S100 - North American Specification for the Design of Cold-Formed Steel
         Structural Members, with Supplement 1, 2010.
   C. American Welding Society:
      1. AWS D1.3 - Structural Welding Code - Sheet Steel.
   D. ASTM International:
      1. ASTM A653/A653M - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-
         Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
      2. ASTM A780 - Practice for Repair of Damaged and Uncoated Areas of Hot-Dip
         Galvanized Coatings.
      3. ASTM A1008/A1008M - Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural,
         High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability,
         Solution Hardened, and Bake Hardenable.
      4. ASTM C423 - Test Method for Sound Absorption and Sound Absorption Coefficients by
         the Reverberation Room Method.
      6. ASTM E329 - Specification for Agencies Engaged in Construction Inspection and/or
         Testing.
   E. Occupational Safety and Health Administration:
      1. OSHA regulations, including, but not limited to, 29 CFR 1926 Subpart R - Steel Erection.
   F. Steel Deck Institute:
      1. SDI DDM03 - DDM03.
      2. SDI MOC2 - Manual of Construction with Steel Deck.
      3. SDI Publication No. 31 - Design Manual for Composite Decks, Form Decks, and Roof
         Decks.
   G. Underwriters Laboratories Inc.:
      1. UL 209 - Cellular Metal Floor Raceways and Fittings (ANSI).
1.04 SUBMITTALS:
   A. Product Data: For each type of deck, accessory, and product indicated.
      1. Include a signed and sealed statement by a licensed professional engineer of the lateral
         diaphragm capacity of each type of deck based on SDI DDM03 or certified laboratory
         tests of shear capacity for the deck and fastening system provided. The stated lateral
         diaphragm capacity shall not exceed the value indicated in SDI DDM03.
      2. Include documentation of each roof construction assembly's uplift capacity in accordance
         with UL 580.
   B. Shop Drawings:
      1. Include layout and types of deck panels, anchorage details, reinforcing channels, pans,
         cut deck openings, special jointing, accessories, and attachments to other construction.
   C. Two certified copies of all mill reports or laboratory reports covering chemical and physical
      properties of steel used if requested by Engineer.
   D. Welding certificates.
   E. Product Certificates: For each type of steel deck.
   F. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified
      testing agency, indicating that each of the following complies with requirements:
         1. Power-actuated mechanical fasteners.
   G. Evaluation Reports: For steel deck.
   H. Field quality-control reports.

1.05 QUALITY ASSURANCE:
   A. Manufacturer Qualifications: A member of SDI.
   B. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.
   C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.3.

1.06 DELIVERY, STORAGE, AND HANDLING:
   A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and
      handling.
   B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a
      waterproof covering and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS:
   A. AISI Specifications: Comply with calculated structural characteristics of steel deck according
      to AISI S100.
   B. Comply with all applicable OSHA regulations, including, but not limited to, 29 CFR 1926
      Subpart R - Steel Erection.

2.02 MANUFACTURERS:
   A. Subject to compliance with requirements, provide products by one of the following:
      1. ASC Profiles, Inc.; a Blue Scope Steel company.
      2. Canam United States; Canam Group Inc.
      4. Verco Manufacturing Co.
      5. Engineer approved equal.

2.03 ROOF DECK:
SECTION 05 31 00 – STEEL DECKING: continued

A. General: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck" in SDI Publication No. 31.
B. Galvanized and Shop-Primed Steel Sheet: ASTM A653/A653M, Structural Steel (SS), Grade 33 (230), G60 (Z180) zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.
   1. Color: Gray top surface with white underside.
C. Deck Profile: As indicated.
D. Profile Depth: As indicated.
E. Design Uncoated-Steel Thickness; Deck Unit: As indicated.
F. Span Condition: As indicated.
G. Side Laps: Overlapped or interlocking seam at Contractor's option.
H. Shear Capacity: Roof deck and attachments shall provide a minimum allowable diaphragm shear capacity indicated on Drawings under wind and earthquake loads in accordance with AISI S100 and SDI DDM03.
I. Uplift Capacity: Roof construction assembly shall be capable of resisting wind uplift pressures indicated on Drawings when tested in accordance with UL 580.

2.04 ACCESSORIES
A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.
B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.
C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 (4.8-mm) minimum diameter.
D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.
E. 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 or required for application.
F. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, 0.0598 inch (1.52 mm) thick, with factory-punched hole of 3/8-inch (9.5-mm) minimum diameter.
G. Galvanizing Repair Paint: ASTM A780.

PART 3 - EXECUTION

3.01 EXAMINATION:
A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION, GENERAL:
A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, SDI MOC2, manufacturer's written instructions, and requirements in this Section.
B. Install temporary shoring before placing deck panels if required to meet strength or deflection limitations during construction.
C. Locate deck bundles to prevent overloading of supporting members.
D. 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.
SECTION 05 31 00 – STEEL DECKING: continued

E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.
F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck. Cutting of deck shall be performed by sawing or nipping. Sharp edges shall be trimmed and ground smooth.
G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.
H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.
I. Unless noted otherwise, power-actuated fasteners may be used in lieu of welding to fasten deck to supports. Locate fasteners and install according to deck and fastener manufacturers' written instructions to provide equal or greater shear and uplift capacity where welding is indicated.
J. Comply with all applicable OSHA regulations, including, but not limited to, 29 CFR 1926 Subpart R - Steel Erection.

3.03 ROOF DECK INSTALLATION:
A. Fasten roof deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that are not less than 1-1/2 inches (38 mm) long, and as follows:
   1. Weld Diameter: 5/8 inch (16 mm), nominal.
   2. Weld Spacing: Weld edge and interior ribs of deck units with a minimum of two welds per deck unit at each support. Space welds as indicated.
B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of half of the span or 12 inches unless otherwise indicated, and as follows:
   1. At overlaps, mechanically fasten with self-drilling, No. 10 (4.8-mm) diameter or larger, carbon-steel screws.
C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches (38 mm), with end joints as follows:
   1. End Joints: Lapped 2 inches (51 mm) minimum.

3.04 FIELD QUALITY CONTROL:
A. Testing Agency: Contractor shall engage a qualified testing agency to perform tests and inspections.
B. Field welds will be subject to inspection.
C. Testing agency will report inspection results promptly and in writing to Contractor and Engineer.
D. Remove and replace work that does not comply with specified requirements.
E. Additional inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

3.05 PROTECTION:
A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A780 and manufacturer's written instructions.
B. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.

END OF SECTION 05 31 00
SECTION 05 50 00 - METAL FABRICATIONS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. This Section includes:
      1. Steel framing and supports for mechanical and electrical equipment.
      2. Steel framing and supports for applications where framing and supports are not specified in other Sections.
      3. Ledger angles.
      4. Metal ladders.
      5. Miscellaneous steel trim including steel edgings.
      6. Metal ballasts.
      7. Abrasive metal nosings.
      8. Loose bearing and leveling plates for applications where they are not specified in other Sections.
   B. Products furnished, but not installed, under this Section include the following:
      1. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.

1.03 RELATED REQUIREMENTS:
   A. Section 03 30 00 - Cast-in-Place Concrete for installing anchor bolts, steel pipe sleeves, slotted-channel inserts, wedge-type inserts, and other items cast into concrete.
   B. Section 04 20 00 - Unit Masonry for installing loose lintels, anchor bolts, and other items built into unit masonry.
   C. Section 09 90 00 – Protective Coatings for prime and paint of miscellaneous steel items.

1.04 REFERENCE STANDARDS:
   A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
   B. American Architectural Manufacturers Association
      1. AAMA 611: Voluntary Standards for Anodized Architectural Aluminum
   C. American Institute of Steel Construction
      1. AISC 360: Specifications for Structural Steel Buildings (available at www.aisc.org)
   D. American National Standards Institute
      1. ANSI A14.3: American National Standard for Ladders-Fixed-Safety Requirements
   E. American Welding Society
      1. AWS D1.1/D1.1M: Structural Welding Code - Steel
      2. AWS D1.2/D1.2M: Structural Welding Code - Aluminum
   F. ASTM International
      1. ASTM A 27/A 27M: Specification for Steel Castings, Carbon, for General Application
      2. ASTM A 36/A 36M: Specification for Carbon Structural Steel
      4. ASTM A 153/A 153M: Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
5. ASTM A 307: Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength  
6. ASTM A 325: Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength  
7. ASTM A 500/A 500M: Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes  
8. ASTM A 563: Specification for Carbon and Alloy Steel Nuts  
9. ASTM A 653/A 653M: Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process  
10. ASTM A 780/A 780M: Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings  
11. ASTM A 786/A 786M: Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates  
12. ASTM A 1008/A 1008M: Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable  
14. ASTM B 209: Specification for Aluminum and Aluminum-Alloy Sheet and Plate  
15. ASTM B 221: Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes  
17. ASTM B 633: Specification for Electrodeposited Coatings of Zinc on Iron and Steel  
22. ASTM F 1554: Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength  
23. ASTM F 1941: Specification for Electrodeposited Coatings on Threaded Fasteners  

G. Master Painters Institute  
1. MPI#20: Epoxy Zinc-Rich Primer  
2. MPI#79: Alkyd Anti-Corrosive Metal Primer  
3. MPI#107: Water Based Rust-Inhibitive Primer  

H. Metal Framing Manufacturers Association  
1. MFMA-4: Metal Framing Standards Publication  

I. SSPC: The Society for Protective Coatings  
1. SSPC-PA 1: Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel  
2. SSPC-Paint 20: Paint Specification No. 20: Zinc-Rich Primers (Type I, "Inorganic," and Type II, "Organic")  
3. SSPC-SP 3: Surface Preparation Specification No. 3: Power Tool Cleaning  
4. SSPC-SP 6/NACE No. 3: Joint Surface Preparation Standard SSPC-SP 6/NACE No. 3: Commercial Blast Cleaning
SECTION 05 50 00 – METAL FABRICATIONS: continued

1.05 COORDINATION:
   A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
   B. Coordinate installation of metal fabrications that are anchored to or that receive other Work. 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 Project Site in time for installation.

1.06 SUBMITTALS:
   A. Product Data: For the following:
      1. Nonslip aggregates and nonslip-aggregate surface finishes.
      2. Metal nosings and treads.
      3. Paint products.
   B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide Shop Drawings for the following:
      1. Steel framing and supports for mechanical and electrical equipment.
      2. Steel framing and supports for applications where framing and supports are not specified in other Sections.
      3. Ledger angles.
      4. Metal ladders.
      5. Miscellaneous steel trim including steel edgings.
      6. Metal bollards.
      7. Abrasive metal.
   C. Delegated-Design Submittal: Stairways and ramps, including analysis data signed and sealed by professional Engineer licensed in the jurisdiction where the project is located and who is responsible for their preparation.
   D. Qualification Data: For professional Engineer.
   E. Welding certificates.
   F. Research/Evaluation Reports: For post-installed anchors, from ICC-ES.

1.07 QUALITY ASSURANCE:
   A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.08 FIELD CONDITIONS:
   A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.01 METALS:
   A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
   B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
   C. Steel Tubing: ASTM A500/A500M, cold-formed steel tubing.
D. Steel Pipe: ASTM A53/A53M, Standard Weight (Schedule 40) unless otherwise indicated.
E. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.
   1. Size of Channels: As indicated.
   2. Material: Galvanized steel, ASTM A653/A653M, commercial steel, Type B, with G90
      (Z275) coating; 0.064-inch (1.6-mm) nominal thickness.
I. Aluminum Castings: ASTM B26/B26M, Alloy 443.0-F.

2.02 FASTENERS:
A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior
   use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941
   (ASTM F1941M), Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class
   required.
   1. Provide stainless-steel fasteners for fastening aluminum.
   2. Provide stainless-steel fasteners for fastening stainless steel.
B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A (ASTM F568M,
   Property Class 4.6); with hex nuts, ASTM A563 (ASTM A563M); and, where indicated, flat
   washers.
C. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts,
   ASTM F593 (ASTM F738M); with hex nuts, ASTM F594 (ASTM F836M); and, where
   indicated, flat washers; Alloy Group 1 (A1).
D. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, ASTM A563
   (ASTM A563M); and, where indicated, flat washers.
   1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being
      fastened is indicated to be galvanized.
E. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise
   indicated; galvanized ferrous castings, either ASTM A47/A47M malleable iron or
   ASTM A27/A27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip
   galvanized per ASTM F2329.
F. Post-Installed Anchors: See Section 05 05 19.

2.03 MISCELLANEOUS MATERIALS:
A. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer
   complying with MPI#79 and compatible with topcoat.
   1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
B. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal
   and compatible with finish paint systems indicated.
C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and
   compatible with paints specified to be used over it.
D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
E. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous
   grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by
   manufacturer for interior and exterior applications.
SECTION 05 50 00 – METAL FABRICATIONS:  continued

2.04  FABRICATION, GENERAL:
A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing Work.
D. Form exposed Work with accurate angles and surfaces and straight edges.
E. Weld corners and seams continuously to comply 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. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing.
F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.
G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches (3.2 by 38 mm), with a minimum 6-inch (150-mm) embedment and 2-inch (50-mm) hook, not less than 8 inches (200 mm) from ends and corners of units and 24 inches (600 mm) o.c., unless otherwise indicated.

2.05  MISCELLANEOUS FRAMING AND SUPPORTS:
A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.
B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
   1. Fabricate units from slotted channel framing where indicated.
   2. Furnish inserts for units installed after concrete is placed.
C. Fabricate supports for operable partitions from continuous steel beams of sizes recommended by partition manufacturer with attached bearing plates, anchors, and braces as recommended by partition manufacturer. Drill or punch bottom flanges of beams to receive partition track hanger rods; locate holes where indicated on operable partition Shop Drawings.
D. Prime miscellaneous framing and supports with zinc-rich primer.
SECTION 05 50 00 – METAL FABRICATIONS: continued

2.06  LEDGER ANGLES:
   A. Fabricate ledger angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch (19-mm) bolts, spaced not more than 6 inches (150 mm) from ends and 24 inches (600 mm) o.c., unless otherwise indicated.
      1. Provide mitered and welded units at corners.
      2. Provide open joints in ledger angles at expansion and control joints. Make open joint approximately 2 inches (50 mm) larger than expansion or control joint.
   B. Galvanize ledger angles located in exterior walls.

2.07  METAL LADDERS:
   A. General:
   B. Steel Ladders:
      1. Siderails: Continuous, 3/8-by 2-1/2-inch steel flat bars, with eased edges.
      2. Rungs: 3/4-inch diameter steel bars.
      3. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
      4. Provide nonslip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.
      5. Support each ladder at top and bottom with welded or bolted steel brackets.
      6. Prime ladders, including brackets and fasteners, with zinc-rich primer.

2.08  MISCELLANEOUS STEEL TRIM:
   A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.
   B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other Work.
      1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.
   C. Galvanize exterior miscellaneous steel trim.

2.09  METAL BOLLARDS:
   A. Fabricate metal bollards from Schedule 40 steel pipe1/4-inch (6.4-mm) wall-thickness rectangular steel tubing.
   B. Fabricate sleeves for bollard anchorage from steel pipe with 1/4-inch (6.4-mm) thick steel plate welded to bottom of sleeve. Make sleeves not less than 8 inches (200 mm) deep and 3/4 inch (19 mm) larger than OD of bollard.
   C. Prime bollards with zinc-rich primer.

2.10  LOOSE BEARING AND LEVELING PLATES:
   A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.
   B. Prime plates with zinc-rich primer.

2.11  LOOSE STEEL LINTELS:
   A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for
each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.

B. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span, but not less than 8 inches (200 mm) unless otherwise indicated.

C. Galvanize and prime loose steel lintels located in exterior walls.

2.12 STEEL WELD PLATES AND ANGLES:
A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.13 FINISHES, GENERAL:
A. Finish metal fabrications after assembly.
B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.14 STEEL AND IRON FINISHES:
A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A23M for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

B. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.

C. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

D. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."


3. Items Indicated to Receive Primers Specified in Section 09 96 00 - High-Performance Coatings: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

4. Other Items: SSPC-SP 3, "Power Tool Cleaning."

E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL:
A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:
SECTION 05 50 00 – METAL FABRICATIONS: continued

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. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.02 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS:
A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

3.03 INSTALLING NOSINGS, TREADS, AND THRESHOLDS:
A. Center nosings on tread widths unless otherwise indicated.
B. For nosings embedded in concrete steps or curbs, align nosings flush with riser faces and level with tread surfaces.
C. Seal thresholds exposed to exterior with elastomeric sealant complying with Section 07 92 00 - Joint Sealants to provide a watertight installation.

3.04 INSTALLING BEARING AND LEVELING PLATES:
B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with nonshrink grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.05 ADJUSTING AND CLEANING:
A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
   1. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.
B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 09 90 00 Protective Coatings. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 05 50 00
SECTION 06 10 00 – ROUGH CARPENTRY

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary
      Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. This Section includes:
      1. Rooftop equipment bases and support curbs.
      2. Wood blocking, cants, and nailers.
      3. Plywood backing panels.

1.03 RELATED REQUIREMENTS:

1.04 REFERENCED STANDARDS:
   A. Publication Dates: Comply with standards in effect as of date of the Contract Documents
      unless otherwise indicated.
   B. American Forest & Paper Association:
      1. WCD 1: Details for Conventional Wood Frame Construction (available in PDF at
         www.awc.org).
   C. American Wood Protection Association:
      1. AWPA M4: Care of Preservative-Treated Wood Products.
      2. AWPA U1: Use Category System: User Specification for Treated Wood (The first 15
         pages, which describe the various Use categories, are available in PDF at
         www.awpa.com).
   D. ASTM International:
      2. A 653/A 653M: Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron
         Alloy-Coated (Galvannealed) by the Hot-Dip Process.
      3. A 666: Specification for Annealed or Cold-Worked Austenitic Stainless-Steel Sheet,
         Strip, Plate, and Flat Bar.
      5. C 1289: Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation
         Board.
      6. D 2559: Specification for Adhesives for Bonded Structural Wood Products for Use Under
         Exterior Exposure Conditions.
      7. D 2898: Practice for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire
         Testing.
         Wood-Based Products.
      9. D 3498: Specification for Adhesives for Field-Gluing Plywood to Lumber Framing for
         Floor Systems.
     11. D 5664: Test Method for Evaluating the Effects of Fire-Retardant Treatments and
         Elevated Temperatures on Strength Properties of Fire-Retardant Treated Lumber.
     12. D 6841 Practice for Calculating Design Value Treatment Adjustment Factors for Fire-
         Retardant-Treated Lumber.

E. ICC Evaluation Service, LLC:
1. ICC-ES AC01: Expansion Anchors in Masonry Elements.
2. ICC-ES AC58: Adhesive Anchors in Masonry Elements.
3. ICC-ES AC70: Fasteners Power Driven into Concrete, Steel, and Masonry Elements.
4. ICC-ES AC193: Mechanical Anchors in Concrete Elements.
5. ICC-ES AC308: Post-installed Adhesive Anchors in Concrete Elements.

F. U.S. Department of Commerce, National Institute of Standards and Technology:

1.05 DEFINITIONS:
A. Boards or Strips: Lumber of less than 2 inches nominal (38 mm actual) size in least dimension.
B. Dimension Lumber: Lumber of 2 inches nominal (38 mm actual) size or greater but less than 5 inches nominal (114 mm actual) size in least dimension.
C. OSB: Oriented strand board.

1.06 SUBMITTALS:
A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
   1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
   2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
   3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D5664.
   4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project Site.
B. Material Certificates: Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.
   1. Evaluation Reports: For the following, from ICC-ES:
      a. Wood-preservative-treated wood.
      b. Fire-retardant-treated wood.
      c. Power-driven fasteners.
      d. Post-installed anchors.
      e. Metal framing anchors.

1.07 QUALITY ASSURANCE:
A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.
1.08 **DELIVERY, STORAGE, AND HANDLING:**
   A. Stack wood products flat with spacers beneath and between each bundle to provide air circulation. Protect wood products from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

**PART 2 - PRODUCTS**

2.01 **WOOD PRODUCTS, GENERAL:**
   A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, comply with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Grade lumber by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
      1. Factory mark each piece of lumber with grade stamp of grading agency.
      2. Dress lumber, S4S, unless otherwise indicated.

2.02 **WOOD-PRESERVATIVE-TREATED LUMBER:**
   A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground.
      1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
   B. Kiln-dry lumber after treatment to a maximum moisture content of 19%. Do not use material that is warped or that does not comply with requirements for untreated material.
   C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
   D. Application: Treat all rough carpentry unless otherwise indicated.

2.03 **FIRE-RETARDANT-TREATED MATERIALS:**
   A. General: Where fire-retardant-treated materials are indicated, materials shall comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.
   B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.
      1. Treatment shall not promote corrosion of metal fasteners.
      2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D2898. Use for exterior locations and where indicated.
   C. Kiln-dry lumber after treatment to maximum moisture content of 19%. Kiln-dry plywood after treatment to maximum moisture content of 15%.
   D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.
   E. Application: Treat items indicated on Drawings, and the following:
      1. Concealed blocking.
      2. Framing for non-load-bearing partitions.
3. Framing for non-load-bearing exterior walls.
4. Roof construction.
5. Plywood backing panels.

2.04 MISCELLANEOUS LUMBER:
A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
   1. Blocking.
   2. Nailers.
   3. Rooftop equipment bases and support curbs.
   5. Furring.
B. Dimension Lumber Items: Standard, Stud, or No. 3 grade lumber of any species.
C. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.
D. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.
E. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

2.05 PLYWOOD BACKING PANELS:
A. Equipment Backing Panels: Plywood, DOC PS 1, Exterior, C-C Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than 3/4 inch (19 mm) nominal thickness.

2.06 FASTENERS:
A. General: Fasteners shall be of size and type indicated and shall comply with requirements specified in this article for material and manufacture.
   1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M.
B. Nails, Brads, and Staples: ASTM F1667.
C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
D. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01, ICC-ES AC58, ICC-ES AC193 or ICC-ES AC308 as appropriate for the substrate and as indicated in Section 05 05 19.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL:
A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
B. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry accurately to other construction. Locate furring, nailers, blocking, and similar supports to comply with requirements for attaching other construction.
SECTION 06 10 00 – ROUGH CARPENTRY: continued

C. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant-treated plywood backing panels with classification marking of testing agency exposed to view.

D. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
   1. ICC-ES evaluation report for fastener.

3.02 PROTECTION:
   A. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes wet apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 06 10 00
SECTION 06 40 23 – INTERIOR ARCHITECTURAL WOODWORK

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01, Specification Sections, apply to this Section.

1.02 SUMMARY:
A. This Section includes the following:
   1. Plastic-laminate cabinets.
   2. Solid-surfacing-material countertops.
   3. Closet and utility shelving.

1.03 RELATED REQUIREMENTS:
A. Division 06, Section "Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing woodwork and concealed within other construction before woodwork installation.

1.04 REFERENCE STANDARDS:
A. American National Standards Institute:
   1. ANSI A208.1-2009 - Particleboard.
B. American Wood Protection Association:
   1. AWPA N1-2006 - All Millwork Products - Preservative Treatment by Nonpressure Process.
C. ASTM International:
D. Builders Hardware Manufacturers Association:
   1. BHMA A156.9-2003 - Cabinet Hardware.
   2. BHMA A156.16-2008 - Auxiliary Hardware.
E. Hardwood Plywood & Veneer Association:
F. National Electrical Manufacturers Association:
G. U.S. Department of Commerce, National Institute of Standards and Technology:
1.05 **DEFINITIONS:**
   A. Interior architectural woodwork includes wood furring, blocking, shims, and hanging strips for installing woodwork items unless concealed within other construction before woodwork installation.

1.06 **SUBMITTALS:**
   A. **Product Data:** For high-pressure decorative laminate, adhesive for bonding plastic laminate, solid-surfacing material, cabinet hardware and accessories and finishing materials and processes.
      1. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements.
   B. **Shop Drawings:** Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.
      1. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
      2. Show locations and sizes of cutouts and holes for plumbing fixtures, faucets and other items installed in architectural woodwork.
   C. **Samples for Verification:**
      1. Plastic laminates, 8 by 10 inches, for each type, color, pattern, and surface finish, with 1 sample applied to core material and specified edge material applied to 1 edge.
      2. Solid-surfacing materials, 6 inches square.
      3. Corner pieces as follows:
         a. Cabinet-front frame joints between stiles and rails, as well as exposed end pieces, 18 inches high by 18 inches wide by 6 inches deep.
         b. Miter joints for standing trim.
      4. Exposed cabinet hardware and accessories, one unit for each type.
   D. **Qualification Data:** For Installer & fabricator.

1.07 **QUALITY ASSURANCE:**
   A. **Fabricator Qualifications:** Shop that employs skilled workers who custom-fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.
   B. **Source Limitations:** Engage a qualified woodworking firm to assume undivided responsibility for production of interior architectural woodwork with sequence-matched wood veneers [and wood doors with face veneers that are sequence matched with woodwork] [and transparent-finished wood doors that are required to be of same species as woodwork].

1.08 **DELIVERY, STORAGE, AND HANDLING:**
   A. Do not deliver woodwork until painting and similar operations that could damage woodwork have been completed in installation areas. If woodwork must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Project Conditions" Article.

1.09 **PROJECT CONDITIONS:**
   A. **Environmental Limitations:** Do not deliver or install woodwork until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.
   B. **Field Measurements:** Where woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate
measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being enclosed, and indicate measurements on Shop Drawings.

2. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating woodwork without field measurements. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.10 COORDINATION:

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that interior architectural woodwork can be supported and installed as indicated.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. General: Provide materials that comply with requirements of AWI's quality standard for each type of woodwork and quality grade specified, unless otherwise indicated.

B. Wood Products: Comply with the following:

1. Particleboard: ANSI A208.1, Grade M-2, made with binder containing no urea formaldehyde.

2. Softwood Plywood: DOC PS 1, Medium Density Overlay.

C. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or, if not indicated, as required by woodwork quality standard.

1. Manufacturer: Subject to compliance with requirements, provide high-pressure decorative laminates by one of the following:
   a. Formica Corporation.
   b. Wilsonart International; Div. of Premark International, Inc.
   c. Haworth.
   d. Architect approved equal.

D. Solid-Surfacing Material: Homogeneous solid sheets of filled plastic resin complying with ISSFA-2.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Corian by DuPont.
   b. Wilsonart International; Div. of Premark International, Inc.
   c. Architect approved equal.

2. Type: Standard type, unless Special Purpose type is indicated.

3. Colors and Patterns: As selected by Architect from manufacturer's full range.

2.02 CABINET HARDWARE AND ACCESSORIES:

A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets, except for items specified in Division 08, Section "Door Hardware (Scheduled by Describing Products)."

B. Frameless Concealed Hinges (European Type): BHMA A156.9, B01602, 100 degrees of opening.

C. Back-Mounted Pulls: BHMA A156.9, B02011.

D. Adjustable Shelf Standards and Supports: BHMA A156.9, B04071; with shelf rests, B04081.
E. Shelf Rests: BHMA A156.9, B04013; metal.
F. Drawer Slides: BHMA A156.9, B05091.
   1. Heavy Duty (Grade 1HD-100 and Grade 1HD-200): Side mounted; full-extension type; zinc-plated steel ball-bearing slides.
   2. Trash Bin Slides: Grade 1HD-100; for trash bins not more than 20 inches (500 mm) high and 16 inches (400 mm) wide.
G. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.
   1. Satin Chromium Plated: BHMA 626 for brass or bronze base; BHMA 652 for steel base.
   2. Satin Stainless Steel: BHMA 630.
II. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.
I. Concealed Dish Drying Rack: Above sink provide cabinet concealed dish drying rack.
   1. Product: TheDripDry.com, Type A Large

2.03 MISCELLANEOUS MATERIALS:
A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln dried to less than 15% moisture content.
B. Adhesives, General: Adhesives shall not contain urea formaldehyde.
C. Adhesive for Bonding Plastic Laminate: Unpigmented contact cement.

2.04 FABRICATION, GENERAL:
A. Interior Woodwork Grade: Unless otherwise indicated, provide Custom grade interior woodwork complying with referenced quality standard.
B. Wood Moisture Content: Comply with requirements of referenced quality standard for wood moisture content in relation to ambient relative humidity during fabrication and in installation areas.
C. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.
D. Fabricate woodwork to dimensions, profiles, and details indicated. Ease edges to radius indicated for the following:
   1. Corners of Cabinets and Edges of Solid-Wood (Lumber) Members and Rails: 1/16 inch (1.5 mm).
      a. Eased edges are not required where closet shelving abuts a finished wall face.
E. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

2.05 PLASTIC-LAMINATE CABINETS:
A. Grade: Custom.
B. WI Construction Style: Style A, Frameless.
C. WI Construction Type: Type II, single-length sections to fit access openings.
D. WI Door and Drawer Front Style: Flush.
E. Laminate Cladding for Exposed Surfaces: High-pressure decorative laminate complying with the following requirements:
   1. Horizontal Surfaces Other Than Tops: Grade HGS.
   2. Postformed Surfaces: Grade HGP.
   3. Vertical Surfaces: Grade HGS.
SECTION 06 40 23 – INTERIOR ARCHITECTURAL WOODWORK: continued

4. Edges: Grade HGS.

F. Materials for Semiexposed Surfaces:
   1. Surfaces Other Than Drawer Bodies: High-pressure decorative laminate, Grade VGS.
      a. Edges of Plastic-Laminate Shelves: PVC edge banding, 0.12 inch (3 mm) thick, matching laminate in color, pattern, and finish.
      b. For semiexposed backs of panels with exposed plastic-laminate surfaces, provide surface of high-pressure decorative laminate, Grade VGS.
   2. Drawer Sides and Backs: Solid-hardwood lumber.
   3. Drawer Bottoms: Hardwood plywood.

G. Concealed Backs of Panels with Exposed Plastic Laminate Surfaces: High-pressure decorative laminate, Grade BKL.

H. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
   1. As selected by Architect from laminate manufacturer's full range in the following categories:
      a. Solid colors, gloss & matte finish.
      b. Wood grains, gloss & matte finish.

I. Provide dust panels of 1/4-inch (6.4-mm) plywood or tempered hardboard above compartments and drawers, unless located directly under tops.

2.06 SOLID-SURFACING-MATERIAL COUNTERTOPS:
   A. Grade: Custom.
   B. Solid-Surfacing-Material Thickness: 1 inch.
   C. Colors, Patterns, and Finishes: Provide materials and products that result in colors of solid-surfacing material complying with the following requirements:
      1. As selected by Architect from manufacturer's full range.
   D. Fabricate tops in one piece, unless otherwise indicated. Comply with solid-surfacing-material manufacturer's written recommendations for adhesives, sealers, fabrication, and finishing.
      1. Fabricate tops with shop-applied edges of materials and configuration indicated.
      2. Fabricate tops with shop-applied backsplashes.
   E. Install integral sink bowls in countertops in shop.
   F. Drill holes in countertops for plumbing fittings and soap dispensers in shop.

2.07 CLOSET SHELVING:
   A. Grade: Custom.
   B. Shelf Material: 3/4-inch (19-mm) solid lumber.
   C. Cleats: 3/4-inch (19-mm) solid lumber.
   D. Wood Species: Match species indicated for door to closet where shelving is located.

2.08 SHOP FINISHING:
   A. Grade: Provide finishes of same grades as items to be finished.
   B. General: Finish architectural woodwork at fabrication shop as specified in this Section. Defer only final touchup, cleaning, and polishing until after installation.
   C. Transparent Finish:
      1. Grade: Custom.
      2. AWI Finish System: Catalyzed vinyl.
3.01 **PREPARATION:**
A. Before installation, condition woodwork to average prevailing humidity conditions in installation areas.
B. Before installing architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming.

3.02 **INSTALLATION:**
A. Grade: Install woodwork to comply with requirements for the same grade specified in Part 2 for fabrication of type of woodwork involved.
B. Assemble woodwork and complete fabrication at Project site to comply with requirements for fabrication in Part 2, to extent that it was not completed in the shop.
C. Install woodwork level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb (including tops) to a tolerance of 1/8 inch in 96 inches.
D. Scribe and cut woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
E. Fire-Retardant-Treated Wood: Handle, store, and install fire-retardant-treated wood to comply with chemical treatment manufacturer's written instructions, including those for adhesives used to install woodwork.
F. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing as required for complete installation. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork and matching final finish if transparent finish is indicated.
G. Cabinets: Install without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
   1. Install cabinets with no more than 1/8 inch in 96-inch (3 mm in 2400-mm) sag, bow, or other variation from a straight line.
   2. Fasten wall cabinets through back, near top and bottom, at ends and not more than 16 inches (400 mm) o.c. with No. 10 wafer-head sheet metal screws through metal backing or metal framing behind wall finish.
H. Countertops: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.
   1. Align adjacent solid-surfacing-material countertops and form seams to comply with manufacturer's written recommendations using adhesive in color to match countertop. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
   2. Install countertops with no more than 1/8 inch in 96-inch (3 mm in 2400-mm) sag, bow, or other variation from a straight line.
   3. Calk space between backsplash and wall with sealant specified in Division 07, Section "Joint Sealants."
I. Touch up finishing work specified in this Section after installation of woodwork. Fill nail holes with matching filler where exposed.

3.03 **ADJUSTING AND CLEANING:**
A. Repair damaged and defective woodwork, where possible, to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.
B. Clean, lubricate, and adjust hardware.
SECTION 06 40 23 – INTERIOR ARCHITECTURAL WOODWORK: continued

C. Clean woodwork on exposed and semiexposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

END OF SECTION 06 40 23
SECTION 07 21 00 – THERMAL INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary
      Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. This Section includes:
      1. Extruded polystyrene foam-plastic board.
      2. Molded polystyrene foam-plastic board.
      3. Polyisocyanurate foam-plastic board.
      5. Glass-fiber board.
      8. Loose-fill insulation.

1.03 RELATED REQUIREMENTS:
   A. Section 07 21 19 - Foamed-in-Place Insulation for spray-applied polyurethane foam insulation.
   B. Section 07 53 23 - Ethylene-Propylene-Diene-Monomer (EPDM) Roofing for insulation
      specified as part of roofing construction.

1.04 REFERENCE STANDARDS:
   A. Publication Dates: Comply with standards in effect as of date of the Contract Documents
      unless otherwise indicated.
   B. ASTM International:
      1. ASTM C553: Specification for Mineral Fiber Blanket Thermal Insulation for
         Commercial and Industrial Applications.
      5. ASTM C1015: Practice for Installation of Cellulosic and Mineral Fiber Loose-Fill
         Thermal Insulation.
         Insulation.
      7. ASTM C1149: Specification for Self-Supported Spray Applied Cellulosic Thermal
         Insulation.
      8. ASTM C1158: Practice for Installation and Use of Radiant Barrier Systems (RBS) in
         Building Construction.
         Insulation Board.
     10. ASTM C1313: Specification for Sheet Radiant Barriers for Building Construction
         Applications.
     11. ASTM C1320: Practice for Installation of Mineral Fiber Batt and Blanket Thermal
         Insulation for Light Frame Construction.
SECTION 07 21 00 – THERMAL INSULATION: continued

17. ASTM E136: Test Method for Behavior of Materials in a Vertical Tube Furnace at 750ºC.

C. NFPA:

1.05 SUBMITTALS:
A. Product Data: For each type of product.
B. Product Test Reports: For each product, for tests performed by a qualified testing agency.
C. Evaluation Reports: For foam-plastic insulation, from ICC-ES.

1.06 DELIVERY, STORAGE, AND HANDLING:
A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
B. Protect foam-plastic board insulation as follows:
   1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
   2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project Site until just before installation time.
   3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

PART 2 - PRODUCTS

2.01 MOLDED POLYSTYRENE FOAM-PLASTIC BOARD;
A. Molded Polystyrene Board, Type II: ASTM C578, Type II, 15-psi (104-kPa) minimum compressive strength.
   1. Use for insulation of foundation walls and below slabs on grade as indicated on Drawings.

2.02 MINERAL-WOOL BLANKETS:
A. Mineral-Wool Blanket, Unfaced: ASTM C665, Type I (blankets without membrane facing); consisting of fibers; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E84; passing ASTM E136 for combustion characteristics.
   1. Use for insulation of interior gyp board partition walls.

2.03 SPRAY-APPLIED CELLULOSIC INSULATION:
A. Use on interior side of exterior CMU walls. See Section 07 21 19.
SECTION 07 21 00 – THERMAL INSULATION:  continued

2.04  INSULATION FASTENERS:
A. Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of specified thickness securely in position with self-locking washer in place.  
   1. Plate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.  
   2. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation.  
B. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch thick galvanized-steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 1-1/2 inches square or in diameter.  
   1. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in the following locations:  
      a. Below grade insulation  
C. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates without damaging insulation, fasteners, or substrates.

2.05  ACCESSORIES:
A. Adhesive for Bonding Insulation: Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.

PART 3 - EXECUTION

3.01  PREPARATION:
A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or vapor retarders, or that interfere with insulation attachment.

3.02  INSTALLATION, GENERAL:
A. Comply with insulation manufacturer's written instructions applicable to products and applications.  
B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.  
C. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.  
D. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

3.03  INSTALLATION OF SLAB INSULATION:
A. On vertical slab edge and foundation surfaces, set insulation units using manufacturer's recommended adhesive according to manufacturer's written instructions.  
   1. If not otherwise indicated, extend insulation a minimum of 36 inches below exterior grade line.  
B. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.  
   1. If not otherwise indicated, extend insulation a minimum of 30 inches in from exterior walls.

3.04  INSTALLATION OF FOUNDATION WALL INSULATION:
A. Butt panels together for tight fit.
SECTION 07 21 00 – THERMAL INSULATION: continued

B. Adhesive Installation: Install with adhesive or press into tacky waterproofing or dampproofing according to manufacturer's written instructions.

3.05 INSTALLATION OF INSULATION IN FRAMED CONSTRUCTION:
A. Blanket Insulation: Install in cavities formed by framing members according to the following requirements:
   1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
   2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
   3. Maintain 3 inch clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
   4. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.
   5. Vapor-Retarder-Faced Blankets: Tape joints and ruptures in vapor-retarder facings and seal each continuous area of insulation to ensure airtight installation.
      a. Interior Walls: Set units with facing placed toward areas of high humidity.

B. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:
   1. Spray Polyurethane Insulation: Apply according to manufacturer's written instructions.

C. Spray-Applied Cellulosic Insulation: Apply spray-applied insulation according to manufacturer's written instructions. Do not apply insulation until installation of pipes, ducts, conduits, wiring, and electrical outlets in walls is completed and windows, electrical boxes, and other items not indicated to receive insulation are masked. After insulation is applied, make flush with face of studs by using method recommended by insulation manufacturer.

3.06 INSTALLATION OF REFLECTIVE INSULATION:
A. Install sheet reflective insulation according to ASTM C727.
B. Install sheet radiant barriers according to ASTM C1744.
C. Install interior radiation control coating system according to ASTM C1321.

3.07 PROTECTION:
A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 07 21 00
SECTION 07 21 19 - FOAMED-IN-PLACE INSULATION & AIR BARRIER

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. This Section includes:
      1. Closed-cell spray polyurethane foam.

1.03 REFERENCE STANDARDS:
   A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
   B. ASTM International:
   C. NFPA:

1.04 SUBMITTALS:
   A. Product Data: For each type of product.
   B. Qualification Data: For Installer.
   C. Product Test Reports: For each product, for tests performed by a qualified testing agency.
   D. Evaluation Reports: For spray-applied polyurethane foam-plastic insulation, from ICC-ES.

1.05 QUALITY ASSURANCE:
   A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:
   A. System Performance: Substantiate that air barrier material used in a system assembly, will have an air permeance not to exceed 0.004 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft. when tested in accordance with ASTM E 2357.
   B. Wall Assembly:
      1. Exterior wall assembly shall comply with NFPA 285.
      2. The wall must have a potential heat of 1961 BTU/ft² or less (per inch of thickness) when tested in accordance with NFPA 259.
      3. Fire Resistant Assemblies: If a fire- resistance rating is required for the wall assembly, then the wall must be tested in accordance with ASTM E 119 or UL 263 or have substantiation in the form of an Engineering Judgment based on results from tested assemblies.
   C. Connections to adjacent materials and assemblies: Provide connections to prevent air leakage at the following locations:
      1. Foundation and walls, including penetrations, ties and anchors.
      2. Walls and building fenestration e.g. doors and windows.
SECTION 07 21 19 – FOAMED-IN-PLACE INSULATION & AIR BARRIER: continued

3. Dissimilar wall assemblies and fixed openings within those assemblies.
4. Wall and roof connections.
5. Floors over unconditioned space.
6. Walls, floor and roof across construction, control and expansion joints.
7. Utility, pipe, and duct penetrations.
8. Leakage pathways in the building envelope.

2.02 CLOSED-CELL SPRAY POLYURETHANE FOAM:
A. Closed-Cell Spray Polyurethane Foam: ASTM C1029, Type II, minimum density of 2.0 lb./ft.³ and minimum aged R-value at 1 inch thickness of 6.7°F by hr. by ft.²/Btu at 75°F.
   1. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
      a. Flame-Spread Index: 25 or less.
      b. Smoke-Developed Index: 350 or less.
   3. Compressive Strength: 26psi minimum, ASTM D1621.
   4. Tensile Strength: 62.4psi minimum, ASTM D1623, Type C.
   7. Air Permeance: Less than 0.04 cfm/ft² of surface area at 1.57lb/ft² when tested in accordance with ASTM E2178.

B. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Walltite Eco® v.2 – BASF Corporation.
   2. Architect approved equal.

2.03 AUXILIARY MATERIALS
A. Sealant at Transitions in Substrate and Connections to Adjacent Elements: One-component, high-performance, very low-modulus, high-movement, non-sag, fast-curing, hybrid sealant, "MasterSeal® NP 150™" (BASF Construction Systems); or approved substitution.
B. Transition Membrane: For use between spray polyurethane foam air barrier and roofing and other adjacent materials, and for use to flash around building fenestration, wall penetrations, and similar conditions, in accordance with local building codes.
   1. General: Comply with both general recommendations for air barriers and with air barrier material manufacturer’s recommendations.
   2. "MasterSeal AWB®660-I" fluid-applied air/water-resistive barrier membrane including:
         (1) Provide "Quick Corner™ 6", premanufactured corner reinforcement for use with sheathing joint fabric specified.
   C. Counter flashing for Masonry Through-Wall Flashing: "MasterSeal®-TWF"; or approved substitution.
   D. Foam Stop Angle: Metal or plastic angle used for foam stop.
      1. Plastic: Extruded thermoplastic angle, 60 mils thick, "Jam-Ex" (EXO-TEC Manufacturing, Inc.); or approved substitution.
SECTION 07 21 19 – FOAMED-IN-PLACE INSULATION & AIR BARRIER:  continued

E. Primers: Air barrier manufacturer's recommended primers to enhance foam adhesion to certain substrates, including penetrating water-based epoxy primer/scaler, "FE Coat 1601", or elastomeric acrylic primer, "Spraycoat 1800".

F. Portable SPF Application Units: “Kit” foam containers with closed cell SPF, Class 1, nominal 2 lb per cubic foot density, for incidental use; one of the following:
   1. "Touch n' Seal" (Convenience Products).
   2. "Versi-Foam" (RHH Foam Systems, Inc.).

G. One-Component Foams (OCF): Air barrier manufacturer's suggested open cell, one component product for use around windows and doors; one of the following:
   1. "Touch n’ Seal" (Convenience Products).
   2. "Versi-Tite Window & Door Foam Sealant" (RHH Foam Systems, Inc.).

PART 3 - EXECUTION

3.01 PREPARATION:
   A. Verify that substrates are clean, dry, and free of substances that are harmful to insulation.
   B. Priming: Prime substrates where recommended by insulation manufacturer. Apply primer to comply with insulation manufacturer's written instructions. Confine primers to areas to be insulated; do not allow spillage or migration onto adjoining surfaces.

3.02 INSTALLATION:
   A. Comply with insulation manufacturer's written instructions applicable to products and applications.
   B. Spray insulation to envelop entire area to be insulated and fill voids.
   C. Apply in multiple passes to not exceed maximum thicknesses recommended by manufacturer. Do not spray into rising foam.
   D. Framed Construction: Install into cavities formed by framing members to achieve thickness indicated on Drawings.
   E. Miscellaneous Voids: Apply according to manufacturer's written instructions.

3.03 PROTECTION:
   A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes.

END OF SECTION 07 21 19
PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
A. This Section includes:
   1. Adhered ethylene-propylene-diene-monomer (EPDM) roofing system.
   2. Vapor retarder.
   3. Roof insulation.

1.03 RELATED REQUIREMENTS:
A. Section 06 10 00 - Rough Carpentry for wood nailers, curbs, and blocking.
B. Section 07 62 00 - Sheet Metal Flashing and Trim for metal roof flashings and counterflashings.
C. Section 07 92 00 - Joint Sealants for joint sealants, joint fillers, and joint preparation.

1.04 REFERENCE STANDARDS:
A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
B. ASTM International:
   1. ASTM C140: Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
   5. ASTM D312: Specification for Asphalt Used in Roofing.

C. Cool Roof Rating Council:
   1. CRRC-1: Product Rating Program.

D. National Roofing Contractors Association:

E. Single Ply Roofing Industry:

F. Underwriters Laboratories Inc.:

G. U.S. Department of Commerce, National Institute of Standards and Technology:
   1. DOC PS 2: Performance Standard for Wood-Based Structural-Use Panels.

H. U.S. Department of Energy:
   1. DOE ENERGY STAR Roof Products Qualified Product List.

1.05 DEFINITIONS:

1.06 PREINSTALLATION MEETINGS:
A. Preliminary Roofing Conference: Before starting roof deck construction, conduct conference at Project Site.
   1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
   2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
   3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
   4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
   5. Review structural loading limitations of roof deck during and after roofing.
   6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
   7. Review governing regulations and requirements for insurance and certificates if applicable.
   8. Review temporary protection requirements for roofing system during and after installation.
   9. Review roof observation and repair procedures after roofing installation.

1.07 SUBMITTALS:
A. Product Data: For each type of product.
B. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work, including:
1. Base flashings and membrane terminations.
2. Tapered insulation, including slopes.
3. Roof plan showing orientation of steel roof deck and orientation of roofing and fastening spacings and patterns for mechanically fastened roofing.
4. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.

C. Samples for Verification: For the following products:
   1. Sheet roofing, of color required.
   2. Walkway pads or rolls, of color required.

D. Qualification Data: For Installer and manufacturer.

E. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
   1. Submit evidence of complying with performance requirements.

F. Product Test Reports: For components of roofing system, tests performed by manufacturer and witnessed by a qualified testing agency.

G. Research/Evaluation Reports: For components of roofing system, from ICC-ES.

H. Sample Warranties: For manufacturer's special warranties.

I. Maintenance Data: For roofing system to include in maintenance manuals.

1.08 QUALITY ASSURANCE:
A. Manufacturer Qualifications: A qualified manufacturer that is UL listed for roofing system identical to that used for this Project.
B. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

1.09 DELIVERY, STORAGE, AND HANDLING:
A. Deliver roofing materials to Project Site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
   1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
D. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.

1.10 FIELD CONDITIONS:
A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

1.11 WARRANTY:
A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.
SECTION 07 53 23 – ETHYLENE-PROPYLENE-DIENE-MONOMER (EPDM) ROOFING: continued

1. Special warranty includes membrane roofing, base flashings, roof insulation, cover boards, substrate board, roofing accessories and other components of roofing system.

2. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:
   A. Source Limitations: Obtain components including roof insulation and fasteners for roofing system from same manufacturer as membrane roofing or manufacturer approved by membrane roofing manufacturer.

2.02 PERFORMANCE REQUIREMENTS:
   A. General Performance: Installed roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roofing and base flashings shall remain watertight.
      1. Accelerated Weathering: Roofing system shall withstand 2,000 hours of exposure when tested according to ASTM G152, ASTM G154, or ASTM G155.
      2. Impact Resistance: Roofing system shall resist impact damage when tested according to ASTM D3746 or ASTM D4272.
   B. Material Compatibility: Roofing materials shall be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roofing manufacturer based on testing and field experience.
   C. Roofing System Design: Tested by a qualified testing agency to resist the following uplift pressures:
      1. Corner Uplift Pressure: 77.0lbf./ft.².
      2. Perimeter Uplift Pressure: 58lbf./ft.².
      3. Field-of-Roof Uplift Pressure: 44lbf./ft.².
   D. Exterior Fire-Test Exposure: ASTM E108 or UL 790, Class A; for application and roof slopes indicated; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

2.03 EPDM ROOFING:
   A. EPDM: ASTM D4637, Type I, nonreinforced, uniform, flexible EPDM sheet.
      1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         a. Firestone Building Products.
         b. Johns Manville.
         c. Versico Incorporated.
         d. Architect approved equal.
      2. Thickness: 60 mils nominal.

2.04 AUXILIARY ROOFING MATERIALS:
   A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with roofing.
      1. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
   B. Sheet Flashing: 60-mil thick EPDM, partially cured or cured, according to application.
C. Bonding Adhesive: Manufacturer's standard.


E. Seaming Material: Single-component, butyl splicing adhesive and splice cleaner.

F. Lap Sealant: Manufacturer's standard, single-component sealant, colored to match membrane roof.

G. Water Cutoff Mastic: Manufacturer's standard butyl mastic sealant.

H. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch thick; with anchors.

I. Metal Battens: Manufacturer's standard, aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately 1 inch wide by 0.05 inch thick, prepunched.

J. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening membrane to substrate, and acceptable to roofing system manufacturer.

K. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, molded pipe boot flashings, preformed inside and outside corner sheet flashings, reinforced EPDM securement strips, T-joint covers, in-seam sealants, termination reglets, cover strips, and other accessories.

1. Provide white flashing accessories for white EPDM membrane roofing.

2.05 SUBSTRATE BOARDS:

A. Use as first layer of roofing system above metal roof deck.

B. Substrate Board: ASTM C728, perlite board, 3/4 inch thick, seal coated.

C. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening substrate panel to roof deck.

2.06 VAPOR RETARDER:

A. Glass-Fiber Felts: ASTM D2178, Type IV, asphalt impregnated.

2.07 ROOF INSULATION:

A. General: Preformed roof insulation boards manufactured or approved by EPDM roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated.

B. Install in thickness required to meet R-value indicated on the Drawings.

C. Polyisocyanurate Board Insulation: ASTM C1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Carlisle SynTec Incorporated.

   b. Firestone Building Products.

   c. Insulfoam LLC; a Carlisle company.

   d. Johns Manville.

D. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches (1:48) unless otherwise indicated.

E. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.
INSULATION ACCESSORIES:
A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with roofing.
B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening roof insulation and cover boards to substrate, and acceptable to roofing system manufacturer.
C. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer as follows:
   1. Modified asphaltic, asbestos-free, cold-applied adhesive.
   2. Bead-applied, low-rise, one-component or multicomponent urethane adhesive.
   3. Full-spread spray-applied, low-rise, two-component urethane adhesive.
D. Cover Board: DOC PS 2, Exposure 1, oriented strand board, 7/16 inch thick.

ASPHALT MATERIALS:
A. Roofing Asphalt: ASTM D312, Type III or Type IV.
B. Asphalt Primer: ASTM D41/D41M.

WALKWAYS:
A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, solid-rubber, slip-resisting, surface-textured walkway pads or rolls, approximately 3/16 inch (5 mm) thick and acceptable to roofing system manufacturer.

EXAMINATION:
A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work:
   1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
   2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
   3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Section 05 31 00 - Steel Decking.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

PREPARATION:
A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

ROOFING INSTALLATION, GENERAL:
A. Install roofing system according to roofing system manufacturer's written instructions.
B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.
3.04 **SUBSTRATE BOARD INSTALLATION:**
   A. Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.
      1. Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to roofing system manufacturers' written instructions.

3.05 **VAPOR-RETARDER INSTALLATION:**
   A. Built-Up Vapor Retarder: Install two glass-fiber felt plies lapping each felt 19 inches (483 mm) over preceding felt. Embed each felt in a solid mopping of hot roofing asphalt. Glaze coat completed surface with hot roofing asphalt. Apply hot roofing asphalt within ±25°F (14°C) of equiviscous temperature.
   B. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into roofing system.

3.06 **INSULATION INSTALLATION:**
   A. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.
   B. Comply with roofing system and insulation manufacturer's written instructions for installing roof insulation.
   C. Install tapered insulation under area of roofing to conform to slopes indicated.
   D. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches in each direction.
   E. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.
   F. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch with insulation.
      1. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
   G. Mechanically Fastened and Adhered Insulation: Install first layer of insulation to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
      1. Fasten first layer of insulation to resist uplift pressure at corners, perimeter, and field of roof.
      2. Set each subsequent layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
   H. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches (150 mm) in each direction. Loosely butt cover boards together [and fasten to roof deck].
      1. Fasten cover boards to resist uplift pressure at corners, perimeter, and field of roof.

3.07 **ADHERED MEMBRANE ROOFING INSTALLATION:**
   A. Adhere roofing over area to receive roofing according to membrane roofing system manufacturer's written instructions. Unroll membrane roofing and allow to relax before installing.
   B. Start installation of roofing in presence of roofing system manufacturer's technical personnel.
   C. Accurately align roofing, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
D. Bonding Adhesive: Apply to substrate and underside of roofing at rate required by manufacturer and allow to partially dry before installing roofing. Do not apply to splice area of roofing.

E. Hot Roofing Asphalt: Apply a solid mopping of hot roofing asphalt to substrate at temperature and rate required by manufacturer, and install fabric-backed roofing. Do not apply to splice area of roofing.

F. In addition to adhering, mechanically fasten roofing securely at terminations, penetrations, and perimeters.

G. Apply roofing with side laps shingled with slope of roof deck where possible.

H. Adhesive Seam Installation: Clean both faces of splice areas, apply splicing cement, and firmly roll side and end laps of overlapping roofing according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of roofing terminations.
   1. Apply a continuous bead of in-seam sealant before closing splice if required by roofing system manufacturer.

I. Repair tears, voids, and lapped seams in roofing that do not comply with requirements.

J. Spread sealant or mastic bed over deck-drain flange at roof drains, and securely seal membrane roofing in place with clamping ring.

3.08 BASE FLASHING INSTALLATION:
   A. Install sheet flashings and preformed flashing accessories, and adhere to substrates according to roofing system manufacturer's written instructions.
   B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate, and allow to partially dry. Do not apply to seam area of flashing.
   C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.
   D. Clean splice areas, apply splicing cement, and firmly roll side and end laps of overlapping sheets to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of sheet flashing terminations.
   E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.09 WALKWAY INSTALLATION:
   A. Flexible Walkways: Install walkway products in locations indicated. Adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

3.10 FIELD QUALITY CONTROL:
   A. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.
      1. Notify Engineer or Owner 48 hours in advance of date and time of inspection.
   B. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.
   C. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

3.11 PROTECTING AND CLEANING:
   A. Protect membrane roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing, inspect roofing for
SECTION 07 53 23 – ETHYLENE-PROPYLENE-DIENE-MONOMER (EPDM) ROOFING: continued

deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.

B. Correct deficiencies in or remove membrane roofing system that does not comply with requirements, repair substrates, and repair or reinstall membrane roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 07 53 23
SECTION 07 62 00 – SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. This Section includes:
      1. Formed roof-drainage sheet metal fabrications.
      2. Formed low-slope roof sheet metal fabrications.
      3. Formed equipment support flashing.

1.03 RELATED REQUIREMENTS:
   A. Section 04 22 00 – Concrete Unit Masonry for through-wall flashing and other integral masonry flashings specified as part of Masonry work.
   B. Section 06 10 00 - Rough Carpentry for wood nailers, curbs, and blocking.
   C. Section 07 53 23 – EPDM Roofing for materials and installation of sheet metal flashing and trim integral with roofing.
   D. Section 07 72 36 - Roof Accessories for set-on-type curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.
   E. Section 07 95 00 - Expansion Control for manufactured sheet metal expansion-joint covers.

1.04 REFERENCE STANDARDS:
   A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
   B. American Architectural Manufacturers Association (AAMA):
      1. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum
      2. AAMA 620 - Voluntary Specification High Performance Organic Coatings on Coil Coated Architectural Aluminum Substrates
      3. AAMA 621 - Voluntary Specification for High Performance Organic Coatings on Coil Coated Architectural Hot Dipped Galvanized (HDG) and Zinc-Aluminum Coated Steel Substrates
   C. ASTM International:
      1. ASTM A 153/A 153M - Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
      2. ASTM A 240/A 240M - Specification for Chromium and Chromium-Nickel Stainless-Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
      3. ASTM A 653/A 653M - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
      4. ASTM A 666 - Specification for Annealed or Cold-Worked Austenitic Stainless-Steel Sheet, Strip, Plate, and Flat Bar
      5. ASTM A 755/A 755M - Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepaintated by the Coil-Coating Process for Exterior Exposed Building Products
      6. ASTM A 792/A 792M - Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
      7. ASTM B 32 - Specification for Solder Metal
10. ASTM B 209 - Specification for Aluminum and Aluminum-Alloy Sheet and Plate
11. ASTM B 370 - Specification for Copper Sheet and Strip for Building Construction
12. ASTM B 506 - Specification for Copper-Clad Stainless Steel Sheet and Strip for Building Construction
13. ASTM B 882 - Specification for Pre-Patinated Copper for Architectural Applications
14. ASTM C 920 - Specification for Elastomeric Joint Sealants
15. ASTM C 1311 - Specification for Solvent Release Sealants
17. ASTM D 1187 - Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal
18. ASTM D 1970 - Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal
19. ASTM D 2244 - Practice for Calculation of Color Differences from Instrumentally Measured Color Coordinates
20. ASTM D 4214 - Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films
21. ASTM D 4586 - Specification for Asphalt Roof Cement, Asbestos-Free
22. ASTM F 2329 - Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners

D. Copper Development Association Inc.:

E. Metal Construction Association:

F. National Association of Architectural Metal Manufacturers (NAAMM):
1. Metal Finishes Manual for Architectural and Metal Products.

G. National Roofing Contractors Association:
1. The NRCA Roofing Manual. Four volumes; various dates.

H. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):

I. Single Ply Roofing Industry:
1. SPRI ES-1: Wind Design Standard for Edge Systems Used with Low Slope Roofing Systems (ANSI and FM4435)

1.05 COORDINATION:
A. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.
B. Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints, and seams to provide leakproof, secure, and noncorrosive installation.

1.06 SUBMITTALS:
A. Product Data: For each type of product.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each manufactured product and accessory.
B. Shop Drawings: For sheet metal flashing and trim.
1. Include plans, elevations, sections, and attachment details.
SECTION 07 62 00 – SHEET METAL FLASHING AND TRIM: continued

2. Detail fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled work.
3. Include identification of material, thickness, weight, and finish for each item and location in Project.
4. Include details for forming, including profiles, shapes, seams, and dimensions.
5. Include details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.
6. Include details of termination points and assemblies.
7. Include details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction from fixed points.
8. Include details of roof-penetration flashing.
9. Include details of edge conditions, including eaves, ridges, valleys, rakes, crickets, and counterflashing as applicable.
10. Include details of special conditions.
11. Include details of connections to adjoining work.

C. Samples for Verification: For each type of exposed finish.
1. Sheet Metal Flashing: 12 inches (300 mm) long by actual width of unit, including finished seam and in required profile. Include fasteners, cleats, clips, closures, and other attachments.
2. Trim, Metal Closures, Expansion Joints, Joint Intersections, and Miscellaneous Fabrications: 12 inches (300 mm) long and in required profile. Include fasteners and other exposed accessories.
3. Anodized Aluminum Samples: Samples to show full range to be expected for each color required.

D. Qualification Data: For fabricator.
E. Sample Warranty: For special warranty.
F. Maintenance Data: For sheet metal flashing and trim, and its accessories, to include in maintenance manuals.

1.07 QUALITY ASSURANCE:
A. Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.

1.08 DELIVERY, STORAGE, AND HANDLING:
A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.

1.09 WARRANTY:
A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.
1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
   a. Color fading more than 5 Hunter units when tested according to ASTM D2244.
   b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:

A. General: Sheet metal flashing and trim assemblies shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.

B. Sheet Metal Standard for Flashing and Trim: Comply with SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change: 120°F (67°C), ambient; 180°F (100°C), material surfaces.

2.02 SHEET METALS:

A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.

B. Aluminum Sheet: ASTM B209 (ASTM B209M), alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required; with smooth, flat surface.

1. Color Anodic Finish Coil Coated: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.
   a. Color: Dark bronze.

C. Zinc Sheet: 99.995% electrolytic high-grade zinc with alloy additives of copper (0.08 to 0.20%), titanium (0.07 to 0.12%), and aluminum (0.015%); with manufacturer's standard factory-applied, flexible, protective back coating.

1. Finish: Preweathered black.

2.03 MISCELLANEOUS MATERIALS:

A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.

B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.

1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.

   a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.

   b. Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.

   c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
3. Fasteners for Zinc Sheet: Series 300 stainless steel or hot-dip galvanized steel according to ASTM A153/A153M or ASTM F2329.

C. Sealant Tape: Pressure-sensitive, 100% solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2-inch-wide and 1/8 inch thick.

D. Elastomeric Sealant: Sealant of type, grade, class, and use classifications recommended by sheet metal manufacturer to seal joints in sheet metal flashing and trim and remain watertight.

E. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.

F. Bituminous Coating: Cold-applied asphalt emulsion according to ASTM D1187.


2.04 FABRICATION, GENERAL:

A. General: Custom fabricate sheet metal flashing and trim to comply with details shown and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required. Fabricate sheet metal flashing and trim in shop to greatest extent possible.

1. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.

2. Obtain field measurements for accurate fit before shop fabrication.

3. Form sheet metal flashing and trim to fit substrates without excessive oil canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.

4. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.

B. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."

C. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.

1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.

2. Use lapped expansion joints only where indicated on Drawings.

D. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal to provide for proper installation of elastomeric sealant according to cited sheet metal standard.

E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

1. Fabricate as recommended by cited sheet metal standard for application, but not less than thickness of metal being secured.

F. Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use.

G. Do not use graphite pencils to mark metal surfaces.

2.05 ROOF-DRAINAGE SHEET METAL FABRICATIONS:

A. Downspouts: Fabricate rectangular open-face downspouts to dimensions indicated, complete with mitered elbows. Furnish with metal hangers from same material as downspouts and anchors.

1. Fabricate from the following materials:
SECTION 07 62 00 – SHEET METAL FLASHING AND TRIM: continued

a. Aluminum: 0.024 inch thick.

B. Parapet Scuppers: Fabricate scuppers to 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. Fabricate from the following materials:
   1. Aluminum: 0.032 inch thick.

C. Conductor Heads: Fabricate conductor heads with flanged back and stiffened top edge and of dimensions and shape required, complete with outlet tubes. Fabricate from the following materials:
   1. Aluminum: 0.032 inch thick.

2.06 LOW-SLOPE ROOF SHEET METAL FABRICATIONS:
A. Copings: Fabricate in minimum 96-inch long, but not exceeding 12-foot long, sections. Fabricate joint plates of same thickness as copings. Furnish with continuous cleats to support edge of external leg and interior leg. Miter corners fasten and seal watertight. Shop fabricate interior and exterior corners.
   1. Fabricate from the Following Materials:
      a. Aluminum: 0.050 inch thick.

B. Roof-Penetration Flashing: Fabricate from the following materials:
   1. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch thick.

2.07 MISCELLANEOUS SHEET METAL FABRICATIONS:
A. Equipment Support Flashing: Fabricate from the following materials:
   1. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch thick.

PART 3 - EXECUTION

3.01 EXAMINATION:
A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, substrate, and other conditions affecting performance of the Work.
   1. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
   2. Verify that air- or water-resistant barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 UNDERLAYMENT INSTALLATION:
A. Felt Underlayment: Install felt underlayment, wrinkle free, using adhesive to minimize use of mechanical fasteners under sheet metal flashing and trim. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches.
B. Synthetic Underlayment: Install synthetic underlayment, wrinkle free, according to manufacturers' written instructions, and using adhesive where possible to minimize use of mechanical fasteners under sheet metal.
C. Self-Adhering Sheet Underlayment: Install self-adhering sheet underlayment, wrinkle free. Prime substrate if recommended by underlayment manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures. Apply in shingle fashion to shed water, with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3-1/2 inches. Roll laps and edges with roller. Cover underlayment within 14 days.
3.03 INSTALLATION, GENERAL:
A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.

1. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
2. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
3. Space cleats not more than 12 inches apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.
4. Install exposed sheet metal flashing and trim with limited oil canning, and free of buckling and tool marks.
5. Torch cutting of sheet metal flashing and trim is not permitted.
6. Do not use graphite pencils to mark metal surfaces.

B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.

1. Coat concealed side of uncoated-aluminum sheet metal flashing and trim with bituminous coating where flashing and trim contact wood, ferrous metal, or cementitious construction.
2. Underlayment: Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with slip sheet.

C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at maximum of 10 feet with no joints within 24 inches of corner or intersection.

1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.
2. Use lapped expansion joints only where indicated on Drawings.

D. Fasteners: Use fastener sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.

E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.

F. Seal joints as required for watertight construction.

1. Use sealant-filled joints unless otherwise indicated. Embed hooked flanges of joint members not less than 1 inch into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is between 40 and 70°F (4 and 21°C), set joint members for 50% movement each way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40°F (4°C).
2. Prepare joints and apply sealants to comply with requirements in Section 07 92 00 - Joint Sealants.

G. Rivets: Rivet joints in uncoated aluminum where necessary for strength.
3.04 **ROOF-DRAINAGE SYSTEM INSTALLATION:**
   A. **General:** Install sheet metal roof-drainage items to produce complete roof-drainage system according to cited sheet metal standard unless otherwise indicated. Coordinate installation of roof perimeter flashing with installation of roof-drainage system.
   
   B. **Downspouts:** Join sections with 1-1/2-inch telescoping joints.
      1. Provide hangers with fasteners designed to hold downspouts securely to walls. Locate hangers at top and bottom and at approximately 60 inches o.c.
      2. Provide elbows at base of downspout to direct water away from building.
   
   C. **Parapet Scuppers:** Continuously support scupper, set to correct elevation, and seal flanges to interior wall face, over cant's or tapered edge strips, and under roofing membrane.
      1. Anchor scupper closure trim flange to exterior wall and seal with elastomeric sealant to scupper.
      2. Loosely lock front edge of scupper with conductor head.
      3. Seal with elastomeric sealant exterior wall scupper flanges into back of conductor head.
   
   D. **Conductor Heads:** Anchor securely to wall, with elevation of conductor head rim at minimum of 1 inch below scupper discharge.
   
3.05 **ROOF FLASHING INSTALLATION:**
   A. **General:** Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and cited sheet metal standard. Provide concealed fasteners where possible, and set units true to line, levels, and slopes. Install work with laps, joints, and seams that are permanently watertight and weather resistant.
   
   B. **Copings:** Anchor to resist uplift and outward forces according to recommendations in cited sheet metal standard unless otherwise indicated.
      1. Interlock exterior bottom edge of coping with continuous cleat anchored to substrate at 24-inch centers.
   
   C. **Copings:** Anchor to resist uplift and outward forces according to recommendations in FM Global Property Loss Prevention Data Sheet 1-49 for specified FM Approvals' listing for required windstorm classification.
   
   D. **Pipe or Post Counterflashing:** Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending minimum of 4 inches over base flashing. Install stainless-steel draw band and tighten.
   
   E. **Counterflashing:** Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing 4 inches over base flashing. Lap counterflashing joints minimum of 4 inches. Secure in waterproof manner by means of snap-in installation and sealant or lead wedges and sealant, interlocking folded seam or blind rivets and sealant or anchor and washer at 36-inch centers unless otherwise indicated.
   
   F. **Roof-Penetration Flashing:** Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with elastomeric sealant and clamp flashing to pipes that penetrate roof.

3.06 **MISCELLANEOUS FLASHING INSTALLATION:**
   A. **Equipment Support Flashing:** Coordinate installation of equipment support flashing with installation of roofing and equipment. Weld or seal flashing with elastomeric sealant to equipment support member.
SECTION 07 62 00 – SHEET METAL FLASHING AND TRIM: continued

3.07 ERECTION TOLERANCES:
   A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."

3.08 CLEANING AND PROTECTION:
   A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
   B. Clean off excess sealants.
   C. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended by sheet metal flashing and trim manufacturer. Maintain sheet metal flashing and trim in clean condition during construction.
   D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07 62 00
SECTION 07 72 36 – ROOF SCUTTLES

PART 1 - GENERAL

1.01 SUMMARY:
   A. This Section includes roof scuttle(s), related accessories, and ladder safety post device.

1.02 RELATED REQUIREMENTS:
   A. Section 06 10 00 - Rough Carpentry.
   B. Section 07 62 00 - Flashing and Sheet Metal.
   C. Section 07 53 23 – EPDM Roofing System.

1.03 REFERENCE STANDARDS:
   A. Applicable Standards:
      1. Factory Mutual (FM).
      2. Underwriters Laboratories (UL).

1.04 SUBMITTALS:
   A. Submit as specified in Division 01.
   B. Include, but not limited to, the following:
      1. Product data and Specifications, rough-in diagram, details, fabrication and erection details, and Drawings.
      2. Coordination drawings for items interfacing with units. Indicate dimensions of items and locations of items provided under this Section, together with relationships and method of attachment to adjacent construction.
         a. Operation and maintenance data.

1.05 DELIVERY, STORAGE, AND HANDLING:
   A. Handle and store units to prevent racking, warping, or other damage.

1.06 GUARANTEE:
   A. Roof scuttles shall be guaranteed by the manufacturer for proper operation and against defects in workmanship and materials for 5 years.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:
   A. Babcock-Davis Hatchways, Inc.
   B. The Bilco Company.
   C. Milcor, Inc.
   D. Nystrom Products Company.

2.02 ROOF SCUTTLE(S):
   A. Prefabricated unit, single-leaf, complete with curbs, mounting flanges, insulation, weather seal, gaskets, hardware and accessories, and integral cap flashing. Weld corner joints for weathertightness. Units shall be designed for 40-psf external loading and 20-psf internal loading pressure. Fabricate for ladder access.
   B. Metal: Aluminum mill-finish cover and curb. Metal gages for curb and cover shall be as required by size of unit.
SECTION 07 72 36 – ROOF SCUTTLES: continued

C. Insulation: Not less than 3-inch thickness in curb and in hatch door; provide with cover liner.
D. Well Liner: Sheet metal same as metal for unit.
E. Hardware: Hinges, automatic self-lifting devices, hold-open device, latch, interior padlock hasp and vinyl-grip operating handle, and exterior operating handle. All hardware shall be zinc- or cadmium-plated.
F. Fasteners: Same metal as metal being fastened or other noncorrosive metal as recommended by scuttle manufacturer. Match finish of exposed fasteners with finish of material being fastened.
G. Size(s): As indicated with 12-inch curb. Where roof slope exceeds 1/4 inch per foot, fabricate curbs with height tapered to match slope and to result in level installation of top of unit.

2.03 SAFETY POST DEVICE:
A. Ladder extension device of high-strength steel with tubular section that locks automatically when fully extended.
B. Upward and downward movement controlled by spring-balancing mechanism.
C. Hot-dip galvanized finish.
D. Provide device with components and fasteners for securing to type of ladder rungs indicated.
E. Manufacturer: Bilco Co. - LadderUp Safety Post and BilGuard® 2.0 Safety Railing.

PART 3 - EXECUTION

3.01 INSTALLATION: ROOF SCUTTLES:
A. Coordinate installation with roof deck construction, roof insulation, and roofing system to ensure that each element of the Work performs properly, and that combined elements are waterproof and weathertight. Anchor units securely to supporting structural substrates, adequate to withstand lateral and thermal stresses, as well as inward and outward loading pressures.
B. Separate metal surfaces from dissimilar metals, wood, and cementitious substrates as required to prevent corrosive action. Separate with a thick coating of bituminous compound or other separation as recommended by the roof unit manufacturer.
C. Bed flanges in mastic or compound which is compatible with roofing and flashing to form a seal.

3.02 INSTALLATION: SAFETY POST DEVICE:
A. Install device on rungs at top of fixed ladder in scuttles and heat-smoke vents to provide for safe assistance in getting in and out of unit.
B. Install device securely to rungs with components and fasteners so that devices operate properly and without interference of proper scuttle or vent operation.

3.03 FIELD QUALITY CONTROL, ADJUSTMENT, AND CLEANING:
A. Test and adjust units as required for proper operation. Lubricate joints and hardware.
B. Clean surfaces as required to prevent deterioration and uneven weathering.
C. Touch up any damaged coatings with coating equivalent to that used in fabrication. Prepare surfaces as required prior to touch-up.

END OF SECTION 07 72 36
SECTION 07 92 00 – JOINT SEALANTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. This Section includes:
      1. Silicone joint sealants.
      2. Urethane joint sealants.

1.03 REFERENCED STANDARDS:
   A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
   B. ASTM International:

1.04 SUBMITTALS:
   A. Product Data: For each joint-sealant product.
   B. Joint-Sealant Schedule: Include the following information:
      1. Joint-sealant application, joint location, and designation.
      2. Joint-sealant manufacturer and product name.
   C. Qualification Data: For qualified testing agency.
   D. Product Test Reports: For each kind of joint sealant, for tests performed by a qualified testing agency.
   E. Sample Warranties: For special warranties.

1.05 QUALITY ASSURANCE:
   A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.06 FIELD CONDITIONS:
   A. Do not proceed with installation of joint sealants under the following conditions:
1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40°F (5°C).
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.07 WARRANTY:
A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
   1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
   2. Disintegration of joint substrates from causes exceeding design specifications.
   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.

PART 2 - PRODUCTS

2.01 JOINT SEALANTS, GENERAL:
A. 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 joint-sealant manufacturer, based on testing and field experience.
B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.02 SILICONE JOINT SEALANTS:
A. Silicone, S, NS, 25, NT: Single-component, nonsag, +25% and -25% movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Dow Corning Corporation.
      b. GE Construction Sealants; Momentive Performance Materials Inc.
      c. Sika Corporation.
B. Silicone, Acid Curing, S, NS, 25, NT: Single-component, nonsag, +25% and -25% movement capability, nontraffic-use, acid-curing silicone joint sealant: ASTM C920, Type S, Grade NS, Class 25, Use NT.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Dow Corning Corporation.
      b. Pecora Corporation.
      c. Sika Corporation; Joint Sealants.
SECT 07 92 00 – JOINT SEALANTS: continued

2.03 URETHANE JOINT SEALANTS:
A. Urethane, S, NS, 25, NT: Single-component, nonsag, nontraffic-use, +25% and -25% movement capability, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.
   1. Manufacturers: Subject to compliance with requirements, products by one of the following:
      a. BASF Corporation-Construction Systems.
      b. Pecora Corporation.
      c. Sika Corporation; Joint Sealants.

2.04 MILDEW-RESISTANT JOINT SEALANTS:
A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.
B. Silicone, Mildew Resistant, Acid Curing, S, NS, 25, NT: Mildew-resistant, single-component, nonsag, +25% and -25% movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Dow Corning Corporation.
      b. GE Construction Sealants; Momentive Performance Materials Inc.
      c. Sika Corporation.
   2. Use in the following locations:
      a. Sinks and plumbing fixtures where conditions of high humidity and temperature exist.

2.05 JOINT-SEALANT BACKING:
A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. BASF Corporation-Construction Systems.
      b. Construction Foam Products; a division of Nomaco, Inc.
   B. Cylindrical Sealant Backings: ASTM C1330, Type C (closed-cell material with a surface skin), Type O (open-cell material), Type B (bicellular material with a surface skin), or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
   C. 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.

2.06 MISCELLANEOUS MATERIALS:
A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or
harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.01 EXAMINATION:
A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION:
A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
   1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
   2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
      a. Concrete.
      b. Masonry.
      c. Unglazed surfaces of ceramic tile.
   3. Remove laitance and form-release agents from concrete.
   4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
      a. Metal.
      b. Glass.
      c. Porcelain enamel.
      d. Glazed surfaces of ceramic tile.
B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.03 INSTALLATION OF JOINT SEALANTS:
A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
B. Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
   1. Do not leave gaps between ends of sealant backings.
   2. Do not stretch, twist, puncture, or tear sealant backings.
   3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
   1. Place sealants so they directly contact and fully wet joint substrates.
   2. Completely fill recesses in each joint configuration.
   3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
   1. Remove excess sealant from surfaces adjacent to joints.
   2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
   3. Provide concave joint profile per Figure 8A in ASTM C1193 unless otherwise indicated.
   4. Provide flush joint profile at locations indicated on Drawings according to Figure 8B in ASTM C1193.
   5. Provide recessed joint configuration of recess depth and at locations indicated on Drawings according to Figure 8C in ASTM C1193.
      a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

3.04 FIELD QUALITY CONTROL:

A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:
   1. Extent of Testing: Test completed and cured sealant joints as follows:
      a. Perform 5 tests for the first 1,000 feet of joint length for each kind of sealant and joint substrate.
      b. Perform one test for each 1,000 feet of joint length thereafter or one test per each floor per elevation.
      a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
   3. Inspect tested joints and report on the following:
      a. Whether sealants filled joint cavities and are free of voids.
      b. Whether sealant dimensions and configurations comply with specified requirements.
c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion complies with sealant manufacturer's field-adhesion hand-pull test criteria.

4. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant material, sealant configuration, and sealant dimensions.

5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

B. Evaluation of Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.05 CLEANING:
A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.06 PROTECTION:
A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.07 JOINT-SEALANT SCHEDULE:
   1. Joint Locations:
      b. Control and expansion joints in unit masonry.
      c. Joints between different materials listed above.
      d. Perimeter joints between materials listed above and frames of doors and windows.
      e. Control and expansion joints in ceilings and other overhead surfaces.
      f. Joints at roof flashing materials.
      g. Other joints as indicated on Drawings.
   2. Joint Sealant: Urethane, S, NS, 25, NT
   3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

B. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces not subject to significant movement.
   1. Joint Locations:
      a. Control joints on interior surfaces of exterior walls.
      b. Perimeter joints between interior wall surfaces and frames of interior doors and windows.
c. Other joints as indicated on Drawings.

2. Joint Sealant: Silicone, S, NS, 25, NT.
   a. Use acid cure only on non-metallic surfaces.

3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

C. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces.
   1. Joint Locations:
      a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
      b. Tile control and expansion joints where indicated.
      c. Other joints as indicated on Drawings.

2. Joint Sealant: Silicone, mildew resistant, acid curing, S, NS, 25, NT.

3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

END OF SECTION 07 92 00
SECTION 08 11 13 – HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. This Section includes:
      1. Interior standard steel doors and frames.
      2. Exterior standard steel doors and frames.

1.03 RELATED REQUIREMENTS:
   A. Section 08 70 00 – Finish Hardware for door hardware for hollow-metal doors.
   B. Section 08 80 00 – Glazing for glass in hollow-metal doors.

1.04 REFERENCED STANDARDS:
   A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
   B. ASTM International:
      1. ASTM A 153/A 153M - Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
      2. ASTM A 653/A 653M - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
      4. ASTM A 1008/A 1008M - Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
     10. ASTM E 136 - Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 Degree C.
   C. Builders Hardware Manufacturers Association (BHMA):
      1. BHMA A156.115 - Hardware Preparation in Steel Doors and Steel Frames (ANSI)
   D. National Fire Protection Association (NFPA):
      1. NFPA 80 - Fire Doors and Other Opening Protectives (ANSI).
      2. NFPA 252 - Fire Tests of Door Assemblies (ANSI).
      3. NFPA 257 - Fire Test for Window and Glass Block Assemblies (ANSI).
   E. Steel Door Institute (SDI):
      1. SDI 111C - Recommended Louver Details for Standard Steel Doors
      2. SDI A250.3 - Test Procedure and Acceptance Criteria for Factory Applied Finish Coatings for Steel Doors and Frames (ANSI).
3. SDI A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames and Frame Anchors (ANSI).
4. SDI A250.6 - Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames (ANSI).
5. SDI A250.8 - Specifications for Standard Steel Doors and Frames (ANSI).
6. SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames (ANSI).
7. SDI A250.11 - Recommended Erection Instructions for Steel Frames (ANSI).

F. Underwriters Laboratories Inc. (UL):
1. UL 9 - Fire Tests of Window Assemblies.
2. UL 10C - Positive Pressure Fire Tests of Door Assemblies.
3. UL 1784 - Air Leakage Tests of Door Assemblies and Other Opening Protectives.

1.05 DEFINITIONS:
A. Minimum Thickness: Minimum thickness of base metal without coatings according to SDI A250.8.

1.06 COORDINATION:
A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project Site in time for installation.
B. Coordinate requirements for installation of door hardware, electrified door hardware, and access control and security systems.

1.07 SUBMITTALS:
A. Product Data: For each type of product.
   1. Include construction details, material descriptions, core descriptions, fire-resistance ratings and finishes.
B. Shop Drawings: Include the following:
   1. Elevations of each door type.
   2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
   3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
   4. Locations of reinforcement and preparations for hardware.
   5. Details of each different wall opening condition.
   6. Details of anchorages, joints, field splices, and connections.
   7. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
   8. Details of accessories.
   9. Details of moldings, removable stops, and glazing.
C. Product Schedule: For hollow-metal doors and frames, prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final Door Hardware Schedule.
D. Product Test Reports: For each type of hollow-metal door and frame assembly, for tests performed by a qualified testing agency.

1.08 DELIVERY, STORAGE, AND HANDLING:
A. Deliver hollow-metal doors and frames palletized, packaged, or crated to provide protection during transit and Project-Site storage. Do not use nonvented plastic.
1. Provide additional protection to prevent damage to factory-finished units.
   B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
   C. Store hollow-metal doors and frames vertically under cover at Project Site with head up. Place on minimum 4-inch high wood blocking. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Ceco Door; ASSA ABLOY.
      b. Curries Company; ASSA ABLOY.
      c. Fleming Door Products Ltd.; Assa Abloy Group Company.
      d. Republic Doors and Frames.
      e. Steelcraft; an Allegion brand.
      f. Architect approved equal.
   B. Source Limitations: Obtain hollow-metal work from single source from single manufacturer.

2.02 PERFORMANCE REQUIREMENTS:
   A. Fire-Rated Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
   B. Thermally Rated Door Assemblies: Provide door assemblies with U-factor of not more than 0.38 deg Btu/F x h x sq. ft. when tested according to ASTM C 518.

2.03 INTERIOR STANDARD STEEL DOORS AND FRAMES:
   A. Construct interior hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
   B. Standard-Duty Doors and Frames: SDI A250.8, Level 1; SDI A250.4, Level C.
      1. Doors:
         a. Type: As indicated in the Door and Frame Schedule.
         c. Edge Construction: Model 1, Full Flush.
         d. Edge Bevel: Provide manufacturer's standard beveled or square edges.
         e. Core: Manufacturer's standard.
         f. Fire-Rated Core: Manufacturer's standard core for fire-rated doors.
      2. Frames:
         a. Materials: Metallic-coated, steel sheet, minimum thickness of 0.042 inch.
         b. Sidelite Frames: Fabricated from same thickness material as adjacent door frame.
         c. Construction: Full profile welded.

2.04 EXTERIOR STANDARD STEEL DOORS AND FRAMES:
   A. Construct exterior doors and frames to comply with the standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
B. Heavy-Duty Doors and Frames: SDI A250.8, Level 2; SDI A250.4, Level B.
   1. Doors:
      a. Type: As indicated in the Door and Frame Schedule.
      b. Thickness: 1-3/4 inches (44.5 mm.)
      c. Face: Metallic-coated steel sheet, minimum thickness of 0.042 inch, with minimum A40 (ZF120) coating.
      d. Edge Construction: Model 1, Full Flush.
      e. Edge Bevel: Provide manufacturer’s standard beveled or square edges
      f. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
      g. Bottom Edges: Close bottom edges of doors with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
      h. Core: Manufacturer’s standard.
      i. Fire-Rated Core: Manufacturer’s standard core for fire-rated doors.
   2. Frames:
      a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch, with minimum A40 (ZF120) coating.
      b. Construction: Full profile welded.

2.05 BORROWED LITES:
   A. Fabricate of metallic-coated steel sheet, minimum thickness of 0.053 inch.
   B. Construction: Full profile welded.
   C. Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as metal as frames.
   D. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.

2.06 HOLLOW-METAL PANELS:
   A. Provide hollow-metal panels of same materials, construction, and finish as adjacent door assemblies.

2.07 FRAME ANCHORS:
   A. Jamb Anchors:
      1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.042 inch thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.
      2. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042 inch thick.
      3. Compression Type for Drywall Slip-on Frames: Adjustable compression anchors.
      4. Post-installed Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.
   B. Floor Anchors: Formed from same material as frames, minimum thickness of 0.042 inch, and as follows:
      1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.
2.08 MATERIALS:
A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
B. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B.
D. Frame Anchors: ASTM A879/A879M, Commercial Steel (CS), 04Z (12G) coating designation; mill phosphatized.
E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A153/A153M.
F. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.
G. Grout: ASTM C476, except with a maximum slump of 4 inches, as measured according to ASTM C143/C143M.
H. Mineral-Fiber Insulation: ASTM C665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E136 for combustion characteristics.
I. Glazing: Comply with requirements in Section 08 80 00 - Glazing.
J. Bituminous Coating: Cold-applied asphalt mastic, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.09 FABRICATION:
A. Fabricate hollow-metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for metal thickness. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project Site, clearly identify work that cannot be permanently factory assembled before shipment.
B. Hollow-Metal Doors:
1. Steel-Stiffened Door Cores: Provide minimum thickness 0.026 inch, steel vertical stiffeners of same material as face sheets extending full-door height, with vertical webs spaced not more than 6 inches apart. Spot weld to face sheets no more than 5 inches o.c. Fill spaces between stiffeners with glass- or mineral-fiber insulation.
2. Fire Door Cores: As required to provide fire-protection ratings indicated.
C. Door Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch (19 mm) beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.
D. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of same or greater thickness metal as frames.
1. Sidelite Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by welding.
2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
3. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
4. Floor Anchors: Weld anchors to bottoms of jambs with at least four spot welds per anchor; however, for slip-on drywall frames, provide anchor clips or countersunk holes at bottoms of jambs.

5. Jamb Anchors: Provide number and spacing of anchors as follows:
   a. Masonry Type: Locate anchors not more than 16 inches from top and bottom of frame. Space anchors not more than 32 inches o.c., to match coursing, and as follows:
      (1) Two anchors per jamb up to 60 inches high.
      (2) Three anchors per jamb from 60 to 90 inches high.
   b. Stud-Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:
      (1) Three anchors per jamb up to 60 inches high.
      (2) Four anchors per jamb from 60 to 90 inches high.
   c. Compression Type: Not less than two anchors in each frame.
   d. Postinstalled Expansion Type: Locate anchors not more than 6 inches from top and bottom of frame. Space anchors not more than 26 inches o.c.

6. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.
   a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.

E. Fabricate concealed stiffeners and edge channels from either cold- or hot-rolled steel sheet.

F. Hardware Preparation: Factory prepare hollow-metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.
   1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
   2. Comply with applicable requirements in SDI A250.6 and BHMA A156.115 for preparation of hollow-metal work for hardware.

G. Stops and Moldings: Provide stops and moldings around glazed lites and louvers where indicated. Form corners of stops and moldings with butted or mitered hairline joints.
   1. Provide stops and moldings flush with face of door, and with square stops unless otherwise indicated.
   2. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow-metal work.
   3. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
   4. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames. Provide loose stops and moldings on inside of hollow-metal work.
   5. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.
   6. Provide stops for installation with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

2.10 STEEL FINISHES:
A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
   1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.
SECTION 08 11 13 – HOLLOW METAL DOORS AND FRAMES: continued

2.11 ACCESSORIES:
A. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.
B. Grout Guards: Formed from same material as frames, not less than 0.016 inch (0.4 mm) thick.

PART 3 - EXECUTION

3.01 EXAMINATION:
A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION:
A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.
B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.03 INSTALLATION:
A. General: Install hollow-metal doors and frames plumb, rigid, properly aligned, and securely fastened in place. Comply with Drawings and manufacturer's written instructions.
B. Hollow-Metal Frames: Comply with SDI A250.11.
   1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
      a. Install frames with removable stops located on secure side of opening.
      b. Install door silencers in frames before grouting.
      c. Remove temporary braces necessary for installation only after frames have been properly set and secured.
      d. Check plumb, square, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
      e. Field apply bituminous coating to backs of frames that will be filled with grout containing antifreezing agents.
   2. At fire-rated openings, install frames according to NFPA 80.
   3. Floor Anchors: Secure with postinstalled expansion anchors.
      a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
   5. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.
   6. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
   7. In-Place Metal or Wood-Stud Partitions: Secure slip-on drywall frames in place according to manufacturer's written instructions.
8. Installation Tolerances: Adjust hollow-metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
   a. Squareness: ±1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
   b. Alignment: ±1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
   c. Twist: ±1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
   d. Plumbness: ±1/16 inch (1.6 mm), measured at jambs at floor.

C. Hollow-Metal Doors: Fit hollow-metal doors accurately in frames, within clearances specified below.
   1. Non-Fire-Rated Steel Doors: Comply with SDI A250.8.
   2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.

D. Glazing: Comply with installation requirements in Section 08 80 00 - Glazing and with hollow-metal manufacturer's written instructions.

3.04 ADJUSTING AND CLEANING:
   A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave Work in complete and proper operating condition. Remove and replace defective work, including hollow-metal work that is warped, bowed, or otherwise unacceptable.
   B. Remove grout and other bonding material from hollow-metal work immediately after installation.
   C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

END OF SECTION 08 11 13
SECTION 08 14 16 – WOOD DOORS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. This Section includes:
      1. Solid-core doors with wood-veneer faces.
      2. Factory finishing flush wood doors.
      3. Factory fitting flush wood doors to frames and factory machining for hardware.

1.03 RELATED REQUIREMENTS:
   A. Section 08 11 13 – Hollow Metal Doors and Frames for metal frames.
   B. Section 08 70 00 – Door Hardware.
   C. Section 08 80 00 - Glazing for glass view panels in flush wood doors.

1.04 REFERENCED STANDARDS:
   A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
   B. American National Standards Institute (ANSI):
      1. ANSI A208.1 - Particleboard.
   C. Architectural Woodwork Institute (AWI)/Architectural Woodwork Manufacturers Association of Canada (AWMA)/Woodwork Institute (WI):
      1. Architectural Woodwork Standards.
   D. Builders Hardware Manufacturers Association (BHMA):
      1. BHMA-156.115-W-2006: Hardware Preparation in Wood Doors with Wood or Steel Frames.
   E. Door and Hardware Institute (DHI):
      1. DHI-WDHS-3-1996: Recommended Hardware Locations for Wood Flush Doors.
   F. Forest Stewardship Council:
   G. Underwriters Laboratories Inc. (UL):
      1. UL 10C - Positive Pressure Fire Tests of Door Assemblies.
      2. UL 1784 - Air Leakage Tests of Door Assemblies and Other Opening Protectives.
   H. Window & Door Manufacturers Association (WDMA):
      3. WDMA T.M.-6 - Adhesive Durability.
      4. WDMA T.M.-10 - Screw Holding Capacity.

1.05 SUBMITTALS:
   A. Product Data: For each type of door. Include details of core and edge construction and trim for openings. Include factory-finishing specifications.
   B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; and the following:
      1. Dimensions and locations of blocking.
      2. Dimensions and locations of mortises and holes for hardware.
SECTION 08 14 16 – WOOD DOORS: continued

3. Dimensions and locations of cutouts.
4. Undercuts.
5. Doors to be factory finished and finish requirements.
   C. Samples for Initial Selection: For factory-finished doors.
   D. Sample Warranty: For special warranty.
   E. Quality Standard Compliance Certificates: WI Certified Compliance Program certificates.

1.06 QUALITY ASSURANCE:
   A. Manufacturer Qualifications: A qualified manufacturer that is a licensee of WI's Certified Compliance Program.

1.07 DELIVERY, STORAGE, AND HANDLING:
   A. Comply with requirements of referenced standard and manufacturer's written instructions.
   B. Package doors individually in cardboard cartons and wrap bundles of doors in plastic sheeting.
   C. Mark each door on top and bottom rail with opening number used on Shop Drawings.

1.08 FIELD CONDITIONS:
   A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during remainder of construction period.

1.09 WARRANTY:
   A. Special Warranty: Manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
      1. Failures include, but are not limited to, the following:
         a. Warping (bow, cup, or twist) more than 1/4 inch in a 42- by 84-inch section.
         b. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span.
      2. Doors: Life of installation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. Algoma Hardwoods, Inc. - Novodoor
      2. Eggers Industries. – Master Flush-Particle.
      3. Graham Wood Doors; an Assa Abloy Group company – Edge Glued GPC.
      4. Haley Brothers, Inc. – APC.
      5. Mohawk Doors; a Masonite company – Architectural Grade Bonded Particle.
      6. Oshkosh Door Company Edge Glued GPC.
      7. Architect approved equal.
   B. Source Limitations: Obtain flush wood doors from single manufacturer.

2.02 FLUSH WOOD DOORS, GENERAL:
   A. Quality Standard: In addition to requirements specified, comply with AWI's, AWMAC's, and WI's "Architectural Woodwork Standards WDMA I.S.1-A, "Architectural Wood Flush Doors."
SECTION 08 14 16 – WOOD DOORS:  continued

B. Regional Materials: Flush wood doors shall be manufactured within 500 miles (800 km) of Project Site.

C. Low-Emitting Materials: Fabricate doors with adhesives and composite wood products that do not contain urea formaldehyde.

D. Particleboard-Core Doors:
1. Particleboard: ANSI A208.1, Grade LD-1 or Grade LD-2, made with binder containing no urea-formaldehyde.

2.03 VENEER-FACED DOORS FOR TRANSPARENT FINISH:
A. Interior Solid-Core Doors:
1. Grade: Custom (Grade A faces).
2. Species: Red oak.
3. Cut: Plain sliced (flat sliced).
5. Assembly of Veneer Leaves on Door Faces: Running match.
6. Pair and Set Match: Provide for doors hung in same opening.
7. Room Match: Provide door faces of compatible color and grain within each separate room or area of building.
8. Transom Match: Continuous match.
9. Exposed Vertical Edges: Same species as faces - Edge Type A.
11. Construction: Five plies. Stiles and rails are bonded to core, then entire unit is abrasive planed before veneering.

2.04 LIGHT FRAMES AND LOUVERS:
A. Wood Beads for Light Openings in Wood Doors: Provide manufacturer's standard wood beads unless otherwise indicated.
1. Wood Species: Same species as door faces.
2. Profile: Flush rectangular beads.

2.05 FABRICATION:
A. Factory fit doors to suit frame-opening sizes indicated. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
B. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, BHMA-156.115-W, and hardware templates.
1. Coordinate with hardware mortises in metal frames to verify dimensions and alignment before factory machining.

C. Openings: Factory cut and trim openings through doors.
1. Light Openings: Trim openings with moldings of material and profile indicated.
2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Section 08 80 00 - Glazing.

2.06 FACTORY FINISHING:
A. General: Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
1. Finish faces, all four edges, edges of cutouts, and mortises. Stains and fillers may be omitted on top and bottom edges, edges of cutouts, and mortises.
SECTION 08 14 16 – WOOD DOORS: continued

B. Factory finish doors.
C. Transparent Finish:
   1. Grade: Custom.
   2. Staining: As selected by Architect from manufacturer's full range.
   3. Effect: Open-grain finish.

PART 3 - EXECUTION

3.01 EXAMINATION:
   A. Examine doors and installed door frames, with Installer present, before hanging doors.
   1. Verify that installed frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
   2. Reject doors with defects.
   B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:
   A. Hardware: For installation, see Section 08 71 00 - Door Hardware.
   B. Installation Instructions: Install doors to comply with manufacturer's written instructions and referenced quality standard, and as indicated.
   C. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.
   D. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project Site.

3.03 ADJUSTING:
   A. Operation: Rehang or replace doors that do not swing or operate freely.
   B. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION 08 14 16
SECTION 08 33 23 – OVERHEAD COILING DOORS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. This Section includes:
      1. Insulated service doors.

1.03 RELATED REQUIREMENTS:
   A. Section 05 50 00 - Metal Fabrications for miscellaneous steel supports.

1.04 REFERENCE STANDARDS:
   A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
   B. American Architectural Manufacturers Association:
   C. American Society of Civil Engineers/Structural Engineering Institute:
   D. ASTM International:
      1. ASTM A653/A653M: Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
      2. ASTM A666: Specification for Annealed or Cold-Worked Austenitic Stainless-Steel Sheet, Strip, Plate, and Flat Bar.
      6. ASTM E283: Test Method for Determining the Rate of Air Leakage through Exterior Windows, Curtain Walls, and Doors under Specified Pressure Differences across the Specimen.
   E. Door and Access Systems Manufacturers Association:
   F. International Code Council:
SECTION 08 33 23 – OVERHEAD COILING DOORS: continued

G. National Association of Architectural Metal Manufacturers/National Ornamental & Miscellaneous Metals Association:
   1. Metal Finishes Manual for Architectural and Metal Products (AMP 500).

H. National Electrical Manufacturers Association:
   1. NEMA ICS 1: Industrial Control and Systems General Requirements.
   2. NEMA ICS 6: Industrial Control and Systems Enclosures.

I. NFPA:

J. Underwriters Laboratories Inc.:
   1. UL 325: Door, Drapery, Gate, Louver, and Window Operators and Systems.
   2. UL 1784: Air Leakage Tests of Door Assemblies.

1.05 SUBMITTALS:
A. Product Data: For each type and size of overhead coiling door and accessory.
   1. Include construction details, material descriptions, dimensions of individual components, profiles for slats, and finishes.

B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data.
   1. Include plans, elevations, sections, and mounting details.
   2. Include details of equipment assemblies, and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include points of attachment and their corresponding static and dynamic loads imposed on structure.
   4. For exterior components, include details of provisions for assembly expansion and contraction and for excluding and draining moisture to the exterior.
   5. Show locations of controls, locking devices, and other accessories.

C. Qualification Data: For Installer.

D. Maintenance Data: For overhead coiling doors to include in maintenance manuals.

1.06 QUALITY ASSURANCE:
A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project.

PART 2 - PRODUCTS

2.01 MANUFACTURERS, GENERAL:
A. Source Limitations: Obtain overhead coiling doors from single source from single manufacturer.

2.02 PERFORMANCE REQUIREMENTS:
A. Structural Performance, Exterior Doors: Capable of withstanding the design wind loads.
   1. Design Wind Load: As indicated on Drawings.
   2. Deflection Limits: Design overhead coiling doors to withstand design wind load without evidencing permanent deformation or disengagement of door components.
   3. Operability under Wind Load: Design overhead coiling doors to remain operable under uniform pressure (velocity pressure) of 20 lbf./ft.² wind load, acting inward and outward.
2.03 DOOR ASSEMBLY:
A. Insulated Service Door: Overhead coiling door formed with curtain of interlocking metal slats.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Overhead Door Company, Themacore® Sectional Steel Door or comparable product by one of the following:
      a. ACME Rolling Doors.
      b. Alpine Overhead Doors, Inc.
      c. Raynor.
      d. Engineer approved equal.
B. Operation Cycles: Door components and operators capable of operating for not less than 20,000. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.
C. Air Infiltration: Maximum rate of 0.08 cfm/ft.² (0.406 L/s per m²) at 15 and 25 mph tested according to ASTM E283.
D. Curtain R-Value: 15 minimum.
E. Door Curtain Material: Galvanized steel.
F. Door Curtain Slats: Flat profile slats of [1-7/8-inch (48-mm)] [2-5/8-inch (67-mm)] [3-1/4-inch (83-mm)] <Insert dimension> center-to-center height.
   1. Vision Panels: Approximately 44 by 15-inch openings equally spaced and beginning 12 inches from end guides; in two adjacent rows of slats, with the bottom row at 5° above the bottom of the door. Installed with insulated vision-panel glazing.
   2. Insulated-Slat Interior Facing: Metal.
G. Curtain Jamb Guides: Galvanized steel with exposed finish matching curtain slats.
H. Locking Devices: Equip door with slide bolt for padlock.
J. Curtain Accessories: Equip door with weatherseals.
K. Door Finish:
   1. Factory Prime Finish: Manufacturer's standard color.

2.04 DOOR CURTAIN MATERIALS AND CONSTRUCTION:
A. Door Curtains: Fabricate overhead coiling-door curtain of interlocking metal slats, designed to withstand wind loading indicated, in a continuous length for width of door without splices. Unless otherwise indicated, provide slats of thickness and mechanical properties recommended by door manufacturer for performance, size, and type of door indicated, and as follows:
   1. Steel Door Curtain Slats: Zinc-coated (galvanized), cold-rolled structural steel sheet; complying with ASTM A653/A653M, with G90 (Z275) zinc coating; nominal sheet thickness (coated) of 0.028 inch (0.71 mm); and as required.
   2. Vision-Panel Glazing: Manufacturer's standard clear glazing, fabricated from transparent acrylic sheet or fire-protection rated glass as required for type of door; set in glazing channel secured to curtain slats.
   3. Insulation: Fill slats for insulated doors with manufacturer's standard thermal insulation complying with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E84 or UL 723. Enclose insulation completely within slat faces.
   4. Metal Interior Curtain-Slat Facing: Match metal of exterior curtain-slat face, with minimum steel thickness of 0.010 inch.
B. Curtain Jamb Guides: Manufacturer's standard angles or channels and angles of same material and finish as curtain slats unless otherwise indicated, with sufficient depth and strength to
SECTION 08 33 23 – OVERHEAD COILING DOORS: continued

retain curtain, to allow curtain to operate smoothly, and to withstand loading. Slot bolt holes for guide adjustment. Provide removable stops on guides to prevent overtravel of curtain.

2.05 LOCKING DEVICES:
A. Slide Bolt: Fabricate with side-locking bolts to engage through slots in tracks for locking by padlock, located on both left and right jamb sides, operable from coil side.
B. Chain Lock Keeper: Suitable for padlock.

2.06 CURTAIN ACCESSORIES:
A. Weatherseals for Exterior Doors: Equip each exterior door with weather-stripping gaskets fitted to entire exterior perimeter of door for a weather-resistant installation unless otherwise indicated.
   1. At door head, use 1/8-inch (3-mm) thick, replaceable, continuous-sheet baffle secured to inside of hood or field-installed on the header.
   2. At door jambs, use replaceable, adjustable, continuous, flexible, 1/8-inch (3-mm) thick seals of flexible vinyl, rubber, or neoprene.

2.07 COUNTERBALANCING MECHANISM:
A. General: Counterbalance doors by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.
B. Counterbalance Barrel: Fabricate spring barrel of manufacturer's standard hot-formed, structural-quality, seamless carbon-steel pipe, of sufficient diameter and wall thickness to support rolled-up curtain without distortion of slats and to limit barrel deflection to not more than 0.03 inch/ft. of span under full load.
C. Counterbalance Spring: One or more oil-tempered, heat-treated steel helical torsion springs. Size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Secure ends of springs to barrel and shaft with cast-steel barrel plugs.
D. Torsion Rod for Counterbalance Shaft: Fabricate of manufacturer's standard cold-rolled steel, sized to hold fixed spring ends and carry torsional load.
E. Brackets: Manufacturer's standard mounting brackets of either cast iron or cold-rolled steel plate.

2.08 MANUAL DOOR OPERATORS:
A. General: Equip door with manual door operator by door manufacturer.
B. Chain-Hoist Operator: Consisting of endless steel hand chain, chain-pocket wheel and guard, and gear-reduction unit with a maximum 30-lbf. force for door operation. Provide alloy-steel hand chain with chain holder secured to operator guide.

2.09 GENERAL FINISH REQUIREMENTS:
A. Comply with NAAMM/NOMMA's "Metal Finishes Manual for Architectural and Metal Products (AMP 500-06)" for recommendations for applying and designating finishes.
B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
SECTION 08 33 23 – OVERHEAD COILING DOORS: continued

2.10 STEEL AND GALVANIZED-STEEL FINISHES:
   A. Factory Prime Finish: Manufacturer's standard primer, compatible with field-applied finish. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.
   B. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.

PART 3 - EXECUTION

3.01 EXAMINATION:
   A. Examine substrates areas and conditions, with Installer present, for compliance with requirements for substrate construction and other conditions affecting performance of the Work.
   B. Examine locations of electrical connections.
   C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:
   A. Install overhead coiling doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.
   B. Install overhead coiling doors, hoods, controls, and operators at the mounting locations indicated for each door.

3.03 STARTUP SERVICE:
   A. Engage a factory-authorized service representative to perform startup service.
      1. Perform installation and startup checks according to manufacturer's written instructions.
      2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

3.04 ADJUSTING:
   A. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion.
      1. Adjust exterior doors and components to be weather-resistant.
   B. Lubricate bearings and sliding parts as recommended by manufacturer.
   C. Adjust seals to provide tight fit around entire perimeter.

3.05 DEMONSTRATION:
   A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain overhead coiling doors.

END OF SECTION 08 33 23
SECTION 08 51 13 – ALUMINUM WINDOWS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary
      Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. This Section includes aluminum windows for exterior locations.

1.03 RELATED REQUIREMENTS:
   A. Section 08 80 00 - Glazing

1.04 REFERENCE STANDARDS:
   A. Publication Dates: Comply with standards in effect as of date of the Contract Documents
      unless otherwise indicated.
   B. American Architectural Manufacturers Association:
      1. AAMA 502: Voluntary Specification for Field Testing of Newly Installed Fenestration
         Products.
      3. AAMA 901: Voluntary Specification for Rotary & Linear Operators in Window
         Applications.
      5. AAMA 907: Voluntary Specification for Corrosion Resistant Coatings on Carbon-Steel
         Components.
      6. AAMA 1503: Voluntary Test Method for Thermal Transmittance and Condensation
         Resistance of Windows, Doors and Glazed Wall Sections.
      7. AAMA 2603: Voluntary Specification, Performance Requirements and Test Procedures
         for Pigmented Organic Coatings on Aluminum Extrusions and Panels.
      8. AAMA 2604: Voluntary Specification, Performance Requirements and Test Procedures
         for High Performance Organic Coatings on Aluminum Extrusions and Panels.
      9. AAMA 2605: Voluntary Specification, Performance Requirements and Test Procedures
         for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.
   C. American Architectural Manufacturers Association/Window & Door Manufacturers:
      1. AAMA/WDMA/CSA 101/I.S.2/A440: NAFS - North American Fenestration
   D. ASTM International:
      1. ASTM C1036: Specification for Flat Glass.
      3. ASTM D3656/D3656M: Specification for Insect Screening and Louver Cloth Woven
         from Vinyl-Coated Glass Yarns.
      4. ASTM E90: Test Method for Laboratory Measurement of Airborne Sound Transmission
         Loss of Building Partitions and Elements.
      6. ASTM E413: Classification for Rating Sound Insulation.
      7. ASTM E1332: Classification for Rating Outdoor-Indoor Sound Attenuation.
      8. ASTM E1886: Test Method for Performance of Exterior Windows, Curtain Walls,
         Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic
         Pressure Differentials.
SECTION 08 51 13 – ALUMINUM WINDOWS: continued


E. National Association of Architectural Metal Manufacturers:

F. National Fenestration Rating Council:
1. NFRC 100-: Procedure for Determining Fenestration Product U-Factors.

G. Screen Manufacturers Association:
1. SMA 1004: Specifications for Aluminum Tubular Frame Screens for Windows (ANSI).

1.05 SUBMITTALS:
A. Product Data: For each type of product.
   1. Include construction details, material descriptions, glazing and fabrication methods, dimensions of individual components and profiles, hardware, and finishes for aluminum windows.
B. Shop Drawings: Include plans, elevations, sections, hardware, accessories, insect screens, operational clearances, and details of installation, including anchor, flashing, and sealant installation.
C. Samples: For each exposed product and for each color specified, 2 by 4 inches (50 by 100 mm) size.
D. Product Schedule: For aluminum windows. Use same designations indicated on Drawings.
E. Qualification Data: For manufacturer and Installer.
F. Product Test Reports: For each type of aluminum window, for tests performed by a qualified testing agency.
G. Sample Warranties: For manufacturer's warranties.

1.06 QUALITY ASSURANCE:
A. Manufacturer Qualifications: A manufacturer capable of fabricating aluminum windows that meet or exceed performance requirements indicated and of documenting this performance by test reports, and calculations.
B. Installer Qualifications: An installer acceptable to aluminum window manufacturer for installation of units required for this Project.

1.07 WARRANTY:
A. Manufacturer's Warranty: Manufacturer agrees to repair or replace aluminum windows that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Failure to meet performance requirements.
      b. Structural failures including excessive deflection, water leakage, condensation, and air infiltration.
      c. Faulty operation of movable sash and hardware.
      d. Deterioration of materials and finishes beyond normal weathering.
      e. Failure of insulating glass.
   2. Warranty Period:
SECTION 08 51 13 – ALUMINUM WINDOWS: continued

a. Window: Five years from date of Substantial Completion.
b. Glazing Units: Five years from date of Substantial Completion.
c. Aluminum Finish: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:
A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. EFCO Corporation; a Pella company.
   2. Kawneer North America; an Alcoa company.
   3. Architect approved equal.
B. Source Limitations: Obtain aluminum windows from single source from single manufacturer.

2.02 WINDOW PERFORMANCE REQUIREMENTS:
A. Product Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 for definitions and minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.
B. Performance Class and Grade: AAMA/WDMA/CSA 101/I.S.2/A440 as follows:
   1. Minimum Performance Class: CW.
C. Thermal Transmittance: NFRC 100 maximum whole-window U-factor of:
   1. Fixed Windows – 0.36 Btu/ft.² by h by °F (1.71 W/m² by K)
   2. Operable Windows – 0.43 Btu/ft.² by h by °F (1.83 W/m² by K)
D. Solar Heat-Gain Coefficient (SHGC): NFRC 200 maximum whole-window SHGC of 0.40.
E. Condensation-Resistance Factor (CRF): Provide aluminum windows tested for thermal performance according to AAMA 1503, showing a CRF of 45.
F. Thermal Movements: Provide aluminum windows, including anchorage, that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   1. Temperature Change: 120°F (67°C), ambient; 180°F (100°C) material surfaces.
G. Outside-Inside Transmission Class (OITC): Rated for not less than 26OITC when tested for laboratory sound transmission loss according to ASTM E90 and determined by ASTM E1332.

2.03 ALUMINUM WINDOWS:
A. Operating Types: Provide the following operating types in locations indicated on Drawings:
   1. Horizontal sliding.
   2. Fixed.
   1. Thermally Improved Construction: Fabricate frames, sashes, and muntins with an integral, concealed, low-conductance thermal barrier located between exterior materials and window members exposed on interior side in a manner that eliminates direct metal-to-metal contact.
C. Glass: Comply with Section 088000 – Glazing.
SECTION 08 51 13 – ALUMINUM WINDOWS:  continued

D. Hardware, General: Provide manufacturer's standard hardware fabricated from aluminum, stainless steel, carbon steel complying with AAMA 907, or other corrosion-resistant material compatible with adjacent materials; designed to smoothly operate, tightly close, and securely lock windows, and sized to accommodate sash weight and dimensions.
   1. Exposed Hardware Color and Finish: As indicated by manufacturer's designations.

E. Horizontal-Sliding Window Hardware:
   1. Sill Cap/Track: Extruded-aluminum track with natural anodized finish, of dimensions and profile indicated; designed to comply with performance requirements indicated and to drain to the exterior.
   2. Locks and Latches: Allow unobstructed movement of the sash across adjacent sash in direction indicated and operated from the inside only.
   3. Roller Assemblies: Low-friction design.

F. Weather Stripping: Provide full-perimeter weather stripping for each operable sash unless otherwise indicated.

G. Fasteners: Noncorrosive and compatible with window members, trim, hardware, anchors, and other components.
   1. Exposed Fasteners: Do not use exposed fasteners to the greatest extent possible. For application of hardware, use fasteners that match finish hardware being fastened.

2.04 INSECT SCREENS:
   A. General: Fabricate insect screens to integrate with window frame. Provide screen for each operable exterior sash. Screen wickets are not permitted.
      1. Type and Location: Half, outside for sliding sashes.
   B. Aluminum Frames: Manufacturer's standard aluminum alloy complying with SMA 1004 or SMA 1201. Fabricate frames with mitered or coped joints or corner extrusions, concealed fasteners, and removable PVC spline/anchor concealing edge of frame.
      1. Tubular Framing Sections and Cross Braces: Roll formed from aluminum sheet.
   C. Glass-Fiber Mesh Fabric: 18 by 14 (1.1- by 1.4-mm) or 18 by 16 (1.0- by 1.1-mm) mesh of PVC-coated, glass-fiber threads; woven and fused to form a fabric mesh resistant to corrosion, shrinkage, stretch, impact damage, and weather deterioration. Comply with ASTM D3656.
      1. Mesh Color: Manufacturer's standard.

2.05 FABRICATION:
   A. Fabricate aluminum windows in sizes indicated. Include a complete system for assembling components and anchoring windows.
   B. Glaze aluminum windows in the factory.
   C. Weather strip each operable sash to provide weathertight installation.
   D. Weep Holes: Provide weep holes and internal passages to conduct infiltrating water to exterior.
   E. Mullions: Provide mullions and cover plates, matching window units, complete with anchors for support to structure and installation of window units. Allow for erection tolerances and provide for movement of window units due to thermal expansion and building deflections, as indicated. Provide mullions and cover plates capable of withstanding design wind loads of window units.
   F. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to greatest extent possible. Disassemble components only as necessary for shipment and installation.
SECTION 08 51 13 – ALUMINUM WINDOWS: continued

2.06 GENERAL FINISH REQUIREMENTS:
A. Comply with NAAMM's "Metal Finishes Manual" for recommendations for applying and designating finishes.
B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.07 ALUMINUM FINISHES:
A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
B. Class II, Color Anodic Finish: AA-M12C22A32/A34 (Mechanical Finish: Nonspecular as fabricated; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class II, integrally colored or electrolytically deposited color coating 0.010 mm or thicker) complying with AAMA 611.
1. Color: Dark bronze.

PART 3 - EXECUTION

3.01 EXAMINATION:
A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Verify rough opening dimensions, levelness of sill plate, and operational clearances.
C. Examine wall flashings, vapor retarders, water and weather barriers, and other built-in components to ensure weathertight window installation.
D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:
A. Comply with manufacturer's written instructions for installing windows, hardware, accessories, and other components. For installation procedures and requirements not addressed in manufacturer's written instructions, comply with installation requirements in ASTM E2112.
B. Install windows level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction to produce weathertight construction.
C. Install windows and components to drain condensation, water penetrating joints, and moisture migrating within windows to the exterior.
D. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

3.03 FIELD QUALITY CONTROL:
A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
1. Testing and inspecting agency will interpret tests and state in each report whether tested work complies with or deviates from requirements.
B. Testing Services: Testing and inspecting of installed windows shall take place as follows:
1. Testing Methodology: Testing of windows for air infiltration and water resistance shall be performed according to AAMA 502.

2. Water-Resistance Testing:
   b. Allowable Water Infiltration: No water penetration.

3. Testing Extent: Two windows of each type as selected by Architect and a qualified independent testing and inspecting agency. Windows shall be tested after perimeter sealants have cured.


  C. Remove and replace noncomplying windows and retest as specified above.

  D. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

  E. Prepare test and inspection reports.

3.04 ADJUSTING, CLEANING, AND PROTECTION:

  A. Adjust operating sashes and hardware for a tight fit at contact points and weather stripping for smooth operation and weathertight closure.

  B. Clean exposed surfaces immediately after installing windows. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.

    1. Keep protective films and coverings in place until final cleaning.

  C. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

  D. Protect window surfaces from contact with contaminating substances resulting from construction operations. If contaminating substances do contact window surfaces, remove contaminants immediately according to manufacturer's written instructions.

END OF SECTION 08 51 13
SECTION 08 70 00 - FINISH HARDWARE

PART 1 - GENERAL

1.01 **SUMMARY:**
A. This Section includes hardware for the proper installation, operation, and control of doors.

1.02 **RELATED WORK SPECIFIED ELSEWHERE:**
A. Section 08 11 13 – Hollow Metal Doors and Frames
B. Section 08 14 00 – Wood Doors.
C. Section 281000 - Electronic Access Control and Intrusion Detection.

1.03 **REFERENCES:**
A. Applicable Standards:
   1. American National Standards Institute (ANSI):
      a. A115 Series - Door and Frame Preparation.
      b. A156 Series - Hardware.
   2. Builders Hardware Manufacturers Association (BHMA):
      a. 1301 - Materials and Finishes.
   3. Door and Hardware Institute (DHI):
      a. Keying - Procedures, Systems and Nomenclature.
      b. Architectural Hardware Scheduling Sequence and Schedule Format.
      c. Abbreviations and Symbols.
      d. Recommended Locations for Builder's Hardware for Standard Steel Doors and Frames.
      e. Recommended Procedure for Processing Hardware Schedules and Templates.
      f. Recommended Locations for Builder's Hardware for Standard Steel Doors and Frames.
   4. Underwriters Laboratories (UL):
      b. 305 - Panic Hardware.

1.04 **SUBMITTALS:**
A. Submit as specified in DIVISION 01.
B. Includes, but not limited to, the following:
   1. Product data includes manufacturers' technical product data for each item of door hardware, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements.
   2. Final hardware schedule coordinated with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
      a. Final Hardware Schedule Content: Based on hardware indicated, organize schedule into "hardware sets" indicating complete designations of every item required for each door or opening. Include the following information:
         (1) Type, style, function, size, and finish of each hardware item.
         (2) Name and manufacturer of each item.
         (3) Fastenings and other pertinent information.
         (4) Location of each hardware set cross referenced to indications on drawings both on floor plans and in door and frame schedule.
         (5) Explanation of all abbreviations, symbols, and codes contained in schedule.
         (6) Mounting locations for hardware.
         (7) Door and frame sizes and materials.
SECTION 08 70 00 - FINISH HARDWARE: continued

(8) Keying information.

b. Keying Schedule: Submit separate detailed schedule indicating clearly how the Engineer's final instructions on keying of locks has been fulfilled.

c. Templates for doors, frames, and other work specified to be factory prepared for the installation of door hardware. Check shop drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

C. Iron and steel products must be produced in the United States and certifications of such production must be provided to the Owner prior to shipment.

1.05 QUALITY ASSURANCE:

A. Supplier Qualifications: A recognized architectural door hardware supplier, with warehousing facilities in the Project's vicinity, that has a record of successful in-service performance for supplying door hardware similar in quantity, type, and quality to that indicated for this Project and that employs an experienced architectural hardware consultant (AHC) who is available to Engineer and Contractor for consultation at reasonable times during the course of the Work.

1. Require supplier to meet with Engineer to finalize keying requirements and to obtain final instructions in writing.

1.06 DELIVERY, STORAGE, AND HANDLING:

A. Tag each item or package separately with identification related to final hardware schedule and include basic installation instructions with each item or package.

B. Packaging of door hardware is responsibility of supplier. As material is received by hardware supplier from various manufacturers, sort and repackage in containers clearly marked with appropriate hardware set number to match set numbers of approved hardware schedule. Two or more identical sets may be packed in same container.

C. Inventory door hardware jointly with representatives of hardware supplier and hardware installer until each is satisfied that count is correct.

D. Deliver individually packaged door hardware items promptly to place of installation (Project Site).

E. Provide secure lock-up for door hardware delivered to the project, but not yet installed. Control handling and installation of hardware items that are not immediately replaceable so that completion of the work will not be delayed by hardware losses both before and after installation.

1.07 COORDINATION:

A. Coordinate hardware with other Work.

B. Furnish templates and other detail matter as required to each fabricator of doors and frames, and to other Work to be prepared for the installation of hardware.

C. Where Modifications to this Specification are required due to unanticipated conditions, make recommendations of alternative procedures to the Engineer for his consideration and approval.

1.08 MAINTENANCE:

A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner’s continued adjustment, maintenance, and removal and replacement of door hardware.
PART 2 - PRODUCTS

2.01 ACCEPTABLE PRODUCTS:
A. Items of hardware are specified in Door Schedule, with reference to the listing given in this PART - PRODUCT REQUIREMENTS.

2.02 PRODUCT REQUIREMENTS:
A. Hardware shall meet the respective applicable standards specified in PART 1, this Section.
B. Provide hardware complete with all fasteners, anchors, instructions, layout templates, and any specialized tools as required for satisfactory installation and adjustment.
C. Provide manufacturer's standard products meeting the design intent of this Specification, free of imperfections affecting appearance or serviceability.
D. Hardware is specified in PART 2 - HARDWARE SETS, this Section, by type and function category, each of which has been selected as that best meeting the application. Acceptable products are given for each category as follows:

2.03 HARDWARE SCHEDULE:
A. Refer to the Door Schedule and the Drawings to ascertain hands, and sizes.

### HARDWARE SET: 01

FOR USE ON DOOR #101 103

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ADA INGRESS/EGRESS BY ACTUATOR EACH SIDE WHEN EXIT DEVICE IS DOGGED.
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### HARDWARE SET: 08
FOR USE ON DOOR #(S):
102 104

**PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:**

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<td>630</td>
<td>IVE</td>
</tr>
<tr>
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<td>630</td>
<td>IVE</td>
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<td>BK</td>
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<td>8192AA</td>
<td>AA</td>
<td>ZER</td>
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ADA INGRESS/EGRESS BY ACTUATOR EITHER SIDE AT ALL TIMES.

### HARDWARE SET: 09
FOR USE ON DOOR #(S):
105 106

**PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:**

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<th>DESCRIPTION</th>
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<th>MFR</th>
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<td>8303 10&quot; 4&quot; X 16&quot;</td>
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<td>SURFACE CLOSER</td>
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<td>689</td>
<td>LCN</td>
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<tr>
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<td>8400 10&quot; X 2&quot; LDW B-CS</td>
<td>630</td>
<td>IVE</td>
</tr>
<tr>
<td>1</td>
<td>WALL STOP</td>
<td>WS406/407CCV</td>
<td>630</td>
<td>IVE</td>
</tr>
<tr>
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### HARDWARE SET: 10
FOR USE ON DOOR #(S):
113 114 115

**PROVIDE EACH BP DOOR(S) WITH THE FOLLOWING:**

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</thead>
<tbody>
<tr>
<td>1</td>
<td>BYPASS DOOR KIT</td>
<td>100SD X SIZE REQ'D</td>
<td>AL</td>
<td>JOH</td>
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</tbody>
</table>

**Mfr. = MANUFACTURER**

SCH = Schlage
SCE = Schlage Electronics
LCN = LCN
IVE = Ives
ZER = Zero International
VON = Von Duprin
JOH = Johnson Hardware
Or engineer approved equal

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08 70 00 - 6

CHEYENNE LANDFILL ENTRANCE DESIGN  MARCH 2020
SECTION 08 70 00 - FINISH HARDWARE: continued

2.04 **KEYING:**
   A. Keying requirements shall be determined by consultation with the Owner.
   B. Tag and identify keys.
   C. Provide three keys for each lock or cylinder.
   D. Key to existing master key system.
   E. Provide construction master keys for all exterior doors.

2.05 **MATERIALS AND FABRICATION:**
   A. Manufacturer's Name Plate: Do not use manufacturers' products that have manufacturer's name or trade name displayed in a visible location.
      1. Manufacturer's identification will be permitted on rim of lock cylinders only.
   B. Base Metals: Product hardware units of basic metal using manufacturer's standard metal alloy, composition, temper, and hardness, but in no case of lesser quality than specified for applicable hardware units by applicable ANSI/BHMA A156 series standards for each type of hardware item and with ANSI/BHMA A156.18 for finish designations indicated. Do not furnish "optional" materials or forming methods except as otherwise specified.
   C. Fasteners: Provide hardware manufactured to conform to published templates, generally prepared for machine screw installation. Do not provide hardware that has been prepared for self-tapping sheet metal screws, except as specifically indicated or specified.
   D. Furnish screws for installation with each hardware item. Provide Phillips flat-head screws except as otherwise indicated. Finish exposed screws to match hardware finish.
   E. Provide concealed fasteners for hardware units that are exposed when door is closed except to the extent no standard units of type specified are available with concealed fasteners. Do not use thru-bolts for installation where bolt head or nut on opposite face is exposed in other work unless their use is the only means of reinforcing the work adequately to fasten the hardware securely. Where thru-bolts are used as a means of reinforcing the work, provide sleeves for each thru-bolt or use hex screw fasteners.

PART 3 - EXECUTION

3.01 **PREPARATION:**
   A. Check all frames and doors for proper hardware cutouts and reinforcements.
   B. Except as specified otherwise, install articles of hardware after finishes have been completed on the substrate. Note all requirements for coordination with protective coating applications.
   C. Install hardware at such a time in the Project schedule so as to minimize the possibility of damage from the activity of other trades prior to acceptance.
   D. Check the installation directions of PART 1, paragraph 1.02 - Related Work Specified Elsewhere, this Section, before proceeding.

3.02 **INSTALLATION:**
   A. Mount articles of hardware at locations and in the manner prescribed in the respective DHI standards specified in PART 1, this Section, unless otherwise specified.
   B. Install each hardware item in compliance with the manufacturer's instructions and recommendations. Where cutting and fitting is required to install hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation or application of surface protection with finishing work specified in the DIVISION 09 Sections. Do not install surface-mounted items until finishes have been completed on the substrates involved.
   C. Set units level, plumb, and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.
D. All field preparations, such as drilling, cutting, tapping, and countersinking shall be accurately executed to assure precise fitting and adjustment.

E. Use fasteners of correct size and type with anchoring devices as required by construction conditions, suited to the nature of the attachment substrate, and the duty performance required.

F. In the course of installation, avoid damage to hardware mechanisms, finishes, and surrounding surfaces; smearing of paints, sealants, and lubricants onto surfaces not intended to receive them; and the admission of foreign matter into chassis and cases of units and their associated preparations.

G. Seal weather-protection components attached to the exterior sides of doors and frames in place with clear silicone caulk in such a manner as to ensure a continuously filled seam throughout the joinery.

H. Cut and fit weatherstripping accurately so as to affect the greatest possible continuity of the contact element. Where hardware-compatible extrusions are specified "do not cut," adjust templating of soffit-mounted hardware to suit the extrusion thickness and mount all such items on the extrusions.

I. Protection plates shall be installed on visual centers of closed doors. Bottom edges of all such plates shall be flush with bottoms of doors or shall meet top edges of surface-applied door sweeps where they are specified.

J. At exterior doors, obtain satisfactory operation of the installation, then apply a thin layer of clear silicone caulk under hinge leaves, both door and frame. Remove excess caulk after torquing fasteners.

K. Adjust door closers immediately upon installation. Adjust in exact conformance with manufacturer's printed instructions. Back-check shall be advanced to reduce shock at dead stop. Latching speed shall be set to assure unassisted positive latching. Readjustment of closers may be required prior to acceptance as directed by the Engineer. Adjust hold open device so door closes with normal use. Hold open device to be engaged only when extra push to the door is applied.

L. Degrees of swing of doors are given for closers where exact dimensioning, of the installation to achieve the indicated angles, is required.

3.03 ADJUSTMENT AND CLEANING:

A. Check and adjust each operating item of hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate freely and smoothly or as intended for the application made.

1. Where door hardware is installed more than one month prior to acceptance or occupancy return to the installation during the week prior to acceptance or occupancy and make final check and adjustment of all hardware items in such space or area. Clean operating items as necessary to restore proper function and finish of hardware and doors. Adjust door control devices to compensate for final operation of heating and ventilating equipment.

2. Checking and adjustment shall be performed by a certified Architectural Hardware Consultant to ensure proper operation and function of each unit.

B. Lubricate units only as recommended by their manufacturers.

C. Remove excess sealants, lubricants, and any other foreign substances, and protect all installations from subsequent damage.

D. Clean units just prior to final acceptance, with only materials and procedures recommended by their manufacturers.

E. Maintain the sheets of instruction, layout templates, and any supplementary literature regarding hardware in a readable condition. Transmit to the Engineer all such matter together with all spare parts, specialized tools, and other accessories supplied with the hardware. Also, transmit...
to the Engineer a copy of the approved hardware schedule. Notify the Engineer in writing that such transmittal has occurred.

F. Instruct Owner's maintenance personnel in the proper adjustment and maintenance of door hardware and finishes. Instructions shall be performed by a certified Architectural Hardware Consultant or a qualified representative of the manufacturer.

END OF SECTION 08 70 00
SECTION 08 80 00 – GLAZING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary
      Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. This Section includes:
      1. Glass for windows, doors and interior borrowed lites.
      2. Glazing sealants and accessories.

1.03 RELATED REQUIREMENTS:
   A. Section 08 11 13 – Hollow Metal Doors and Frames.
   B. Section 08 14 16 – Flush Wood Doors.
   C. Section 08 51 13 – Aluminum Windows.

1.04 REFERENCE STANDARDS:
   A. Publication Dates: Comply with standards in effect as of date of the Contract Documents
      unless otherwise indicated.
   B. American Society of Civil Engineers/ Structural Engineering Institute:
   C. ASTM International:
      4. ASTM C1048: Specification for Heat-Treated Flat Glass - Kind HS, Kind FT Coated
         and Uncoated Glass.
         with Accessories Used in Structural Glazing Systems.
      7. ASTM C1330: Specification for Cylindrical Sealant Backing for Use with Cold Liquid
         Applied Sealants.
   D. Code of Federal Regulations:
   E. Glass Association of North America:
   F. Insulating Glass Manufacturers Alliance:
         Units for Commercial and Residential Use.
   G. International Code Council:
   H. National Fenestration Rating Council:
      1. NFRC 100: Procedure for Determining Fenestration Product Thermal Properties
         (Currently Limited to U-Factors).
SECTION 08 80 00 – GLAZING: continued


I. National Fire Protection Association (NFPA):
   1. 80 - Fire Doors and Windows.
   2. 252 - Fire Tests of Door Assemblies.
   3. 257 - Fire Test for Window and Glass Block Assemblies.

1.05 DEFINITIONS:
   A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.
   B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C1036.
   D. Interspace: Space between lites of an insulating-glass unit.

1.06 COORDINATION:
   A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.07 SUBMITTALS:
   A. Product Data: For each type of product.
   B. Glass Samples: For each type of glass product other than clear monolithic vision glass; 12 inches (300 mm) square.
   C. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.
   D. Qualification Data: For Installer and glass testing agency.
   E. Product Certificates: For glass.
   F. Product Test Reports: For insulating glass, fire rated glass and glazing sealants, 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.
   G. Preconstruction adhesion and compatibility test report.
   H. Sample Warranties: For special warranties.

1.08 QUALITY ASSURANCE:
   A. Manufacturer Qualifications for Insulating-Glass Units with Sputter-Coated, Low-E Coatings: A qualified insulating-glass manufacturer who is approved by coated-glass manufacturer.
   B. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.
   C. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C1021 to conduct the testing indicated.

1.09 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.
SECTION 08 80 00 – GLAZING: continued

1.10 FIELD CONDITIONS:
A. 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°F (4.4°C).

1.11 WARRANTY:
A. General: Warranties specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and will be in addition to and run concurrent with other warranties made by the Contractor under requirements of the Contract Documents.
B. Manufacturer's Special Warranty for Insulating Glass: Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.
1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:
A. Source Limitations for Glass: Obtain from single source from single manufacturer for each glass type.
1. Obtain tinted glass from single source from single manufacturer.
2. Obtain reflective-coated glass from single source from single manufacturer.
B. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.

2.02 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. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined according to the IBC and ASTM E1300.
1. Design Wind Pressures: As indicated on Drawings.
2. Thickness of Patterned Glass: Base design of patterned glass on thickness at thinnest part of the glass.
C. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.
D. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
1. For monolithic-glass lites, properties are based on units with lites 6 mm thick.
2. For laminated-glass lites, properties are based on products of construction indicated.
SECTION 08 80 00 – GLAZING: continued

3. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
4. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL’s WINDOW 5.2 computer program, expressed as Btu/ft.² by h by °F (W/m² by K).
5. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to IECC Table C402.4.
6. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

2.03 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: "Glazing Manual."
B. Thickness: Where glass thickness is indicated, it is a minimum.

2.04 GLASS PRODUCTS:
A. Clear Annealed Float Glass: ASTM C1036, Type I, Class 1 (clear), Quality-Q3.
B. Heat-Strengthened Float Glass: ASTM C1048, 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.

2.05 INSULATING GLASS:
A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E2190.
1. Sealing System: Dual seal, with manufacturer's standard primary and secondary sealants.
2. Spacer: Manufacturer's standard spacer material and construction.
3. Desiccant: Molecular sieve or silica gel, or a blend of both.
4. Performance Characteristics: Visible light transmittance of 15, exterior light reflectance of 10%, interior light reflectance of 38%, winter nighttime U-value of 0.36 (fixed windows). 0.43 (operable windows) and 0.77 (entrance doors), solar heat gain coefficient of according to IECC Table C402.4, and light-to-solar gain of 0.60.
5. Basis of Design Product: Vitro Architectural Glass Solarcool Pacifica
6. Use in the following Admin and Scale House locations:
   a. Exterior doors.
   b. Exterior windows.
   c. Scale building

2.06 HEAT-TREATED GLASS PRODUCTS:
A. Tempered Glass:
1. Float glass, ASTM C1048 Condition A, uncoated surfaces, transparent glass, flat, clear, glazing select quality q3, find FT (fully tempered) conforming to ANSI Z97.1.
2. 1/4 inch thickness.
3. IGU with ¼ inch lite, ½ inch air space and ¼ inch glass used at Lab Storefront and Control Room Storefront.
SECTION 08 80 00 – GLAZING: continued

5. Use in following locations:
   a. Non-Fire Rated interior doors.
   b. Non-Fire Rated interior windows and sidelites.

2.07 FIRE RATED GLASS:
   A. Fire rated glass:
      1. 90 minute fired rated glass.
      2. Pilkington Pyrostop Fire-Rated, Impact Safety-Rated Transparent Wall Panels. 90 minute rated 2 1/8” thick IGU. Provide framing to accommodate IGU. Or engineer approved equal.
      3. Use in the following locations:
         a. Fire rated interior doors.

2.08 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: As selected by Architect from manufacturer's full range
   B. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C920, Type S, Grade NS, Class 25, Use NT.
      1. Sika Corporation – Sikasil SG-10, or architect approved equal.
      2. Applications: Use in locations with single-pane glass.

2.09 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 Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, ±5.
   D. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
   E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

2.10 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°F (67°C), ambient; 180°F (100°C), material surfaces.
SECTION 08 80 00 – GLAZING: continued

B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.

PART 3 - EXECUTION

3.01 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.

3.02 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.

3.03 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 blocks 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. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
H. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.
I. Set glass lites with proper orientation so that coatings face exterior or interior as specified.
SECTION 08 80 00 – GLAZING: continued

3.04 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.

3.05 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 21 16 - GYPSUM BOARD ASSEMBLIES

PART 1 - GENERAL

1.01 SUMMARY:
   A. This Section includes the following:
      1. Nonload-bearing steel framing members for gypsum board assemblies.
      2. Gypsum board assemblies attached to steel framing.

1.02 REFERENCES:
   A. American National Standards Institute (ANSI):
      1. A108.11 - Interior Installation of Cementitious Backer Units.
      2. A118.9 - Cementitious Backer Units.
   B. American Society for Testing and Materials (ASTM):
      1. A568/A568MN - Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements.
      3. A653/A653M - Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
      9. C475 - Joint Compound and Joint Tape for Finishing Gypsum Board.
     13. C630/C630M - Water-Resistant Gypsum Backing Board.
     14. C645 - Nonload (Axial) Bearing Steel Studs, Runners (Track) and Rigid Furring Channels for Screw Application of Gypsum Board.
     16. C754 - Installation of Steel Framing Members to Receive Screw-Attached Gypsum Board.
     21. C954 - Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness.
     22. C1002 - Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
     24. C1178/C1178M - Glass Mat Water-Resistant Gypsum Backing Board.
30. E413 - Classification for Rating Sound Insulation.

C. Gypsum Association (GA):
   2. 216 - Application and Finishing of Gypsum Board.

D. Underwriters Laboratories (UL):

E. United States Gypsum Co.

1.03 DEFINITIONS:
A. Gypsum Board Construction Terminology: Refer to ASTM C11 for definitions of terms for gypsum board assemblies not defined in this Section or in other referenced standards.

1.04 SUBMITTALS:
A. Product Data for each type of product specified.
B. Shop Drawings showing locations, fabrication, and installation of control and expansion joints including plans, elevations, sections, details of components, and attachments to other units of Work.
C. Product certificates signed by manufacturers of gypsum board assembly components certifying that their products comply with specified requirements.

1.05 QUALITY ASSURANCE:
A. Single-Source Responsibility for Steel Framing: Obtain steel framing members for gypsum board assemblies from a single manufacturer, unless otherwise indicated.
B. Single-Source Responsibility for Panel Products: Obtain each type of gypsum board and other panel products from a single manufacturer.
C. Single-Source Responsibility for Finishing Materials: Obtain finishing materials from either the same manufacturer that supplies gypsum board and other panel products or from a manufacturer acceptable to gypsum board manufacturer.
D. Fire-Test-Response Characteristics: Where fire-resistance-rated gypsum board assemblies are indicated, provide gypsum board assemblies that comply with the following requirements:
   1. Fire-Resistance Ratings: As indicated by GA File Numbers in GA-600 "Fire Resistance Design Manual" or design designations in UL "Fire Resistance Directory" or in the listing of another testing and inspecting agency acceptable to authorities having jurisdiction.
   2. Gypsum board assemblies indicated are identical to assemblies tested for fire resistance according to ASTM E119 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.
SECTION 09 21 16 - GYPSUM BOARD ASSEMBLIES: CONTINUED

3. Deflection and Firestop Track: Top runner provided in fire-resistance-rated assemblies indicated is labeled and listed by UL, Intertek Testing Services, or another testing and inspecting agency acceptable to authorities having jurisdiction.

1.06 DELIVERY, STORAGE, AND HANDLING:
A. Deliver materials in original packages, containers, or bundles bearing brand name and identification of manufacturer or supplier.
B. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes. Neatly stack gypsum panels flat to prevent sagging.

1.07 PROJECT CONDITIONS:
A. Environmental Conditions, General: Establish and maintain environmental conditions for applying and finishing gypsum board to comply with ASTM C840 requirements or gypsum board manufacturer's recommendations, whichever are more stringent.
B. Room Temperatures: For non-adhesive attachment of gypsum board to framing, maintain not less than 40°F (4°C). For adhesive attachment and finishing of gypsum board, maintain not less than 50°F (10°C) for 48 hours before application and continuously after until dry. Do not exceed 95°F (35°C) when using temporary heat sources.
C. Ventilation: Ventilate building spaces as required to dry joint treatment materials. Avoid drafts during hot, dry weather to prevent finishing materials from drying too rapidly.

1.08 WARRANTY
A. The Manufacturer shall warrant that all assemblies shall be free from defects caused by faulty material or workmanship for a minimum period of two (2) years from the date of Substantial Completion, unless otherwise specified.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Steel Framing and Furring:
      b. Consolidated Systems, Inc.
      c. National Gypsum Co.; Gold Bond Building Products Division.
      d. Unimast, Inc.
      e. The Steel Network.
   2. Grid Suspension Assemblies:
      a. Ref to Specification 09 51 23.
   3. Gypsum Board and Related Products:
      a. American Gypsum Co.
      b. Georgia-Pacific Corp.
      c. National Gypsum Co.; Gold Bond Building Products Division.
      d. United States Gypsum Co.
      e. CertainTeed, a Saint Gobain Company
SECTION 09 21 16 - GYPSUM BOARD ASSEMBLIES: CONTINUED

B. Products: Subject to compliance with requirements, provide one of the following products where proprietary gypsum wallboard is indicated:
1. Gyprock Fireguard C Gypsum Board; Domtar Gypsum.
2. Firestop Type C; Georgia-Pacific Corp.
3. Fire-Shield G; National Gypsum Co.; Gold Bond Building Products Division.
4. SHEETROCK Brand Gypsum Panels, FIRECODE C Core; United States Gypsum Co.
5. SHEETROCK Brand Gypsum Panels, ULTRACODE Core; United States Gypsum Co.

2.02 STEEL FRAMING COMPONENTS FOR SUSPENDED AND FURRED CEILINGS:
A. General: Provide components complying with ASTM C754 for conditions indicated.
B. Wire Ties: ASTM A641 (ASTM A641M), Class 1 zinc coating, soft temper, 0.062 inch thick.
C. Wire Hangers: ASTM A641 (ASTM A641M), Class 1 zinc coating, soft temper, 0.162-inch diameter.
D. Hanger Rods: Mild steel and zinc coated or protected with rust-inhibitive paint.
E. Flat Hangers: Mild steel and zinc coated or protected with rust-inhibitive paint.
F. Angle-Type Hangers: Angles with legs not less than 7/8-inch wide, formed from 0.0635-inch thick galvanized steel sheet complying with ASTM A653, G90 (ASTM A653M, Z180) coating designation, with bolted connections and 5/16-inch diameter bolts.
G. Channels: Cold-rolled steel, 0.0598-inch minimum thickness of base (uncoated) metal and 7/16-inch wide flanges, and as follows:
1. Carrying Channels: 2 inches deep, 590 lb/1000 feet, unless otherwise indicated.
2. Finish: Rust-inhibitive paint, unless otherwise indicated.
H. Grid Suspension System for Interior Ceilings: ASTM C645, manufacturer's standard direct-hung grid suspension system composed of main beams and cross-furring members that interlock to form a modular supporting network.

2.03 STEEL FRAMING FOR INTERIOR PARTITIONS:
A. General: Provide steel framing members complying with the following requirements:
1. Protective Coating:
   b. Manufacturer's standard corrosion-resistant coating.
   c. ASTM A653, G40 (ASTM A653M, Z90) hot-dip galvanized coating for framing members attached to and within 10 feet of exterior walls.
B. Steel Studs and Runners: ASTM C645, with flange edges of studs bent back 90° and doubled over to form 3/16 inch wide minimum lip (return), and complying with the following requirements for minimum thickness of base (uncoated) metal and for depth:
1. Thickness:
   a. 20 Gauge.
2. Depth:
   a. 3-5/8 inches, unless otherwise indicated.
C. Deflection Track: Manufacturer's top runner complying with the requirements of ASTM C645 and with 3-inch deep flanges and 0.0456 inch (20 Gauge) minimum thickness.
D. Vertical Deflection Clips: Manufacturer's standard clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web and capable of resisting forces imposed by the wall system.
1. ClarkDetrich Fast Top Clip FTC3 with a slip allowance of 1-1/4".
2. Or approved equal.

E. Steel Rigid Furring Channels: ASTM C645, hat shaped, depth and minimum thickness of base (uncoated) metal as follows:
   1. Thickness:
      a. 0.0456 inch (20 Gauge).
   2. Depth:
      a. 1-1/2 inch.

F. Z-Furring Members: Manufacturer's standard Z-shaped furring members with slotted or nonslotted web, fabricated from steel sheet complying with ASTM A653 (ASTM A653M) or ASTM A568 (ASTM A568M); with a minimum base metal (uncoated) thickness of 0.0179 inch, face flange of 1-1/4 inch, wall-attachment flange of 7/8 inch, and of depth required to fit insulation thickness indicated.

G. Steel Channel Bridging: Cold-rolled steel, 0.0598-inch minimum thickness of base (uncoated) metal and 7/16-inch wide flanges, 1-1/2 inches deep, 475 lb/1000 feet, unless otherwise indicated.

H. Steel Flat Strap and Backing Plate: Steel sheet for blocking and bracing complying with ASTM A653 (ASTM A653M) or ASTM A568 (ASTM A568M); with a minimum base metal (uncoated) thickness as follows:
   1. Thickness:
      a. 0.0179-inch, unless otherwise indicated.

I. Fasteners for Metal Framing: Provide fasteners of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel framing and furring members securely to substrates involved; complying with the recommendations of gypsum board manufacturers for applications indicated.
   1. All steel stud, runner, and track fastening shall be accomplished using a minimum #12 self-drilling screw, unless noted otherwise.

2.04 GYPSUM BOARD PRODUCTS:
   A. General: Provide gypsum board of types indicated in maximum lengths available that will minimize end-to-end butt joints in each area indicated to receive gypsum board application.
   1. Width:
      a. Provide gypsum board in widths of 48 inches.

B. Gypsum Wallboard: ASTM C36 and as follows:
   1. Type:
      a. Regular for vertical surfaces, unless otherwise indicated.
      b. Type X where required for fire-resistance-rated assemblies.
      c. Sag-resistant type for ceiling surfaces.
      d. Moisture resistant drywall as indicated on drawings.
   2. Edges:
      a. Tapered.
   3. Thickness:
      a. 5/8-inch unless indicated otherwise.

2.05 SUBSTRATE BOARD:
   A. ASTM D3273, glass-mat, water-resistant gypsum substrate, 1/2 inch.
   1. Products: Subject to compliance with requirements, provide one of the following:
SECTION 09 21 16 - GYPSUM BOARD ASSEMBLIES: CONTINUED

a. Georgia-Pacific Corporation; DensGlass.

2.06 CEMENTITIOUS BACKER UNITS:
   A. Provide cementitious backer units under all wall tile and as indicated on drawings complying
      with ANSI A118.9, of thickness and width indicated below, and in maximum lengths available
      to minimize end-to-end butt joints.
      1. Thickness:
         a. 1/2-inch, unless otherwise indicated.
      2. Width:
         a. 32 inches.
   B. Products: Subject to compliance with requirements, provide one of the following products:
      1. The Original Wonderboard; Custom Building Products.
      2. Wonderboard Multi+Board; Custom Building Products.
      3. Util-A-Crete Concrete Backer Board; FinPan, Inc.
      4. DUROCK Cement Board; United States Gypsum Co.
      5. Or approved equal.

2.07 INSULATING MATERIALS:
   A. General: Provide insulating materials that comply with requirements and with referenced
      standards.
      1. Preformed Units: Sizes to fit applications indicated; selected from manufacturer's
         standard thicknesses, widths, and lengths.
   B. Manufacturers: Subject to compliance with requirements, provide insulation products by one
      of the following:
      1. Glass-Fiber Blanket Insulation:
         a. CertainTeed Corporation.
         b. Guardian Fiberglass, Inc.
         c. Johns Manville.
         d. Knauf Fiber Glass.
         e. Owens Corning.
      C. Unfaced, Glass-Fiber Blanket Insulation: ASTM C665, Type I (blankets without membrane
         facing); consisting of fibers; with maximum flame spread and smoke-developed indexes of 25
         and 50, respectively; passing ASTM E136 for combustion characteristics.
      D. Where glass-fiber blanket insulation is indicated by the following thicknesses, provide blankets
         in batt or roll form with thermal resistances indicated:
         1. 3-1/2 inches thick with a thermal resistance of 11ºF by h by sq. ft./Btu at 75ºF.

2.08 INTERIOR WALL INSULATING MATERIALS:
   A. Mineral-Wool Blanket, Unfaced: ASTM C665, Type 1 (blankets without membrane facing);
      consisting of fibers; with maximum flame spread and smoke-developed indexes of 25
      and 50, respectively, per ASTM E84; passing ASTM E136 for combustion characteristics.
      1. Sound Transmission Class: minimum 52.
      2. Noise Reduction Coefficient: minimum of 1.00.
      3. Thickness: 3 inches.
      4. Moisture repellent; does not promote fungi growth.
   B. Manufacturers: Subject to compliance with requirements, provide insulation products by one
      of the following:
SECTION 09 21 16 - GYPSUM BOARD ASSEMBLIES: CONTINUED

1. Roxul AFB.
2. Engineer approved equal.
C. See Section 07 21 19 – Foamed-in-Place Insulation for insulation at interior side of exterior walls.

2.09 TRIM ACCESSORIES:
A. Accessories for Interior Installation: Cornerbead, edge trim, and control joints complying with ASTM C1047 and requirements indicated below:
1. Material: Formed metal or plastic, with metal complying with the following requirement:
   a. Steel sheet zinc coated by hot-dip process or rolled zinc.
2. Shapes indicated below by reference to Fig. 1 designations in ASTM C1047:
   a. Cornerbead on outside corners, unless otherwise indicated.
   b. LC-bead with both face and back flanges; face flange formed to receive joint compound. Use LC-beads for edge trim, unless otherwise indicated.
   c. L-bead with face flange only; face flange formed to receive joint compound. Use L-bead where indicated.

2.10 JOINT TREATMENT MATERIALS:
A. General: Provide joint treatment materials complying with ASTM C475 and the recommendations of both the manufacturers of sheet products and of joint treatment materials for each application indicated.
B. Joint Tape for Gypsum Board: Paper reinforcing tape, unless otherwise indicated.
   1. Use pressure-sensitive or staple-attached, open-weave, glass-fiber reinforcing tape with compatible joint compound where recommended by manufacturer of gypsum board and joint treatment materials for application indicated.
C. Joint Tape for Cementitious Backer Units: As recommended by cementitious backer unit manufacturer.
D. Setting-Type Joint Compounds for Gypsum Board: Factory-packaged, job-mixed, chemical-hardening powder products formulated for uses indicated.
   1. Where setting-type joint compounds are indicated as a taping compound only or for taping and filling only, use formulation that is compatible with other joint compounds applied over it.
   2. For prefilling gypsum board joints, use formulation recommended by gypsum board manufacturer.
   3. For filling joints and treating fasteners of water-resistant gypsum backing board behind base for ceramic tile, use formulation recommended by gypsum board manufacturer.
   4. For topping compound, use sandable formulation.
E. Drying-Type Joint Compounds for Gypsum Board: Factory-packaged vinyl-based products complying with the following requirements for formulation and intended use.
      a. Taping compound formulated for embedding tape and for first coat over fasteners and face flanges of trim accessories.
      b. Topping compound formulated for fill (second) and finish (third) coats.
      c. All-purpose compound formulated for both taping and topping compounds.
      a. Taping compound formulated for embedding tape and for first coat over fasteners and face flanges of trim accessories.
b. Topping compound formulated for fill (second) and finish (third) coats.
c. All-purpose compound formulated for both taping and topping compounds.

F. Joint Compound for Cementitious Backer Units: Material recommended by cementitious backer unit manufacturer.

2.11 MISCELLANEOUS MATERIALS:
A. General: Provide auxiliary materials for gypsum board construction that comply with referenced standards and recommendations of gypsum board manufacturer.
B. Laminating Adhesive: Special adhesive or joint compound recommended for laminating gypsum panels.
C. Spot Grout: ASTM C475, setting-type joint compound recommended for spot-grouting hollow metal door frames.
D. Fastening Adhesive for Metal: Special adhesive recommended for laminating gypsum panels to steel framing.
E. Steel drill screws complying with ASTM C1002 for the following applications:
   1. Fastening gypsum board to steel members less than 0.033 inch thick.
F. Foam Gaskets: Closed-cell vinyl foam adhesive-backed strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit metal stud size indicated.

PART 3 - EXECUTION

3.01 EXAMINATION:
A. Examine substrates to which gypsum board assemblies attach or abut, installed hollow metal frames, cast-in-anchors, and structural framing, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of assemblies specified in this Section. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 PREPARATION:
A. Ceiling Anchorages: Coordinate installation of ceiling suspension systems with installation of overhead structural assemblies to ensure that inserts and other provisions for anchorages to building structure have been installed to receive ceiling hangers that will develop their full strength and at spacing required to support ceilings.

3.03 INSTALLING STEEL FRAMING, GENERAL:
A. Steel Framing Installation Standard: Install steel framing to comply with ASTM C754 and with ASTM C840 requirements that apply to framing installation.
B. Install supplementary framing, blocking, and bracing at terminations in gypsum board assemblies to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction. Comply with details indicated and with recommendations of gypsum board manufacturer or, if none available, with United States Gypsum Co. "Gypsum Construction Handbook."
C. Isolate steel framing from building structure at locations indicated to prevent transfer of loading imposed by structural movement. Comply with details shown on Drawings.
   1. Where building structure abuts ceiling perimeter or penetrates ceiling.
   2. Where partition framing and wall furring abut structure, except at floor.
SECTION 09 21 16 - GYPSUM BOARD ASSEMBLIES: CONTINUED

a. Provide slip or cushioned-type joints as detailed to attain lateral support and avoid axial loading.

b. Install deflection track top runner and vertical deflection clips, as indicated, to attain lateral support and avoid axial loading.

c. Install deflection and vertical deflection clips, as indicated, and firestop track top runner at fire-resistance-rated assemblies where indicated.

D. Do not bridge building control and expansion joints with steel framing or furring members. Independently frame both sides of joints with framing or furring members as indicated.

3.04 INSTALLING STEEL FRAMING FOR SUSPENDED AND FURRED GYPSUM CEILINGS:

A. Suspend ceiling hangers from building structural members and as follows:
   1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or ceiling suspension system. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
   2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with the location of hangers required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.
   3. Secure wire hangers by looping and wire-tying, either directly to structures or to inserts, eyescrews, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause them to deteriorate or otherwise fail.
   4. Secure flat, angle, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eyescrews, or other devices and fasteners that are secure and appropriate for structure as well as for type of hanger involved, and in a manner that will not cause them to deteriorate or otherwise fail.
   5. Do not attach hangers to steel deck tabs.
   6. Do not attach hangers to steel roof deck. Attach hangers to structural members.
   7. Do not connect or suspend steel framing from ducts, pipes, or conduit.

B. Sway-brace suspended steel framing with hangers used for support.

C. Install suspended steel framing components in sizes and at spacings indicated, but not less than that required by the referenced steel framing installation standard.
   1. Wire Hangers: 48 inches o.c.

D. Grid Suspension System: Attach perimeter wall track or angle where grid suspension system meets vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.

3.05 INSTALLING STEEL FRAMING FOR WALLS AND PARTITIONS:

A. Install runners (tracks) at floors, ceilings, and structural walls and columns where gypsum board stud assemblies abut other construction.
   1. Where studs are installed directly against exterior walls, install asphalt felt strips or foam gaskets between studs and wall.
B. Installation Tolerances: Install each steel framing and furring member so that fastening surfaces do not vary more than 1/8-inch from the plane formed by the faces of adjacent framing.

C. Extend partition framing above suspended ceilings and secure to structural supports as indicated on the Drawings. Continue framing over frames for doors and openings and frame around ducts penetrating partitions above ceiling to provide support for gypsum board.
   1. Cut studs 1-inch short of full height to provide perimeter relief. Install top track and vertical deflection clips. Fasten vertical deflection clips and top track to primary structure as required. Fasten vertical deflection clips to stud with manufacturer provided hardware in accordance with the manufacturer's instructions. Do not fasten stud to top track.
   2. For fire-resistance-rated partitions that extend to the underside of floor/roof slabs and decks or other continuous solid structural surfaces to obtain ratings, install framing around structural and other members extending below floor/roof slabs and decks, as needed, to support gypsum board closures needed to make partitions continuous from floor to underside of solid structure.
      a. Terminate partition framing at suspended ceilings where indicated.

D. Install steel studs and furring in sizes and at spacings indicated.
   1. Double-Layer Construction: Space studs at 16 inches o.c., unless otherwise indicated.

E. Install steel studs so flanges point in the same direction and leading edge or end of each gypsum board panel can be attached to open (unsupported) edges of stud flanges first.

F. Frame door openings to comply with GA-600, and with applicable published recommendations of gypsum board manufacturer, unless otherwise indicated. Attach vertical studs at jambs with screws either directly to frames or to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
   1. Install 2 studs at each jamb, unless otherwise indicated.
   2. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint.

G. Frame openings other than door openings to comply with details indicated or, if none indicated, as required for door openings. Install framing below sills of openings to match framing required above door heads.

H. Install thermal insulation as follows:
   1. Erect insulation vertically and hold in place with Z-furring members spaced 24 inches o.c.
   2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
   3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw attach short flange of furring channel to web of attached channel. Start from this furring channel with standard width insulation panel and continue in regular manner. At interior corners, space second member no more than 12 inches from corner and cut insulation to fit.
   4. Until gypsum board is installed, hold insulation in place with 10-inch staples fabricated from 0.0625-inch diameter tie wire and inserted through slot in web of member.

I. Install polyethylene vapor retarder where indicated to comply with the following requirements:
   1. Extend vapor retarder to extremities of areas to be protected from vapor transmission. Secure in place with mechanical fasteners or adhesives. Extend vapor retarder to cover
miscellaneous voids in insulated substrates, including those filled with loose mineral fiber insulation.
2. Seal vertical joints in vapor retarders over framing by lapping not less than 2 wall studs. Fasten vapor retarders to framing at top, end, and bottom edges, at perimeter of wall openings, and at lap joints; space fasteners 16 inches o.c.
3. Seal joints in vapor retarders caused by pipes, conduits, electrical boxes, and similar items penetrating vapor retarders with vapor retarder tape.
4. Repair any tears or punctures in vapor retarder immediately before concealing it with the installation of gypsum board or other construction.

3.06 INSTALLATION OF GENERAL BUILDING INSULATION:
A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.
B. Seal joints between foam-plastic insulation units by applying adhesive, mastic, or sealant to edges of each unit to form a tight seal as units are shoved into place. Fill voids in completed installation with adhesive, mastic, or sealant as recommended by insulation manufacturer.
C. Maintain 3-inch clearance of insulation around recessed lighting fixtures.
D. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically and support faced blankets by taping stapling flanges to flanges of metal studs.

3.07 APPLYING AND FINISHING GYPSUM BOARD, GENERAL:
A. Gypsum Board Application and Finishing Standards: Install and finish gypsum panels to comply with ASTM C840 and GA-216.
B. Install ceiling board panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in the central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
C. Install gypsum panels with face side out. Do not install imperfect, damaged, or damp panels. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.
D. Locate both edge or end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Avoid joints other than control joints at corners of framed openings where possible.
E. Attach gypsum panels to steel studs so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
F. Attach gypsum panels to framing provided at openings and cutouts.
G. Spot grout hollow metal door frames. Apply spot grout at each jamb anchor clip and immediately insert gypsum panels into frames.
H. Form control and expansion joints at locations indicated and as detailed, with space between edges of adjoining gypsum panels, as well as supporting framing behind gypsum panels.
I. Cover both faces of steel stud partition framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases that are braced internally.
1. Except where concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
2. Fit gypsum panels around ducts, pipes, and conduits.
J. Isolate perimeter of nonload-bearing gypsum board partitions at structural abutments, except floors, as detailed. Provide 1/4- to 1/2-inch wide spaces at these locations and trim edges with U-bead edge trim where edges of gypsum panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

K. Space fasteners in gypsum panels according to referenced gypsum board application and finishing standard and manufacturer's recommendations.
   1. Space screws a maximum of 12 inches o.c. for vertical applications.
   2. Space fasteners in panels that are tile substrates a maximum of 8 inches o.c.

3.08 GYPSUM BOARD APPLICATION METHODS:
   A. Single-Layer Application: Install gypsum wallboard panels as follows:
      1. On partitions/walls, apply gypsum panels vertically (parallel to framing), unless otherwise indicated, and provide panel lengths that will minimize end joints.

   B. Wall Tile Substrates: For substrates indicated to receive thin-set ceramic tile and similar rigid applied wall finishes, comply with the following:
      1. Install cementitious backer units to comply with ANSI A108.11 at locations indicated to receive wall tile.
      2. Install water-resistant gypsum backing board panels at showers, tubs, and where indicated. Install with 1/4-inch open space where panels abut other construction or penetrations.
      3. Install gypsum wallboard panels with tapered edges taped and finished to produce a flat surface except at showers, tubs, and other locations indicated to receive water-resistant panels.

   C. Single-Layer Fastening Methods: Apply gypsum panels to supports as follows:
      1. Fasten with screws.

   D. Multilayer Fastening Methods: Apply base layers of gypsum panels and face layer to base layers as follows:
      1. Fasten both base layers and face layers separately to supports with screws.

   E. Direct-Bonding to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer's recommendations, and temporarily brace or fasten gypsum panels until fastening adhesive has set.

3.09 INSTALLING TRIM ACCESSORIES:
   A. General: For trim accessories with back flanges, fasten to framing with the same fasteners used to fasten gypsum board. Otherwise, fasten trim accessories according to accessory manufacturer's directions for type, length, and spacing of fasteners.
   B. Install metal cornerbead at external corners.
   C. Install edge trim where edge of gypsum panels would otherwise be exposed. Provide edge trim type with face flange formed to receive joint compound, except where other types are indicated.
      1. Install aluminum trim and other accessories where indicated.
   D. Install control joints according to ASTM C840 and manufacturer's recommendations and in specific locations approved by Engineer/Architect for visual effect.
3.10  **FINISHING GYPSUM BOARD ASSEMBLIES:**
   A. General: Treat gypsum board joints, interior angles, flanges of cornerbead, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration.
   B. Prefill open joints, rounded or beveled edges, and damaged areas using setting-type joint compound.
   C. Apply joint tape over gypsum board joints, except those with trim accessories having flanges not requiring tape.
   D. Levels of Gypsum Board Finish: Provide the following levels of gypsum board finish per GA-214.
      1. Level 1 for ceiling plenum areas, concealed areas, and where indicated, unless a higher level of finish is required for fire-resistance-rated assemblies and sound-rated assemblies.
      2. Level 2 where panels form substrates for tile and where indicated.
      3. Level 4 for gypsum board surfaces, unless otherwise indicated.
   E. For Level 4 gypsum board finish, embed tape in joint compound and apply first, fill (second), and finish (third) coats of joint compound over joints, angles, fastener heads, and accessories. Touch up and sand between coats and after last coat as needed to produce a surface free of visual defects and ready for decoration.
   F. Where Level 2 gypsum board finish is indicated, embed tape in joint compound and apply first coat of joint compound.
   G. Where Level 1 gypsum board finish is indicated, embed tape in joint compound.
   H. Finish water-resistant gypsum backing board forming base for ceramic tile to comply with ASTM C840 and gypsum board manufacturer's directions for treatment of joints behind tile.
   I. Finish glass-mat, water-resistant gypsum backing board to comply with gypsum board manufacturer's directions.
   J. Finish cementitious backer units to comply with unit manufacturer's directions.

3.11  **CLEANING AND PROTECTION:**
   A. Promptly remove any residual joint compound from adjacent surfaces.
   B. Provide final protection and maintain conditions, in a manner acceptable to Installer, that ensure gypsum board assemblies are without damage or deterioration at the time of Substantial Completion.

END OF SECTION 09 21 16
SECTION 09 30 13 – CERAMIC TILING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. This Section includes:
      1. Porcelain tile.
      2. Waterproof membrane for thinset applications.
      3. Crack isolation membrane.
      4. Metal edge strips.

1.03 RELATED REQUIREMENTS:
   A. Section 07 92 00 - Joint Sealants for sealing of expansion, contraction, control, and isolation joints in tile surfaces.
   B. Section 09 29 00 - Gypsum Board for glass-mat, water-resistant backer board.

1.04 REFERENCE STANDARDS:
   A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
   B. American National Standards Institute (ANSI) (The 12 standards below and the TCNA Handbook are available on a CD offered by TCNA.):
      1. ANSI A108 Series (A108.01, .02, .1A, .1B, .1C, .4, .5, .6, .8, .9, .10, .11, .12, .13, .14, .15, .16, and .17) - Specifications for Installation of Ceramic Tile.
      2. ANSI A118.1 - Specifications for Standard Dry-Set Mortar.
      3. ANSI A118.3 - Specifications for Chemical Resistant Water Cleanable Tile-Setting and Grouting Epoxy and Water Cleanable Tile-Setting Epoxy Adhesive.
      4. ANSI A118.4 - Specifications for Modified Dry-Set Mortar.
      5. ANSI A118.6 - Specifications for Standard Cement Grouts for Tile Installation.
      6. ANSI A118.7 - Specifications for High Performance Cement Grouts for Tile Installation.
      7. ANSI A118.9 - Test Methods and Specifications for Cementitious Backer Units.
      8. ANSI A118.10 - Specifications for Load Bearing, Bonded, Waterproof Membranes for ThinSet Ceramic Tile and Dimension Stone Installations.
      9. ANSI A118.12 - Specifications for Crack Isolation Membranes for Thin-Set Ceramic Tile and Dimension Stone Installations.
     10. ANSI A118.15 - Specifications for Improved Modified Dry-Set Mortar.
     12. ANSI A137.1 - Specifications for Ceramic Tile.
   C. Tile Council of North America, Inc.
      1. Handbook for Ceramic, Glass, and Stone Tile Installation. (Also available on a CD that includes ANSI standards for tile, tile installation material, and tile installation methods).

1.05 DEFINITIONS:
   A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.
SECTION 09 30 13 – CERAMIC TILING:  continued

ANSI A108.16, and ANSI A108.17, which are contained in its "Specifications for Installation of Ceramic Tile."

C. Module Size: Actual tile size plus joint width indicated.
D. Face Size: Actual tile size, excluding spacer lugs.

1.06  SUBMITTALS:
A. Product Data: For each type of product.
B. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.
C. Samples for Verification:
   1. Full-size units of each type and composition of tile and grout and for each color and finish required.
   2. Full-size units of each type of trim and accessory.
D. Qualification Data: For Installer.
E. Product Certificates: For each type of product.
F. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Tile and Trim Units: Furnish quantity of full-size units equal to 2% of amount installed for each type, composition, color, pattern, and size indicated.
   2. Grout: Furnish quantity of grout equal to 2% of amount installed for each type, composition, and color indicated.

1.07  QUALITY ASSURANCE:
A. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Build mockup of floor tile installation.
   2. Build mockup of wall tile installation.
   3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.08  DELIVERY, STORAGE, AND HANDLING:
A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.
B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.
C. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.
D. Store liquid materials in unopened containers and protected from freezing.

1.09  FIELD CONDITIONS:
A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

PART 2 - PRODUCTS
A. Source Limitations for Tile: Obtain tile from single source or producer.
   1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.
SECTION 09 30 13 – CERAMIC TILING: continued

B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from single manufacturer and each aggregate from single source or producer.
   1. Obtain setting and grouting materials, except for unmodified Portland cement and aggregate, from single manufacturer.

C. Source Limitations for Other Products: Obtain each of the following products specified in this Section from a single manufacturer:
   1. Waterproof membrane.
   2. Crack isolation membrane.
   3. Metal edge strips.

2.02 PRODUCTS, GENERAL:
A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.
   1. Provide tile complying with Standard grade requirements unless otherwise indicated.

B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.

C. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.

2.03 TILE PRODUCTS:
A. Ceramic Tile Type Porcelain tile.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Dal-Tile Ironcraft or comparable product by one of the following:
      a. Architect approved equal.
   2. Certification: Tile certified by the Porcelain Tile Certification Agency.
   4. Grout Color: As selected by Architect from manufacturer's full range.
   5. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:
      a. External Corners: Surface bullnose, module size.
      b. Internal Corners: Field-butted square corners.

2.04 THRESHOLDS/TRANSITIONS:
A. General: Fabricate to sizes and profiles indicated or required to provide transition between adjacent floor finishes.
   1. Bevel edges at 1:2 slope, with lower edge of bevel aligned with or up to 1/16 inch above adjacent floor surface. Finish bevel to match top surface of threshold. Limit height of threshold to 1/2 inch or less above adjacent floor surface.
   2. Products: Subject to compliance with requirements, provide one of the following:
      a. Schluter Systems L.P.
      b. Engineer approved equal.
SECTION 09 30 13 – CERAMIC TILING: continued

2.05 WATERPROOF MEMBRANE:
A. Polyethylene Sheet: Polyethylene faced on both sides with fleece webbing; 0.008-inch nominal thickness.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Schluter Systems L.P.; KERDI.
      b. Engineer approved equal.

2.06 CRACK ISOLATION MEMBRANE:
A. Corrugated Polyethylene: Corrugated polyethylene with dovetail-shaped corrugations and with anchoring webbing on the underside; 3/16-inch (4-mm) nominal thickness.
   1. Products: Subject to compliance with requirements, provide the following:
      a. Schluter Systems L.P.; DITRA.
      b. Engineer approved equal.

2.07 SETTING MATERIALS:
A. Latex-Portland Cement Mortar (Thinset): ANSI A118.4.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide TEC 3N1 Performance Mortar or comparable product by one of the following:
      a. Architect approved equal.
   2. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project Site.
   3. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.

2.08 GROUT MATERIALS:
A. Sand-Portland Cement Grout: ANSI A108.10, consisting of white or gray cement and white or colored aggregate as required to produce color indicated.
   1. Color: As selected by Architect from manufacturer’s standard colors.

2.09 MISCELLANEOUS MATERIALS:
A. Metal Edge Strips: Angle or L-shaped, height to match tile and setting-bed thickness, metallic or combination of metal and PVC or neoprene base, designed specifically for flooring applications; stainless-steel, ASTM A666, 300 Series exposed-edge material.
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Schluter Systems L.P.
      b. Engineer approved equal.
   B. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

2.10 MIXING MORTARS AND GROUT:
A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.
B. Add materials, water, and additives in accurate proportions.
C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.
PART 3 - EXECUTION

3.01 EXAMINATION:
A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
2. Verify that concrete substrates for tile floors installed with thinset mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.
   a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
   b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.
3. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
4. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION:
A. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with thinset mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.
B. Where indicated, prepare substrates to receive waterproofing by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1/4 inch per foot (1:50) toward drains.
C. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project Site before installing.

3.03 CERAMIC TILE INSTALLATION:
A. Comply with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.
1. For the following installations, follow procedures in the ANSI A108 series of tile installation standards for providing 95% mortar coverage:
   a. Tile floors consisting of tiles 8 by 8 inches (200 by 200 mm) or larger.
B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
SECTION 09 30 13 – CERAMIC TILING: continued

D. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.

E. Jointing Pattern: Lay tile in running bond pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.
   1. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
   2. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.

F. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:
   1. Porcelain Tile: 3/16 inch.

G. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.
   1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.

H. Metal Edge Strips: Install where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with or below top of tile and no threshold is indicated.

3.04 WATERPROOFING INSTALLATION:
A. Install waterproofing to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness that is bonded securely to substrate.
B. Allow waterproofing to cure and verify by testing that it is watertight before installing tile or setting materials over it.

3.05 CRACK ISOLATION MEMBRANE INSTALLATION:
A. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness that is bonded securely to substrate.
B. Allow crack isolation membrane to cure before installing tile or setting materials over it.

3.06 ADJUSTING AND CLEANING:
A. Remove and replace tile that is damaged or that does not match adjoining tile. Provide new matching units, installed as specified and in a manner to eliminate evidence of replacement.
B. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
   1. Remove grout residue from tile as soon as possible.
   2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.

3.07 PROTECTION:
A. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.
B. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.
C. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

END OF SECTION 09 30 13
SECTION 09 51 23 - ACOUSTICAL TILE CEILINGS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. This Section includes:
      1. Acoustical tiles for ceilings.
      2. Concealed suspension systems.

1.03 RELATED REQUIREMENTS:
   A. Grilles and Diffusers: Division 23
   B. Interior Lighting Fixtures: Division 26

1.04 REFERENCE STANDARDS
   A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
   B. American Architectural Manufacturers Association (AAMA):
      1. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum.
   C. American Society of Civil Engineers/Structural Engineering Institute (ASCE):
   D. ASTM International:
      1. ASTM A 641/A 641M - Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
      2. ASTM A 653/A 653M - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
      5. ASTM C 636/C 636M - Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels.
      7. ASTM D 3274 - Test Method for Evaluating Degree of Surface Disfigurement of Paint Films by Fungal or Algal Growth, or Soil and Dirt Accumulation.
     12. ASTM E 1264 - Classification for Acoustical Ceiling Products.

1.05 SUBMITTALS:
   A. Product Data: For each type of product.
SECTION 09 51 23 – ACOUSTICAL TILE CEILINGS: continued

B. Samples: For each component indicated and for each exposed finish required, prepared on
Samples of size indicated below.
1. Acoustical Tile: Set of full-size Samples of each type, color, pattern, and texture.
2. Concealed Suspension-System Members: 6-inch long Sample of each type.
3. Exposed Moldings and Trim: Set of 6-inch long Samples of each type and color.

C. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items
are shown and coordinated with each other, using input from installers of the items involved:
1. Ceiling suspension-system members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers,
access panels, and special moldings.

D. Field quality-control reports.
E. Maintenance Data: For finishes to include in maintenance manuals.
F. Furnish extra materials that match products installed and that are packaged with protective
covering for storage and identified with labels describing contents.
1. Acoustical Ceiling Units: Full-size tiles equal to 2 percent of quantity installed.
2. Suspension-System Components: Quantity of each concealed grid and exposed
component equal to 2 percent of quantity installed.

1.06 DELIVERY, STORAGE, AND HANDLING:
A. Deliver acoustical tiles, suspension-system components, and accessories to Project Site in
original, unopened packages and store them in a fully enclosed, conditioned space where they
will be protected against damage from moisture, humidity, temperature extremes, direct
sunlight, surface contamination, and other causes.
B. Before installing acoustical tiles, permit them to reach room temperature and a stabilized
moisture content.
C. Handle acoustical tiles carefully to avoid chipping edges or damaging units in any way.

1.07FIELD CONDITIONS:
A. Environmental Limitations: Do not install acoustical tile ceilings until spaces are enclosed and
weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and
ambient temperature and humidity conditions are maintained at the levels indicated for Project
when occupied for its intended use.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:
A. Seismic Performance: Acoustical ceiling shall withstand the effects of earthquake motions
determined according to ASCE/SEI 7.
1. Seismic requirements are indicated on the structural drawings.
B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing
agency. Identify products with appropriate markings of applicable testing agency.
1. Flame-Spread Index: Comply with ASTM E1264 for Class A materials.

2.02 ACOUSTICAL TILES, GENERAL:
A. Source Limitations: Obtain each type of acoustical ceiling tile and supporting suspension
system from single source from single manufacturer.
SECTION 09 51 23 – ACOUSTICAL TILE CEILINGS: continued

B. Acoustical Tile Standard: Provide manufacturer's standard tiles of configuration indicated that comply with ASTM E1264 classifications as designated by types, patterns, acoustical ratings, and light reflectance unless otherwise indicated.

C. Acoustical Tile Colors and Patterns: Match appearance characteristics indicated for each product type.

2.03 ACOUSTICAL TILES:

A. Subject to compliance with requirements, similar products of the manufacturers listed below are acceptable:
   1. Armstrong World Industries, Inc.
   2. CertainTeed, a Saint-Gobain company
   3. USG Interiors, Inc.

A. Classification: Provide tiles complying with ASTM E1264 for type, form, and pattern as follows:
   1. Type and Form: Type III, mineral base with painted finish; Form 1, nodular.
   2. Pattern: Equivalent to Performa Symphony M as manufactured by CertainTeed.

B. Color: White.

C. NRC: Not less than 0.70.

D. CAC: Not less than 30.

E. AC: Not less than 170.

F. Edge/Joint Detail: Square, kerfed and rabbeted; tongue and grooved; or butt.

G. Thickness: 3/4 inch.

H. Modular Size: 24 by 24 inches.

I. Broad Spectrum Antimicrobial Fungicide and Bactericide Treatment: Provide acoustical tiles treated with manufacturer's standard antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D3273 and evaluated according to ASTM D3274 or ASTM D3274 or ASTM G21.

2.04 METAL SUSPENSION SYSTEMS, GENERAL:

A. Metal Suspension-System Standard: Provide manufacturer's standard metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C635/C635M.

B. Attachment Devices: Size for five times the design load indicated in ASTM C635/C635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.

C. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
   2. Size: Select wire diameter so its stress at three times hanger design load (ASTM C635/C635M, Table 1, "Direct Hung") will be less than yield stress of wire but provide not less than 12-gauge wire.

2.05 METAL SUSPENSION SYSTEM:

A. Direct-Hung, Double-Web Suspension System: Main and cross runners roll formed from and capped with cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A653/A653M, G30 (Z90) coating designation.
SECTION 09 51 23 – ACOUSTICAL TILE CEILINGS: continued

2. Access: Upward, with initial access openings of size indicated below and located throughout ceiling within each module formed by main and cross runners, with additional access available by progressively removing remaining acoustical tiles.
   a. Initial Access Opening: In each module, 24 by 24 inches.

PART 3 - EXECUTION

3.01 EXAMINATION:
   A. Examine substrates, areas, and conditions, including structural framing and substrates to which acoustical tile ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other sections that affect ceiling installation and anchorage and for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
   B. Examine acoustical tiles before installation. Reject acoustical tiles that are wet, moisture damaged, or mold damaged.
   C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION:
   A. Measure each ceiling area and establish layout of acoustical tiles to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width tiles at borders and comply with layout shown on reflected ceiling plans.

3.03 INSTALLATION OF SUSPENDED ACOUSTICAL TILE CEILINGS:
   A. General: Install acoustical panel ceilings to comply with ASTM C636/C636M and seismic design requirements indicated, according to manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
   B. Suspend ceiling hangers from building's structural members and as follows:
      1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
      2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
      3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
      4. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
      5. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
      6. Do not attach hangers to steel deck tabs.
      7. Attach hangers to structural members where possible. Hangers may be attached to steel roof deck only with written approval from the Engineer.
      8. Space hangers not more than 48 inches (1200 mm) o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches (200 mm) from ends of each member.
      9. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
C. Install edge moldings and trim of type indicated at perimeter of acoustical tile ceiling area and where necessary to conceal edges of acoustical tiles.
   1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
   2. Screw attach moldings to substrate at intervals not more than 16 inches (400 mm) o.c. and not more than 3 inches (75 mm) from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet (3.2 mm in 3.6 m). Miter corners accurately and connect securely.
   3. Do not use exposed fasteners, including pop rivets, on moldings and trim.

D. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

E. Install acoustical tiles in coordination with suspension system and exposed moldings and trim. Place splines or suspension-system flanges into kerfed edges so tile-to-tile joints are closed by double lap of material.
   1. Fit adjoining tile to form flush, tight joints. Scribe and cut tile for accurate fit at borders and around penetrations through tile.
   2. Hold tile field in compression by inserting leaf-type, spring-steel spacers between tile and moldings, spaced 12 inches (305 mm) o.c.

3.04 CLEANING:
   A. Clean exposed surfaces of acoustical tile ceilings, including trim and edge moldings. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace tiles and other ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 09 51 23
SECTION 09 65 13 – RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. This Section includes:
      1. Resilient base.

1.03 REFERENCE STANDARDS:
   A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
   B. ASTM International:
      2. ASTM F 710 - Practice for Preparing Concrete Floors to Receive Resilient Flooring.
      3. ASTM F 1861 - Specification for Resilient Wall Base.
      4. ASTM F 1869 - Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
   C. National Fire Protection Association (NFPA):

1.04 SUBMITTALS:
   A. Product Data: For each type of product.
   B. Samples: For each exposed product and for each color and texture specified, not less than 12 inches (300 mm) long.
   C. Product Schedule: For resilient base and accessory products.
   D. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
      1. Furnish not less than 10 linear feet for every 500 linear feet or fraction thereof, of each type, color, pattern, and size of resilient product installed.

1.05 QUALITY ASSURANCE:
   A. Source Limitations: Obtain each type, color, and pattern of product specified from one source with resources to provide products of consistent quality in appearance and physical properties without delaying the Work.

1.06 DELIVERY, STORAGE, AND HANDLING:
   A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50°F (10°C) or more than 90°F (32°C).
1.07 FIELD CONDITIONS:
   A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70°F (21°C) or more than 95°F (35°C), in spaces to receive resilient products during the following time periods:
      1. 48 hours before installation.
      2. During installation.
      3. 48 hours after installation.
   B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55°F (13°C) or more than 95°F (35°C).
   C. Install resilient products after other finishing operations, including painting, have been completed.
   D. Maintain the ambient relative humidity between 40% and 60% during installation.

PART 2 - PRODUCTS

2.01 THERMOSET-RUBBER BASE:
   A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   B. Product Standard: ASTM F1861, Type TS vulcanized thermoset, Group I solid, homogeneous.
      1. Style and Location:
         a. Style A, Straight: Provide in areas with carpet.
         b. Style B, Cove: Provide in areas with resilient flooring.
   C. Thickness: 0.125 inch (3.2 mm).
   D. Height: 4 inches (102 mm).
   E. Lengths: Cut lengths 48 inches (1219 mm) long or coils in manufacturer's standard length.
   F. Outside Corners: Job formed or preformed.
   G. Inside Corners: Job formed or preformed.
   H. Colors: 014 Medium Gray.

2.02 INSTALLATION MATERIALS:
   A. Trowelable Leveling and Patching Compounds: Latex-modified, Portland-cement-based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.
   B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.

PART 3 - EXECUTION

3.01 EXAMINATION:
   A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
      1. Verify that finishes of substrates comply with tolerances and other requirements specified in other sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.
   B. Proceed with installation only after unsatisfactory conditions have been corrected.
      1. Installation of resilient products indicates acceptance of surfaces and conditions.
3.02 **PREPARATION:**
   A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
   B. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
   C. Do not install resilient products until they are the same temperature as the space where they are to be installed.
      1. At least 48 hours in advance of installation, move resilient products and installation materials into spaces where they will be installed.
   D. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.03 **RESILIENT BASE INSTALLATION:**
   A. Comply with manufacturer's written instructions for installing resilient base.
   B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
   C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.
   D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
   E. Do not stretch resilient base during installation.
   F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.
   G. Preformed Corners: Install preformed corners before installing straight pieces.
   H. Job-Formed Corners:
      1. Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.
         a. Form without producing discoloration (whitening) at bends.
      2. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.
         a. Miter corners to minimize open joints.

3.04 **CLEANING AND PROTECTION:**
   A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.
   B. Perform the following operations immediately after completing resilient-product installation:
      1. Remove adhesive and other blemishes from exposed surfaces.
      2. Sweep and vacuum horizontal surfaces thoroughly.
      3. Damp-mop horizontal surfaces to remove marks and soil.
   C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
   D. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION 09 65 13
SECTION 09 65 19 – RESILIENT TILE FLOORING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. Section Includes:
      1. Rubber floor tile.

1.03 REFERENCED STANDARDS:
   A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
   B. ASTM International:
      5. ASTM F 710 - Practice for Preparing Concrete Floors to Receive Resilient Flooring.
      7. ASTM F 1344 - Specification for Rubber Floor Tile.
      8. ASTM F 1516 - Practice for Sealing Seams of Resilient Flooring Products by the Heat Weld Method (when Recommended).
      9. ASTM F 1869 - Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
   C. NFPA:

1.04 SUBMITTALS:
   A. Product Data: For each type of product.
   B. Shop Drawings: For each type of floor tile.
      1. Include floor tile layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
      2. Show details of special patterns.
    C. Samples: Full-size units of each color and pattern of floor tile required.
      1. For heat-welding bead, manufacturer's standard-size Samples, but not less than 9 inches long, of each color required.
   D. Product Schedule: For floor tile.
   E. Qualification Data: For Installer.
   F. Maintenance Data: For each type of floor tile to include in maintenance manuals.
   G. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Floor Tile: Furnish one box for every 50 boxes or fraction thereof, of each type, color, and pattern of floor tile installed.

1.05 QUALITY ASSURANCE:
   A. Installer Qualifications: An entity that employs installers and supervisors who are competent in techniques required by manufacturer for floor tile installation and seaming method indicated.
      1. Engage an installer who employs workers for this Project who are trained or certified by floor tile manufacturer for installation techniques required.

1.06 DELIVERY, STORAGE, AND HANDLING:
   A. Store floor tile and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F (10 deg C) or more than 90 deg F (32 deg C). Store floor tiles on flat surfaces.

1.07 FIELD CONDITIONS:
   A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F (21 deg C) or more than 95 deg F (35 deg C), in spaces to receive floor tile during the following time periods:
      1. 48 hours before installation.
      2. During installation.
      3. 48 hours after installation.
   B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F (13 deg C) or more than 95 deg F (35 deg C).
   C. Close spaces to traffic during floor tile installation.
   D. Close spaces to traffic for 48 hours after floor tile installation.
   E. Install floor tile after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.01 RUBBER FLOOR TILE:
   A. Products: Subject to compliance with requirements, provide the following or architect approved equal:
      1. Flexco; Evolving Styles Tile.
   C. Hardness: Manufacturer's standard hardness, measured using Shore, Type A durometer according to ASTM D 2240.
   D. Wearing Surface: Smooth.
   E. Thickness: 0.125 inch.
   F. Size: 18 by 18 inches.
   G. Colors and Patterns: French Grey w/ Black CE-103.

2.02 INSTALLATION MATERIALS:
   A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by floor tile manufacturer for applications indicated.
   B. Adhesives: Water-resistant type recommended by floor tile and adhesive manufacturers to suit floor tile and substrate conditions indicated.
PART 3 - EXECUTION

3.01 EXAMINATION:
   A. Examine substrates, with Installer present, for compliance with requirements for maximum
      moisture content and other conditions affecting performance of the Work.
      1. Verify that finishes of substrates comply with tolerances and other requirements specified
         in other Sections and that substrates are free of cracks, ridges, depressions, scale, and
         foreign deposits that might interfere with adhesion of floor tile.
   B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION:
   A. Prepare substrates according to floor tile manufacturer's written instructions to ensure adhesion
      of resilient products.
   B. Concrete Substrates: Prepare according to ASTM F 710.
      1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
      2. Remove substrate coatings and other substances that are incompatible with adhesives and
         that contain soap, wax, oil, or silicone, using mechanical methods recommended by floor
         tile manufacturer. Do not use solvents.
      3. Alkalinity and Adhesion Testing: Perform tests recommended by floor tile manufacturer.
         Proceed with installation only after substrate alkalinity falls within range on pH scale
         recommended by manufacturer in writing.
      4. Moisture Testing: Perform tests so that each test area does not exceed 1000 sq. ft., and
         perform no fewer than three tests in each installation area and with test areas evenly
         spaced in installation areas.
         a. Relative Humidity Test: Using in-situ probes, ASTM F 2170. Proceed with
            installation only after substrates have a maximum 80 percent relative humidity level
            measurement.
   C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching
      compound; remove bumps and ridges to produce a uniform and smooth substrate.
   D. Do not install floor tiles until they are the same temperature as the space where they are to be
      installed.
      1. At least 48 hours in advance of installation, move resilient floor tile and installation
         materials into spaces where they will be installed.
   E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient
      floor tile.

3.03 FLOOR TILE INSTALLATION:
   A. Comply with manufacturer's written instructions for installing floor tile.
   B. Lay out floor tiles from center marks established with principal walls, discounting minor
      offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid
      using cut widths that equal less than one-half tile at perimeter.
      1. Lay tiles square with room axis.
   C. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as
      manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed
      tiles.
      1. Lay tiles with grain running in one direction.
   D. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent
      fixtures including pipes, outlets, and door frames.
SECTION 09 65 19 – RESILIENT TILE FLOORING: continued

E. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.
F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent marking device.
G. Adhere floor tiles to flooring substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

3.04 CLEANING AND PROTECTION:
A. Comply with manufacturer's written instructions for cleaning and protecting floor tile.
B. Perform the following operations immediately after completing floor tile installation:
   1. Remove adhesive and other blemishes from exposed surfaces.
   2. Sweep and vacuum surfaces thoroughly.
   3. Damp-mop surfaces to remove marks and soil.
C. Protect floor tile from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
D. Cover floor tile until Substantial Completion.

END OF SECTION 09 65 19
SECTION 09 68 13 – TILE CARPETING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. This Section includes modular carpet tile.

1.03 RELATED REQUIREMENTS:
   A. Section 09 65 13 - Resilient Base and Accessories for resilient wall base and accessories installed with carpet tile.

1.04 REFERENCE STANDARDS:
   A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
   B. American Association of Textile Chemists and Colorists:
      1. AATCC 16: Colorfastness to Light.
      2. AATCC 134: Electrostatic Propensity of Carpets.
   C. American National Standards Institute/NSF International:
      1. ANSI/NSF 140: Sustainability Assessment for Carpet.
   D. ASTM International:
      1. ASTM C423: Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
      7. ASTM F710: Practice for Preparing Concrete Floors to Receive Resilient Flooring.
   E. The Carpet and Rug Institute:
      1. CRI Carpet Installation Standard.
   F. International Organization for Standardization:
   G. NFPA:

1.05 SUBMITTALS:
   A. Product Data: For each type of product.
      1. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
2. Include manufacturer's written installation recommendations for each type of substrate.

B. Shop Drawings: For carpet tile installation, plans showing the following:
   1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet tiles.
   2. Carpet tile type, color, and dye lot.
   3. Type of subfloor.
   4. Type of installation.
   5. Pattern of installation.
   6. Pattern type, location, and direction.
   7. Pile direction.
   8. Type, color, and location of insets and borders.
   9. Type, color, and location of edge, transition, and other accessory strips.
   10. Transition details to other flooring materials.

C. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.
   2. Exposed Edge, Transition, and Other Accessory Stripping: 12 inch long Samples.

D. Product Schedule: For carpet tile. Use same designations indicated on Drawings.

E. Qualification Data: For Installer.

F. Product Test Reports: For carpet tile, for tests performed by a qualified testing agency.

G. Sample Warranty: For special warranty.

H. Maintenance Data: For carpet tiles to include in maintenance manuals. Include the following:
   1. Methods for maintaining carpet tile, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
   2. Precautions for cleaning materials and methods that could be detrimental to carpet tile.

I. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Carpet Tile: Full-size units equal to 5% of amount installed for each type indicated, but not less than 10 yd.².

1.06 QUALITY ASSURANCE:
A. Installer Qualifications: An experienced installer who is certified by the International Certified Floorcovering Installers Association at the Commercial II certification level.

1.07 DELIVERY, STORAGE, AND HANDLING:
A. Comply with CRI's "CRI Carpet Installation Standard."

1.08 FIELD CONDITIONS:
A. Comply with CRI's "CRI Carpet Installation Standard" for temperature, humidity, and ventilation limitations.

B. Environmental Limitations: Do not deliver or install carpet tiles until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at levels planned for building occupants during the remainder of the construction period.

C. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.
D. Where demountable partitions or other items are indicated for installation on top of carpet tiles, install carpet tiles before installing these items.

1.09 WARRANTY:
A. Special Warranty for Carpet Tiles: Manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.
   1. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.
   2. Failures include, but are not limited to, the following:
      a. More than 10% edge raveling, snags, and runs.
      b. Dimensional instability.
      c. Excess static discharge.
      d. Loss of tuft-bind strength.
      e. Loss of face fiber.
      f. Delamination.
   3. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 CARPET TILE:
A. Basis-of-Design Product: Subject to compliance with requirements, provide the following or approval equal:
B. Fiber Type: Dynex SD Nylon.
C. Pile Characteristic: Stratatec Patterned Loop pile.
D. Pile Thickness: 0.085” according to ASTM D6859.
E. Primary Backing/Backcoating: Synthetic Non-Woven.
F. Secondary Backing: Manufacturer's standard material.
G. Backing System: Powerbond® Cushion.
H. Size: 24 by 24 inches.
I. Applied Treatments:
   2. Antimicrobial Treatment: Manufacturer's standard treatment that protects carpet tiles as follows:
      a. Antimicrobial Activity: Not less than 2 mm halo of inhibition for gram-positive bacteria, not less than 1 mm halo of inhibition for gram-negative bacteria, and no fungal growth, according to AATCC 174.
J. Performance Characteristics:
   1. Appearance Retention Rating: Heavy traffic, 3.0 minimum according to ASTM D7330.
   2. Critical Radiant Flux Classification: Not less than 0.45 W/cm² according to NFPA 253.
   3. Dry Breaking Strength: Not less than 100 lbf. (445 N) according to ASTM D2646.
   4. Tuft Bind: Not less than 8 lbf. (36 N) according to ASTM D1335.
   5. Delamination: Not less than 4 lbf./inch (0.7 N/mm) according to ASTM D3936.
   6. Dimensional Tolerance: Within 1/32 inch (0.8 mm) of specified size dimensions, as determined by physical measurement.
   7. Dimensional Stability: 0.2% or less according to ISO 2551 (Aachen Test).
   8. Colorfastness to Crocking: Not less than 4, wet and dry, according to AATCC 165.
SECTION 09 68 13 – TILE CARPETING: continued

9. Colorfastness to Light: Not less than 4 after 60 AFU (AATCC fading units) according to AATCC 16, Option E.
10. Electrostatic Propensity: Less than 2 kV according to AATCC 134.

2.02 INSTALLATION ACCESSORIES:
A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.
B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that comply with flammability requirements for installed carpet tile, and are recommended by carpet tile manufacturer for releasable installation.
C. Metal Edge/Transition Strips: Extruded aluminum with mill finish of profile and width shown, of height required to protect exposed edge of carpet, and of maximum lengths to minimize running joints.
   1. Products: Subject to compliance with requirements, provide the following:
      a. Schluter Systems LP.
      b. Engineer approved equal.

PART 3 - EXECUTION

3.01 EXAMINATION:
A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance.
B. Examine carpet tile for type, color, pattern, and potential defects.
C. Concrete Slabs: Verify that finishes comply with requirements specified in Section 03 30 00 - Cast-in-Place Concrete and that surfaces are free of cracks, ridges, depressions, scale, and foreign deposits.
   1. Moisture Testing: Perform tests so that each test area does not exceed 1,000 ft.², and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
      a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb. of water/1,000 ft.² in 24 hours.
      b. Relative Humidity Test: Using in situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 75 % relative humidity level measurement.
      c. Perform additional moisture tests recommended in writing by adhesive and carpet tile manufacturers. Proceed with installation only after substrates pass testing.
D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION:
A. General: Comply with CRI's "CRI Carpet Installation Standards" and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile.
B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch wide or wider, and protrusions more than 1/32 inch unless more stringent requirements are required by manufacturer's written instructions.
SECTION 09 68 13 – TILE CARPETING: continued

C. Concrete Substrates: Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by adhesive and carpet tile manufacturers.

D. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.03 INSTALLATION:
A. General: Comply with CRI's "CRI Carpet Installation Standard," Section 18, "Modular Carpet" and with carpet tile manufacturer's written installation instructions.
B. Installation Method: As recommended in writing by carpet tile manufacturer.
C. Maintain dye-lot integrity. Do not mix dye lots in same area.
D. Maintain pile-direction patterns indicated on Drawings.
E. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.
F. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
G. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on carpet tile as marked on subfloor. Use nonpermanent, nonstaining marking device.
H. Install pattern parallel to walls and borders.

3.04 CLEANING AND PROTECTION:
A. Perform the following operations immediately after installing carpet tile:
   1. Remove excess adhesive and other surface blemishes using cleaner recommended by carpet tile manufacturer.
   2. Remove yarns that protrude from carpet tile surface.
B. Protect installed carpet tile to comply with CRI's "CRI Carpet Installation Standard," Section 20, "Protecting Indoor Installations."
C. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION 09 68 13
SECTION 09 90 00 – PROTECTIVE COATINGS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. This Section includes coating of exterior and interior surfaces throughout the Project and which are listed in Part 2, with systems specified on "coating system" sheets at the end of this Section.
   B. Coating systems include surface preparation, prime coat (first coat), finish coats (second and third coats), inspection, cleaning, and touch-up of surfaces and equipment. Shop preparation, prime coat, and finish coats to be shop-applied, may be specified elsewhere or referenced to this Section so that a complete system is specified and coordinated.
      1. Where surface preparation and first (prime) coat are specified in other Sections to be shop-applied, such as for structural steel, hollow metal doors or equipment, only the touch up and finish coats are a part of field painting. Surface preparation is the required degree of preparation prior to application of first (prime) coat regardless if done in shop or field.
      2. If materials are provided without shop primer such as miscellaneous steel or sheet metal, then surface preparation, first, second, and third coats are a part of field painting.
      3. Concealed surfaces subject to corrosion or attack if unprotected shall be prime-coated and touched up prior to concealment under insulation or other protective layer.
      4. Where Equipment and Materials are provided with shop-applied finished coating system, only touch up and finish coats are a part of field painting.
      5. Refer to applicable Sections to determine whether surface preparation and first coat, or complete coating system, is to be shop-applied.

1.03 RELATED REQUIREMENTS:
   A. Shop Painting and Coatings: All applicable Divisions.
   B. Factory Prefinished Items: All applicable Divisions.
   C. Colors:
      1. Color of finish coatings shall match accepted color Samples.
      2. When second and finish coats of a system are of same type, tint or use an alternate color on second coat to enable visual coverage inspection of the third coat. When first and second coats only are specified and are of same or different types, tint or use an alternate color on first coat to enable visual coverage inspection of the second coat.
      3. Contract Price shall include the following approximate number of finish coat colors to form a basis for bidding:
         a. Alkyd: 3 colors.
         b. Latex: 3 colors.
         c. Acrylic: 7 colors.
         d. Epoxy: 3 colors.
         e. Polyurethane: 3 colors.
         f. Stains: 3 colors.

1.04 REFERENCE STANDARDS:
   A. Applicable Standards:
      1. American National Standards Institute (ANSI):

2. ASTM International (ASTM):
   a. ASTM D6386 - Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting.
   b. ASTM D4258 - Surface Cleaning Concrete for Coating.
   c. ASTM D4259 - Abrading Concrete.
   d. ASTM D4260 - Acid Etching Concrete.
   e. ASTM D4261 - Surface Cleaning Concrete Unit Masonry for Coating.

3. Society for Protective Coatings (SSPC) Surface Preparation Specifications:
   a. SP1 - Solvent Cleaning: Removes oil, grease, soil, drawing and cutting compounds, and other soluble contaminants.
   b. SP2 - Hand Tool Cleaning: Remove loose material. Not intended to remove adherent mill scale, rust, and paint.
   c. SP3 - Power Tool Cleaning: Removes loose material. Not intended to remove all scale or rust.
   d. SP5 - White Metal Blast Cleaning: Removes all scale, rust, foreign matter. Leaves surface gray-white uniform metallic color.
   e. SP6 - Commercial Blast Cleaning: Two-thirds of every 9 inches² free of all visible residues; remainder only light discoloration.
   f. SP7 - Brush-Off Blast Cleaning: Removes only loose material, remaining surface tight and abraded to give anchor pattern.
   g. SP10 - Near-White Blast Cleaning: At least 95% of every 9 inches² shall be free of all visible residues.
   h. SP11 - Power Tool Cleaning to Bare Metal.
   i. SP12 - Surface Preparation and Cleaning of Steel and Other Hard Materials by High and Ultrahigh Pressure Water Jetting Prior to Recoating.
   j. SP13 - Surface Preparation of Concrete.

1.05 SUBMITTALS:
   A. Submit as specified in Division 01.
   B. Includes, but not limited to, the following:
      1. Schedule of products and paint systems to be used. Schedule shall include the following information:
         a. Surfaces for system to be applied.
         b. Surface preparation method and degree of cleanliness.
         c. Product manufacturer, name, and number.
         d. Method of application.
         e. Dry film mil thickness per coat of coating to be applied.
      2. Color charts for selection and acceptance.
      3. Technical and material safety data sheets.
      4. Certification(s) by coating manufacturer(s) that all coatings are suitable for service intended as stated on each coating system sheet. If manufacturer has an equivalent product as that specified, and it is suitable for the intended purpose, Contractor shall submit the recommended product for approval at no increase in cost, and state reasons for substitution.
5. Contractor shall certify in writing to the Engineer/Architect that applicators have previously applied all the systems in this Specification and have the ability and equipment to prepare the surfaces and apply the coatings correctly.

C. Submittals for industrial maintenance coatings shall be prepared by, or have assistance in preparation of, a corrosion engineer or industrial coatings technical representative of the coating manufacturer.

1.06 QUALITY ASSURANCE:
A. Include on label of container:
   1. Manufacturer's name, product name, and number.
   2. Type of paint and generic name.
   3. Color name and number.
   4. Storage and temperature limits.
   5. Mixing and application instructions, including requirements for precautions which must be taken.
   6. Drying, recoat, or curing time.
B. A coating report shall be completed daily by Contractor at each phase of the coating system starting with surface preparation. These shall be submitted on the form attached at end of this Section.
C. In the event a problem occurs with coating system, surface preparation, or application, Contractor shall require coating applicator and coating manufacturer's technical representative to promptly investigate the problem and submit results to Engineer/Architect.

1.07 DELIVERY, STORAGE, AND HANDLING:
A. Delivery of Materials:
   1. Deliver in sealed containers with labels and information legible and intact. Containers shall also have correct labels with required information.
   2. Allow sufficient time for testing if required.
B. Storage of Materials:
   1. Store only acceptable materials on Project Site.
   2. Provide separate area and suitable containers for storage of coatings and related coating equipment.
   3. Dispose of used or leftover containers, thinners, rags, brushes, and rollers in accordance with applicable regulations.

1.08 REGULATORY REQUIREMENTS:
A. In addition to requirements specified elsewhere for environmental protection, provide coating materials that conform to the restrictions of the U.S. EPA and the local and regional jurisdictions. Notify Engineer/Architect of any coating specified herein that fails to conform to the requirements for the location of the Project or location of application.
B. Lead Content: Use only coatings that are totally lead free.
C. Chromate Content: Do not use coatings containing zinc-chromate or strontium chromate.
D. Asbestos Content: Materials shall not contain asbestos.
E. Mercury Content: Materials shall not contain mercury or mercury compounds.
PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:
A. Proprietary names and product numbers are specified in most systems for material identification from these manufacturers:
1. Ameron Protective Coatings Systems Group, Ameron Corp.
2. Carboline Company, Inc.
3. Devoe Coating Company, Division of ICI.
4. ITW Devcon Futura Coatings, Inc.
5. International Protective Coatings.
7. Pittsburgh Paints, PPG Industries Inc.
10. Equivalent coatings (on approval by Engineer/Architect) are acceptable from the following alternate companies:
   a. E.I. DuPont de Nemours & Co., Inc.
   b. Benjamin Moore Company.
   c. Coronado Paint Company.
   d. Rust-Oleum.
   e. Sigma Coatings USA B.V.
   f. U.S. Coatings, Inc.
   g. Kwal-Howells, Inc.

2.02 GENERAL:
A. Materials furnished for each coating system must be compatible to the substrate.
B. When unprimed surfaces are to be coated, entire coating system shall be by the same coating manufacturer to assure compatibility of coatings.
C. When shop-painted surfaces are to be coated, ascertain whether finish materials will be compatible with shop coating. Inform Engineer/Architect of any unsuitable substrate or coating conditions.

2.03 COATING SYSTEMS:
A. Specified on the "Protective Coating System" sheets at the end of this Section.

2.04 SURFACES TO BE COATED:
A. System A-5:
   1. Steel Bollards and exterior exposed carbon steel
      a. Reference: Section 05 50 00, Civil, Structural and Architectural drawings.
      b. Location: As indicated.
B. System A-11:
   1. Bar Joists and Metal Roof Deck.
      a. Reference: Section 05 21 00, 05 31 00, Structural and Architectural drawings.
      b. Location: Electrical and Mechanical rooms (Rooms 110 and 111).
C. System B-4:
   1. Galvanized steel, galvanized steel doors and frames.
      a. Reference: Section 05 50 00, Section 08 11 13, Structural and Architectural drawings.
b. Location: All door frames, hollow metal doors and as indicated.

D. System F-2:
   1. Interior CMU walls.
      b. Location: As indicated.

E. System J-2:
   1. Interior Gypsum Board.
      b. Location: As indicated.

F. System K-2:
   1. Wood.
      b. Location: Wood closet shelving.

G. System K-5:
   1. Plywood.
      b. Location: Plywood walls in Electrical room (Room 111).

PART 3 - EXECUTION

3.01 SURFACE PREPARATION:
   A. Prepare surfaces for each coating system conforming to SSPC or ASTM surface preparation
      specifications listed.
      1. If grease or oils are present, SSPC SP1 shall precede any other method specified for
         metal substrates.
      2. Remove surface irregularities such as weld spatter, burrs, or sharp edges prior to
         specified surface preparation.
   B. Depth of profile will be as specified or as recommended by the manufacturer for each system,
      but in no instance shall it exceed one-third of the total dry film thickness of complete system.
   C. Prepare only those areas which will receive the first coat of the system on the same day.
      1. On steel substrates, apply coating before rust bloom forms.
   D. Concrete and masonry surfaces shall be adequately cured prior to coating application.
      1. Use surface cleaning methods, followed by mechanical or chemical surface preparation
         as specified in SSPC SP13.
   E. For new galvanized steel to be coated, if absence of hexavalent stain inhibitors is not
      documented, test as described in ASTM D2092, Appendix X2, and remove by one of the
      methods described therein.

3.02 APPLICATION:
   A. Apply coatings in accordance with coating manufacturer's recommendations.
   B. Use properly designed brushes, rollers, and spray equipment for all applications.
   C. On unprimed surfaces apply first coat of the system the same day as surface preparation.
   D. Dry film thickness of each system shall meet the minimum specified. Maximum dry film
      thickness shall not exceed the minimum more than 20% or coating manufacturer's requirements
      if less. Where a dry film thickness range is specified, the range shall not be less than or
      exceeded.
   E. Shop and field painting shall remain 3 inches (75 mm) away from unprepared surface of any
      substrate such as areas to be welded or bolted.
F. Environmental Conditions:
   1. Atmospheric temperature must be 50°F (10°C) or higher during application, unless otherwise approved by coating manufacturer. Do not apply coatings when inclement weather or freezing temperature may occur within coating recoat cure times.
   2. Wind velocities for exterior applications shall be at a minimum to prevent overspray or fallout and not greater than coating manufacturer's limits.
   3. Relative humidity must be less than 85%. The ambient temperature and the temperature of the surface to be painted must be at least 5°F (2.8°C) above the dew point.
   4. Provide adequate ventilation in all areas of application to ensure that at no time does the content of air exceed the Threshold Limit Value given on the manufacturer's Material Safety Data Sheets for the specific coatings being applied.

G. Recoat Time: In the event a coating, such as an epoxy, has exceeded its recoat time limit, prepare the applied coating in accordance with manufacturer's recommendations.

H. Protection:
   1. Cover or otherwise protect surfaces not to be painted. Remove protective materials when appropriate.
   2. Mask, remove, or otherwise protect finish hardware, machined surfaces, grilles, lighting fixtures, and prefinished units as necessary.
   3. Provide cover or shields to prevent surface preparation media and coatings from entering orifices in electrical or mechanical Equipment. Where ventilation systems must be kept in operation at time of surface preparation, take precautions to shield intakes and exhausts to prevent the materials from entering system or being dispersed.
   4. Provide signs to indicate fresh paint areas.
   5. Provide daily cleanup of both storage and working areas and removal of all paint refuse, trash, rags, and thinners. Dispose of leftover containers, thinners, rags, brushes, and rollers which cannot be reused in accordance with applicable regulations.
   6. Do not remove or paint over Equipment data plates, code stamps on piping, or UL fire-rating labels.

3.03 INSPECTION:
   A. Contractor shall provide and use a wet film gauges to check each application approximately every 15 min. in order to immediately correct film thickness under or over that specified.
   B. Contractor shall provide and use a dry film gauge to check each coat mil (mm) thickness when dry, and the total system mil (mm) thickness when completed.
   C. Use holiday or pinhole detector on systems over metal substrates to detect and correct voids when indicated on system sheet.
   D. Check air temperature and temperature of the substrate at regular intervals to be certain surface is 5°F (2.8°C) or more above the dew point.

3.04 CLEANING AND REPAIRS:
   A. Remove spilled, dripped, or splattered paint from surfaces.
   B. Touch up and restore damaged finishes to original condition. This includes surface preparation and application of coatings specified.

END OF SECTION 09 90 00
PROTECTIVE COATING SYSTEM

System: A-5

SERVICE: Steel - Moderate to Severe Exposure (Nonimmersion)

Surface Preparation:
Shop: SSPC-SP6 and profile depth 1.5 to 2.5 mils (38 to 63 microns).
Field: SSPC-SP2/3. Clean and dry.

First Coat:
High solids polyamine or polyamide epoxy with minimum 67% solids by volume. Apply at 5.0 to 7.0 mils (125 to 175 microns) dry film thickness.

Second Coat:
High solids aliphatic acrylic polyurethane gloss enamel with minimum 52% solids by volume. Apply at 3.0 to 5.0 mils (75 to 125 microns) film thickness.

System Total:
Minimum 8.0 mils (200 microns) dry film thickness.

Volatile Organic Content:
Maximum 2.8 lb/gal (340 g/L)

<table>
<thead>
<tr>
<th>COATING MANUFACTURER</th>
<th>FIRST COAT</th>
<th>TOUCH UP</th>
<th>SECOND COAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>PPG</td>
<td>Amerlock 2 or 400</td>
<td>Same as first coat</td>
<td>Amercoat 450 H</td>
</tr>
<tr>
<td>Carboline</td>
<td>Carboguard 890</td>
<td>Same as first coat</td>
<td>Carbothane 134 HG</td>
</tr>
<tr>
<td>Tnemec</td>
<td>Hi-Build Epoxoline II, Series N69</td>
<td>Same as first coat</td>
<td>Endura-Shield II, Series 1074</td>
</tr>
<tr>
<td>Sherwin-Williams</td>
<td>Macropoxy 646 B58-600/B58V600</td>
<td>Same as first coat</td>
<td>HS Polyurethane B65-300 Series</td>
</tr>
</tbody>
</table>
PROTECTIVE COATING SYSTEM

System: A-11 voc

SERVICE: Steel: Bar Joists, Metal Roof Deck: Interior

Surface Preparation: Clean and dry, free of oil, grease, loose mill scale and paint, and other contaminants. Clean bare and rusted areas per SSPC-SP11.

First Coat: Spot prime bare and rusted area with primer as recommended by manufacturer of finish coats. Pretreat galvanized metal as required by manufacturer of finish coats.

Touch Up: Touch-up same as first coat.

Second Coat: Acrylic Emulsion, dry-fall type, matte finish, minimum of 30% solids by volume. Apply at 2.0 to 3.0 mils (50 to 75 microns) dry film thickness.

Third Coat: Same as second coat.

System Total: Minimum 4.0 mils (100 microns) dry film thickness in addition to prime coat.

VOC (per coat): Maximum 50 g/L (each coat).

<table>
<thead>
<tr>
<th>COATING MANUFACTURER</th>
<th>FIRST COAT</th>
<th>TOUCH UP</th>
<th>SECOND COAT</th>
<th>THIRD COAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>PPG</td>
<td>Amercoat 148</td>
<td>Same as First Coat</td>
<td>Amercoat 222</td>
<td>Amercoat 222</td>
</tr>
<tr>
<td>Carboline</td>
<td>Carbocrylic 3359</td>
<td>Same as First Coat</td>
<td>Carbocrylic 3359</td>
<td>Carbocrylic 3359</td>
</tr>
<tr>
<td>Devoe</td>
<td>Spraymaster Uni-Grip-WB</td>
<td>Same as First Coat</td>
<td>Spraymaster Uni-Grip-WB</td>
<td>Spraymaster Uni-Grip-WB</td>
</tr>
<tr>
<td>International</td>
<td>Intercryl 520</td>
<td>Same as First Coat</td>
<td>Intercryl 530</td>
<td>Intercryl 530</td>
</tr>
<tr>
<td>Sherwin-Williams</td>
<td>Waterborne Acrylic Dry Fall</td>
<td>Same as First Coat</td>
<td>Waterborne Acrylic Dry Fall</td>
<td>Waterborne Acrylic Dry Fall</td>
</tr>
<tr>
<td>Tnemec</td>
<td>Uni-Bond DF 115</td>
<td>Same as First Coat</td>
<td>Uni-Bond DF 115</td>
<td>Uni-Bond DF 115</td>
</tr>
</tbody>
</table>
## PROTECTIVE COATING SYSTEM

**System:** B-4

### SERVICE:
Nonferrous & Galvanized Metal — Moderate to Severe Exposure Exterior or Interior (Including Galvanized Handrail)

### Surface Preparation:
Shop or field first coat: Remove oil or soap film with neutral detergent or emulsion cleaner.

### First Coat:
Pretreat and/or allow to weather as recommended by coating manufacturer.

### Second Coat:
High build polyamide or polyamidoamine epoxy with minimum 65% solids by volume. Apply at 4.0 - 6.0 mils (100 - 150 microns) dry film thickness.

### Third Coat:
High solids aliphatic acrylic polyurethane gloss enamel with minimum 60% solids by volume. Apply at 2.0 – 3.0 mils (50 – 75 microns) dry film thickness.

### System Total:
Minimum 6.0 mils (150 microns) dry film thickness in addition to galvanizing.

### Volatile Organic Content:
Maximum 2.8 lb/gal (340 g/L).

### Surface Preparation:
Shop or field first coat: Remove oil or soap film with neutral detergent or emulsion cleaner.

<table>
<thead>
<tr>
<th>COATING MANUFACTURER</th>
<th>FIRST COAT</th>
<th>TOUCH UP</th>
<th>SECOND COAT</th>
<th>THIRD COAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>PPG</td>
<td>See above</td>
<td></td>
<td>Amercoat 385</td>
<td>Amercoat 450 H</td>
</tr>
<tr>
<td>Carboline</td>
<td>See above</td>
<td></td>
<td>Carboguard 893 SG</td>
<td>Carbothane 134 HG</td>
</tr>
<tr>
<td>Sherwin-Williams</td>
<td>See above</td>
<td></td>
<td>Macropoxy 646 B58-600 Series</td>
<td>HS Polyurethane B65-300 Series</td>
</tr>
<tr>
<td>Tnemec</td>
<td>See above</td>
<td></td>
<td>F.C. Typoxy Series 27</td>
<td>Endura-Shield II 1074</td>
</tr>
</tbody>
</table>
**PROTECTIVE COATING SYSTEM**

**System:** F-2

**SERVICE:** Concrete Masonry Units (CMU) Normal Exposure Interior (Nonimmersion) Exterior or Interior

**Surface Preparation:**
- Concrete: ASTM D4258, clean and dry. Fill pits in concrete with patching compound as recommended by coating manufacturer. CMU: ASTM D4261, clean and dry.

**First Coat:** Acrylic Latex block filler with minimum 44% solids by volume. Apply at approximately 800 square feet per gallon (20 square meters per liter) on concrete and as required to fill pores on CMU.

**Second Coat:** Water reducible acrylic coating with minimum 34% solids by volume, gloss finish. Apply at 2.0 to 2.5 (50 to 63 microns) dry film thickness.

**Third Coat:** Same as second coat.

**System Total:** Minimum 4.0 mils (100 microns) dry film thickness in addition to filler.

**Volatile Organic Content:** Maximum 2.8 lb/gal (340 g/L).

<table>
<thead>
<tr>
<th>COATING MANUFACTURER</th>
<th>PRODUCT DESIGNATION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FIRST COAT</strong></td>
<td><strong>TOUCH UP</strong></td>
</tr>
<tr>
<td>Ameron</td>
<td>Amerlock 400BF</td>
</tr>
<tr>
<td>Carboiline</td>
<td>Sanitile 100</td>
</tr>
<tr>
<td>Devoe - AkzoNobel</td>
<td>Bloxfil 4000</td>
</tr>
<tr>
<td>International</td>
<td>Intercryl 320</td>
</tr>
<tr>
<td>Keeler &amp; Long</td>
<td>Kolor-Tex HS Block Filler KLC6442</td>
</tr>
<tr>
<td>Pittsburgh Paints</td>
<td>Pitt-Glaze 16-90</td>
</tr>
<tr>
<td>Sherwin-Williams</td>
<td>PrepRite Block Filler B25W25</td>
</tr>
<tr>
<td>Tnemec</td>
<td>Series 54-1205</td>
</tr>
</tbody>
</table>
PROTECTIVE COATING SYSTEM

System: J-2

SERVICE: Gypsum Board & Plaster – Normal Exposure Interior Walls

Surface Preparation: Clean and dry.

First Coat: Acrylic Sealer. Apply at 1.5 to 2.0 mils (38 to 50 microns) dry film thickness.

Second Coat: Water reducible acrylic coating with minimum 34% solids by volume, semi-gloss finish. Apply at 1.5 to 2.0 mils (38 to 50 microns) dry film thickness.

Third Coat: Same as second coat.

System Total: Minimum 4.5 mils (114 microns) dry film thickness.

Volatile Organic Content: Maximum 2.8 lb/gal (340 g/L).

<table>
<thead>
<tr>
<th>COATING MANUFACTURER</th>
<th>PRODUCT DESIGNATION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FIRST COAT</strong></td>
<td><strong>TOUCH UP</strong></td>
</tr>
<tr>
<td>Carboline</td>
<td>Carbocrylic 120</td>
</tr>
<tr>
<td>Glidden Professional</td>
<td>High Hide Acrylic Primer 1000</td>
</tr>
<tr>
<td>International</td>
<td>Intercryl 530</td>
</tr>
<tr>
<td>PPG</td>
<td>Speedhide Latex Primer 6-2</td>
</tr>
<tr>
<td>Sherwin-Williams</td>
<td>ProMar 200 Primer B28W8200</td>
</tr>
<tr>
<td>Tnemec</td>
<td>PVA Sealer 512 Series 51-1204</td>
</tr>
</tbody>
</table>
PROTECTIVE COATING SYSTEM

System: K-2

SERVICE: Wood, Clear Finish Interior

Surface Preparation: Sand smooth, clean and dry. Sand between coats.

First Coat: Clear, urethane varnish with minimum 40% solids by volume. Satin finish. Thin first coat with mineral spirits as recommended by varnish manufacturer for type of wood to be sealed.

Second Coat: Same as first coat, except do not thin. Apply full coat.

Third Coat: Same as second coat.

System Total: Per manufacturer's recommendations.

<table>
<thead>
<tr>
<th>COATING MANUFACTURER</th>
<th>PRODUCT DESIGNATION</th>
<th>FIRST COAT</th>
<th>TOUCH UP</th>
<th>SECOND COAT</th>
<th>THIRD COAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>PPG</td>
<td>Olympic WB Sanding Sealer 41061</td>
<td>Olympic Int. Polyurethane 42786</td>
<td>Same as second coat</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sherwin-Williams</td>
<td>Polyurethane Varnish A67 Series</td>
<td>Same as first coat, but do not thin</td>
<td>Same as second coat</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Product numbers shown are for satin finish. Revise if desiring a gloss finish.
### PROTECTIVE COATING SYSTEM

**System:** K-5

**SERVICE:** Wood and Plywood – Exterior or Interior, Normal Exposure

**Surface Preparation:** Sand smooth, clean and dry.

**First Coat:** Alkyd exterior wood primer with minimum 42% solids by volume. Apply at 1.5 to 2.5 mils (38 to 63 microns) dry film thickness.

**Second Coat:** Alkyd gloss enamel with minimum 40% solids by volume. Apply at 1.5 to 2.0 mils (38 to 50 microns) dry film thickness.

**Third Coat:** Same as second coat.

**System Total:** Minimum 4.5 mils (114 microns) dry film thickness.

**Volatile Organic Content:** Maximum 3.5 lb/gal.

<table>
<thead>
<tr>
<th>COATING MANUFACTURER</th>
<th>PRODUCT DESIGNATION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FIRST COAT</strong></td>
<td>TOUCH UP</td>
</tr>
<tr>
<td>Ameron</td>
<td>Amercoat 5105</td>
</tr>
<tr>
<td>Carboline</td>
<td>Carbocoat 150 HG</td>
</tr>
<tr>
<td>Glidden Professional</td>
<td>Ultra-Hide Durus 2110</td>
</tr>
<tr>
<td>International</td>
<td>Interlac 393</td>
</tr>
<tr>
<td>Keeler &amp; Long</td>
<td>Tri-Polar Primer No. KL6040</td>
</tr>
<tr>
<td>PPG</td>
<td>Speedhide Exterior Latex</td>
</tr>
<tr>
<td>Sherwin-Williams</td>
<td>A-100 Exterior Wood Primer</td>
</tr>
<tr>
<td>Tnemec</td>
<td>Primer Series 10-99W</td>
</tr>
</tbody>
</table>
SECTION 10 14 00 – SIGNAGE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. This Section includes the following:
      1. Interior melamine plastic-laminate Plaques.

1.03 REFERENCE STANDARDS:
   A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
   B. ASTM International:
      6. ASTM D4802 - Specification for Poly(Methyl Methacrylate) Acrylic Plastic Sheet
   C. International Code Council/American National Standards Institute:
   D. NFPA:
      1. NFPA 70 - National Electrical Code.
   E. U.S. Architectural & Transportation Barriers Compliance Board:

1.04 DEFINITIONS:

1.05 SUBMITTALS:
   A. Product Data: For each type of product indicated.
   B. Shop Drawings: Show fabrication and installation details for signs.
      1. Show sign mounting heights, locations of supplementary supports to be provided by others, and accessories.
      2. Provide message list, typestyles, graphic elements, including tactile characters and Braille, and layout for each sign.
   C. Samples for Verification: For each of the following products and for the full range of color, texture, and sign material indicated, of sizes indicated:
      1. Plaque: 6 inches (150 mm) square.
      2. Dimensional Characters: Full-size Samples of each type of dimensional character (letter, number, and graphic element).
   D. Sign Schedule.
SECTION 10 14 00 – SIGNAGE: continued

1.06 QUALITY ASSURANCE:
   A. Source Limitations for Signs: Obtain each sign type indicated from one source from a single manufacturer.

1.07 PROJECT CONDITIONS:
   A. Weather Limitations: Proceed with installation only when weather conditions permit installation of signs in exterior locations to be performed according to manufacturers’ written instructions and warranty requirements.
   B. Field Measurements: Verify recess openings by field measurements before fabrication and indicate measurements on Shop Drawings.

1.08 WARRANTY:
   A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
      1. Failures include, but are not limited to, the following:
         a. Deterioration of polymer finishes beyond normal weathering.
         b. Deterioration of embedded graphic image colors and sign lamination.
   B. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MATERIALS:
   A. Aluminum Castings: ASTM B26/B26M, of alloy and temper recommended by sign manufacturer for casting process used and for use and finish indicated.
   B. Acrylic Sheet: ASTM D4802, Category A-1 (cell-cast sheet), Type UVA (UV absorbing).

2.02 DIMENSIONAL CHARACTERS:
   A. 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:
      1. ACE Sign Systems, Inc.
      2. Advance Corporation; Braille-Tac Division.
      4. ASI-Modulex, Inc.
      5. Bunting Graphics, Inc.
      6. Charleston Industries, Inc.
      8. Grimco, Inc.
      10. Metal Arts; Div. of L&H Mfg. Co.
      15. Southwell Company (The).
SECTION 10 14 00 – SIGNAGE: continued

B. Cast Characters: Produce characters with smooth flat faces, sharp corners, and precisely formed lines and profiles, free of pits, scale, sand holes, and other defects. Cast lugs into back of characters and tap to receive threaded mounting studs. Alloy and temper recommended by sign manufacturer for casting process used and for use and finish indicated. Comply with the following requirements.
   2. Thickness: 5/8 inches.
   3. Color(s): As indicated on Drawings.

C. Aluminum Extrusions: Comply with the following requirements:
   1. Finish: Anodized.
   2. Thickness: 5/8 inches.
   3. Color(s): As indicated on drawings.
   4. Mounting: Concealed studs for substrates encountered on 1 ½” standoffs.

D. Dimensional Character Sign Schedule:
   1. Sign Type, Exterior Facility Sign:
      a. Sign Size: As Indicated.
      b. Character Size: As indicated.
      c. Text/Message: As indicated.
      d. Location: North Entrance.

2.03 PANEL SIGNS:

A. 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:
   1. ACE Sign Systems, Inc.
   2. Advance Corporation; Braille-Tac Division.
   3. Allen Industries Architectural Signage
   4. Allenite Signs; Allen Marking Products, Inc.
   5. APCO Graphics, Inc.
   6. ASI-Modulex, Inc.
   7. Best Sign Systems Inc.
   11. Grimco, Inc.
   12. Innerface Sign Systems, Inc.
   13. InPro Corporation
   14. Matthews International Corporation; Bronze Division.
   19. Signature Signs, Incorporated.
   20. Supersine Company (The).

B. Laminated Interior & Exterior Signs: Solid phenolic panel core with graphic image covered with thermosetting resin face layer.
   1. Surface Finish: Mat or UV resistant, outdoor.
   2. Edge Condition: Beveled.
3. Corner Condition: Square.

C. Tactile and Braille Sign: Manufacturer's standard process for producing text and symbols complying with ADA-ABA Accessibility Guidelines and with ICC/ANSI A117.1. Text shall be accompanied by Grade 2 Braille. Produce precisely formed characters with square-cut edges free from burrs and cut marks; Braille dots with domed or rounded shape.
2. Raised-Copy Thickness: Not less than 1/32 inch (0.8 mm).

D. Panel Sign Schedule:
1. Sign Size: 8 inch by 8 inch.
6. Sign Type; Picture Signs:
   a. Room: Women’s Locker Room.
      (1) Location: On Door 106.
      (2) Image: Woman picture and handicap symbol.
      (3) Text/Message: Restroom.
   b. Room: Men’s Locker Room.
      (1) Location: On Door 105.
      (2) Image: Man picture and handicap symbol.
      (3) Text/Message: Restroom.
   c. Room: Public Restroom.
      (1) Location: On Door 116.
      (2) Image: Unisex picture and handicap symbol.
      (3) Text/Message: Restroom.
7. Sign Type; Word Signs:
   a. Room: Utility Room.
      (1) Location: Outside Door 110.
      (2) Text/Message: Utility.
   b. Room: Electrical Room.
      (1) Location: Outside Door 110.
      (2) Text/Message: Electrical/IT.

2.04 ACCESSORIES:
A. Anchors and Inserts: Provide nonferrous-metal or hot-dip galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use toothed steel or lead expansion-bolt devices for drilled-in-place anchors. Furnish inserts, as required, to be set into concrete or masonry work.

2.05 FABRICATION:
A. General: Provide manufacturer's standard signs of configurations indicated.
1. Mill joints to tight, hairline fit. Form joints exposed to weather to exclude water penetration.
2. Preassemble signs in the shop to greatest extent possible. Disassemble signs only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation, in location not exposed to view after final assembly.
SECTION 10 14 00 – SIGNAGE: continued

3. Conceal fasteners if possible; otherwise, locate fasteners where they will be inconspicuous.

2.06 FINISHES, GENERAL:
   A. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.07 ALUMINUM FINISHES:
   A. Color Anodic Finish: Manufacturer's standard Class 1 integrally colored or electrolytically deposited color anodic coating, 0.018 mm or thicker, in dark bronze applied over a satin directionally textured mechanical finish, complying with AAMA 611.

2.08 ACRYLIC SHEET FINISHES:
   A. Colored Coatings for Acrylic Sheet: For copy colors, provide colored coatings, including inks, dyes, and paints, that are recommended by acrylic manufacturers for optimum adherence to acrylic surface and that are UV and water resistant for five years for application intended.

PART 3 - EXECUTION

3.01 EXAMINATION:
   A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of Work.
   B. Verify that items are sized and located to accommodate signs.
   C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:
   A. Locate signs and accessories where indicated, using mounting methods of types described and complying with manufacturer's written instructions.
      1. Install signs level, plumb, and at heights indicated, with sign surfaces free of distortion and other defects in appearance.
      2. Interior Wall Signs: Install signs on walls adjacent to latch side of door where applicable. Where not indicated or possible, such as double doors, install signs on nearest adjacent walls. Locate to allow approach within 3 inches (75 mm) of sign without encountering protruding objects or standing within swing of door.
   B. Wall-Mounted Signs: Comply with sign manufacturer's written instructions except where more stringent requirements apply.
      1. Two-Face Tape: Mount signs to smooth, nonporous surfaces. Do not use this method for vinyl-covered or rough surfaces.
      2. Shim Plate Mounting: Provide 1/8-inch (3-mm) thick, concealed aluminum shim plates with predrilled and countersunk holes, at locations indicated, and where other mounting methods are not practicable. Attach plate with fasteners and anchors suitable for secure attachment to substrate. Attach panel signs to plate using method specified above.
   C. Dimensional Characters: Mount characters using standard fastening methods to comply with manufacturer's written instructions for character form, type of mounting, wall construction, and...
condition of exposure indicated. Provide heavy paper template to establish character spacing
and to locate holes for fasteners.
1. Projected Mounting: Mount characters at projection distance from wall surface indicated.

3.03 CLEANING AND PROTECTION:
   A. After installation, clean soiled sign surfaces according to manufacturer's written instructions.
   Protect signs from damage until acceptance by Owner.

END OF SECTION 10 14 00
SECTION 10 21 13.13 - METAL TOILET COMPARTMENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary
      Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. This Section includes painted steel toilet compartments, urinal screens and related accessories.

1.03 RELATED REQUIREMENTS:
   A. Section 05 50 00 - Metal Fabrications for supports that attach ceiling-hung compartments to
      overhead structural system.
   B. Section 10 28 00 - Toilet, Bath, and Laundry Accessories for toilet tissue dispensers, grab bars,
      and similar accessories mounted on toilet compartments.

1.04 REFERENCE STANDARDS:
   A. Publication Dates: Comply with standards in effect as of date of the Contract Documents
      unless otherwise indicated.
   B. ASTM International:
      1. ASTM A653/A653M: Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-
         Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
      2. ASTM A666: Specification for Annealed or Cold-Worked Austenitic Stainless-Steel Sheet,
         Strip, Plate, and Flat Bar.
         Nickel, Corrosion Resistant, for General Application.
      4. ASTM A879/A879M: Specification for Steel Sheet, Zinc Coated by the Electrolytic
         Process for Applications Requiring Designation of the Coating Mass on Each Surface.
      6. ASTM B86: Specification for Copper-Zinc-Lead Alloy (Leaded-Brass) Extruded
         Shapes.
      7. ASTM B221: Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods,
         Wire, Profiles, and Tubes.
      8. ASTM B455: Specification for Copper-Zine-Lead Alloy (Leaded-Brass) Extruded
         Shapes.
     10. ASTM F446: Consumer Safety Specification for Grab Bars and Accessories Installed in
         the Bathing Area.
   C. International Code Council:
   D. U.S. Architectural & Transportation Barriers Compliance Board:
      1. Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA)
         Accessibility Guidelines for Buildings and Facilities. (Available in PDF at

1.05 SUBMITTALS:
   A. Product Data: For each type of product.
      1. Include construction details, material descriptions, dimensions of individual components
         and profiles, and finishes for toilet compartments.
   B. Shop Drawings: For toilet compartments.
SECTION 10 21 13.13 – METAL TOILET COMPARTMENTS: continued

1. Include plans, elevations, sections, and attachment details.
2. Show locations of reinforcements for compartment-mounted grab bars and locations of blocking for surface-mounted toilet accessories.
3. Show locations of centerlines of toilet fixtures.
4. Show locations of floor drains.

C. Samples for Verification: For the following products, in manufacturer's standard sizes unless otherwise indicated:
   1. Each type of material, color, and finish required for toilet compartments, prepared on 6-inch (152-mm) square Samples of same thickness and material indicated for Work.
   2. Each type of hardware and accessory.

D. Product Certificates: For each type of toilet compartment.

E. Maintenance Data: For toilet compartments to include in maintenance manuals.

F. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Door Hinges: Two hinges with associated fasteners.
   2. Latch and Keeper: One latch and keeper with associated fasteners.
   3. Door Bumper: Two door bumpers with associated fasteners.
   4. Door Pull: One door pull with associated fasteners.
   5. Fasteners: Ten fasteners of each size and type.

1.06 PROJECT CONDITIONS:
A. Field Measurements: Verify actual locations of toilet fixtures, walls, columns, ceilings, and other construction contiguous with toilet compartments by field measurements before fabrication.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:
A. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1 for toilet compartments designated as accessible.

2.02 PAINTED STEEL TOILET COMPARTMENTS:
A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Bradley Corporation; Mills Partitions.
   3. Global Steel Products Corp.
   4. Scranton Products.
   5. Special-Lite.
   6. Architect approved equal.

B. Toilet-Enclosure Style: Floor anchored.
C. Urinal-Screen Style: Wall hung, flat panel.
D. Door, Panel, and Pilaster Construction: Seamless, metal facing sheets pressure laminated to core material; with continuous, interlocking molding strip or lapped-and-formed edge closures; corners secured by welding or clips and exposed welds ground smooth. Exposed surfaces shall be free of pitting, seam marks, roller marks, stains, discolorations, telegraphing of core material, or other imperfections.
SECTION 10 21 13.13 – METAL TOILET COMPARTMENTS: continued

1. Core Material: Manufacturer's standard sound-deadening honeycomb of resin-impregnated Kraft paper in thickness required to provide finished thickness of 1 inch (25 mm) for doors and panels and 1-1/4 inches (32 mm) for pilasters.

2. Tapping Reinforcement: Provide concealed reinforcement for tapping (threading) at locations where machine screws are used for attaching items to units.

E. Urinal-Screen Construction:
1. Flat-Panel Urinal Screen: Matching panel construction.

F. Facing Sheets and Closures: Electrolytically coated steel sheet with nominal base-metal (uncoated) thicknesses as follows:
1. Pilasters, Braced at Both Ends: Manufacturer's standard thickness, but not less than 0.036 inch.
2. Pilasters, Unbraced at One End: Manufacturer's standard thickness, but not less than 0.048 inch.
3. Panels: Manufacturer's standard thickness, but not less than 0.030 inch.
4. Doors: Manufacturer's standard thickness, but not less than 0.030 inch.
5. Flat-Panel Urinal Screens: Thickness matching the panels.

G. Pilaster Shoes and Sleeves (Caps): Stainless-steel sheet, not less than 0.031-inch nominal thickness and 3 inches high, finished to match hardware.

H. Brackets (Fittings):
1. Stirrup Type: Ear or U-brackets; stainless steel.

I. Steel Sheet Finish: Immediately after cleaning and pretreating, apply manufacturer's standard baked-on finish, including thermosetting, electrostatically applied, and powder coatings. Comply with coating manufacturer's written instructions for applying and baking.
1. Color: As selected by Architect from manufacturer's full range.

2.03 HARDWARE AND ACCESSORIES:
A. Hardware and Accessories: Manufacturer's standard operating hardware and accessories.
2. Hinges: Manufacturer's standard continuous, spring-loaded type, allowing emergency access by lifting door.
3. Latch and Keeper: Manufacturer's standard recessed latch unit designed for emergency access and with combination rubber-faced door strike and keeper. Provide units that comply with regulatory requirements for accessibility at compartments designated as accessible.
4. Coat Hook: Manufacturer's standard combination hook and rubber-tipped bumper, sized to prevent in-swinging door from hitting compartment-mounted accessories.
5. Door Bumper: Manufacturer's standard rubber-tipped bumper at out-swinging doors.
6. Door Pull: Manufacturer's standard unit at out-swinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at compartments designated as accessible.

B. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel, finished to match the items they are securing, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use stainless steel, hot-dip galvanized steel, or other rust-resistant, protective-coated steel compatible with related materials.

2.04 MATERIALS:
A. Steel Sheet: Commercial steel sheet for exposed applications; mill phosphatized and selected for smoothness.
SECTION 10 21 13.13 – METAL TOILET COMPARTMENTS: continued

1. Electrolytically Zinc-Coated: ASTM A879/A879M, 01Z (03G).

B. Stainless-Steel Sheet: ASTM A666, Type 304, stretcher-leveled standard of flatness.
C. Stainless-Steel Castings: ASTM A743/A743M.

2.05 FABRICATION:
A. Fabrication, General: Fabricate toilet compartment components to sizes indicated. Coordinate requirements and provide cutouts for through-partition toilet accessories, and solid blocking within panel where required for attachment of toilet accessories.
B. Floor-Anchored Units: Provide manufacturer's standard corrosion-resistant anchoring assemblies with leveling adjustment nuts at pilasters for structural connection to floor. Provide shoes at pilasters to conceal anchorage.
C. Door Size and Swings: Unless otherwise indicated, provide 24-inch (610-mm) wide, doors for standard toilet compartments and 36-inch (914-mm) wide, doors with a minimum 32-inch (813-mm) wide, clear opening for compartments designated as accessible. Provide swing direction as indicated on the Drawings.

PART 3 - EXECUTION

3.01 EXAMINATION:
A. Examine substrates, areas and conditions, with Installer present, for compliance with requirements for fastening, support, alignment, operating clearances, and other conditions affecting performance of the Work.
1. Confirm location and adequacy of blocking and supports required for installation.
B. Proceed with installation only after unsatisfactory conditions have been corrected.
C. Coordinate layout and installation of supports, inserts, and anchors built into other units of work for toilet compartment anchorage.

3.02 INSTALLATION:
A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position indicated with manufacturer's recommended anchoring devices.
1. Maximum Clearances:
   a. Pilasters and Panels: 1/2 inch (13 mm).
   b. Panels and Walls: 1 inch (25 mm).
2. Stirrup Brackets: Secure panels to walls and to pilasters with no fewer than three brackets attached at midpoint and near top and bottom of panel.
   a. Locate wall brackets so holes for wall anchors occur in masonry or tile joints.
   b. Align brackets at pilasters with brackets at walls.
B. Floor-Anchored Units: Set pilasters with anchors penetrating not less than 2 inches (51 mm) into structural floor unless otherwise indicated in manufacturer's written instructions. Level, plumb, and tighten pilasters. Hang doors and adjust so tops of doors are level with tops of pilasters when doors are in closed position.
C. Urinal Screens: Attach with anchoring devices to suit supporting structure. Set units level and plumb, rigid, and secured to resist lateral impact.

3.03 ADJUSTING:
A. Hardware Adjustment: Adjust and lubricate hardware according to hardware manufacturer's written instructions for proper operation. Set hinges on in-swinging doors to hold doors open
SECTION 10 21 13.13 – METAL TOILET COMPARTMENTS: continued

approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors to return doors to fully closed position.

END OF SECTION 10 21 13.13
SECTION 10 28 00 – TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. This Section includes:
      1. Public-use washroom accessories.
      2. Under lavatory guards.
      3. Custodial accessories.

1.03 RELATED REQUIREMENTS:
   A. Section 09 30 13 - Ceramic Tiling for ceramic toilet and bath accessories.

1.04 REFERENCE STANDARDS:
   A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
   B. ASTM International:
      3. A666: Specification for Annealed or Cold-Worked Austenitic Stainless-Steel Sheet, Strip, Plate, and Flat Bar.
   C. NFPA:
      1. 70: National Electrical Code.

1.05 SUBMITTALS:
   A. Product Data: For each type of product.
      1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
      2. Include anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
   B. Samples: Full size, for each exposed product.
      1. Approved full-size Samples will be returned and may be used in the Work.
   C. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.
1. Identify locations using room designations indicated.
2. Identify accessories using designations indicated.
D. Sample Warranty: For manufacturer's special warranty.
E. Maintenance Data: For accessories to include in maintenance manuals.

1.06 COORDINATION:
A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.
B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.07 WARRANTY:
A. Manufacturer's Special Warranty for Mirrors: Manufacturer agrees to repair or replace mirrors that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, visible silver spoilage defects.
   2. Warranty Period: 2 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PUBLIC-USE WASHROOM ACCESSORIES:
A. Source Limitations: Obtain public-use washroom accessories from single source from single manufacturer.
B. Seat-Cover Dispenser <Mark B2>.
C. Combination Towel (Folded) Dispenser/Waste Receptacle <Mark B3>:
   1. Description: Combination unit for dispensing C-fold or multifold towels, with removable waste receptacle.
D. Toilet Tissue (Roll) Dispenser <Mark B4>
E. Grab Bar <Mark B5>:
   1. Mounting: Flanges with concealed fasteners.
F. Mirror Unit <Mark B6>:
      a. One-piece, galvanized-steel, wall-hanger device with spring-action locking mechanism to hold mirror unit in position with no exposed screws or bolts, or;
      b. Wall bracket of galvanized steel equipped with concealed locking devices requiring a special tool to remove.
   2. Size: As indicated on Drawings.
G. Sanitary-Napkin Disposal Unit <Mark B7>:
   1. Receptacle: Removable.
H. Automatic Liquid-Soap Dispenser <Mark B8>:
   1. Description: Automatic dispenser with infrared sensor to detect presence of hands; battery powered; designed for dispensing antibacterial soap in liquid or lotion form.
I. Coat Hook (Installed on the back of toilet partition doors):
   1. Description: Double-prong unit.
SECTION 10 28 00 – TOILET, BATH, AND LAUNDRY ACCESSORIES: continued

2.02 UNDER LAVATORY GUARDS:
   A. Under lavatory Guard
      1. Description: Insulating pipe covering for supply and drain piping assemblies that prevents direct contact with and burns from piping; allow service access without removing coverings.

2.03 CUSTODIAL ACCESSORIES:
   A. Source Limitations: Obtain custodial accessories from single source from single manufacturer.
   B. Combination Utility Shelf with Mop and Broom Holder<Mark B11>:
      1. Description: Unit with shelf, hooks and holders.
      2. Length: 34 inches (914 mm).
      5. Material and Finish: Stainless steel, No. 4 finish (satin).

2.04 FABRICATION:
   A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.
   B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.01 INSTALLATION:
   A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
   B. Grab Bars: Install to withstand a downward load of at least 250 lbf. (1112 N), when tested according to ASTM F446.

3.02 ADJUSTING AND CLEANING:
   A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.
   B. Remove temporary labels and protective coatings.
   C. Clean and polish exposed surfaces according to manufacturer's written instructions.

END OF SECTION 10 28 00
SECTION 10 44 16 – FIRE EXTINGUISHERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. This Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.

1.03 REFERENCE STANDARDS:
   A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
   B. NFPA:
      1. NFPA 10: Portable Fire Extinguishers.

1.04 SUBMITTALS:
   A. Product Data: For each type of product. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets.
   B. Warranty: Sample of special warranty.
   C. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

1.05 WARRANTY:
   A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
      1. Failures include, but are not limited to, the following:
         a. Failure of hydrostatic test according to NFPA 10.
         b. Faulty operation of valves or release levers.
      2. Warranty Period: 2 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:
   A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."
   B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

2.02 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS:
   A. Fire Extinguishers: Type, size, and capacity for each fire-protection cabinet indicated.
      1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
         a. Amerex Corporation.
         b. Ansul Incorporated.
         c. Badger Fire Protection.
         d. Buckeye Fire Equipment Company.
SECTION 10 44 16 – FIRE EXTINGUISHERS: continued

e. Fire End & Croker Corporation.
f. Guardian Fire Equipment, Inc.
g. JL Industries, Inc.; a division of the Activar Construction Products Group.
h. Kidde Residential and Commercial Division; Subsidiary of Kidde plc.
i. Larsens Manufacturing Company.
j. Moon American.
k. Nystrom Building Products.
l. Pem All Fire Extinguisher Corp.
m. Potter Roemer LLC.
n. Pyro-Chem; Tyco Safety Products.
o. Strike First Corporation of America.

2. Valves: Manufacturer's standard.
3. Handles and Levers: Manufacturer's standard.
4. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B.

B. Multipurpose Dry-Chemical Type in Steel Container: UL rated 2-A:10-B:C, 5-lb. nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

C. Clean-Agent Type in Steel Container: UL rated 5-B:C, 5-lb. nominal capacity, with HFC blend agent and inert material in enameled-steel container; with pressure-indicating gage.

2.03 MOUNTING BRACKETS:
A. Mounting Brackets: Manufacturer's standard galvanized steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or black baked-enamel finish.
1. Manufacturers: Same as extinguisher provided.
B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.
1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.

C.

PART 3 - EXECUTION

3.01 EXAMINATION:
A. Examine fire extinguishers for proper charging and tagging.
1. Remove and replace damaged, defective, or undercharged fire extinguishers.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:
A. General: Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.
1. Mounting Brackets: 5 ft. above finished floor to top of fire extinguisher.
B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

END OF SECTION 10 44 16
SECTION 10 51 13 - METAL LOCKERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. This Section includes:
      1. Welded athletic lockers.
      2. Locker benches.

1.03 REFERENCE STANDARDS:
   A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
   B. ASTM International:
      1. ASTM A500/A500M: Specification for Cold-Formed Welded and Seamless Carbon-Steel Structural Tubing in Rounds and Shapes.
      2. ASTM A653/A653M: Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
      3. ASTM A666-03: Specification for Annealed or Cold-Worked Austenitic Stainless-Steel Sheet, Strip, Plate, and Flat Bar.
      6. ASTM D6007: Test Method for Determining Formaldehyde Concentration in Air from Wood Products Using a Small-Scale Chamber.
   C. California Air Resources Board (1001 "I" Street, Sacramento, CA 95814: www.arb.ca.gov; 800242-4450):
      1. Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products.
   D. California Department of Public Health:
   E. International Code Council:
   F. National Electrical Manufacturers Association:
      1. NEMA LD 3: High-Pressure Decorative Laminates.
   G. U.S. Architectural & Transportation Barriers Compliance Board:
      1. Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities.

1.04 SUBMITTALS:
   A. Product Data: For each type of metal locker.
SECTION 10 51 13 – METAL LOCKERS: continued

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of metal locker [and bench].

B. Shop Drawings: For metal lockers.
   1. Include plans, elevations, sections, details, and attachments to other work.
   2. Show locker trim and accessories.

C. Samples: For each color specified, in manufacturer's standard size.

D. Product Schedule: For lockers.

E. Qualification Data: For Installer.

F. Sample Warranty: For special warranty.

G. Maintenance Data: For adjusting, repairing, and replacing locker doors and latching mechanisms to include in maintenance manuals.

H. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Full-size units of the following metal locker hardware items equal to 10% of amount installed for each type and finish installed, but no fewer than 2 units:
      a. Identification plates.
      b. Hooks.

1.05 DELIVERY, STORAGE, AND HANDLING:
   A. Do not deliver metal lockers until spaces to receive them are clean, dry, and ready for their installation.
   B. Deliver master and control keys to Owner by registered mail or overnight package service.

1.06 FIELD CONDITIONS:
   A. Field Measurements: Verify actual dimensions of recessed openings by field measurements before fabrication.

1.07 COORDINATION:
   A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of work specified in other sections to ensure that metal lockers can be supported and installed as indicated.

1.08 WARRANTY:
   A. Special Warranty: Manufacturer agrees to repair or replace components of metal lockers that fail in materials or workmanship, excluding finish, within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures.
      b. Faulty operation of latches and other door hardware.
   2. Damage from deliberate destruction and vandalism is excluded.
   3. Warranty Period for Welded Metal Lockers: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:
   A. Source Limitations: Obtain metal lockers, locker benches, and accessories from single source from single locker manufacturer.
   1. Obtain locks from single lock manufacturer.
2.02 PERFORMANCE REQUIREMENTS:
   A. Accessibility Requirements: For lockers indicated to be accessible, comply with applicable provisions in ICC A117.1.

2.03 WELDED ATHLETIC LOCKERS:
   A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      1. Penco Products, Inc.
      2. DeBourgh Mfg. Co. (Basis of Design)
      3. Olympus Lockers & Storage Products, Inc.
      4. Engineer approved equal.
   B. Expanded-Metal Doors: Fabricated from 0.090-inch (2.28-mm) nominal-thickness expanded metal; welded to 0.105-inch (2.66-mm) nominal-thickness steel angle frame; with 0.090-inch (2.28-mm) nominal-thickness, steel sheet lock panel backed by 0.060-inch (1.52-mm) nominal-thickness, steel sheet retainer welded to door frame.
   C. Body: Assembled by welding body components together. Fabricate from unperforated steel sheet with thicknesses as follows:
      1. Tops and Bottoms: 0.060-inch (1.52-mm) nominal thickness, with single bend at edges.
      2. Backs: 0.048-inch (1.21-mm) nominal thickness.
      3. Shelves: 0.060-inch (1.52-mm) nominal thickness, with double bend at front and single bend at sides and back.
   D. Unperforated Sides: Fabricated from 0.060-inch (1.52-mm) nominal-thickness steel sheet.
   E. Frames: Channel formed; fabricated from 0.060-inch (1.52-mm) nominal-thickness steel sheet or 0.097-inch (2.45-mm) nominal-thickness steel angles; lapped and factory welded at corners; with top and bottom main frames factory welded into vertical main frames. Form continuous, integral, full-height door strikes on vertical main frames.
   F. Hinges: Welded to door and attached to door frame with no fewer than two factory-installed rivets per hinge that are completely concealed and tamper resistant when door is closed; fabricated to swing 180 degrees.
      1. Hinges: Manufacturer's standard, steel, continuous or knuckle type.
   G. Recessed Door Handle and Latch: Stainless-steel cup with integral door pull, recessed so locking device does not protrude beyond door face; pry and vandal resistant.
      1. Single-Point Latching: Nonmoving latch hook with steel padlock loop that projects through recessed cup and is finished to match metal locker body.
         a. Latch Hook: Equip each door with one latch hook, fabricated from 0.120-inch (3.04-mm) nominal-thickness steel sheet; welded midway up full-height door strike; with resilient silencer.
   H. Locks: Provided by owner.
   I. Identification Plates: Manufacturer's standard, etched, embossed, or stamped aluminum plates, with numbers and letters at least 3/8 inch (9 mm) high.
   J. Hooks: Manufacturer's standard ball-pointed type, aluminum or steel; zinc plated.
   L. Continuous Zee Base: 4 inches (102 mm) high; fabricated from 0.075-inch (1.90-mm) nominal-thickness steel sheet.
   M. Filler Panels: Fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet.
   N. Materials:
      1. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B, suitable for exposed applications.
SECTION 10 51 13 – METAL LOCKERS: continued

2. Expanded Metal: ASTM F1267, Type II (flattened), Class I, 3/4-inch (19-mm) steel mesh, with at least 70% open area.

O. Finish: Baked enamel or powder coat.
   1. Color: As selected by Architect from manufacturer's full range.

2.04 LOCKER BENCHES:
   A. Provide bench units with overall assembly height of 17-1/2 inches (445 mm).
   B. Bench Tops: Manufacturer's standard one-piece units, with rounded corners and edges.
      1. Size: Minimum 9-1/2 inches wide by 1-1/4 inches thick (241 mm wide by 32 mm thick).
      2. Laminated clear hardwood with one coat of clear sealer on all surfaces and one coat of clear lacquer on top and sides.
   C. Fixed Pedestals: Manufacturer's standard supports, with predrilled fastener holes for attaching bench top and anchoring to floor, complete with fasteners and anchors, and as follows:
      1. Tubular Steel: 1-1/2-inch (38-mm) diameter steel tubing threaded on both ends, with standard pipe flange at top and bell-shaped cast-iron base; powder-coat finish; anchored with exposed fasteners.
   D. Materials:
      1. Stainless Steel: ASTM A666, Type 304.
      2. Plastic Laminate: NEMA LD 3, Grade HGP.
      3. Extruded Aluminum: ASTM B221 (ASTM B221M), alloy and temper recommended by aluminum producer and manufacturer for type of use and finish indicated.
      4. Steel Tube: ASTM A500/A500 M, cold rolled.

2.05 FABRICATION:
   A. Fabricate metal lockers square, rigid, without warp, and with metal faces flat and free of dents or distortion. Make exposed metal edges safe to touch and free of sharp edges and burrs.
      1. Form body panels, doors, shelves, and accessories from one-piece steel sheet unless otherwise indicated.
      2. Provide fasteners, filler plates, supports, clips, and closures as required for complete installation.
   B. Fabricate each metal locker with an individual door and frame; individual top, bottom, and back; and common intermediate uprights separating compartments. Factory weld frame members of each metal locker together to form a rigid, one-piece assembly.
   C. Equipment: Provide each locker with an identification plate and the following equipment:
      1. Single-Tier Units: Shelf and two single-prong wall hooks.
      2. Coat Rods: In lieu of ceiling hook.
   D. Knocked-Down Construction: Fabricate metal lockers using nuts, bolts, screws, or rivets for preassembly at plant prior to shipping.
   E. Accessible Lockers: Fabricate as follows:
      1. Where hooks, coat rods, or additional shelves are provided, locate no higher than 48 inches (1219 mm) above the floor.
   F. Continuous Base: Formed into channel or zee profile for stiffness and fabricated in lengths as long as practical to enclose base and base ends of metal lockers; finished to match lockers.
   G. Filler Panels: Fabricated in an unequal leg angle shape; finished to match lockers. Provide slip-joint filler angle formed to receive filler panel.
SECTION 10 51 13 – METAL LOCKERS: continued

2.06 ACCESSORIES:
   A. Fasteners: Zinc- or nickel-plated steel, slotless-type, exposed bolt heads; with self-locking nuts or lock washers for nuts on moving parts.
   B. Anchors: Material, type, and size required for secure anchorage to each substrate.
      1. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls for corrosion resistance.

PART 3 - EXECUTION

3.01 EXAMINATION:
   A. Examine walls, floors, and support bases, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
   B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
   C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:
   A. General: Install lockers level, plumb, and true; shim as required, using concealed shims.
      1. Anchor locker runs at ends and at intervals recommended by manufacturer, but not more than 36 inches (910 mm) o.c. Using concealed fasteners, install anchors through backup reinforcing plates, channels, or blocking as required to prevent metal distortion.
      2. Anchor single rows of metal lockers to walls near top of lockers and to floor.
   B. Knocked-Down Lockers: Assemble with standard fasteners, with no exposed fasteners on door faces or face frames.
   C. Equipment:
      1. Attach hooks with at least two fasteners.
      2. Attach door locks on doors using security-type fasteners.
      3. Identification Plates: Identify metal lockers with identification indicated on Drawings.
         a. Attach plates to each locker door, near top, centered, with at least two aluminum rivets.
         b. Attach plates to upper shelf of each open-front metal locker, centered, with a least two aluminum rivets.
   D. Trim: Fit exposed connections of trim, fillers, and closures accurately together to form tight, hairline joints, with concealed fasteners and splice plates.
      1. Attach filler panels with concealed fasteners. Locate filler panels where indicated on Drawings.
   E. Fixed Locker Benches: Provide no fewer than two pedestals for each bench, uniformly spaced not more than 72 inches (1830 mm) apart. Securely fasten tops of pedestals to undersides of bench tops, and anchor bases to floor.

3.03 ADJUSTING:
   A. Clean, lubricate, and adjust hardware. Adjust doors and latches to operate easily without binding.

3.04 PROTECTION:
   A. Protect metal lockers from damage, abuse, dust, dirt, stain, or paint. Do not permit use during construction.
SECTION 10 51 13 – METAL LOCKERS: continued

B. Touch up marred finishes or replace metal lockers that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by locker manufacturer.

END OF SECTION 10 51 13
SECTION 12 24 13 – ROLLER WINDOW SHADES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. Section Includes:
      1. Manually operated roller shades with single rollers at every window.

1.03 REFERENCED STANDARDS:
   A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
   B. NFPA:
   C. Window Covering Manufacturers Association:
      1. WCMA A 100.1 - Safety of Corded Window Covering Products (ANSI).

1.04 SUBMITTALS:
   A. Product Data: For each type of product.
      1. Include construction details, material descriptions, dimensions of individual components and profiles, features, finishes, and operating instructions for roller shades.
   B. Shop Drawings: Show fabrication and installation details for roller shades, including shadeband materials, their orientation to rollers, and their seam and batten locations.
   C. Samples: For each exposed product and for each color and texture specified, 10 inches (250 mm) long.
   D. Product Schedule: For roller shades.
   E. Qualification Data: For Installer.
   F. Product Certificates: For each type of shade and material.
   G. Operation and Maintenance Data: For roller shades to include in maintenance manuals.
   H. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
      1. Roller Shades: Full-size units equal to 5 percent of quantity installed for each size, color, and shadeband material indicated, but no fewer than two units.

1.05 QUALITY ASSURANCE:
   A. Installer Qualifications: Fabricator of products.
   B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
      1. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
      2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.06 DELIVERY, STORAGE, AND HANDLING:
   A. Deliver roller shades in factory packages, marked with manufacturer, product name, and location of installation using same designations indicated on Drawings.
SECTION 12 24 13 – ROLLER WINDOW SHADES: continued

1.07 FIELD CONDITIONS:
   A. Environmental Limitations: Do not install roller shades until construction and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
   B. Field Measurements: Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:
   A. Source Limitations: Obtain roller shades from single source from single manufacturer.

2.02 MANUALLY OPERATED SHADES WITH SINGLE ROLLERS:
   A. Basis-of-Design Product: Subject to compliance with requirements, provide Mecho/5 System or comparable product by one of the following:
      2. Lutron Electronics Co., Inc.
      3. MechoShade Systems, Inc.
   B. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated.
         a. Loop Length: Full length of roller shade.
         b. Limit Stops: Provide upper and lower ball stops.
         c. Chain-Retainer Type: Clip, jamb mount.
   C. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.
      1. Roller Drive-End Location: Accessible, opposite end of furniture shown in plan. Indicate on shop drawings.
      2. Direction of Shadeband Roll: Regular, from back (exterior face) of roller.
   D. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.
   E. Shadebands:
      2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
         a. Type: Enclosed in sealed pocket of shadeband material.
   F. Installation Accessories:
      1. Front Fascia: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.
         a. Shape: L-shaped.
         b. Height: Manufacturer's standard height required to conceal roller and shadeband assembly when shade is fully open, but not less than 4 inches (102 mm).
SECTION 12 24 13 – ROLLER WINDOW SHADES: continued

2. Endcap Covers: To cover exposed endcaps. Match fascia color.
3. Installation Accessories Color and Finish: As selected from manufacturer's full range.

2.03 SHADEBAND MATERIALS:
A. Shadeband Material Flame-Resistance Rating: Comply with NFPA 701. Testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
B. Light-Filtering Fabric: Woven fabric, stain and fade resistant.
   1. Source: Roller shade manufacturer.
   2. Type: PVC-coated polyester.
   4. Thickness: 0.03 inches.
   5. Roll Width: To match window.
   6. Openness Factor: 2 percent.
   7. Color: As selected by Architect from manufacturer's full range.

2.04 ROLLER SHADE FABRICATION:
A. Product Safety Standard: Fabricate roller shades to comply with WCMA A 100.1, including requirements for flexible, chain-loop devices; lead content of components; and warning labels.
B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F (23 deg C):
   1. Between (Inside) Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which shade is installed less 1/4 inch (6 mm) per side or 1/2-inch (13-mm) total, plus or minus 1/8 inch (3.1 mm). Length equal to head-to-sill or -floor dimension of opening in which shade is installed less 1/4 inch (6 mm), plus or minus 1/8 inch (3.1 mm).
C. Shadeband Fabrication: Fabricate shadebands without battens or seams to extent possible.

PART 3 - EXECUTION

3.01 EXAMINATION:
A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, other conditions affecting performance of the Work.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 ROLLER SHADE INSTALLATION:
A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions.
   1. Opaque Shadebands: Located so shadeband is not closer than 3 inches to interior face of glass. Allow clearances for window operation hardware.
B. Roller Shade Locations:
   1. Administration building: At all exterior windows.
   2. Scale House: At all widows except the transaction windows.

3.03 ADJUSTING:
A. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

3.04 CLEANING AND PROTECTION:
A. Clean roller shade surfaces, after installation, according to manufacturer's written instructions.
SECTION 12 24 13 – ROLLER WINDOW SHADES: continued

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that roller shades are without damage or deterioration at time of Substantial Completion.

C. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

3.05 DEMONSTRATION:

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain roller shades.

END OF SECTION 12 24 13
SECTION 12 48 13 – ENTRANCE FLOOR MATS AND FRAMES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. This Section includes:
      1. Resilient entrance mats.
      2. Recessed frames.

1.03 REFERENCE STANDARDS:
   A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
   B. American Architectural Manufacturers Association (AAMA):
      1. 611 - Voluntary Specifications for Anodized Architectural Aluminum
   C. ASTM International:
   D. International Code Council (ICC):
   E. National Association of Architectural Metal Manufacturers (NAAMM):
      1. Metal Finishes Manual for Architectural and Metal Products.
   F. U.S. Architectural & Transportation Barriers Compliance Board:

1.04 COORDINATION:
   A. Coordinate size and location of recesses in concrete to receive floor mats and frames.

1.05 SUBMITTALS:
   A. Product Data: For each type of product.
      1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for floor mats and frames.
   B. Shop Drawings:
      1. Items penetrating floor mats and frames, including door control devices.
      2. Divisions between mat sections.
      3. Perimeter floor moldings.
   C. Samples: For the following products, in manufacturer's standard sizes:
      1. Floor Mat: Assembled sections of floor mat.
      2. Tread Rail: Sample of each type and color.
      3. Frame Members: Sample of each type and color.
   D. Maintenance Data: For floor mats and frames to include in maintenance manuals.
   E. Extra Material: Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
      1. Resilient-Tile Entrance Mats: Full-size tile units equal to 2% of amount installed, but no fewer than 5 units.
PART 2 - PRODUCTS

2.01 ENTRANCE FLOOR MATS AND FRAMES, GENERAL:
   A. Regulatory Requirements: Comply with applicable provisions in ICC A117.1.

2.02 RESILIENT ENTRANCE MATS:
   A. Basis-of-Design Product: Subject to compliance with requirements, provide Helix® HZ1 &
      HZ2 or a comparable product by one of the following:
      1. American Floor Products Company, Inc.
      2. C/S Group (Basis of Design).

2.03 FRAMES:
   A. Recessed Frames: Manufacturer's standard extrusion.
      1. Extruded Aluminum: ASTM B221 (ASTM B221M), Alloy 6061-T6 or Alloy 6063-T5,
         T6, or T52.

2.04 CONCRETE FILL AND GROUT MATERIALS:
   A. Provide concrete fill and grout equivalent in strength to cast-in-place concrete slabs for
      recessed mats and frames. Use aggregate no larger than one-third fill thickness.

2.05 FABRICATION:
   A. Floor Mats: Shop fabricate units to greatest extent possible in sizes indicated. Unless
      otherwise indicated, provide single unit for each mat installation; do not exceed manufacturer's
      recommended maximum sizes for units that are removed for maintenance and cleaning. Where
      joints in mats are necessary, space symmetrically and away from normal traffic lanes. Miter
      corner joints in framing elements with hairline joints or provide prefabricated corner units
      without joints.
   B. Recessed Frames: As indicated, for permanent recessed installation, complete with corner pins
      or reinforcement and anchorage devices.
      1. Fabricate edge-frame members in single lengths or, where frame dimensions exceed
         maximum available lengths, provide minimum number of pieces possible, with hairline
         joints equally spaced and pieces spliced together by straight connecting pins.
   C. Coat concealed surfaces of aluminum frames that contact cementitious material with
      manufacturer's standard protective coating.

2.06 ALUMINUM FINISHES:
   A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

PART 3 - EXECUTION

3.01 EXAMINATION:
   A. Examine substrates and floor conditions for compliance with requirements for location, sizes,
      minimum recess depth, and other conditions affecting installation of floor mats and frames.
   B. Proceed with installation only after unsatisfactory conditions have been corrected.
SECTION 12 48 13 – ENTRANCE FLOOR MATS AND FRAMES: continued

3.02 INSTALLATION:
A. Install recessed mat frames to comply with manufacturer's written instructions. Set mat tops at height recommended by manufacturer for most effective cleaning action; coordinate tops of mat surfaces with bottoms of doors that swing across mats to provide clearance between door and mat.
   1. Install grout and fill around frames and, if required to set mat tops at proper elevations, in recesses under mats. Finish grout and fill smooth and level.

3.03 PROTECTION:
A. After completing frame installation and concrete work, provide temporary filler of plywood or fiberboard in recesses and cover frames with plywood protective flooring. Maintain protection until construction traffic has ended and Project is near Substantial Completion.

END OF SECTION 12 48 13
SECTION 13 34 23.16 - FABRICATED SCALE HOUSES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
A. Section includes fabricated steel scale houses.

1.03 ACTION SUBMITTALS:
A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for scale houses.
B. Shop Drawings: For scale houses. Include plans, elevations, sections, details, accessories, and fastening and anchorage details, including mechanical fasteners.
   1. Anchor-Bolt Plans: Submit anchor-bolt plans and templates. Include location, diameter, and projection of anchor bolts required to attach scale houses to foundation. Indicate post reactions at each location.
C. Samples for Initial Selection: For each type of exposed finish.
D. Samples for Verification: For each type of exposed finish in manufacturer's standard sizes.
   1. Include Samples of wall panels and accessories to verify finish selection.

1.04 QUALITY ASSURANCE:
A. The building manufacturer shall have been engaged in the manufacture of similar equipment buildings for at least five years.
B. The Contractor and Engineer shall be provided the opportunity to verify all materials and workmanship are in accordance with these Specification and the Contract Drawings prior to delivery of the building to the job site.

1.05 INFORMATIONAL SUBMITTALS:
A. Sample Warranty: For special warranty.

1.06 DELIVERY, STORAGE, AND HANDLING:
A. Deliver enclosure, pre-assembled to the extent possible, complete with factory installation of all equipment specified, f.o.b. jobsite unless noted otherwise, freight prepaid and allowed.
B. Enclosures and all components mounted thereon shall be designed for and anchored sufficiently for transportation to the jobsite. Protect all components from damage during shipment, unloading and installation.
C. Delivery truck shall be positioned adjacent to the foundation on the Project Site to facilitate lifting and setting on the foundation by others.
D. Enclosure shall be designed to rest on concrete foundations by others. Attachment locations and mounting details shall be provided as Submittals by the manufacturer.
E. Oversee, instruct and guide on-site contractor in proper off-loading and installation procedures of Equipment.

1.07 CLOSEOUT SUBMITTALS:
A. Maintenance Data: For scale houses to include in maintenance manuals.
SECTION 13 34 23.16 – FABRICATION SCALE HOUSES: CONTINUED

1.08 COORDINATION:
A. Cast-in Anchorage: Coordinate installation of anchorages for scale houses. Furnish sleeves, concrete inserts, anchor bolts, and items with integral anchors that are to be embedded in concrete bases. Include setting drawings, templates, and directions for installing anchorages. Deliver such items to Project site in time for installation.

1.09 WARRANTY:
A. Special Warranty: Manufacturer agrees to repair finish or replace scale houses that fail in materials or workmanship within specified warranty period.
1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:
A. Porta-King Building Systems
B. Panel Built, Inc.
C. Par-Kut International, Inc.
D. Keystone Structures, Inc.
E. Engineer Approved Equal.

2.02 PERFORMANCE REQUIREMENTS:
A. Structural Performance: Scale houses shall withstand the following loads and stresses within limits and under conditions indicated according to ASCE/SEI 7:
1. Loads: As indicated on Drawings.
B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
D. Safety Glazing Products: Category II materials complying with testing requirements in 16 CFR 1201.

2.03 FABRICATED STEEL SCALE HOUSE:
A. General: Fabricate scale houses from an integrated set of mutually dependent components to form a completed assembly, ready for installation on Project site.
B. Building Style: Standard square corners.
C. Structural Framework: Fabricated from 2-by-2-by-0.075-inch (50-by-50-by-1.90-mm) steel structural or mechanical tubing. Connect framework by welding.
D. Doors: As indicated on Drawings.
E. Windows: As indicated on Drawings, glazed with clear insulating glass per section 2.03K.11
2. Screens: Insect screens for each window.
3. Corner Shape: Square.
F. Wall Panel Assembly: Assembly consisting of exterior face panel fabricated from 0.079-inch (2.01-mm) nominal-thickness, galvanized-steel sheet; and interior face panel fabricated from 0.064-inch (1.63-mm) nominal-thickness, galvanized-steel sheet; with insulation in cavity between exterior and interior face panels to meet R-Value indicated on Drawings.

G. Base/Floor Assembly: 4-inch- (102-mm-) high assembly consisting of perimeter frame welded to structural framework of booth. Fabricate frame from 2-by-4-inch (51-by-102-mm) galvanized-steel structural tubing; 0.108-inch (2.74-mm) nominal-thickness, C-shaped, galvanized-steel sheet channels; or galvanized structural-steel angles. Include anchor clips fabricated from 1/4-inch- (6-mm-) thick galvanized-steel plate, predrilled and welded to exterior of integral floor frame.

1. Subfloor and Finished Floor: Assembly consisting of one layer of 3/4-inch- (19-mm-) thick plywood or oriented strand board.
   a. At restroom provide moisture resistant subfloor.

2. Floor Finishes – See performance criteria on drawings.

3. Base shall be insulated to meet the R-Value indicated on the Drawings.

H. Flat Roof/Ceiling Assembly: Assembly consisting of exterior roof panels, interior ceiling panels, and insulation between exterior and interior panels; sloped to drain at booth perimeter.

1. Insulated Exterior/Interior Panel: Fabricated from 0.028-inch (0.71-mm) nominal-thickness, galvanized-steel sheet faces and expanded-foam insulation core.

2. Provide ceiling assembly as indicated on Drawings.

3. Canopy Fascia: Fabricated from 0.079-inch (2.01-mm) nominal-thickness, galvanized-steel sheet, of manufacturer's standard design:
   a. Height: 6 inches (152 mm).
   b. Overhang: 4 inches (76 mm) beyond face of walls below.

4. Downspouts: Integral, extending 3 inches (76 mm) beyond booth walls, location as indicated on Drawings.

I. Accessories: Provide the following for each scale house:

1. Pre-plumbed restroom, with fixtures as shown on Drawings.

2. Ventilation fan.

J. Anchorage: Cast-in-place anchor bolts fabricated from non-ferrous or corrosion-resistant materials, with allowable load or strength design greater than or equal to the design load as determined by testing conducted by a qualified testing agency.

1. Anchor locations shall be concealed below the floor on the interior of the base frame.

K. Materials:

1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, commercial quality, G90 (Z275) coating designation; mill phosphatized.

2. Steel Structural Tubing: ASTM A500/A500M, Grade B.

3. Steel Plates, Shapes, and Bars: ASTM A36/A36M.


5. Zinc-Coated (Galvanized) Steel: Hot-dip galvanized according to ASTM A123/A123M.

6. Aluminum: Alloy and temper recommended by aluminum producer and manufacturer for type of use and finish indicated, and as follows:

7. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304.

8. Plastic Laminate: NEMA LD 3, HGS or HGL grade.


SECTION 13 34 23.16 – FABRICATION SCALE HOUSES: CONTINUED

11. Clear Insulating Glass: ASTM E2190. Factory-assembled units consisting of two lites of 2.5-mm-thick clear float glass, ASTM C1036, Type I, Class 1, Quality q3, and dehydrated air space 3/4 inch (19 mm) and with manufacturer's standard dual seal.

L. Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
   1. Color and Gloss: As selected by Architect from manufacturer's full range.

2.04 FABRICATION:
   A. Factory fabricate scale houses completely.
   B. Factory preglaze windows and doors.
   C. Factory prewire scale houses, ready for connection to service at Project site.
   D. Fabricate scale houses with lifting lugs on the roof.
   E. Accessible Scale houses: Where indicated to be accessible, fabricate scale houses as follows:
      1. Provide service windows located no higher than 34 inches (865 mm) above exterior grade.
      2. Provide door opening with minimum 32-inch (813-mm) clear width.
      3. Provide minimum 60-inch (1525-mm) clear turning spacing within the booth.
      4. Provide minimum 27-inch (685-mm) clearance beneath interior work surfaces. Locate work surfaces 28 inches (710 mm) minimum and 34 inches (865 mm) maximum above the floor.
      5. Locate controls and operable parts no lower than 15 inches (381 mm) and no higher than 48 inches (1219 mm) above the floor where reach is unobstructed. Where side reach is obstructed, locate controls and operable parts no lower than 15 inches (381 mm) and no higher than 46 inches (1219 mm) above the floor.

PART 3 - EXECUTION

3.01 EXAMINATION:
   A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, including concrete bases; accurate placement, pattern, and orientation of anchor bolts; critical dimensions; and other conditions affecting performance of the Work.
   B. Examine roughing-in for electrical and communication systems to verify actual locations of connections before scale house installation.
   C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
   D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:
   A. Install scale houses according to manufacturer's written instructions.
   B. Accessible Scale houses: Install with interior floor surface at same elevation as adjacent paved surfaces.
   C. Set scale houses plumb and aligned. Level baseplates true to plane with full bearing on concrete bases.
   D. Fasten scale houses securely to concrete base with anchorage indicated by manufacturer.
   E. Connect to electrical power service and data systems.
   F. Perform startup checks of heating and cooling units according to manufacturer's written instructions.
SECTION 13 34 23.16 – FABRICATION SCALE HOUSES: CONTINUED

3.03 ADJUSTING:
   A. Adjust doors, operable windows, and hardware to operate smoothly, easily, properly, and without binding. Confirm that locks engage accurately and securely without forcing or binding.
   B. Lubricate hardware and other moving parts.
   C. After completing installation, inspect exposed finishes and repair damaged finishes.

END OF SECTION 13 34 23.16
SECTION 22 05 17 – SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

1.02 SUMMARY:
   A. This Section includes:
      1. Sleeves.
      2. Sleeve-seal systems.

1.03 SUBMITTALS:
   A. Product data: For each type of product indicated.

PART 2 - PRODUCTS

2.01 SLEEVES:
   A. Galvanized-Steel-Pipe Sleeves: ASTM A53, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

2.02 SLEEVE-SEAL SYSTEMS:
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. Metraflex Company (The).
      2. Link-Seal.
   B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
      1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
      2. Pressure Plates: Stainless steel.
      3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.03 GROUT:
   B. Characteristics: Nonshrink; recommended for interior and exterior applications.
   C. Design Mix: 5,000-psi, 28-day compressive strength.
   D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.01 SLEEVE INSTALLATION:
   A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
   B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1 inch annular clear space between piping and concrete slabs and walls.
      1. Sleeves are not required for core-drilled holes.
   C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
      1. Cut sleeves to length for mounting flush with both surfaces.
a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.
   1. Cut sleeves to length for mounting flush with both surfaces.
   2. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07.

3.02 SLEEVE-SEAL-SYSTEM INSTALLATION:
   A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
   B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.03 SLEEVE AND SLEEVE-SEAL SCHEDULE:
   A. Use sleeves and sleeve seals for the following piping-penetration applications:
      1. Exterior Concrete Walls above Grade:
         a. Galvanized-steel-pipe sleeves.
      2. Concrete Slabs-on-Grade:
         a. Galvanized-steel-pipe sleeves with sleeve-seal system.
         Select sleeve size to allow for 1 inch annular clear space between piping and sleeve for installing sleeve-seal system.
      3. Interior Partitions:
         a. Galvanized-steel-pipe sleeves.

END OF SECTION 22 05 17
SECTION 22 05 18 – ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 SUMMARY:
A. This Section includes:
   1. Escutcheons.

1.02 SUBMITTALS:
A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.01 ESCUTCHEONS:
A. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
B. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
C. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed and exposed-rivet hinge, and spring-clip fasteners.

PART 3 - EXECUTION

3.01 INSTALLATION:
A. Install escutcheons for piping penetrations of walls and ceilings.
B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.
   1. Escutcheons for New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
      b. Chrome-Plated Piping: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
      c. Insulated Piping: One-piece, stamped-steel type.
      d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
      e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type.
      f. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type.
      g. Bare Piping in Equipment Rooms: One-piece, stamped-steel type.

3.02 FIELD QUALITY CONTROL:
A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 22 05 18
SECTION 22 05 19 – METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 SUMMARY:
A. Section Includes:
   1. Light-activated thermometers.
   2. Thermowells.
   3. Dial-type pressure gages.
   4. Gage attachments.
   5. Test plugs.

1.02 SUBMITTALS:
A. Product Data: For each type of product indicated.
B. Product Certificates: For each type of meter and gage, from manufacturer.
C. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.01 LIGHT-ACTIVATED THERMOMETERS:
A. Direct-Mounted, Light-Activated Thermometers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Flo Fab, Inc.
      b. REOTEMP Instrument Corporation.
      c. Trerice, H. O. Co.
      d. Weiss Instruments, Inc.
      e. WIKA Instrument Corporation - USA.
      f. Winters Instruments - U.S.
   2. Case: Plastic; 7-inch nominal size, unless otherwise indicated.
   3. Scale: ºF.
   6. Stem: Aluminum and of length to suit installation.
      a. Design for Thermowell Installation: Bare stem.
   8. Accuracy: ±2ºF.

2.02 THERMOWELLS:
A. Thermowells:
   2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
   3. Material for Use with Copper Tubing: CNR or CUNI.
   4. Type: Stepped shank, unless straight or tapered shank is indicated.
   5. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
   6. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
   7. Bore: Diameter required to match thermometer bulb or stem.
   8. Insertion Length: Length required to match thermometer bulb or stem.
10. **Bushings**: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. **Heat-Transfer Medium**: Mixture of graphite and glycerin.

### 2.03 PRESSURE GAGES:

**A. Direct-Mounted, Plastic-Case, Dial-Type Pressure Gages:**

1. Manufacturers: Subject to compliance with requirements,
   a. Ashcroft, Inc.
   b. Flo Fab, Inc.
   c. Tel-Tru Manufacturing Company.
   d. Trerice, H. O. Co.
   e. Weiss Instruments, Inc.
   f. Winters Instruments - U.S.


3. Case: Sealed type; plastic; 4-1/2-inch nominal diameter.

4. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.

5. Pressure Connection: Brass, with NPS 1/4, ASME B1.20.1 pipe threads and bottom-outlet type, unless back-outlet type is indicated.

6. Movement: Mechanical, with link to pressure element and connection to pointer.

7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.


9. Window: Glass or plastic.

10. Accuracy: Grade A, ±1% of middle half of scale range.

### 2.04 GAGE ATTACHMENTS:

**A. Snubbers**: ASME B40.100, brass; with NPS 1/4, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.

**B. Valves**: Brass ball, with NPS 1/4, ASME B1.20.1 pipe threads.

### 2.05 TEST PLUGS:

**A. Manufacturers**: Subject to compliance with requirements, provide products by one of the following

1. Flow Design, Inc.
2. Trerice, H. O. Co.
3. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
4. Weiss Instruments, Inc.

**B. Description**: Test-station fitting made for insertion into piping tee fitting.

**C. Body**: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

**D. Thread Size**: NPS 1/4, ASME B1.20.1 pipe thread.

**E. Minimum Pressure and Temperature Rating**: 500 psig at 200°F.

**F. Core Inserts**: Chlorosulfonated polyethylene synthetic self-sealing rubber.

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**PART 3 - EXECUTION**

### 3.01 INSTALLATION:

**A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.**

**B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.**

**C. Install thermowells with extension on insulated piping.**
D. Fill thermowells with heat-transfer medium.
E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
G. Install valve and snubber in piping for each pressure gage for fluids.
H. Install test plugs in piping tees.
I. Install thermometers in the following locations:
   1. Inlet and outlet of each water heater.
J. Install pressure gages in the following locations:
   1. Building water service entrance into building.
   2. Inlet and outlet of each pressure-reducing valve.

3.02 CONNECTIONS:
   A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.03 ADJUSTING:
   A. Adjust faces of meters and gages to proper angle for best visibility.

3.04 THERMOMETER SCALE-RANGE SCHEDULE:
   A. Scale Range for Domestic Cold-Water Piping: 0 to 100ºF.
   B. Scale Range for Domestic Hot-Water Piping: 0 to 250ºF.

3.05 PRESSURE-GAGE SCALE-RANGE SCHEDULE:
   A. Scale Range for Domestic Water Piping: 0 to 100 psi.

END OF SECTION 22 05 19
SECTION 22 05 23 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 SUMMARY:
A. This Section includes:
   1. Bronze ball valves.
   2. Bronze swing check valves.
B. Related Sections:
   1. DIVISION 22 Plumbing Piping Sections for specialty valves applicable to those sections only.
   2. SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT for valve tags and schedules.

1.02 DEFINITIONS:
A. CWP: Cold working pressure.
B. EPDM: Ethylene propylene copolymer rubber.
C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
D. NRS: Nonrising stem.
E. OS&Y: Outside screw and yoke.
F. RS: Rising stem.
G. SWP: Steam working pressure.

1.03 SUBMITTALS:
A. Product Data: For each type of valve indicated.

1.04 QUALITY ASSURANCE:
A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
B. ASME Compliance:
   1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   2. ASME B31.9 for building services piping valves.
C. NSF Compliance: NSF 61 and NSF 372 for valve materials for potable-water service.

1.05 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

2.01 GENERAL REQUIREMENTS FOR VALVES:
A. Refer to valve schedule articles for applications of valves.
B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
C. Valve Sizes: Same as upstream piping, unless otherwise indicated.
D. Valve Actuator Types:
   1. Handwheel: For valves other than quarter-turn types.
   2. Hand lever: For quarter-turn valves NPS 6 and smaller.
E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
   1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
F. Valve-End Connections:
   1. Solder Joint: With sockets according to ASME B16.18.
   2. Threaded: With threads according to ASME B1.20.1.
G. Valve Bypass and Drain Connections: MSS SP-45.

2.02 SILICON BRONZE BALL VALVES:
A. Two-Piece, Regular-Port, Silicon Bronze Ball Valves with Stainless-Steel Trim:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Crane Co.; Crane Valve Group; Jenkins Valves.
      c. NIBCO INC.
      d. Milwaukee Valve Company.
   2. Description:
      b. Maximum Pressure/Temperature Rating: 100 psig at 300ºF.
      c. CWP Rating: 600 psig.
      d. Body Design: Two piece.
      e. Body Material: Bronze.
      f. Ends: Threaded or Solder.
      g. Seats: PTFE or TFE.
      h. Stem: Stainless steel.
      i. Ball: Stainless steel.
      j. Port: Regular.

2.03 SILICON BRONZE SWING CHECK VALVES:
A. Class 125, Silicon Bronze Swing Check Valves with Nonmetallic Disc:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Crane Co.; Crane Valve Group; Crane Valves.
      b. Crane Co.; Crane Valve Group; Jenkins Valves.
      c. Crane Co.; Crane Valve Group; Stockham Division.
      d. Milwaukee Valve Company.
      e. NIBCO INC.
      f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   2. Description:
      a. Standard: MSS SP-80, Type 4.
b. CWP Rating: 200 psig.
c. Body Design: Horizontal flow.
e. Ends: Threaded.
f. Disc: PTFE or TFE.

PART 3 - EXECUTION

3.01 EXAMINATION:
A. 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.
B. Operate valves in positions from fully open to fully close. Examine guides and seats made accessible by such operations.
C. Examine threads on valve and mating pipe for form and cleanliness.
D. 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.
E. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE INSTALLATION:
A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
B. Locate valves for easy access and provide separate support where necessary.
C. Install valves in horizontal piping with stem at or above center of pipe.
D. Install valves in position to allow full stem movement.
E. Install check valves for proper direction of flow and as follows:
   1. Swing Check Valves: In horizontal position with hinge pin level.

3.03 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.

3.04 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS:
A. If valve applications are not indicated, use the following:
   1. Shutoff Service: Ball valves.
   2. Throttling Service: Ball valves.
B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
C. Select valves, except wafer types, with the following end connections:
   1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
   2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
   3. For Grooved-End Copper Tubing Piping: Valve ends may be grooved.

3.05 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE:
A. All Piping:
   1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
   2. Ball Valves: Two-piece, regular port, bronze with stainless-steel trim.
   3. Bronze Swing Check Valves: Class 125, nonmetallic disc.
SECTION 22 05 29 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY:
A. This Section includes:
   1. Metal pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Metal framing systems.
   4. Thermal-hanger shield inserts.

1.02 SUBMITTALS:
A. Product Data: For each type of product indicated.
B. Welding Procedure Specification (WPS) and Welder Performance Qualification Record (WPQR)

1.03 QUALITY ASSURANCE:
A. Structural Steel Welding Qualifications: Qualify welding procedures, welders, and welding operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
B. Pipe Welding Qualifications: Weld piping in accordance with qualified procedures using performance qualified welders and welding operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.01 METAL PIPE HANGERS AND SUPPORTS:
A. Copper Pipe Hangers:
   1. Description: MSS SP-58, Types 1 through 58 (except as noted in PART 3 - EXECUTION), copper-coated-steel, factory-fabricated components.
   2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel or stainless steel.

2.02 TRAPEZE PIPE HANGERS:
A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.03 METAL FRAMING SYSTEMS:
A. MFMA Manufacturer Metal Framing Systems:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Cooper B-Line, Inc.
      b. Flex-Strut Inc.
      c. Powerstrut Corp.
      d. Unistrut Corporation; Tyco International, Ltd.
   2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
   4. Channels: Continuous slotted steel channel with inturned lips.
   5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. **Hanger Rods:** Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.
7. **Metallic Coating:** Electroplated zinc, Hot-dipped galvanized or Mill galvanized.  
8. **Paint Coating:** Epoxy.

### 2.04 THERMAL-HANGER SHIELD INSERTS:

A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
   1. Carpenter & Paterson, Inc.
   2. PHS Industries, Inc.
   3. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.

B. **Insulation-Insert Material for Cold Piping:** ASTM C552, Type II cellular glass with 100-psig or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

C. **Insulation-Insert Material for Hot Piping:** Water-repellent treated, ASTM C533, Type I calcium silicate with 100-psig; ASTM C552, Type II cellular glass with 100-psig or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.

D. **For Trapeze or Clamped Systems:** Insert and shield shall cover entire circumference of pipe.

E. **For Clevis or Band Hangers:** Insert and shield shall cover lower 180 degrees of pipe.

F. **Insert Length:** Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

### 2.05 EQUIPMENT SUPPORTS:

A. **Description:** Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

### 2.06 MISCELLANEOUS MATERIALS:

A. **Structural Steel:** ASTM A36/A36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. **Grout:** ASTM C1107, 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:** 5,000-psi, 28-day compressive strength.

### PART 3 - EXECUTION

3.01 **HANGER AND SUPPORT INSTALLATION:**

A. **Metal Pipe-Hanger Installation:** Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. **Metal Trapeze Pipe-Hanger Installation:** Comply with MSS SP-69 and MSS SP-89. 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 for individual pipe hangers.
   2. **Field Fabricate:** From ASTM A36/A36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. **Metal Framing System Installation:** Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
D. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. See DIVISION 22 Plumbing Fixture Sections for requirements for pipe positioning systems for plumbing fixtures.

E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

F. Install hangers and supports to allow controlled thermal and seismic 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.

G. Install lateral bracing with pipe hangers and supports to prevent swaying.

H. 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.

I. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

J. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

K. Insulated Piping:
   1. Attach clamps and spacers to piping.
      a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
      b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
      c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
   2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
   3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
      a. Option: Thermal-hanger shield inserts may be used.
   4. Shield Dimensions for Pipe: Not less than the following:
      a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.02 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 qualified 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 so contours of welded surfaces match adjacent contours.

3.03 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.**

### 3.04 PAINTING:

A. **Galvanized Surfaces:** Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

### 3.05 HANGER AND SUPPORT SCHEDULE:

A. **Specific hanger and support requirements are in sections specifying piping systems and equipment.**

B. **Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system sections.**

C. **Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.**

D. **Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.**

E. **Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.**

F. **Use thermal-hanger shield inserts for insulated piping and tubing.**

G. **Horizontal-Piping Hangers and Supports:** Unless otherwise indicated and except as specified in piping system sections, install the following types:
   1. **Adjustable, Steel Clevis Hangers (MSS Type 1):** For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
   2. **Single-Pipe Rolls (MSS Type 41):** For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.

H. **Vertical-Piping Clamps:** Unless otherwise indicated and except as specified in piping system sections, install the following types:
   1. **Extension Pipe or Riser Clamps (MSS Type 8):** For support of pipe risers NPS 3/4 to NPS 24.
   2. **Carbon- or Alloy-Steel Riser Clamps (MSS Type 42):** For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

I. **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 (150 mm) for heavy loads.
   2. **Swivel Turnbuckles (MSS Type 15):** For use with MSS Type 11, split pipe rings.

J. **Building Attachments:** Unless otherwise indicated and except as specified in piping system sections, install the following types:
   1. **Exception:** The following figure types given in Figure 1 of MSS SP-69 will not be acceptable: 19, 20, 23, 25, 27, 28, 29, 30, and 34.
   2. **Steel or Malleable Concrete Inserts (MSS Type 18):** For upper attachment to suspend pipe hangers from concrete ceiling.
   3. **Center-Beam Clamps (MSS Type 21):** For attaching to center of bottom flange of beams.
   4. **Welded Beam Attachments (MSS Type 22):** For attaching to bottom of beams if loads are considerable and rod sizes are large.
   5. **Welded-Steel Brackets:** For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
      a. **Light (MSS Type 31):** 750 pounds.
      b. **Medium (MSS Type 32):** 1,500 pounds.
      c. **Heavy (MSS Type 33):** 3,000 pounds.
6. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
7. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

K. Saddles and Shields: Unless otherwise indicated and except as specified in piping system sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

L. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system sections, install the following types:
1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.

M. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system sections.

N. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system sections.

O. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

P. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 220529
SECTION 22 05 53 – IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY:
   A. This Section includes:
      1. Equipment labels.
      2. Warning signs and labels.
      3. Pipe labels.
      4. Valve tags.
      5. Warning tags.

1.02 SUBMITTALS:
   A. Product Data: For each type of product indicated.
   B. Samples: For color, letter style, and graphic representation required for each identification material and device.
   C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
   D. Valve numbering scheme.
   E. Valve Schedules: For each piping system to include in maintenance manuals.

1.03 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 locations of access panels and doors.
   C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.01 EQUIPMENT LABELS:
   A. Plastic Labels for Equipment:
      1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
      2. Letter Color: Black.
      4. Maximum Temperature: Able to withstand temperatures up to 160°F.
      5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
      6. Minimum Letter Size: 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.
      7. Fasteners: Stainless-steel rivets or self-tapping screws.
      8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
   B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
   C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2 by 11-inch (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section
number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.02 WARNING SIGNS AND LABELS:
A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
B. Letter Color: Black.
C. Background Color: White.
D. Maximum Temperature: Able to withstand temperatures up to 160°F.
E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
F. Minimum Letter Size: 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.
G. Fasteners: Stainless-steel rivets or self-tapping screws.
H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.03 PIPE LABELS:
A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.
C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
   2. Lettering Size: At least 1-1/2 inches high.

2.04 VALVE TAGS:
A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
   1. Tag Material: Brass, 0.032 inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Fasteners: Brass wire-link or beaded chain; or S-hook.
B. Valve Schedules: For each piping system, on 8-1/2 by 11-inch (A4) 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-tag schedule shall be included in operation and maintenance data.

2.05 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.
   2. Fasteners: Brass grommet and wire.
   3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."

PART 3 - EXECUTION

3.01 PREPARATION:
   A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.02 EQUIPMENT LABEL INSTALLATION:
   A. Install or permanently fasten labels on each major item of mechanical equipment.
   B. Locate equipment labels where accessible and visible.

3.03 PIPE LABEL INSTALLATION:
   A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed 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 inaccessible 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 ft. along each run. Reduce intervals to 25 ft. in areas of congested piping and equipment.
   B. Pipe Label Color Schedule:
      1. Domestic Water Piping:
         b. Letter Color: Black.
      2. Sanitary Waste Piping:
         b. Letter Color: Black.

3.04 VALVE-TAG INSTALLATION:
   A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; 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 subparagraphs:
      1. Valve-Tag Size and Shape:
      2. Valve-Tag Color:
         b. Hot Water: Natural.
      3. Letter Color:
         b. Hot Water: Black.
3.05 WARNING-TAG INSTALLATION:
   A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 22 05 53
SECTION 22 07 19 – PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.01 SUMMARY:
A. This Section includes requirements for insulating plumbing piping and devices.
   1. Indoor Domestic Hot and Cold Water Piping.

1.02 SUBMITTALS:
A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).
B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Detail insulation application at pipe expansion joints for each type of insulation.
   3. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
   4. Detail removable insulation at piping specialties, equipment connections, and access panels.
   5. Detail application of field-applied jackets.
   6. Detail application at linkages of control devices.

1.03 QUALITY ASSURANCE:
A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing 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.
C. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1.04 DELIVERY, STORAGE, AND HANDLING:
A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.05 COORDINATION:
A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment.
B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
1.06 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

2.01 INSULATION MATERIALS:
B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
C. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
D. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534, Type I for tubular materials.
   1. Products: Subject to compliance with requirements, provide products by one of the following:
      a. Aeroflex USA, Inc.; Aerocel.
      b. Armacell LLC; AP Armaflex.
      c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.
E. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C553, Type II and ASTM C1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements, provide products by one of the following:
      a. CertainTeed Corp.; SoftTouch Duct Wrap.
      b. Johns Manville; Microlite.
      c. Knauf Insulation; Friendly Feel Duct Wrap.
      d. Manson Insulation Inc.; Alley Wrap.
      e. Owens Corning; SOFTR All-Service Duct Wrap.

2.02 INSULATING CEMENTS:
   1. Products: Subject to compliance with requirements, provide products by one of the following:
      a. Ramco Insulation, Inc.; Super-Stik.

2.03 ADHESIVES:
A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself 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 products by one of the following:
      a. Aeroflex USA, Inc.; Aeroseal.
      b. Armacell LLC; Armaflex 520 Adhesive.
      d. K-Flex USA; R-373 Contact Adhesive.
C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. Products: Subject to compliance with requirements, provide products by one of the following:
      b. Eagle Bridges - Marathon Industries; 225.
      d. Mon-Eco Industries, Inc.; 22-25.

D. PVC Jacket Adhesive: Compatible with PVC jacket.
   1. Products: Subject to compliance with requirements, provide products by one of the following:
      a. Dow Corning Corporation; 739, Dow Silicone.
      d. Speedline Corporation; Polycro VP Adhesive.

2.04 MASTICS:
   A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
   B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
      1. Products: Subject to compliance with requirements, provide products by one of the following:
         b. Vimasco Corporation; 749.
      2. Water-Vapor Permeance: ASTM E96, Procedure B, 0.013 perm at 43-mil dry film thickness.
      3. Service Temperature Range: -20 to +180ºF.
      4. Solids Content: ASTM D1644, 58% by volume and 70% by weight.

2.05 SEALANTS:
   A. Joint Sealants:
      1. Products: Subject to compliance with requirements, provide products by one of the following:
         b. Eagle Bridges - Marathon Industries; 405.
         d. Mon-Eco Industries, Inc.; 44-05.
         e. Pittsburgh Corning Corporation; Pittseal 444.
      2. Materials shall be compatible with insulation materials, jackets, and substrates.
      3. Permanently flexible, elastomeric sealant.
      4. Service Temperature Range: +100 to +300ºF.
      5. Color: White or gray.

2.06 FACTORY-APPLIED JACKETS:
   A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, Kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with Kraft-paper backing; complying with ASTM C1136, Type II.

2.07 FIELD-APPLIED JACKETS:
A. Field-applied jackets shall comply with ASTM C921, Type I, unless otherwise indicated.
B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
1. Products: Subject to compliance with requirements, provide products by one of the following:
   a. Johns Manville; Zeston.
   c. Proto Corporation; LoSmoke.
   d. Speedline Corporation; SmokeSafe.
2. Adhesive: As recommended by jacket material manufacturer.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
   a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

2.08 TAPES:
A. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Products: Subject to compliance with requirements, provide products by one of the following:
   a. ABL, Ideal Tape Division; 370 White PVC tape.
   b. Compac Corporation; 130.
   c. Venture Tape; 1506 CW NS.
2. Width: 2 inches.
3. Thickness: 6 mils.
5. Elongation: 500%.
6. Tensile Strength: 18 lbf./inch in width.

2.09 SECUREMENTS:
A. Bands:
1. Products: Subject to compliance with requirements, provide products by one of the following:
   a. ITW Insulation Systems; Gerrard Strapping and Seals.
   b. RPR Products, Inc.; Insul-Mate Strapping and Seals.
2. Aluminum: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H 14, 0.020 inch thick, 1/2 inch wide.
B. Staples: Outward-clinching insulation staples, nominal 3/4-inch wide, stainless steel or Monel.
C. Wire: 0.080-inch nickel-copper alloy or 0.062-inch soft-annealed, galvanized steel.
1. Products: Subject to compliance with requirements, provide products by one of the following:

2.10 PROTECTIVE SHIELDING GUARDS:
A. Protective Shielding Pipe Covers:
   1. Products: Subject to compliance with requirements, provide products by one of the following:
      a. Engineered Brass Company.
      b. Insul-Tect Products Co.; a subsidiary of MVG Molded Products.
      c. McGuire Manufacturing.
      d. Plumberex.
      e. Truebro; a brand of IPS Corporation.
      f. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.
   2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

PART 3 - EXECUTION

3.01 EXAMINATION:
A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
   1. Verify that systems to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 GENERAL INSTALLATION REQUIREMENTS:
A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of 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 top and bottom of 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 recommended by insulation material manufacturer.
I. Install insulation with least number of joints practical.
J. Where vapor barrier is indicated, 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 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 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 bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.  
      a. For below-ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75% of its nominal thickness.

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.

3.03 PENETRATIONS:

A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

B. Insulation Installation at Floor Penetrations:
   1. Pipe: Install insulation continuously through floor penetrations.
   2. Seal penetrations through fire-rated assemblies. Comply with requirements in DIVISION 07.

3.04 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 and polyolefin, 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. 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 long 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.
3.05 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION:
A. Seal longitudinal seams and end joints with manufacturers 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 manufacturers 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.

3.06 INSTALLATION OF MINERAL-FIBER INSULATION:
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. Instead, 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 preformed 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 mineral-fiber blanket insulation.
   4. 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 preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings 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 preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed sections 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.

3.07 FIELD-APPLIED JACKET INSTALLATION:
   A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturers 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.

3.08 FINISHES:
   A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
   B. Do not field paint aluminum or stainless-steel jackets.

3.09 PLUMBING PIPING INSULATION SCHEDULE, GENERAL:
   A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
   B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
      1. Drainage piping located in crawl spaces.
      2. Underground piping.
      3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.10 PLUMBING PIPING INSULATION SCHEDULE:
   A. Indoor Domestic Hot, Cold, and Recirculated Water:
      1. All Pipe Sizes: Insulation shall be one of the following:
         a. Flexible Elastomeric: 1 inch thick.
         b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
   B. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:
      1. All Pipe Sizes: Insulation shall be one of the following:
         a. Flexible Elastomeric: 1 inch thick.
         b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

3.11 INDOOR, FIELD-APPLIED JACKET SCHEDULE:
   A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
   B. Indoor or Outdoor Piping, Concealed:
      1. None.
   C. Indoor or Outdoor Piping, Exposed, below 10 feet, and vertical piping at walls:
      1. PVC: 20 mils thick.
END OF SECTION 22 07 19
SECTION 22 11 16 – DOMESTIC WATER PIPING

PART 1 - GENERAL

1.01 SUMMARY:
   A. This Section includes:
      1. Under-building-slab and aboveground domestic water pipes, tubes, and fittings inside buildings.
      2. Encasement for piping.

1.02 SUBMITTALS:
   A. Product Data: For piping, transition fittings, and dielectric fittings. Submit schedule of pipe materials used for each application.
   B. System purging and disinfecting activities report.
   C. Field quality-control reports.

PART 2 - PRODUCTS

2.01 PIPING MATERIALS:
   A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.
   B. Potable-water piping and components shall comply with NSF 14, NSF 61, and NSF 372.
      Plastic piping components shall be marked with "NSF-pw."
   C. Potable-water piping and components shall comply with 40 CFR 141, Subpart E including all amendments in place at the time of bids.

2.02 COPPER TUBE AND FITTINGS:
   A. Hard Copper Tube: ASTM B88, Type K and ASTM B88, Type L water tube, drawn temper.
   B. Soft Copper Tube: ASTM B88, Type K water tube, annealed temper.
   D. Copper Unions:
      1. MSS SP-123.
      2. Cast-copper alloy, hexagonal-stock body.
      4. Solder-joint or threaded ends.

2.03 PIPING JOINING MATERIALS:
   A. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
   B. Solder Filler Metals: ASTM B32, lead-free alloys.
   C. Flux: ASTM B813, water flushable.
   D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated.

2.04 ENCASEMENT FOR PIPING:
   A. Standard: ASTM A674 or AWWA C105/A21.5.
   B. Form: Sheet or tube.
   C. Color: Manufacturer’s standard.

2.05 TRANSITION FITTINGS:
   A. General Requirements:
1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type Transition Coupling: AWWA C219.3:
1. Manufacturers: Subject to compliance with requirements provide products by one of the following:
   a. Dresser, Inc.; Piping Specialties Products.
   b. JCM Industries.
   d. Smith-Blair, Inc.; a Sensus company.
   e. Viking Johnson.

2.06 DIELECTRIC FITTINGS:
A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:
1. Manufacturers: Subject to compliance with requirements provide products by one of the following:
   c. Watts; a division of Watts Water Technologies, Inc.
   d. Wilkins; a Zurn company.
   e. Zurn Industries, LLC.


3. Pressure Rating: 125 psig, 150 psig, or 250 psig at a minimum temperature of 180°F. Pressure rating shall be minimum 20 psi above system design pressure.


C. Dielectric Flanges:
1. Manufacturers: Subject to compliance with requirements provide products by one of the following:
   b. Watts; a division of Watts Water Technologies, Inc.
   c. Wilkins; a Zurn company.
   d. Zurn Industries, LLC.


3. Factory-fabricated, bolted, companion-flange assembly.

4. Pressure Rating: 125 psig (860 kPa) (82°C), 150 psig (1035 kPa), 175 psig (1200 kPa) or 300 psig (2070 kPa) minimum at 180°F. Pressure rating shall be minimum 20 psi above system design pressure.

5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

PART 3 - EXECUTION

3.01 EARTHWORK:
A. Comply with requirements in DIVISION 31 for excavating, trenching, and backfilling.
3.02  **PIPING INSTALLATION:**

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. 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.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install underground copper tube in PE encasement according to ASTM A674 or AWWA C105/A21.5.

D. Install shutoff valve, hose-end drain valve, strainer, pressure gauge, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gauges in Section 22 05 19 - Meters and Gages for Plumbing Piping and with requirements for drain valves and strainers in Section 22 11 19 - Domestic Water Piping Specialties.

E. Install shutoff valve immediately upstream of each dielectric fitting.

F. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 22 11 19 - Domestic Water Piping Specialties.

G. Install domestic water piping level with 0.25% slope downward toward drain, unless otherwise indicated, and plumb.

H. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

I. Install piping concealed from view and protected from physical contact by building occupants, unless otherwise indicated and except in equipment rooms and service areas.

J. 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.

K. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

L. Install piping to permit valve servicing.

M. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below, unless otherwise indicated.

N. Install piping free of sags and bends.

O. Install fittings for changes in direction and branch connections.

P. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

Q. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Section 22 05 19 - Meters and Gages for Plumbing Piping.

R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 05 17 - Sleeves and Sleeve Seals for Plumbing Piping.

S. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 22 05 17 - Sleeves and Sleeve Seals for Plumbing Piping.

T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 22 05 18 - Escutcheons for Plumbing Piping.

3.03  **JOINT CONSTRUCTION:**

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
C. 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.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

E. Soldered Joints for Copper Tubing: Apply ASTM B813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B828 or CDA's "Copper Tube Handbook."

F. Joint Construction for Grooved-End Copper Tubing: Make joints according to AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.

G. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.04 TRANSITION FITTING INSTALLATION:
A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:
1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
2. Fittings for NPS 2 and Larger: Sleeve-type coupling.

3.05 DIELECTRIC FITTING INSTALLATION:
A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples or unions.
C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

3.06 HANGER AND SUPPORT INSTALLATION:
A. Comply with requirements for pipe hanger, support products, and installation in Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment.
1. Vertical Piping: MSS Type 8 or 42, clamps.
2. Individual, Straight, Horizontal Piping Runs:
   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. Support vertical piping and tubing at base and at each floor.

C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch (10 mm).

D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
4. NPS 2-1/2: 108 inches with 1/2-inch rod.
5. NPS 3 to NPS 4: 10 feet with 1/2-inch rod.
E. Install supports for vertical copper tubing every 10 feet.
F. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.07 IDENTIFICATION:
A. Identify system components. Comply with requirements for identification materials and installation in Section 22 05 53 - Identification for Plumbing Piping and Equipment.
B. Label pressure piping with system operating pressure.

3.08 FIELD QUALITY CONTROL:
A. Perform the following tests and inspections:
   1. Piping Inspections:
      a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
      b. During installation, notify authorities having jurisdiction at least one day 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 authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
      c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
      d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
   2. Piping Tests:
      a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
      b. 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 a separate report for each test, complete with diagram of portion of piping tested.
      c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
      d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
      e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
      f. Prepare reports for tests and for corrective action required.
   B. Domestic water piping will be considered defective if it does not pass tests and inspections.
   C. Prepare test and inspection reports.

3.09 ADJUSTING:
A. Perform the following adjustments before operation:
   1. Close drain valves, hydrants, and hose bibbs.
   2. Open shutoff valves to fully open position.
   3. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
      a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
b. Adjust calibrated balancing valves to flows indicated.
4. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
5. Remove and clean strainer screens. Close drain valves and replace drain plugs.
6. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.10 CLEANING:
A. Clean and disinfect potable domestic water piping as follows:
1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
   a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
   b. Fill and isolate system according to either of the following:
      (1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
      (2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
   c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
   d. Repeat procedures if biological examination shows contamination.
   e. Submit water samples in sterile bottles to authorities having jurisdiction.
B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.
C. Clean interior of domestic water piping system. Remove dirt and debris as Work progresses.

3.11 PIPING SCHEDULE:
A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.
B. Flanges and unions may be used for aboveground piping joints, unless otherwise indicated.
C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
D. Under-building-slab, domestic water, building-service piping shall be one of the following:
   1. Soft copper tube, ASTM B88, Type K; wrought-copper, solder-joint fittings; and brazed joints.
E. Aboveground domestic water piping, NPS 2 and smaller, shall be one of the following:
   1. Hard copper tube, ASTM B88, Type L; cast- or wrought-copper, solder-joint fittings; and brazed or soldered joints.

3.12 VALVE SCHEDULE:
A. All valves serving potable water systems shall meet the requirements of NSF 61.
B. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
C. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION 22 11 16
SECTION 22 11 19 – DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.01 **SUMMARY:**
   A. This Section includes:
      1. Vacuum breakers.
      2. Water pressure-reducing valves.
      4. Strainers.
      5. Hose bibbs.
      6. Wall hydrants.
      7. Drain valves.
      8. Water-hammer arresters.
      9. Air vents.
     10. Trap-seal primer systems.
     11. Flexible connectors.

1.02 **RELATED REQUIREMENTS:**
   A. Section 22 05 19 - Meters and Gauges for Plumbing Piping for thermometers, pressure gauges, and flow meters in domestic water piping.

1.03 **SUBMITTALS:**
   A. Product Data: For each type of product.
   B. Field quality-control reports.
   C. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.01 **GENERAL REQUIREMENTS FOR PIPING SPECIALTIES:**
   A. Potable-water piping and components shall comply with NSF 61 and 372.

2.02 **PERFORMANCE REQUIREMENTS:**
   A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

2.03 **VACUUM BREAKERS:**
   A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
      1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         a. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
         b. Conbraco Industries, Inc.
         c. FEBCO; a division of Watts Water Technologies, Inc.
         d. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
         e. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
      3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
      5. Inlet and Outlet Connections: Threaded.
B. Hose-Connection Vacuum Breakers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Conbraco Industries, Inc.
      b. MIFAB, Inc.
      c. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
      d. Woodford Manufacturing Company; a division of WCM Industries, Inc.
      e. Zurn Industries, LLC; Plumbing Products Group.
   5. Finish: Chrome or nickel plated.

2.04 WATER PRESSURE-REDUCING VALVES:
A. Water Regulators:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Cash Acme; a division of Reliance Worldwide Corporation.
      b. Conbraco Industries, Inc.
      c. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
      d. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
   4. Body: Bronze with chrome-plated finish for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3.
   5. End Connections: Threaded for NPS 2 and smaller, flanged for NPS 2-1/2 and NPS 3.

2.05 BALANCING VALVES:
A. Copper-Alloy Calibrated Balancing Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. ITT Corporation; Bell & Gossett Div.
      c. NIBCO, Inc.
      d. TACO, Incorporated.
      e. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
   2. Type: Ball or Y-pattern globe valve with two readout ports and memory-setting indicator.
   3. Body: Brass or bronze.
   4. Size: Same as connected piping, but not larger than NPS 2.
   5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.
B. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

2.06 STRainers FOR DOMESTIC WATER PIPING:
A. Y-Pattern Strainers:
   1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
   2. Body:
      a. NPS 2 and Smaller: Bronze.
b. NPS 2-1/2 and Larger: Cast iron with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated.

3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.

4. Screen: Stainless steel with round perforations, unless otherwise indicated.

5. Perforation Size:
   a. Strainers NPS 2 and Smaller: 0.033 inches.
   b. Strainers NPS 2-1/2 to NPS 4: 0.045 inches.

6. Drain: Pipe plug or factory-installed, hose-end drain valve as indicated.

2.07 HOSE BIBBS:
A. Hose Bibbs:
   4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
   5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
   8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
   9. Finish for Service Areas: Chrome or nickel plated.
  10. Finish for Finished Rooms: Chrome or nickel plated.
  11. Operation for Equipment Rooms: Wheel handle or operating key.
  12. Operation for Service Areas: Operating key.
  14. Include operating key with each operating-key hose bibb.
  15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.08 WALL HYDRANTS:
A. Nonfreeze Wall Hydrants:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. MIFAB, Inc.
      d. Tyler Pipe; Wade Div.
      e. Watts Drainage Products.
      f. Woodford Manufacturing Company; a division of WCM Industries, Inc.
      g. Zurn Industries, LLC.
   4. Operation: Loose key.
   5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
   6. Inlet: NPS 3/4 or NPS 1.
   7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
   8. Box: Deep, flush mounted with cover.
  11. Operating Keys(s): Two with each wall hydrant.
2.09 DRAIN VALVES:
A. Ball-Valve-Type, Hose-End Drain Valves:
2. Pressure Rating: 400-psig minimum CWP.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
8. Inlet: Threaded or solder joint.

2.10 WATER-HAMMER ARRESTERS:
A. Water-Hammer Arresters:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AMTROL, Inc.
   b. Josam Company.
   c. Precision Plumbing Products, Inc.
   d. Sioux Chief Manufacturing Company, Inc.
   e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   f. Watts Drainage Products.
   g. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.
3. Type: Metal bellows.
4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.11 AIR VENTS:
A. Welded-Construction Automatic Air Vents:
2. Pressure Rating: 150-psig minimum pressure rating.
3. Float: Replaceable, corrosion-resistant metal.

2.12 TRAP-SEAL PRIMER SYSTEMS:
A. Trap-Seal Primer Systems:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Precision Plumbing Products, Inc.
   b. Engineer-approved equal.
2. Standard: ASSE 1044.
3. Piping: NPS 3/4, ASTM B88, Type L; copper, water tubing.
5. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120Vac power.
   a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
7. Number Outlets: Six.

2.13 FLEXIBLE CONNECTORS:
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Hyspan Precision Products, Inc.
   2. Metraflex, Inc.
   3. Engineer-approved equal.
B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
   2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.

PART 3 - EXECUTION

3.01 INSTALLATION:
A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment (refrigerator) and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
B. Install water regulators with inlet and outlet shutoff valves. Install pressure gauges on inlet and outlet.
C. Install water-control valves with inlet and outlet shutoff valves. Install pressure gauges on inlet and outlet.
D. Install balancing valves in locations where they can easily be adjusted.
E. Install Y-pattern strainers for water on supply side of each water pressure-reducing valve.
F. Install water-hammer arresters in water piping according to PDI-WH 201.
G. Install air vents at high points of water piping. Install drain piping and discharge onto floor drain.
H. Install trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1%, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

3.02 LABELING AND IDENTIFYING:
A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
   1. Pressure vacuum breakers.
   2. Water pressure-reducing valves.
   3. Calibrated balancing valves.
   4. Trap-seal primer systems.
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 Section 22 05 53 - Identification for Plumbing Piping and Equipment.

3.03 FIELD QUALITY CONTROL:
A. Perform the following tests and inspections:
   1. Test each pressure vacuum breaker and backflow preventer according to authorities having jurisdiction and the device's reference standard.
B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.
C. Prepare test and inspection reports.
3.04 ADJUSTING:
   A. Set field-adjustable pressure set points of water pressure-reducing valves.
   B. Set field-adjustable flow set points of balancing valves.
   C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

END OF SECTION 22 11 19
SECTION 22 13 16 – SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.01 SUMMARY:
   A. This Section includes:
      1. Pipe, tube, and fittings.
      2. Specialty pipe fittings.

1.02 PERFORMANCE REQUIREMENTS:
   A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:

1.03 ACTION SUBMITTALS:
   A. Product Data: For each type of product indicated.

1.04 INFORMATIONAL SUBMITTALS:
   A. Field quality-control reports.

1.05 QUALITY ASSURANCE:
   A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.01 PIPING MATERIALS:
   A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.02 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS:
   A. Pipe and Fittings: ASTM A888 or CISPI 301.
   B. Sovent Stack Fittings: ASME B16.45 or ASSE 1043, hubless, cast-iron aerator and deaerator drainage fittings.
   C. CISPI, Hubless-Piping Couplings:
      1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         a. ANACO-Husky.
         c. Fernco, Inc.
         d. Matco-Norca, Inc.
         e. MIFAB, Inc.
         f. Mission Rubber Company; a division of MCP Industries, Inc.
         g. Stant.
         h. Tyler Pipe.
      3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

2.03 SPECIALTY PIPE FITTINGS:
   A. Transition Couplings:
1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections same size as and compatible with pipes to be joined.

2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

3. Unshielded, Nonpressure Transition Couplings:
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      (1) Dallas Specialty & Mfg. Co.
      (2) Fernco, Inc.
      (3) Mission Rubber Company; a division of MCP Industries, Inc.
      (4) Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
   c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
   d. Sleeve Materials:
      (1) For Cast-Iron Soil Pipes: ASTM C564, rubber.

PART 3 - EXECUTION

3.01 EARTH MOVING:
   A. Comply with requirements for excavating, trenching, and backfilling specified in Division 31.

3.02 PIPING 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. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
   C. 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.
   D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
   E. Install piping to permit valve servicing.
   F. Install piping at indicated slopes.
   G. Install piping free of sags and bends.
   H. Install fittings for changes in direction and branch connections.
   I. Install piping to allow application of insulation.
   J. 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 two 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.
   K. 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.

L. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
   1. Building Sanitary Drain: 2% downward in direction of flow for piping NPS 3 and smaller; 2% downward in direction of flow for piping NPS 4 and larger.
   2. Horizontal Sanitary Drainage Piping: 2% downward in direction of flow.
   3. Vent Piping: 1% down toward vertical fixture vent or toward vent stack.

M. 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."

N. Plumbing Specialties:
   1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping. Comply with requirements for cleanouts specified in Section 22 13 19 - Sanitary Waste Piping Specialties.

O. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

P. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 05 17 - Sleeves and Sleeve Seals for Plumbing Piping.

Q. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 22 05 17 - Sleeves and Sleeve Seals for Plumbing Piping.

R. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 22 05 18 - Escutcheons for Plumbing Piping.

3.03 JOINT CONSTRUCTION:
   A. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

3.04 SPECIALTY PIPE FITTING INSTALLATION:
   A. Transition Couplings:
      1. Install transition couplings at joints of piping with small differences in ODs.

3.05 HANGER AND SUPPORT INSTALLATION:
   A. Comply with requirements for pipe hanger and support devices and installation specified in Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment.
      1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
      2. Vertical Piping: MSS Type 8 or Type 42 clamps.
      3. Install individual, straight, horizontal piping runs:
         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.
      4. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
      5. Base of Vertical Piping: MSS Type 52, spring hangers.
   B. Support horizontal piping and tubing within 12 inches of each fitting and coupling.
   C. Support vertical piping and tubing at base and at each floor.
D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
   2. NPS 3: 60 inches with 1/2-inch rod.
   3. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
F. Install supports for vertical cast-iron soil piping every 15 feet.
G. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.06 **IDENTIFICATION:**
A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Section 22 05 53 - Identification for Plumbing Piping and Equipment.

3.07 **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.

3.08 **CLEANING AND PROTECTION:**
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.

3.09 **PIPING SCHEDULE:**
A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.
B. Aboveground, soil and waste piping shall be the following:
   1. Hubless, cast-iron soil pipe and fittings and sovent stack fittings; CISPI hubless-piping couplings; and coupled joints.
C. Aboveground, vent piping shall be the following:
   1. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
D. Underground, soil, waste, and vent piping shall be the following:
   1. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.

END OF SECTION 22 13 16
SECTION 22 13 19 – SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01, Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. This Section includes:
      1. Cleanouts.
      2. Floor drains.

1.03 INFORMATIONAL SUBMITTALS:
   A. Field quality-control test reports.

1.04 CLOSEOUT SUBMITTALS:
   A. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.05 QUALITY ASSURANCE:
   A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.
   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.

PART 2 - PRODUCTS

2.01 CLEANOUTS:
   A. Exposed Metal Cleanouts (FCO):
      1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         b. MIFAB, Inc.
         d. Tyler Pipe; Wade Div.
         e. Watts Drainage Products, Inc.
         f. Zurn Plumbing Products Group; Specification Drainage Operation.
      2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
      3. Size: Same as connected drainage piping.
      5. Closure: Countersunk, plastic plug.
      6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
   B. Cast-Iron Wall Cleanouts (WCO):
      1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
b. MIFAB, Inc.
d. Tyler Pipe; Wade Div.
e. Watts Drainage Products, Inc.
f. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

2.02 FLOOR DRAINS:

A. Cast-Iron Floor Drains (FD-1):
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Commercial Enameling Co.
   b. Josam Company; Josam Div.
   c. MIFAB, Inc.
   d. Prier Products, Inc.
   e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   f. Tyler Pipe; Wade Div.
   g. Watts Drainage Products, Inc.
   h. Zurn Plumbing Products Group; Light Commercial Operation.
   i. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.6.3.
5. Seepage Flange: Not required.
6. Anchor Flange: Not required.
7. Clamping Device: Not required.
8. Outlet: Bottom.
11. Sediment Bucket: Not required.
12. Top or Strainer Material: Nickel bronze.
14. Top Shape: Round.
15. Dimensions of Top or Strainer: As scheduled.
17. Funnel: Not required.
18. Inlet Fitting: Not required.
20. Trap Pattern: Not required.
21. Trap Features: Not required.

B. Cast-Iron Floor Drains (FD-2):
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Commercial Enameling Co.
b. Josam Company; Josam Div.
c. MIFAB, Inc.
d. Prier Products, Inc.
e. Smith, Jay R. Mfg. Co.: Division of Smith Industries, Inc.
f. Tyler Pipe; Wade Div.
g. Watts Drainage Products, Inc.
h. Zurn Plumbing Products Group; Light Commercial Operation.
i. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.6.3.
5. Seepage Flange: Not required.
6. Anchor Flange: Not required.
7. Clamping Device: Not required.
8. Outlet: Bottom.
11. Sediment Bucket: Not required.
12. Top or Strainer Material: Nickel bronze.
14. Top Shape: Round.
15. Dimensions of Top or Strainer: As scheduled.
17. Funnel: Required.
18. Inlet Fitting: Not required.
20. Trap Pattern: Not required.
21. Trap Features: Not required.

2.03 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES:
A. Floor-Drain, Trap-Seal Primer Fittings:
1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 side inlet.
B. Vent Caps:
1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

2.04 FLASHING MATERIALS:
A. Lead Sheet: ASTM B749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:
1. General Use: 4.0 lb./sq. ft., 0.0625 inch thickness.
2. Vent Pipe Flashing: 3.0 lb./sq. ft., 0.0469 inch thickness.
3. Burning: 6 lb./sq. ft., 0.0938 inch thickness.
B. Copper Sheet: ASTM B152/B152M, of the following minimum weights and thicknesses, unless otherwise indicated:
1. General Applications: 12 oz./sq. ft.
2. Vent Pipe Flashing: 8 oz./sq. ft.
C. Zinc-Coated Steel Sheet: ASTM A653/A653M, with 0.20% copper content and 0.04 inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.

D. Elastic Membrane Sheet: ASTM D4068, flexible, chlorinated polyethylene, 40 mil minimum thickness.

E. Fasteners: Metal compatible with material and substrate being fastened.

F. Metal Accessories: Sheetmetal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

G. Solder: ASTM B32, lead-free alloy.

H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

**PART 3 - EXECUTION**

3.01 INSTALLATION:

A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping, unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

D. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains for easy access and maintenance.
2. Set floor drains below elevation of surrounding finished floor to allow floor drainage.

   Set with grates depressed according to the following drainage area radii:
   a. Radius, 30 Inches or Less: Equivalent to 1% slope, but not less than 1/4 inch total depression.
   b. Radius, 30 to 60 Inches: Equivalent to 1% slope.
   c. Radius, 60 Inches or Larger: Equivalent to 1% slope, but not greater than 1 inch total depression.

3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.

4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

E. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

F. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.

1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
2. Size: Same as floor drain inlet.

G. Install vent caps on each vent pipe passing through roof.

H. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes, unless trap is indicated.
3.02 FLASHING INSTALLATION:
   A. Fabricate flashing from single piece, unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
      1. Lead Sheets: Burn joints of lead sheets 6.0 lbs./sq. ft., 0.0938 inch thickness or thicker. Solder joints of lead sheets 4.0 lbs./sq. ft., 0.0625 inch thickness or thinner.
      2. Copper Sheets: Solder joints of copper sheets.
   B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
      1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
      2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
      3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
   C. Set flashing on floors and roofs in solid coating of bituminous cement.
   D. Secure flashing into sleeve and specialty clamping ring or device.
   E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 07.
   F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.
   G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.03 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.
SECTION 22 33 00 – ELECTRIC, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.01 SUMMARY:
   A. This Section includes:
      1. Commercial, electric, storage, domestic-water heaters.
      2. Domestic-water heater accessories.

1.02 ACTION SUBMITTALS:
   A. Product Data: For each type and size of domestic-water heater indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
   B. Shop Drawings:
      1. Wiring Diagrams: For power, signal, and control wiring.

1.03 INFORMATIONAL SUBMITTALS:
   A. Source quality-control reports.
   B. Field quality-control reports.

1.04 CLOSEOUT SUBMITTALS:
   A. Operation and Maintenance Data: For electric, domestic-water heaters to include in emergency, operation, and maintenance manuals.

1.05 QUALITY ASSURANCE:
   A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.
   C. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
   D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61, "Drinking Water System Components - Health Effects."

1.06 COORDINATION:
   A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

A. Commercial, Electric, Storage, Domestic-Water Heaters:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      c. Cemline Corporation.
      d. Electric Heater Company (The).
      e. GSW Water Heating.
      f. HESco Industries, Inc.
      g. Lochinvar Corporation.
      h. Precision Boilers, Inc.
      i. PVI Industries, LLC.
      j. RECO USA.
k. Rheem Manufacturing Company.
l. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
m. State Industries.
n. Vaughn Manufacturing Corporation.


a. Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.
   (1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
b. Pressure Rating: 150 psig.
c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.

4. Factory-Installed Storage-Tank Appurtenances:
a. Anode Rod: Replaceable magnesium.
b. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
c. Insulation: Comply with ASHRAE/IESNA 90.1.
d. Jacket: Steel with enameled finish.
e. Heating Elements: Electric, screw-in or bolt-on immersion type arranged in multiples of three.
f. Temperature Control: Adjustable thermostat.
g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
h. Relief Valves: ASME rated and stamped for combination temperature-and-pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

2.02 DOMESTIC-WATER HEATER ACCESSORIES:

A. Domestic-Water Compression Tanks:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. AMTROL, Inc.
b. Flexcon Industries.
c. Honeywell International, Inc.
d. Pentair Pump Group (The); Myers.
e. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
f. State Industries.
g. Taco, Inc.

2. Description: Steel pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.

3. Construction:
a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
c. Air-Charging Valve: Factory installed.

4. Capacity and Characteristics:
c. Air Precharge Pressure: 40 psig (adj.).
2.03 SOURCE QUALITY CONTROL:
A. Factory Tests: Test and inspect domestic-water heaters specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.
B. Hydrostatically test commercial domestic-water heaters to minimum of one and one-half times pressure rating before shipment.
C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 01 for retesting and reinspecting requirements and Division 01 for requirements for correcting the Work.
D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 DOMESTIC-WATER HEATER INSTALLATION:
A. Commercial, Electric, Domestic-Water Heater Mounting: Install commercial, electric, domestic-water heaters on concrete base. Comply with requirements for concrete bases specified in Division 03.
   1. Exception: Omit concrete bases for commercial, electric, domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
   2. Maintain manufacturer's recommended clearances.
   3. Arrange units so controls and devices that require servicing are accessible.
   4. 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 concrete base.
   5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   7. Install anchor bolts to elevations required for proper attachment to supported equipment.
   8. Anchor domestic-water heaters to substrate.
B. Install electric, domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
   1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 22 05 23 - General-Duty Valves for Plumbing Piping.
C. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
D. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for electric, domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 22 11 19 - Domestic Water Piping Specialties.
E. Install thermometers on outlet piping of electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 22 05 19 - Meters and Gauges for Plumbing Piping.
F. Fill electric, domestic-water heaters with water.
G. Charge domestic-water compression tanks with air.

3.02 IDENTIFICATION:
A. Identify system components. Comply with requirements for identification specified in Section 22 05 53 - Identification for Plumbing Piping and Equipment.
3.03 FIELD QUALITY CONTROL:
   A. Perform tests and inspections.
      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.
      2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest
         until no leaks exist.
      3. Operational Test: After electrical circuitry has been energized, start units to confirm
         proper operation.
      4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and
         equipment.
   B. Electric, domestic-water heaters will be considered defective if they do not pass tests and
      inspections. Comply with requirements in Division 01 for retesting and reinspecting
      requirements and Division 01 for requirements for correcting the Work.
   C. Prepare test and inspection reports.

3.04 DEMONSTRATION:
   A. Engage a factory-authorized service representative to train Owner's maintenance personnel to
      adjust, operate, and maintain commercial, electric, domestic-water heaters.

END OF SECTION 22 33 00
SECTION 22 41 00 – RESIDENTIAL PLUMBING FIXTURES

PART 1 - GENERAL

1.01 SUMMARY:
   A. This Section Includes:
      1. Faucets.
      2. Kitchen sinks.

1.02 ACTION SUBMITTALS:
   A. Product Data: For each type of product.
      1. Include construction details, material descriptions, dimensions of individual components
         and profiles, and finishes for lavatories.
      2. Include rated capacities, operating characteristics, electrical characteristics, and furnished
         specialties and accessories.
   B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.03 INFORMATIONAL SUBMITTALS:
   A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted plumbing
      fixtures.
   B. Sample Warranty: For special warranty.

1.04 CLOSEOUT SUBMITTALS:
   A. Operation and Maintenance Data: For plumbing fixtures and faucets to include in emergency,
      operation, and operation and maintenance manuals.

PART 2 - PRODUCTS

2.01 KITCHEN SINKS:
      1. Manufacturers: Subject to compliance with requirements, provide products by one of the
         following:
         a. Elkay Manufacturing Co.
         b. Franke Consumer Products, Inc.
         c. Griffin Products, Inc.
         d. Houzer, Inc.
         e. Just Manufacturing.
         f. Kohler Co.
         g. Revere Sink.
         h. Sterling; a Kohler company.
         i. WhiteRock Corp.
      2. Fixture:
         b. Overall Dimensions: 31 inches long by 19 inches wide.
         c. Metal Thickness: 0.038 inch.
         d. Bowl:
            (1) Dimensions: 28 inches long by 16 inches wide by 7-1/2 inches deep.
            (2) Drain: 3-1/2-inch grid.
               (a) Location: Centered in bowl.

2.02 SINK FAUCETS:
A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for faucet materials that will be in contact with potable water.
B. Sink Faucets (KS Faucet): Solid brass.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Bradley Corporation.
      c. Chicago Faucets.
      d. Delta Faucet Company.
      e. Eljer, Inc.
      f. Elkay Manufacturing Co.
      g. Kohler Co.
      h. Moen, Incorporated.
      i. Price Pfister, Inc.
      j. Speakman Company.
      k. Zurn Industries, LLC; Commercial Brass and Fixtures.
   3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.
   5. Finish: Polished chrome-plated brass.
   6. Maximum Flow Rate: 1.5 gpm, unless otherwise indicated.
   7. Mixing Valve: Single control.
  11. Spout Type: Rigid gooseneck.

2.03 DISPOSERS:
A. Disposers: Continuous-feed household, food waste.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Anaheim Manufacturing, Inc.; a subsidiary of Western Industries, Inc.
      c. Franke Consumer Products, Inc.
      d. InSinkErator.
      e. KitchenAid.
      f. Maytag.
      g. WhiteRock Corp.
   2. Standards: ASSE 1008 and UL 430, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   3. General: Include reset button; wall switch; corrosion-resistant chamber with jam-resistant cutlery or stainless-steel grinder or shredder; NPS 1-1/2 outlet; quick-mounting, stainless-steel sink flange; antisplash guard; and combination cover/stopper.
   5. Motor: 115Vac, 1,725 rpm, 1/3 hp with overload protection.
2.04 **SUPPLY FITTINGS:**
A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for faucet materials that will be in contact with potable water.
B. Standard: ASME A112.18.1/CSA B125.1.
C. Kitchen Sink Supply Fittings:
   1. **Supply Piping:** Chrome-plated-brass pipe or chrome-plated-copper tube matching water-supply piping size. Include chrome-plated wall flange.
   2. **Stops:** Chrome-plated-brass, one-quarter-turn, ball-type or compression stop with inlet connection matching water-supply piping type and size.
      a. **Operation:** Loose key.
   3. **Risers:**
      a. **Size:** NPS 1/2 for kitchen sinks.
      b. **Material:** ASME A112.18.6, braided- or corrugated-stainless-steel flexible hose riser.

2.05 **WASTE FITTINGS:**
A. Standard: ASME A112.18.2/CSA B125.2.
B. **Drain:** Grid type with NPS 1-1/2 offset tailpiece for accessible kitchen sinks.
C. **Trap:**
   1. **Size:** NPS 1-1/2 for kitchen sinks.
   2. **Material:** ASTM F409 PVC one-piece trap and waste to wall and wall flange.

2.06 **GROUT:**
B. Characteristics: Nonshrink; recommended for interior and exterior applications.
C. **Design Mix:** 5,000-psi, 28-day compressive strength.
D. **Packaging:** Premixed and factory packaged.

**PART 3 - EXECUTION**

3.01 **EXAMINATION:**
A. Examine roughing-in of water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing-fixture installation.
B. Examine walls, floors, cabinets, and counters for suitable conditions where fixtures will be installed.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 **INSTALLATION:**
A. Install plumbing fixtures level and plumb according to roughing-in Drawings.
B. Install counter-mounting fixtures in and attached to casework.
C. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
   1. Exception: Use ball valves if supply stops are not specified with fixture. Comply with valve requirements specified in Section 22 05 23 - General-Duty Valves for Plumbing Piping.
D. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
E. Install disposer in outlet of each sink indicated to have a disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.
F. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 22 07 19 - Plumbing Piping Insulation.

G. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 22 05 18 - Escutcheons for Plumbing Piping.

H. Seal joints between plumbing fixtures, counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Division 07.

3.03 ADJUSTING:
A. Operate and adjust plumbing fixtures and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
B. Adjust water pressure at faucets to produce proper flow.

3.04 CLEANING AND PROTECTION:
A. After completing installation of plumbing fixtures, inspect and repair damaged finishes.
B. Clean plumbing fixtures, faucets, and other fittings with manufacturers’ recommended cleaning methods and materials.
C. Provide protective covering for installed plumbing fixtures and fittings.
D. Do not allow use of plumbing fixtures for temporary facilities, unless approved in writing by Owner.

END OF SECTION 22 41 00
SECTION 22 42 13.13 – COMMERCIAL WATER CLOSETS

PART 1 - GENERAL

1.01 SUMMARY:
   A. This Section Includes:
      1. Water closets.
      2. Flushometer valves.
      3. Toilet seats.

1.02 ACTION SUBMITTALS:
   A. Product Data: For each type of product.
      1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for water closets.
      2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.03 CLOSEOUT SUBMITTALS:
   A. Operation and Maintenance Data: For flushometer valves to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.01 WALL-MOUNTED WATER CLOSETS:
   A. Water Closets (WC-1): Wall mounted, top spud.
      1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         b. Crane Plumbing, LLC.
         c. Kohler Co.
         d. TOTO USA, Inc.
         e. Zurn Industries, LLC; Commercial Brass and Fixtures.
      2. Bowl:
         b. Material: Vitreous china.
         c. Type: Siphon jet.
         d. Style: Flushometer valve.
         e. Height: Standard.
         f. Rim Contour: Elongated.
         g. Water Consumption: 1.28 gal. per flush.
         h. Spud Size and Location: NPS 1-1/2; top.
      3. Flushometer Valve: WC Flushometer.
      5. Support:
         a. Standard: ASME A112.6.1M.
         b. Description: Waste-fitting assembly as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Kohler Co.
   c. TOTO USA, Inc.
   d. Zurn Industries, LLC; Commercial Brass and Fixtures.

2. Bowl:
   b. Material: Vitreous china.
   c. Type: Siphon jet.
   d. Style: Flushometer valve.
   e. Height: Standard.
   f. Rim Contour: Elongated.
   g. Water Consumption: 1.28 gal. per flush.
   h. Spud Size and Location: NPS 1-1/2; top.

3. Flushometer Valve: WC Flushometer.


5. Support:
   a. Standard: ASME A112.6.1M.
   b. Description: Waste-fitting assembly as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture.

2.02 FLUSHOMETER VALVES:
A. Lever-Handle, Diaphragm Flushometer Valves (WC Flushometer):
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Coyne & Delany Co.
      b. Gerber Plumbing Fixtures, LLC.
      c. Sloan Valve Company.
      d. Zurn Industries, LLC; Commercial Brass and Fixtures.
   4. Features: Include integral check stop and backflow-prevention device.
   5. Material: Brass body with corrosion-resistant components.
   7. Style: Exposed.
   8. Consumption: 1.28 gal. per flush.

2.03 TOILET SEATS:
A. Toilet Seats (WC Toilet Seat):
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Kohler Co.
      c. TOTO USA, Inc.
      d. Zurn Industries, LLC; Commercial Brass and Fixtures.
4. Type: Commercial (Heavy duty).
5. Shape: Elongated rim, open front.
6. Hinge: Check.
8. Seat Cover: Not required.

PART 3 - EXECUTION

3.01 EXAMINATION:
A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before water closet installation.
B. Examine walls and floors for suitable conditions where water closets will be installed.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:
A. Water Closet Installation:
   1. Install level and plumb according to roughing-in Drawings.
   2. Install accessible, wall-mounted water closets at mounting height for handicapped/elderly, according to ICC/ANSI A117.1.
B. Support Installation:
   1. Install supports, affixed to building substrate, for floor-mounted, back-outlet water closets.
   2. Use carrier supports with waste-fitting assembly and seal.
C. Flushometer Valve Installation:
   1. Install flushometer valve, water supply fitting on each supply to each water closet.
   2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
   3. Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.
   4. Install actuators in locations that are easy for people with disabilities to reach.
D. Install toilet seats on water closets.
E. Wall Flange and Escutcheon Installation:
   1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
   2. Install deep-pattern escutcheons if required to conceal protruding fittings.
   3. Comply with escutcheon requirements specified in Section 22 05 18 - Escutcheons for Plumbing Piping.
F. Joint Sealing:
   1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
   2. Match sealant color to water closet color.
   3. Comply with sealant requirements specified in Division 07.

3.03 ADJUSTING:
A. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.
B. Adjust water pressure at flushometer valves to produce proper flow.
3.04 CLEANING AND PROTECTION:
   A. Clean water closets and fittings with manufacturers’ recommended cleaning methods and materials.
   B. Install protective covering for installed water closets and fittings.
   C. Do not allow use of water closets for temporary facilities, unless approved in writing by Owner.

END OF SECTION 22 42 13.13
SECTION 22 42 13.16 – COMMERCIAL URINALS

PART 1 - GENERAL

1.01 SUMMARY:
   A. This Section includes:
      1. Urinals.
      2. Flushometer valves.

1.02 ACTION SUBMITTALS:
   A. Product Data: For each type of product.
      1. Include construction details, material descriptions, dimensions of individual components
         and profiles, and finishes for urinals.
      2. Include rated capacities, operating characteristics, electrical characteristics, and furnished
         specialties and accessories.

1.03 CLOSEOUT SUBMITTALS:
   A. Operation and Maintenance Data: For flushometer valves to include in operation and
      maintenance manuals.

PART 2 - PRODUCTS

2.01 WALL-HUNG URINALS:
   A. Urinals (UR-1): Wall hung, back outlet, washout, accessible.
      1. Manufacturers: Subject to compliance with requirements, provide products by one of the
         following:
         b. Crane Plumbing, LLC.
         c. Kohler Co.
         d. TOTO USA, Inc.
         e. Zurn Industries, LLC; Commercial Brass and Fixtures.
      2. Fixture:
         b. Material: Vitreous china.
         c. Type: Washout with extended shields.
         d. Strainer or Trapway: Manufacturer’s standard strainer with integral trap.
         e. Water Consumption: Water saving.
         f. Spud Size and Location: NPS 3/4, top.
         g. Outlet Size and Location: NPS 2, back.
         h. Color: White.
      3. Flushometer Valve: UR Flushometer.
      4. Waste Fitting:
         b. Size: NPS 2.
      5. Support: ASME A112.6.1M, Type I, urinal carrier with fixture support plates and
         coupling with seal and fixture bolts and hardware matching fixture.

2.02 URINAL FLUSHOMETER VALVES:
   A. Lever-Handle, Diaphragm Flushometer Valves (UR Flushometer):
      1. Manufacturers: Subject to compliance with requirements, provide products by one of the
         following:
a. Coyne & Delany Co.
b. Gerber Plumbing Fixtures, LLC.
c. Sloan Valve Company.
d. Zurn Industries, LLC; Commercial Brass and Fixtures.

4. Features: Include integral check stop and backflow-prevention device.
5. Material: Brass body with corrosion-resistant components.
7. Style: Exposed.
8. Consumption: 0.125 gal. per flush.

PART 3 - EXECUTION

3.01 EXAMINATION:
A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before urinal installation.
B. Examine walls and floors for suitable conditions where urinals will be installed.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:
A. Urinal Installation:
   1. Install urinals level and plumb according to roughing-in Drawings.
   2. Install wall-hung, back-outlet urinals onto waste fitting seals and attached to supports.
   3. Install accessible, wall-mounted urinals at mounting height for the handicapped/elderly, per ICC/ANSI A117.1.
B. Support Installation:
   1. Install supports, affixed to building substrate, for wall-hung urinals.
   2. Use off-floor carriers with waste fitting and seal for back-outlet urinals.
   3. Use carriers without waste fitting for urinals with tubular waste piping.
   4. Use chair-type carrier supports with rectangular steel uprights for accessible urinals.
C. Flushometer-Valve Installation:
   1. Install flushometer-valve water-supply fitting on each supply to each urinal.
   2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
   3. Install lever-handle flushometer valves for accessible urinals with handle mounted on open side of compartment.
D. Wall Flange and Escutcheon Installation:
   1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations.
   2. Install deep-pattern escutcheons if required to conceal protruding fittings.
   3. Comply with escutcheon requirements specified in Section 22 05 18 - Escutcheons for Plumbing Piping.
E. Joint Sealing:
   1. Seal joints between urinals, walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
   2. Match sealant color to urinal color.
   3. Comply with sealant requirements specified in Division 07.
3.03 **ADJUSTING:**
   A. Operate and adjust urinals and controls. Replace damaged and malfunctioning urinals, fittings, and controls.
   B. Adjust water pressure at flushometer valves to produce proper flow.
   C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.04 **CLEANING AND PROTECTION:**
   A. Clean urinals and fittings with manufacturers’ recommended cleaning methods and materials.
   B. Install protective covering for installed urinals and fittings.
   C. Do not allow use of urinals for temporary facilities, unless approved in writing by Owner.

END OF SECTION 22 42 13.16
SECTION 22 42 16.13 – COMMERCIAL LAVATORIES

PART 1 - GENERAL

1.01 SUMMARY:
   A. This Section includes:
      1. Lavatories.
      2. Faucets.

1.02 ACTION SUBMITTALS:
   A. Product Data: For each type of product.
      1. Include construction details, material descriptions, dimensions of individual components
         and profiles, and finishes for lavatories.
      2. Include rated capacities, operating characteristics, electrical characteristics, and furnished
         specialties and accessories.
   B. Shop Drawings: Include diagrams for power, signal, and control wiring of automatic faucets.

1.03 INFORMATIONAL SUBMITTALS:
   A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted
      lavatories.

1.04 CLOSEOUT SUBMITTALS:
   A. Operation and Maintenance Data: For lavatories and faucets to include in operation and
      maintenance manuals.
      1. In addition to items specified in Division 01, include the following:
         a. Servicing and adjustments of automatic faucets.

PART 2 - PRODUCTS

2.01 VITREOUS-CHINA, COUNTER-MOUNTED LAVATORIES:
   A. Lavatory (LAV-1): Oval, self-rimming, vitreous china, counter mounted.
      1. Manufacturers: Subject to compliance with requirements, provide products by one of the
         following:
         b. Crane Plumbing, LLC.
         c. Kohler Co.
         d. TOTO USA, Inc.
         e. Zurn Industries, LLC; Commercial Brass and Fixtures.
      2. Fixture:
         b. Type: Self-rimming for above-counter mounting.
         c. Nominal Size: Oval, 24 by 18 inches.
         d. Faucet-Hole Punching: Three holes, 4-inch centers.
         e. Faucet-Hole Location: Top.
         g. Mounting Material: Sealant.
      3. Faucet: LAV Faucet.

2.02 VITREOUS-CHINA, WALL-MOUNTED LAVATORIES:
   A. Lavatory (LAV-2): Vitreous china, wall mounted, with back.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Briggs Plumbing Products, Inc.
   c. Crane Plumbing, LLC.
   d. Ferguson Enterprises, Inc.; ProFlo Brand.
   e. Gerber Plumbing Fixtures, LLC.
   f. Kohler Co.
   g. Mansfield Plumbing Products, LLC.
   h. Peerless Pottery Sales, Inc.
   i. Zurn Industries, LLC; Commercial Brass and Fixtures.

2. Fixture:
   b. Type: For wall hanging.
   c. Nominal Size: Oval, 19 by 16 inches.
   d. Faucet-Hole Punching: One hole.
   e. Faucet-Hole Location: Top.
   g. Mounting Material: Chair carrier.

3. Faucet: LAV Faucet

2.03 SOLID-BRASS, AUTOMATICALLY OPERATED LAVATORY FAUCETS:
A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for faucet materials that will be in contact with potable water.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Chicago Faucets.
      c. Kohler Co.
      d. Moen, Incorporated.
      e. Sloan Valve Company.
      f. Speakman Company.
      g. TOTO USA, Inc.
      h. Zurn Industries, LLC; Commercial Brass and Fixtures.
   3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   4. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
   5. Body Type: Three hole.
   7. Finish: Polished chrome plate.
   8. Maximum Flow Rate: 0.5 gpm.
   10. Spout: Rigid type.
   12. Drain: Not part of faucet.
2.04 **SUPPLY FITTINGS:**

A. **NSF Standard:** Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for supply-fitting materials that will be in contact with potable water.

B. **Standard:** ASME A112.18.1/CSA B125.1.

C. **Supply Piping:** Chrome-plated brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated brass or stainless-steel wall flange.

D. **Supply Stops:** Chrome-plated brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.

E. **Operation:** Loose key.

F. **Risers:**
   2. ASME A112.18.6, braided or corrugated stainless-steel, flexible hose riser.

2.05 **WASTE FITTINGS:**

A. **Standard:** ASME A112.18.2/CSA B125.2.

B. **Drain:** Grid type with NPS 1-1/4 offset and straight tailpiece.

C. **Trap:**
   1. **Size:** NPS 1-1/2 by NPS 1-1/4.
   2. **Material:** Chrome-plated, one-piece, cast-brass trap with swivel 0.029-inch thick tubular brass wall bend; and chrome-plated, brass or steel wall flange.

**PART 3 - EXECUTION**

3.01 **EXAMINATION:**

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before lavatory installation.

B. Examine counters and walls for suitable conditions where lavatories will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 **INSTALLATION:**

A. Install lavatories level and plumb according to roughing-in Drawings.

B. Install supports, affixed to building substrate, for wall-mounted lavatories.

C. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, per ICC/ANSI A117.1.

D. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 22 05 18 - Escutcheons for Plumbing Piping.

E. Seal joints between lavatories, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Division 07.

F. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 22 07 19 - Plumbing Piping Insulation.

3.03 **ADJUSTING:**

A. Operate and adjust lavatories and controls. Replace damaged and malfunctioning lavatories, fittings, and controls.

B. Adjust water pressure at faucets to produce proper flow.

C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.
3.04  CLEANING AND PROTECTION:
   A. After completing installation of lavatories, inspect and repair damaged finishes.
   B. Clean lavatories, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
   C. Provide protective covering for installed lavatories and fittings.
   D. Do not allow use of lavatories for temporary facilities, unless approved in writing by Owner.

END OF SECTION 22 42 16.13
SECTION 22 42 16.16 – COMMERCIAL SINKS

PART 1 - GENERAL

1.01 SUMMARY:
   A. This Section includes:
      1. Service basins.
      2. Sink faucets.

1.02 ACTION SUBMITTALS:
   A. Product Data: For each type of product.
      1. Include construction details, material descriptions, dimensions of individual components
         and profiles, and finishes for sinks.
      2. Include rated capacities, operating characteristics and furnished specialties and
         accessories.

1.03 CLOSEOUT SUBMITTALS:
   A. Maintenance Data: For sinks to include in maintenance manuals.

PART 2 - PRODUCTS

2.01 SERVICE BASINS:
   A. Service Basins (MB-1): Terrazzo, floor mounted.
      1. Manufacturers: Subject to compliance with requirements, provide products by one of the
         following:
         b. Crane Plumbing, LLC.
         c. Florestone Products Co., Inc.
         d. Stern-Williams Co., Inc.
         e. E.L. Mustee & Sons, Inc.
      2. Fixture:
         b. Shape: Square.
         c. Nominal Size: 24 by 24 inches.
         d. Height: 10 inches.
         e. Rim Guard: On front top surfaces.
         f. Wall Guard: For all surfaces adjacent to wall.
         g. Color: Not applicable.
         h. Drain: Grid with NPS 2 outlet.
      3. Mounting: On floor and flush to wall.

2.02 SINK FAUCETS:
   A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health
      Effects," for faucet-spout materials that will be in contact with potable water.
      1. Manufacturers: Subject to compliance with requirements, provide products by one of the
         following:
b. Bradley Corporation.
c. Chicago Faucets.
d. Delta Faucet Company.
e. Elkay Manufacturing Co.
f. Kohler Co.
g. Moen, Incorporated.
h. Speakman Company.
i. Zurn Industries, LLC; Commercial Brass and Fixtures.

3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.
4. Body Type: Widespread.
7. Maximum Flow Rate: 4.0 gpm.
8. Handle(s): Wrist blade, 4 inches.
9. Mounting Type: Back/wall, exposed.
10. Spout Type: Rigid, solid brass with wall brace.
12. Spout Outlet: Hose thread according to ASME B1.20.7.

2.03 SUPPLY FITTINGS:
A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for supply-fitting materials that will be in contact with potable water.
B. Standard: ASME A112.18.1/CSA B125.1.
C. Supply Piping: Chrome-plated brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated brass or stainless-steel wall flange.
D. Supply Stops: Chrome-plated brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.
E. Operation: Loose key.
F. Risers:
   2. Chrome-plated, rigid-copper pipe.

2.04 WASTE FITTINGS:
A. Standard: ASME A112.18.2/CSA B125.2.
B. Drain: Grid type with NPS 1-1/2 offset and straight tailpiece.
C. Trap:
   2. Material: Chrome-plated, one-piece, cast-brass trap with swivel 0.029-inch; and chrome-plated brass or steel wall flange.

2.05 GROUT:
B. Characteristics: Nonshrink; recommended for interior and exterior applications.
C. Design Mix: 5,000 psi, 28-day compressive strength.
D. Packaging: Premixed and factory packaged.
PART 3 - EXECUTION

3.01 EXAMINATION:
A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before sink installation.
B. Examine walls, floors, and counters for suitable conditions where sinks will be installed.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:
A. Install sinks level and plumb according to roughing-in Drawings.
B. Set floor-mounted sinks in leveling bed of cement grout.
C. Install water-supply piping with stop on each supply to each sink faucet.
   1. Exception: Use ball, gate, or globe valves if supply stops are not specified with sink.
      Comply with valve requirements specified in Section 22 05 23 - General-Duty Valves for Plumbing Piping.
   2. Install stops in locations where they can be easily reached for operation.
D. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations.
   Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 22 05 18 - Escutcheons for Plumbing Piping.
E. Seal joints between sinks and counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Division 07.

3.03 ADJUSTING:
A. Operate and adjust sinks and controls. Replace damaged and malfunctioning sinks, fittings, and controls.
B. Adjust water pressure at faucets to produce proper flow.

3.04 CLEANING AND PROTECTION:
A. After completing installation of sinks, inspect and repair damaged finishes.
B. Clean sinks, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
C. Provide protective covering for installed sinks and fittings.
D. Do not allow use of sinks for temporary facilities, unless approved in writing by Owner.

END OF SECTION 22 42 16.16
SECTION 23 05 13 – COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY:
   A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.02 COORDINATION:
   A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
      1. Motor controllers.
      2. Torque, speed, and horsepower requirements of the load.
      3. Ratings and characteristics of supply circuit and required control sequence.
      4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.01 GENERAL MOTOR REQUIREMENTS:
   A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.
   B. Comply with NEMA MG 1 unless otherwise indicated.

2.02 MOTOR CHARACTERISTICS:
   A. Duty: Continuous duty at ambient temperature of 40º and at altitude of 3300 feet above sea level.
   B. 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.

2.03 POLYPHASE MOTORS:
   A. Description: NEMA MG 1, Design B, medium induction motor.
   B. Efficiency: Energy efficient, as defined in NEMA MG 1.
   C. Service Factor: 1.15.
   D. Rotor: Random-wound, squirrel cage.
   E. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
Temperature Rise: Match insulation rating.

Insulation: Class F.

Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller than 15 HP: Manufacturer’s standard starting characteristic.

Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS:

Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
2. Bearing Protection: All motors operated on variable frequency drives shall be equipped with maintenance free, 360 degree circumferential conductive micro fiber shaft grounding ring with a minimum two continuous rows of conductive micro fibers completely surrounding the motor shaft to discharge electrical shaft voltages away from the motor’s bearings to ground. Note: Friction/spring contact brushes shall not be acceptable.
3. Application Note: Motors up to 100HP shall be provided with a minimum of one shaft grounding ring as described above installed by the manufacturer internally to the motor or externally on the drive end. Motors over 100HP shall be provided with an insulated bearing on the non-drive end and a shaft grounding ring on the drive end of the motor. Grounding rings shall be provided and installed by the motor manufacturer or contractor and shall be installed in accordance with the manufacturer’s recommendations.
4. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
5. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
6. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

SINGLE-PHASE MOTORS:

Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.

4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. 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.

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION 23 05 13
SECTION 23 05 53 – IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY:
   A. This Section includes:
      1. Equipment labels.
      2. Warning signs and labels.
      3. Duct labels.
      4. Warning tags.

1.02 SUBMITTALS:
   A. Product Data: For each type of product indicated.
   B. Samples: For color, letter style, and graphic representation required for each identification
      material and device.
   C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed
      content for each label.

1.03 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 locations of access panels and doors.
   C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.01 EQUIPMENT LABELS:
   A. Plastic Labels for Equipment:
      1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving,
         1/16 inch thick, and having predrilled holes for attachment hardware.
      2. Letter Color: Black.
      4. Maximum Temperature: Able to withstand temperatures up to 160°F.
      5. Minimum Label Size: Length and width vary for required label content, but not less than
         2-1/2 by 3/4 inches.
      6. Minimum Letter Size: 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.
      7. Fasteners: Stainless-steel rivets or self-tapping screws.
      8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
   B. Label Content: Include equipment's Drawing designation or unique equipment number,
      Drawing numbers where equipment is indicated (plans, details, and schedules), plus the
      Specification Section number and title where equipment is specified.
   C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2 by 11-inch
      (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers
      where equipment is indicated (plans, details, and schedules), plus the Specification Section
      number and title where equipment is specified. Equipment schedule shall be included in
      operation and maintenance data.
2.02 WARNING SIGNS AND LABELS:
A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
B. Letter Color: Black.
C. Background Color: White.
D. Maximum Temperature: Able to withstand temperatures up to 160ºF.
E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inches.
F. Minimum Letter Size: 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.
G. Fasteners: Stainless-steel rivets or self-tapping screws.
H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.03 DUCT LABELS:
A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
B. Letter Color: Black.
C. Background Color: White.
D. Maximum Temperature: Able to withstand temperatures up to 160ºF.
E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inches.
F. Minimum Letter Size: 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.
G. Fasteners: Stainless-steel rivets or self-tapping screws.
H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.
   2. Lettering Size: At least 1-1/2 inches high.

2.04 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."
PART 3 - EXECUTION

3.01 PREPARATION:
   A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.02 EQUIPMENT LABEL INSTALLATION:
   A. Install or permanently fasten labels on each major item of mechanical equipment.
   B. Locate equipment labels where accessible and visible.

3.03 DUCT LABEL INSTALLATION:
   A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:
      1. Blue: For cold-air supply ducts.
      2. Yellow: For hot-air supply ducts.
      4. ASME A13.1 Colors and Designs: For hazardous material exhaust.
   B. Locate labels near points where ducts enter concealed spaces and at maximum intervals of 50 ft. in each space where ducts are exposed or concealed by removable ceiling system.

3.04 WARNING-TAG INSTALLATION:
   A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 23 05 53
SECTION 23 05 93 – TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.01 SUMMARY:
A. This Section includes:
   1. Balancing Air Systems:
      a. Constant-volume air systems.
   2. Other Systems/Equipment:
      a. Motors.
      b. Condensing units.
      c. Heat transfer coils.

1.02 SUBMITTALS:
A. Qualification Data: Within 15 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
D. Certified TAB reports.
E. Sample report forms.
F. Instrument calibration reports, to include the following:
   1. Instrument type and make.
   2. Serial number.
   3. Application.
   4. Dates of use.
   5. Dates of calibration.

1.03 QUALITY ASSURANCE:
A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC, NEBB or TABB.
   1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC, NEBB, or TABB.
   2. TAB Technician: Employee of the TAB contractor and who is certified by AABC, NEBB or TABB as a TAB technician.
B. TAB Conference: Meet with Engineer on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' notice of scheduled meeting time and location.
   1. Agenda Items:
      b. The TAB plan.
      c. Coordination and cooperation of trades and subcontractors.
      d. Coordination of documentation and communication flow.
C. Certify TAB field data reports and perform the following:
   1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
   2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.
D. TAB Report Forms: Use standard TAB contractor's forms approved by Engineer.
E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

F. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.
1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

1.04 PROJECT CONDITIONS:
A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.05 COORDINATION:
A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.
B. Notice: Provide seven days' notice for each test. Include scheduled test dates and times.
C. Perform TAB after leakage and pressure tests on air distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.01 EXAMINATION:
A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
C. Examine the approved submittals for HVAC systems and equipment.
D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Section 23 31 13 - Metal Ducts and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.
F. Examine Equipment performance data including fan and pump curves.
1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate system-effect factors to reduce performance ratings of HVAC Equipment when installed under conditions different from the conditions used to rate Equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
G. Examine system and equipment installations and verify that field quality control testing, cleaning, and adjusting specified in individual Sections have been performed.
H. Examine test reports specified in individual system and equipment Sections.
I. Examine HVAC Equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

L. Examine operating safety interlocks and controls on HVAC Equipment.

M. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

N. Examine automatic temperature system components to verify the following:
   1. Dampers, valves, and other controlled devices are operated by the intended controller.
   2. Dampers and valves are in the position indicated by the controller.
   3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
   4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
   5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
   6. Sensors are located to sense only the intended conditions.
   7. Sequence of operation for control modes in accordance with the Contract Documents.
   8. Controller set points are set at indicated values.
   9. Interlocked systems are operating.
   10. Changeover from heating to cooling mode occurs according to indicated values.

3.02 PREPARATION:

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system-readiness checks and prepare reports. Verify the following:
   1. Permanent electrical-power wiring is complete.
   2. Hydronic systems are filled, clean, and free of air.
   3. Automatic temperature-control systems are operational.
   4. Equipment and duct access doors are securely closed.
   5. Balance, smoke, and fire dampers are open.
   6. Isolating and balancing valves are open and control valves are operational.
   7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
   8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.03 GENERAL PROCEDURES FOR TESTING AND BALANCING:

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" and in this Section.
   1. Comply with requirements in ASHRAE 62.1, Section 7.2.2, "Air Balancing."

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
   1. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 23 33 00 - Duct Accessories.
   2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 23 07 00 - Mechanical Insulation.
C. Mark Equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.04 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS:
A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
B. Prepare schematic diagrams of systems' "as-built" duct layouts.
C. For variable-air-volume systems, develop a plan to simulate diversity.
D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
G. Verify that motor starters are equipped with properly sized thermal protection.
H. Check dampers for proper position to achieve desired airflow path.
I. Check for airflow blockages.
J. Check condensate drains for proper connections and functioning.
K. Check for proper sealing of air-handling-unit components.
L. Verify that air duct system is sealed as specified in Section 23 31 13 - Metal Ducts.

3.05 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS:
A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
   1. Measure total airflow.
      a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
   2. Measure fan static pressures as follows to determine actual static pressure:
      a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
      b. Measure static pressure directly at the fan outlet or through the flexible connection.
      c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
      d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
   3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
      a. Report the cleanliness status of filters and the time static pressures are measured.
   4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
   5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
   6. Obtain approval from Engineer for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Division 23 Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
   7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor
amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
   1. Measure airflow of submain and branch ducts.
      a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
   2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
   3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure air outlets and inlets without making adjustments.
   1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
   1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
   2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.06 PROCEDURES FOR MOTORS:
A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
   1. Manufacturer's name, model number, and serial number.
   4. Efficiency rating.
   5. Nameplate and measured voltage, each phase.
   6. Nameplate and measured amperage, each phase.
   7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.07 PROCEDURES FOR CONDENSING UNITS:
A. Verify proper rotation of fans.
B. Measure entering- and leaving-air temperatures.
C. Record compressor data.

3.08 PROCEDURES FOR HEAT-TRANSFER COILS:
A. Measure, adjust, and record the following data for each electric heating coil:
   1. Nameplate data.
   2. Airflow.
   3. Entering- and leaving-air temperature at full load.
   4. Voltage and amperage input of each phase at full load and at each incremental stage.
   5. Calculated kilowatt at full load.
   6. Fuse or circuit-breaker rating for overload protection.
B. Measure, adjust, and record the following data for each refrigerant coil:
1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

3.09 TOLERANCES:
A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
1. Supply, Return, and Exhaust Fans and Equipment with Fans: ±10%.
2. Air Outlets and Inlets: 0 to +10%.

3.10 REPORTING:
A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
B. Status Reports: Prepare weekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.11 FINAL REPORT:
A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.
B. Final Report Contents: In addition to certified field-report data, include the following:
1. Fan curves.
2. Manufacturers' test data.
3. Field test reports prepared by system and equipment installers.
4. Other information relative to equipment performance; do not include Shop Drawings and product data.
C. General Report Data: In addition to form titles and entries, include the following data:
1. Title page.
2. Name and address of the TAB contractor.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:
   a. Indicated versus final performance.
   b. Notable characteristics of systems.
c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.

13. Data for terminal units, including manufacturer's name, type, size, and fittings.

14. Notes to explain why certain final data in the body of reports vary from indicated values.

15. Test conditions for fans and pump performance forms including the following:
   a. Settings for outdoor-, return-, and exhaust-air dampers.
   b. Conditions of filters.
   c. Cooling coil, wet- and dry-bulb conditions.
   d. Face and bypass damper settings at coils.
   e. Fan drive settings including settings and percentage of maximum pitch diameter.
   f. Inlet vane settings for variable-air-volume systems.
   g. Settings for supply-air, static-pressure controller.
   h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
   1. Quantities of outdoor, supply, return, and exhaust airflows.
   2. Duct, outlet, and inlet sizes.
   3. Pipe and valve sizes and locations.
   4. Terminal units.
   5. Balancing stations.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
   1. Unit Data:
      a. Unit identification.
      b. Location.
      c. Make and type.
      d. Model number and unit size.
      e. Manufacturer's serial number.
      f. Unit arrangement and class.
      g. Discharge arrangement.
      h. Sheave make, size in inches, and bore.
      i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
      j. Number, make, and size of belts.
      k. Number, type, and size of filters.
   2. Motor Data:
      a. Motor make, and frame type and size.
      b. Horsepower and rpm.
      c. Volts, phase, and hertz.
      d. Full-load amperage and service factor.
      e. Sheave make, size in inches, and bore.
      f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
   3. Test Data (Indicated and Actual Values):
      a. Total air flow rate in cfm.
      b. Total system static pressure in inches w.g.
      c. Fan rpm.
      d. Discharge static pressure in inches w.g.
      e. Filter static-pressure differential in inches w.g.
      f. Preheat-coil static-pressure differential in inches w.g.
      g. Cooling-coil static-pressure differential in inches w.g.
      h. Heating-coil static-pressure differential in inches w.g.
      i. Outdoor airflow in cfm.
j. Return airflow in cfm.
k. Outdoor-air damper position.
l. Return-air damper position.
m. Vortex damper position.

F. Apparatus-Coil Test Reports:
   1. Coil Data:
      a. System identification.
      b. Location.
      c. Coil type.
      d. Number of rows.
      e. Fin spacing in fins per inch o.c.
      f. Make and model number.
      g. Face area in ft.².
      h. Tube size in NPS.
      i. Tube and fin materials.
      j. Circuiting arrangement.
   2. Test Data (Indicated and Actual Values):
      a. Air flow rate in cfm.
      b. Average face velocity in fpm.
      c. Air pressure drop in inches w.g.
      d. Outdoor-air, wet- and dry-bulb temperatures in ºF.
      e. Return-air, wet- and dry-bulb temperatures in ºF.
      f. Entering-air, wet- and dry-bulb temperatures in ºF.
      g. Leaving-air, wet- and dry-bulb temperatures in ºF.
      h. Refrigerant expansion valve and refrigerant types.
      i. Refrigerant suction pressure in psig.
      j. Refrigerant suction temperature in ºF.

G. Electric-Coil Test Reports: For electric coils installed in central-station air-handling units, include the following:
   1. Unit Data:
      a. System identification.
      b. Location.
      c. Coil identification.
      d. Capacity in Btu/hr.
      e. Number of stages.
      f. Connected volts, phase, and hertz.
      g. Rated amperage.
      h. Air flow rate in cfm.
      i. Face area in ft.²
      j. Minimum face velocity in fpm.
   2. Test Data (Indicated and Actual Values):
      a. Heat output in Btu/hr.
      b. Air flow rate in cfm.
      c. Air velocity in fpm.
      d. Entering-air temperature in ºF.
      e. Leaving-air temperature in ºF.
      f. Voltage at each connection.
      g. Amperage for each phase.

H. Fan Test Reports: For supply, return, and exhaust fans, include the following:
   1. Fan Data:
      a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches, and bore.
h. Center-to-center dimensions of sheave, and amount of adjustments in inches.

2. Motor Data:
   a. Motor make, and frame type and size.
   b. Horsepower and rpm.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Sheave make, size in inches, and bore.
   f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
   g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm.
   b. Total system static pressure in inches w.g.
   c. Fan rpm.
   d. Discharge static pressure in inches w.g.
   e. Suction static pressure in inches w.g.

I. Round and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
   1. Report Data:
      a. System and air-handling-unit number.
      b. Location and zone.
      c. Traverse air temperature in °F.
      d. Duct static pressure in inches w.g.
      e. Duct size in inches.
      f. Duct area in ft.²
      g. Indicated air flow rate in cfm.
      h. Indicated velocity in fpm.
      i. Actual air flow rate in cfm.
      j. Actual average velocity in fpm.
      k. Barometric pressure in psig.

J. Air-Terminal-Device Reports:
   1. Unit Data:
      a. System and air-handling unit identification.
      b. Location and zone.
      c. Apparatus used for test.
      d. Area served.
      e. Make.
      f. Number from system diagram.
      g. Type and model number.
      h. Size.
      i. Effective area in ft.²
   2. Test Data (Indicated and Actual Values):
      a. Air flow rate in cfm.
      b. Air velocity in fpm.
      c. Preliminary air flow rate as needed in cfm.
      d. Preliminary velocity as needed in fpm.
e. Final air flow rate in cfm.
f. Final velocity in fpm.
g. Space temperature in °F.

K. Compressor and Condenser Reports: For refrigerant side of unitary systems, stand-alone refrigerant compressors, air-cooled condensing units, or water-cooled condensing units, include the following:
1. Unit Data:
   a. Unit identification.
   b. Location.
   c. Unit make and model number.
   d. Compressor make.
   e. Compressor model and serial numbers.
   f. Refrigerant weight in lb.
   g. Low ambient temperature cutoff in °F.
2. Test Data (Indicated and Actual Values):
   a. Inlet-duct static pressure in inches w.g.
   b. Outlet-duct static pressure in inches w.g.
   c. Entering-air, dry-bulb temperature in °F.
   d. Leaving-air, dry-bulb temperature in °F.
   e. Control settings.
   f. Unloader set points.
   g. Low-pressure-cutout set point in psig.
   h. High-pressure-cutout set point in psig.
   i. Suction pressure in psig.
   j. Suction temperature in °F.
   k. Condenser refrigerant pressure in psig.
   l. Condenser refrigerant temperature in °F.
   m. Oil pressure in psig.
   n. Oil temperature in °F.
   o. Voltage at each connection.
   p. Amperage for each phase.
   q. Kilowatt input.
   r. Crankcase heater kilowatt.
   s. Number of fans.
   t. Condenser fan rpm.
   u. Condenser fan airflow rate in cfm.
   v. Condenser fan motor make, frame size, rpm, and horsepower.
   w. Condenser fan motor voltage at each connection.
   x. Condenser fan motor amperage for each phase.

L. Instrument Calibration Reports:
1. Report Data:
   a. Instrument type and make.
   b. Serial number.
   c. Application.
   d. Dates of use.
   e. Dates of calibration.

3.12 INSPECTIONS:
A. Initial Inspection:
1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
2. Check the following for each system:
   a. Measure airflow of at least 10% of air outlets.
   b. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
   c. Verify that balancing devices are marked with final balance position.
   d. Note deviations from the Contract Documents in the final report.

B. Final Inspection:
1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Engineer.
2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Engineer.
3. Engineer shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10% of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10% of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. TAB work will be considered defective if it does not pass final inspections. If TAB work fails, proceed as follows:
1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

3.13 ADDITIONAL TESTS:
A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 23 05 93
SECTION 23 07 13 – DUCT INSULATION

PART 1 - GENERAL

1.01 SUMMARY:
A. This Section includes requirements for insulating sheet metal ductwork.

1.02 SUBMITTALS:
A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and field-applied jackets (if any).
B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
   3. Detail application of field-applied jackets.
   4. Detail application at linkages of control devices.
C. Qualification Data: For qualified Installer.
D. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
E. Field quality-control reports.

1.03 QUALITY ASSURANCE:
A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing 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.

1.04 DELIVERY, STORAGE, AND HANDLING:
A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.05 COORDINATION:
A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 23 05 29 - Hangers and Supports for HVAC Equipment.
B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
1.06 **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**

2.01 **INSULATION MATERIALS:**
   A. Comply with requirements in "Duct Insulation Schedule, General," and "Aboveground Indoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.
   B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
   C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.
   D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.
   E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
   F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534, Type II for sheet materials.
      1. Products: Subject to compliance with requirements, provide products by one of the following:
         a. AeroFlex USA, Inc.; Aerocel.
         b. Armacell, LLC; AP Armaflex.
         c. K-Flex USA; Insul-Sheet, K-Flex Gray Duct Liner, and K-FLEX LS.
   G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C553, Type II and ASTM C1290, Type I.
      1. Products: Subject to compliance with requirements, provide products by one of the following:
         a. CertainTeed Corp.; SoftTouch Duct Wrap.
         b. Johns Manville; Microlite.
         c. Knauf Insulation; Friendly Feel Duct Wrap.
         d. Owens Corning; SOFTR All-Service Duct Wrap.
   H. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C612, Type IA or Type IB. For duct and plenum applications, provide insulation with FSK or ASJ factory-applied jacket.
      1. Products: Subject to compliance with requirements, provide products by one of the following:
         a. CertainTeed Corp.; Commercial Board.
         b. Fibrex Insulations, Inc.; FBX.
         c. Johns Manville; 800 Series Spin-Glas.
         d. Knauf Insulation; Insulation Board.
         e. Owens Corning; Fiberglas 700 Series.

2.02 **ADHESIVES:**
   A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself 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 products by one of the following:
a. Aeroflex USA, Inc.; Aeroseal.
b. Armacell, LLC; Armaflex 520 Adhesive.
d. K-Flex USA; R-373 Contact Adhesive.

C. Mineral-Fiber Board or Blanket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
1. Products: Subject to compliance with requirements, provide products by one of the following:
   b. Eagle Bridges - Marathon Industries; 225.
   d. Mon-Eco Industries, Inc.; 22-25.

1. Products: Subject to compliance with requirements, provide products by one of the following:
   b. Eagle Bridges - Marathon Industries; 225.
   d. Mon-Eco Industries, Inc.; 22-25.

2.03 MASTICS:
A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
   1. Products: Subject to compliance with requirements, provide products by one of the following:
      b. Vimasco Corporation; 749.
   2. Water-Vapor Permeance: ASTM E96/E96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
   3. Service Temperature Range: -20 to +180°F.
   4. Solids Content: ASTM D1644, 58% by volume and 70% by weight.

2.04 SEALANTS:
A. FSK and Metal Jacket Flashing Sealants:
   1. Products: Subject to compliance with requirements, provide products by one of the following:
      b. Eagle Bridges - Marathon Industries; 405.
      c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
      d. Mon-Eco Industries, Inc.; 44-05.
   2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: -40 to +250°F.
5. Color: Aluminum.

2.05 FACTORY-APPLIED JACKETS:
A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with Kraft-paper backing; complying with ASTM C1136, Type II.

2.06 TAPES:
A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.
   1. Products: Subject to compliance with requirements, provide products by one of the following:
      a. ABI, Ideal Tape Division; 491 AWF FSK.
      b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
      c. Compac Corporation; 110 and 111.
      d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
   2. Width: 3 inches.
   3. Thickness: 6.5 mils.
   5. Elongation: 2%.
   6. Tensile Strength: 40 lb/in in width.
   7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
B. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
   1. Products: Subject to compliance with requirements, provide products by one of the following:
      a. ABI, Ideal Tape Division; 488 AWF.
      b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
      c. Compac Corporation; 120.
      d. Venture Tape; 3520 CW.
   2. Width: 2 inches.
   3. Thickness: 3.7 mils.
   5. Elongation: 5%.
   6. Tensile Strength: 34 lb/in in width.

2.07 SECUREMENTS:
A. Bands:
   1. Products: Subject to compliance with requirements, provide products by one of the following:
      a. ITW Insulation Systems; Gerrard Strapping and Seals.
      b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
   2. Stainless Steel: ASTM A167 or ASTM A240, Type 304; 0.015 inch thick, 1/2 inch wide with wing seal or closed seal.
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 products by one of the following:
   (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, 0.135-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 products by one of the following:
      (1) AGM Industries, Inc.; CHP-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 products by one of the following:
      (1) AGM Industries, Inc.; Tactoo Perforated Base Insul-Hangers.
      (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.

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: Subject to compliance with requirements, provide products by the following:

2.08 CORNER ANGLES:
   A. Aluminum Corner Angles: 0.040 inch thick, minimum 1- by 1-inch aluminum according to ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

PART 3 - EXECUTION

3.01 EXAMINATION:
   A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
      1. Verify that systems to be insulated have been tested and are free of defects.
      2. Verify that surfaces to be insulated are clean and dry.
   B. Proceed with installation only after unsatisfactory conditions have been corrected.
3.02 PREPARATION:
A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.03 GENERAL INSTALLATION REQUIREMENTS:
A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct 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 top and bottom of horizontal runs.
E. Install multiple layers of insulation with longitudinal and end seams staggered.
F. Keep insulation materials dry during application and finishing.
G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
H. Install insulation with least number of joints practical.
I. Where vapor barrier is indicated, 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 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.
J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
K. Cut insulation in a manner to avoid compressing insulation more than 75% of its nominal thickness.
L. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
M. 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.

3.04 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 Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
C. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in DIVISION 07.

3.05 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION:
A. Seal longitudinal seams and end joints with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.06 INSTALLATION OF MINERAL-FIBER INSULATION:
A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
   1. Apply adhesives according to manufacturer's recommended coverage rates per unit area.
   2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
   3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
      a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
      b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
      c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
      d. Do not overcompress insulation during installation.
      e. Impale insulation over pins and attach speed washers.
      f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
   4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1-inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
      a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
      b. Install vapor stops for ductwork and plenums operating below 50°F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
   5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
   6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
   7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6-inches o.c.
B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
   1. Apply adhesives according to manufacturer's recommended coverage rates per unit area.
   2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
   3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
      a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16-inches o.c.
      b. On duct sides with dimensions larger than 18 inches, space pins 16-inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
      c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
      d. Do not overcompress insulation during installation.
      e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
   4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1-inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
      a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
      b. Install vapor stops for ductwork and plenums operating below 50°F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
   5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
   6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6-inches o.c.

3.07 FINISHES:
   A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

3.08 DUCT INSULATION SCHEDULE, GENERAL:
   A. Plenums and Ducts Requiring Insulation:
      1. Indoor, supply and return ductwork serving RTUs.
   B. Items Not Insulated:
      1. Metal ducts with duct liner are only allowed where indicated for sound attenuation. (ex: return air grille boots in ceiling plenum and transfer air ducts)
      2. Factory-insulated flexible ducts.
      3. Flexible connectors.
5. Factory-insulated access panels and doors.

3.09 **ABOVEGROUND INDOOR DUCT AND PLENUM INSULATION SCHEDULE:**
   A. Indoor supply, return, and outside air duct insulation shall be one of the following:
      1. Flexible Elastomeric: 1 inch thick.
      2. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb./cu. ft. nominal density.

END OF SECTION 23 07 13
SECTION 23 31 13 – METAL DUCTS

PART 1 - GENERAL

1.01 SUMMARY:
   A. This Section includes:
      1. Single-wall rectangular ducts and fittings.
      2. Single-wall round and fittings.
      4. Sealants and gaskets.
      5. Hangers and supports.

1.02 RELATED REQUIREMENTS:
   A. Section 23 05 93 - Testing, Adjusting and Balancing for HVAC for testing, adjusting, and balancing requirements for metal ducts.
   B. Section 23 33 00 - Air Duct Accessories for dampers, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.03 PERFORMANCE/DESIGN CRITERIA:
   A. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.04 SUBMITTALS:
   A. Product Data: For each type of the following products:
      1. Liners and adhesives.
      2. Sealants and gaskets.
   B. Shop Drawings:
      1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
      2. Factory- and shop-fabricated ducts and fittings.
      3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
      4. Elevation of top of ducts.
      5. Dimensions of main duct runs from building grid lines.
      6. Fittings.
      7. Reinforcement and spacing.
      8. Seam and joint construction.
      9. Penetrations through fire-rated and other partitions.
     10. Equipment installation based on equipment being used on Project.
     11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
     12. Hangers and supports, including methods for duct and building and vibration isolation.
   C. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
      1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
      2. Suspended ceiling components.
      3. Structural members to which duct will be attached.
      4. Size and location of initial access modules for acoustical tile.
      5. Penetrations of smoke barriers and fire-rated construction.
      6. Items penetrating finished ceiling including the following:
a. Lighting fixtures.
b. Air outlets and inlets.
c. Speakers.
d. Sprinklers.
e. Access panels.
f. Perimeter moldings.

D. Welding Procedure Specification (WPS) and Welder Performance Qualification Record (WPQR)
E. Field quality-control reports.

1.05 QUALITY ASSURANCE:
A. Welding Qualifications: Qualify welding procedures, welders, and welding operators according to the following:

PART 2 - PRODUCTS

2.01 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS:
A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class, unless otherwise indicated.
B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.02 SINGLE-WALL ROUND AND FITTINGS:
A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class, unless otherwise indicated.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Lindab, Inc.
   b. McGill AirFlow, LLC.
   c. SEMCO Incorporated.
   d. Sheet Metal Connectors, Inc.
   e. Spiral Manufacturing Co., Inc.
B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   1. Transverse Joints in Ducts Larger than 60 inches in Diameter: Flanged.

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.

D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.03 SHEET METAL MATERIALS:
A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A653.
   1. Galvanized Coating Designation: G60 (Z180).
   2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Reinforcement Shapes and Plates: ASTM A36, steel plates, shapes, and bars; black and galvanized.
   1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.04 SEALANT AND GASKETS:
A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Water-Based Joint and Seam Sealant:
   1. Application Method: Brush on.
   2. Solids Content: Minimum 65%.
   5. Mold and mildew resistant.
   6. VOC: Maximum 75 g/L (less water).
   7. Maximum Static-Pressure Class: 10-inch w.g., positive and negative.
   8. Service: Indoor or outdoor.
   9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

C. Flanged Joint Sealant: Comply with ASTM C920.
2. Type:  S.
3. Grade:  NS.
5. Use:  O.

D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
E. Round Duct Joint O-Ring Seals:
   1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch w.g. and shall be
      rated for 10-inch w.g. static-pressure class, positive or negative.
   2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
   3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings
      and fitting spigots.

2.05 HANGERS AND SUPPORTS:
A. Hanger Rods for Noncorrosive Environments: Zinc-plated steel rods and nuts.
B. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal
   and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2,
   "Minimum Hanger Sizes for Round Duct."
C. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A603.
D. Zinc-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service;
   with an automatic-locking and clamping device.
E. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible
   with duct materials.
F. Trapeze and Riser Supports:

PART 3 - EXECUTION

3.01 DUCT INSTALLATION:
A. Coordinate duct layout and duct accessory arrangement with Drawings. Drawing plans,
schematics, and diagrams indicate general location and arrangement of duct system. Indicated
duct locations, configurations, and arrangements were used to size ducts and calculate friction
loss for air-handling equipment sizing and for other design considerations. Install duct systems
as indicated, unless deviations to layout are approved on Shop Drawings and Coordination
Drawings.
B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and
   Flexible," unless otherwise indicated.
C. Install round ducts in maximum practical lengths.
D. Install ducts with fewest possible joints.
E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for
   branch connections.
F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and
   perpendicular to building lines.
G. Install ducts close to walls, overhead construction, columns, and other structural and permanent
   enclosure elements of building.
H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and
   enclosures.
J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed
to view, cover the opening between the partition and duct or duct insulation with sheet metal
flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2
   inches.
K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 23 33 00 - Air Duct Accessories for fire and smoke dampers.


3.02 INSTALLATION OF EXPOSED DUCTWORK:
A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.03 DUCT SEALING:
A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

3.04 HANGER AND SUPPORT INSTALLATION:
A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
   1. Where practical, install concrete inserts before placing concrete.
   2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
   3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick. These fasteners shall not be used to support ductwork larger than 24 inches square.
   4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
D. Hangers Exposed to View: Threaded rod and angle or channel supports.
E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.05 FIELD QUALITY CONTROL:
A. Perform tests and inspections.
B. Duct system will be considered defective if it does not pass tests and inspections.
C. Prepare test and inspection reports.

3.06 START UP:
A. Air Balance: Comply with requirements in Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC.

3.07 DUCT SCHEDULE:
A. Fabricate ducts with galvanized sheet steel, except as otherwise indicated, and as follows:
B. Supply Ducts:
   1. Ducts Connected to Air-Handling Units:
      a. Pressure Class: Positive w.g. 3-inch w.g..
      b. Minimum SMACNA Seal Class: A.
      c. SMACNA Leakage Class for Rectangular: 6.
      d. SMACNA Leakage Class for Round and Flat Oval: 6.
C. Return Ducts:
   1. Ducts Connected to Air-Handling Units:
      a. Pressure Class: Positive or negative 2-inch w.g.
      b. Minimum SMACNA Seal Class: A.
      c. SMACNA Leakage Class for Rectangular: 6.
      d. SMACNA Leakage Class for Round and Flat Oval: 6.
D. Exhaust Ducts:
   1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
      a. Pressure Class: Negative 1-inch w.g.
      b. Minimum SMACNA Seal Class: B if negative pressure, and A if positive pressure.
      c. SMACNA Leakage Class for Rectangular: 12.
      d. SMACNA Leakage Class for Round and Flat Oval: 6.
E. Intermediate Reinforcement:
   1. Galvanized-Steel Ducts: Galvanized steel or carbon steel coated with zinc-chromate primer.
F. Elbow Configuration:
   1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
      a. Velocity 1,000 fpm or Lower:
         Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
         Mitered Type RE 4 without vanes.
      b. Velocity 1,000 to 1,500 fpm:
         Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
         Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
         Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
      c. Velocity 1,500 fpm or Higher:
         Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
         Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
         Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
   2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
      a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
      b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
   a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
      Velocity 1,000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
      Velocity 1,000 to 1,500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
      Velocity 1,500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
      Radius-to-Diameter Ratio: 1.5.
   b. Round Elbows, 12 inches and Smaller in Diameter: Stamped or pleated.
   c. Round Elbows, 14 inches and Larger in Diameter: Standing seam.

G. Branch Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
   a. Rectangular Main to Rectangular Branch: 45-degree entry.
   b. Rectangular Main to Round Branch: Spin in.
2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90-Degree Tees and Laterals," and Figure 3-6, "Conical Tees."
   Saddles taps are permitted in existing duct.
   a. Velocity 1,000 fpm or Lower: 90-degree tap.
   b. Velocity 1,000 to 1,500 fpm: Conical tap.
   c. Velocity 1,500 fpm or Higher: 45-degree lateral.

END OF SECTION 23 31 13
SECTION 23 33 00 – AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY:
A. This Section includes:
   2. Flange connectors.
   3. Turning vanes.
   4. Duct-mounted access doors.
   5. Flexible connectors.
   6. Flexible ducts.
   7. Duct accessory hardware.

1.02 RELATED DOCUMENTS:
A. DIVISION 28 for duct-mounted fire and smoke detectors.

1.03 SUBMITTALS:
A. Product Data: For each type of product.
   1. For duct silencers, include pressure drop and dynamic insertion loss data. Include
   breakout noise calculations for high transmission loss casings.
B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and
   attachments to other work.
   1. Detail duct accessories fabrication and installation in ducts and other construction.
   Include dimensions, weights, loads, and required clearances; and method of field
   assembly into duct systems and other construction. Include the following:
      a. Special fittings.
      c. Control-damper installations.
      d. Fire-damper installations, including sleeves; and duct-mounted access doors and
         remote damper operators.
      e. Wiring Diagrams: For power, signal, and control wiring.
C. Source quality-control reports.
D. Operation and Maintenance Data: For air duct accessories to include in operation and
   maintenance manuals.

PART 2 - PRODUCTS

2.01 ASSEMBLY DESCRIPTION:
A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems".
B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for
   acceptable materials, material thicknesses, and duct construction methods unless otherwise
   indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains,
   discolorations, and other imperfections.

2.02 MATERIALS:
A. Galvanized Sheet Steel: Comply with ASTM A653.
   1. Galvanized Coating Designation: G60 (Z180).
   2. Exposed-Surface Finish: Mill phosphatized.
B. Extruded Aluminum: Comply with ASTM B221, Alloy 6063, Temper T6.
C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.03 MANUAL VOLUME DAMPERS:
A. Standard, Steel, Manual Volume Dampers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Warming and Ventilating; a division of Mestek, Inc.
      b. McGill AirFlow, LLC.
      c. Nailor Industries, Inc.
      d. Pottoff.
      e. Ruskin Company.
   2. Standard leakage rating, with linkage outside airstream.
   3. Suitable for horizontal or vertical applications.
   4. Frames:
      a. Frame: Hat-shaped, 0.094 inch.
      b. Mitered and welded corners.
      c. Flanges for attaching to walls and flangeless frames for installing in ducts.
   5. Blades:
      a. Multiple or single blade.
      b. Parallel- or opposed-blade design.
      c. Stiffen damper blades for stability.
      d. Galvanized-steel, 0.064 inch thick.
   7. Bearings:
      a. Molded synthetic.
      b. Dampers in ducts with pressure classes of 3-inch w.g. or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
   8. Tie Bars and Brackets: Galvanized steel.

2.04 FLANGE CONNECTORS:
1. Ductmate Industries, Inc.
2. Nexus PDQ; Division of Shilco Holdings, Inc.
B. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
C. Material: Galvanized steel.
D. Gage and Shape: Match connecting ductwork.

2.05 TURNING VANES:
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ductmate Industries, Inc.
2. Duro Dyne, Inc.
3. Elgen Manufacturing.
4. METALAIRE, Inc.
5. SEMCO, Incorporated.
B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."
D. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.06 DUCT-MOUNTED ACCESS DOORS:
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. American Warming and Ventilating; a division of Mestek, Inc.
   2. Ductmate Industries, Inc.
   4. McGill AirFlow, LLC.
   5. Nailor Industries, Inc.
   6. Pottorff.
   1. Door:
      a. Double wall, rectangular.
      b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
      c. Vision panel.
      d. Hinges and Latches: 1- by 1-inch butt or piano hinge and cam latches.
      e. Fabricate doors airtight and suitable for duct pressure class.
   2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
   3. Number of Hinges and Locks:
      a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
      b. Access Doors up to 18 Inches Square: Continuous and two sash locks.
      c. Access Doors up to 24 by 48 Inches: Continuous and two compression latches with outside and inside handles.

2.07 FLEXIBLE CONNECTORS:
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ductmate Industries, Inc.
   2. Duro Dyne, Inc.
   3. Elgen Manufacturing.
   4. Ventfabrics, Inc.
B. Materials: Flame-retardant or noncombustible fabrics.
C. Coatings and Adhesives: Comply with UL 181, Class 1.
D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4 inches wide, 0.028 inch thick, galvanized sheet steel or 0.032 inch thick aluminum sheets. Provide metal compatible with connected ducts.

2.08 FLEXIBLE DUCTS:
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Flexmaster U.S.A., Inc.
   2. McGill AirFlow, LLC.

B. Noninsulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire.
   1. Pressure Rating: 4-inch w.g. positive and 0.5-inch w.g. negative.
   2. Maximum Air Velocity: 4,000 fpm.
   3. Temperature Range: -20 to +175ºF.

C. Flexible Duct Connectors:
   1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.

2.09 DUCT ACCESSORY HARDWARE:
   1. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
   2. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.01 EXAMINATION:
   A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts.
   B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel.
   C. Install control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
   D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
      1. Install steel volume dampers in steel ducts.
   E. Set dampers to fully open position before testing, adjusting, and balancing.
   F. Install test holes at fan inlets and outlets and elsewhere as indicated.
   G. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
      1. On both sides of duct coils.
      2. Upstream from duct filters.
      3. At outdoor-air intakes and mixed-air plenums.
      4. At drain pans and seals.
      5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
      6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
      7. Control devices requiring inspection.
      8. Elsewhere as indicated.
   H. Install access doors with swing against duct static pressure.
I. Access Door Sizes:
   1. One-Hand or Inspection Access: 8 by 5 inches.
   2. Two-Hand Access: 12 by 6 inches.

J. Label access doors according to Section 230553 - Identification for HVAC Equipment to indicate the purpose of access door.

K. Install flexible connectors to connect ducts to equipment.

L. Connect diffusers or light troffer boots to ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.

M. Connect flexible ducts to metal ducts with adhesive.

N. Install duct test holes where required for testing and balancing purposes.

O. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.02 FIELD QUALITY CONTROL:

A. Tests and Inspections:
   1. Operate dampers to verify full range of movement.
   2. Inspect locations of access doors and verify that purpose of access door can be performed.
   3. Inspect turning vanes for proper and secure installation.
   4. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 23 33 00
SECTION 23 34 23 – HVAC POWER VENTILATORS

PART 1 - GENERAL

1.01 SUMMARY:
   A. This Section includes:
      1. Centrifugal roof ventilators.

1.02 PERFORMANCE REQUIREMENTS:
   A. Operating Limits: Classify per AMCA 99.

1.03 SUBMITTALS:
   A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also, include the following:
      1. Certified fan performance curves with system operating conditions indicated.
      2. Certified fan sound-power ratings.
      3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
      4. Material thickness and finishes, including color charts.
      5. Dampers, including housings, linkages, and operators.
      6. Roof curbs.
      7. Fan speed controllers.
   B. Field quality-control reports.
   C. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.04 QUALITY ASSURANCE:
   A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.
   C. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

1.05 COORDINATION:
   A. Coordinate size and location of structural-steel support members.
   B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.01 CENTRIFUGAL ROOF VENTILATORS:
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. Aerovent; a division of Twin City Fan Companies, Ltd.
      2. Greenheck Fan Corporation.
      4. Loren Cook Company.
      5. PennBarry.
   B. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.
1. **Upblast Units:** Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.

2. **Hinged Subbase:** Galvanized-steel hinged arrangement permitting service and maintenance.

C. **Fan Wheels:** Aluminum hub and wheel with backward-inclined blades.

D. **Accessories:**
   1. **Disconnect Switch:** Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
   2. **Bird Screens:** Removable, 1/2-inch mesh, aluminum or brass wire.
   3. **Dampers:** Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
   4. **Motorized Dampers:** Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.

E. **Roof Curbs:** Galvanized steel; mitered and welded corners; 1-1/2-inch thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.
   1. **Configuration:** Self-flashing without a cant strip, with mounting flange.
   2. **Overall Height:** 12 inches.
   3. **Pitch Mounting:** Manufacture curb for roof slope.

### 2.02 MOTORS:

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 23 05 13 - Common Motor Requirements for HVAC Equipment.

   1. **Motor Sizes:** Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   2. **Controllers, Electrical Devices, and Wiring:** Comply with requirements for electrical devices and connections specified in Division 26 Sections.

B. **Enclosure Type:** Totally enclosed, fan cooled.

### 2.03 SOURCE QUALITY CONTROL:

A. Certify sound-power level ratings per AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans per AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests per AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

### PART 3 - EXECUTION

#### 3.01 INSTALLATION:

A. Install power ventilators level and plumb.

B. Secure roof-mounted fans to roof curbs with cadmium-plated hardware. See Division 07 for installation of roof curbs.

C. Install units with clearances for service and maintenance.

D. Label units according to requirements specified in Section 23 05 53 - Identification for HVAC Piping and Equipment.

#### 3.02 FIELD QUALITY CONTROL:

A. Perform tests and inspections.
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.

B. Tests and Inspections:
   1. Verify that shipping, blocking, and bracing are removed.
   2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
   3. Verify that cleaning and adjusting are complete.
   4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
   5. Adjust belt tension.
   6. Adjust damper linkages for proper damper operation.
   7. Verify lubrication for bearings and other moving parts.
   8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
   9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
  10. Shut unit down and reconnect automatic temperature-control operators.
  11. Remove and replace malfunctioning units and retest as specified above.

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Prepare test and inspection reports.

3.03 ADJUSTING:
   A. Adjust damper linkages for proper damper operation.
   B. Adjust belt tension.
   C. Comply with requirements in Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC for testing, adjusting, and balancing procedures.
   D. Replace fan and motor pulleys as required to achieve design airflow.
   E. Lubricate bearings.

END OF SECTION 23 34 23
SECTION 23 37 13 – DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.01 SUMMARY:
   A. This Section includes:
      1. Rectangular and square ceiling diffusers.
      2. Linear slot diffusers.
      3. Adjustable bar registers and grilles.
      4. Fixed face registers and grilles.

1.02 RELATED REQUIREMENTS:
   A. DIVISION 08 for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
   B. Section 23 33 00 - Air Duct Accessories for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.03 SUBMITTALS:
   A. Action Submittals:
      1. Product Data: For each type of product indicated, include the following:
         a. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
         b. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.
   B. Informational Submittals:
      1. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
         a. Ceiling suspension assembly members.
         b. Method of attaching hangers to building structure.
         c. Size and location of initial access modules for acoustical tile.
         d. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
         e. Duct access panels.
      2. Source quality-control reports.

PART 2 - PRODUCTS

2.01 DIFFUSERS, REGISTERS, AND GRILLES:
   A. For all diffusers, registers, and grilles:
      1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         a. Krueger.
         b. Nailor Industries, Inc.
         c. Price Industries.
         d. Titus.
      2. All products shall conform to the schedules.

2.02 SOURCE QUALITY CONTROL:
   A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."
PART 3 - EXECUTION

3.01 EXAMINATION:
   A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
   B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:
   A. Install diffusers, registers, and grilles level and plumb.
   B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
   C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.
   D. Coordinate diffusers, registers, and grille color/finish with Architectural finish schedules, and provide color/finish for review during equipment submittal process.

3.03 ADJUSTING:
   A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 37 13
SECTION 23 74 13 - PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.01 SUMMARY:
   A. This Section includes packaged, outdoor, central-station air-handling units (rooftop units) with the following components and accessories:
      1. Direct-expansion cooling.
      2. Electric-heating coils.
      3. Economizer outdoor- and return-air damper section.
      4. Integral, space temperature controls.
      5. Roof curbs.

1.02 DEFINITIONS:
   A. DDC: Direct-digital controls.
   B. ECM: Electrically commutated motor.
   C. Outdoor-Air Refrigerant Coil: Refrigerant coil in the outdoor-air stream to reject heat during cooling operations and to absorb heat during heating operations. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.
   D. Outdoor-Air Refrigerant-Coil Fan: The outdoor-air refrigerant-coil fan in RTUs. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.
   E. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.
   F. Supply-Air Fan: The fan providing supply air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.
   G. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

1.03 ACTION SUBMITTALS:
   A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
   B. 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.

1.04 INFORMATIONAL SUBMITTALS:
   A. Coordination Drawings: Plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
      1. Structural members to which RTUs will be attached.
      2. Roof openings
      3. Roof curbs and flashing.
   B. Field quality-control test reports.

1.05 CLOSEOUT SUBMITTALS:
A. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.

1.06 QUALITY ASSURANCE:
A. ARI Compliance:
1. Comply with ARI 210/240 and ARI 340/360 for testing and rating energy efficiencies for RTUs.
2. Comply with ARI 270 for testing and rating sound performance for RTUs.
B. ASHRAE Compliance:
1. Comply with ASHRAE 15 for refrigeration system safety.
2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
3. Comply with applicable requirements in ASHRAE 62.1, Section 5, "Systems and Equipment" and Section 7, "Construction and Startup."
C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6, "Heating, Ventilating, and Air-Conditioning."
D. NFPA Compliance: Comply with NFPA 90A.
E. 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.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Carrier Corporation.
2. Lennox Industries, Inc.
4. Trane; American Standard Companies, Inc.
5. YORK International Corporation.

2.02 CASING:
A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.
B. Exterior Casing Material: Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.
1. Exterior Casing Thickness: 0.052 inch thick.
C. Inner Casing Fabrication Requirements:
1. Inside Casing: Galvanized steel, 0.034 inch thick.
D. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
1. Materials: ASTM C1071, Type I.
2. Thickness: 1 inch.
3. Liner materials shall have air-stream surface coated with an erosion- and temperature-resistant coating or faced with a plain or coated fibrous mat or fabric.
4. Liner Adhesive: Comply with ASTM C916, Type I.
E. Condensate Drain Pans: Formed sections of stainless-steel sheet, a minimum of 2 inches deep, and complying with ASHRAE 62.1.
1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
2. Drain Connections: Threaded nipple.
3. Pan-Top Surface Coating: Corrosion-resistant compound.

F. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2.03 FANS:
A. Direct-Driven Supply-Air Fans: Double width, forward curved, centrifugal; with permanently lubricated, ECM motor, resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.
B. Condenser-Coil Fan: Propeller, mounted on shaft of permanently lubricated ECM motor.
C. Powered Exhaust Fan: Propeller, shaft mounted on permanently lubricated motor.
D. Fan Motor: Comply with requirements in SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT.

2.04 COILS:
A. Supply-Air Refrigerant Coil:
1. Aluminum-plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
2. Coil Split: Interlaced.
3. Baked phenolic coating.
B. Electric-Resistance Heating:
1. Open Heating Elements: Resistance wire of 80% nickel and 20% chromium, supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.
2. Overtemperature Protection: Disk-type, automatically reset, thermal-cutout, safety device; serviceable through terminal box.
3. Overcurrent Protection: Manual-reset thermal cutouts, factory wired in each heater stage.
4. Control Panel: Unit mounted with disconnecting means and overcurrent protection. Include the following controls:
   a. Magnetic contactors.
   b. Step Controller: Pilot lights and override toggle switch for each step.
   c. Time-delay relay.
   d. Airflow proving switch.

2.05 REFRIGERANT CIRCUIT COMPONENTS:
A. Number of Refrigerant Circuits: Two.
B. Compressor: Hermetic, scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief.
C. Refrigeration Specialties:
1. Refrigerant: R-410A.
2. Expansion valve with replaceable thermostatic element.
3. Refrigerant filter/dryer.
5. Automatic-reset low-pressure safety switch.
8. Brass service valves installed in compressor suction and liquid lines.
9. Low-ambient kit high-pressure sensor.
2.06 **AIR FILTRATION:**
   A. Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

2.07 **DAMPERS:**
   A. Outdoor- and Return-Air Mixing Dampers: Parallel- or opposed-blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.
   1. Damper Motor: Modulating with adjustable minimum position.
   2. Relief-Air Damper: Motorized, as required by ASHRAE/IESNA 90.1, with bird screen and hood.

2.08 **ELECTRICAL POWER CONNECTION:**
   A. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

2.09 ** CONTROLS:**
   A. Basic Unit Controls:
      1. Control-voltage transformer.
      2. Wall-mounted thermostat or sensor with the following features:
         b. Fan on-auto switch.
         c. Fan-speed switch.
         e. Adjustable deadband.
         f. Concealed set point.
         g. Concealed indication.
         h. Deg F indication.
         i. Unoccupied-period-override push button.
         j. Data entry and access port to input temperature set points, occupied and unoccupied periods, and output room temperature, supply-air temperature, operating mode, and status.
      3. Remote Wall-Mounted Annunciator Panel for Each Unit:
         a. Lights to indicate power on, cooling, heating, fan running, filter dirty, and unit alarm or failure.
         b. DDC controller or programmable timer and interface with HVAC instrumentation and control system.
         c. Digital display of outdoor-air temperature, supply-air temperature, return-air temperature, economizer damper position, indoor-air quality, and control parameters.
   B. Electronic Controller:
      1. Controller shall have volatile-memory backup.
      2. Safety Control Operation:
         a. Firestats: Stop fan and close outdoor-air damper if air greater than 130°F enters unit. Provide additional contacts for alarm interface to fire alarm control panel.
         b. Fire Alarm Control Panel Interface: Provide control interface to coordinate with operating sequence described in DIVISION, 28 Section "Fire Detection and Alarm."
         c. Low-Discharge Temperature: Stop fan and close outdoor-air damper if supply air temperature is less than 40°F.
3. Scheduled Operation: Occupied and unoccupied periods on seven-day clock with a minimum of two programmable periods per day.

4. Unoccupied Period:
   a. Heating Setback: 10°F.
   c. Override Operation: Two hours.

5. Supply Fan Operation:
   a. Occupied Periods: Run fan continuously.
   b. Unoccupied Periods: Cycle fan to maintain setback temperature.

6. Refrigerant Circuit Operation:
   a. Occupied Periods: Cycle or stage compressors, and operate hot-gas bypass to match compressor output to cooling load to maintain room temperature and humidity. Cycle condenser fans to maintain maximum hot-gas pressure. Operate low-ambient control kit to maintain minimum hot-gas pressure.
   b. Unoccupied Periods: Cycle compressors and condenser fans for heating to maintain setback temperature.
   c. Switch reversing valve for heating or cooling mode on air-to-air heat pump.

7. Electric-Heating-Coil Operation:
   a. Occupied Periods: Stage coil to maintain room temperature.
   b. Unoccupied Periods: Energize coil to maintain setback temperature.

8. Economizer Outdoor-Air Damper Operation:
   a. Occupied Periods: Open to fixed minimum intake corresponding to outside air rate in schedules, and maximum 100% of the fan capacity to comply with ASHRAE Cycle II. Controller shall permit air-side economizer operation when outdoor air is less than 60°F. Use mixed-air and outdoor-air temperature to adjust mixing dampers. Start relief-air fan with end switch on outdoor-air damper. During economizer cycle operation, lock out cooling.
   b. Unoccupied Periods: Close outdoor-air damper and open return-air damper.

2.10 ACCESSORIES:
   A. Duplex, 115V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required.
   B. Low-ambient kit using variable-speed condenser fans for operation down to 0°F.
   C. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.
   D. Coil guards of painted, galvanized-steel wire.

2.11 ROOF CURBS:
   A. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.
   1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
      a. Materials: ASTM C1071, Type I or II.
      b. Thickness: 1 inch.
   2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
      a. Liner Adhesive: Comply with ASTM C916, Type I.
      b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
d. Liner Adhesive: Comply with ASTM C916, Type I.

B. Curb Height: 14 inches.

PART 3 - EXECUTION

3.01 EXAMINATION:
A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.
B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.
C. Examine roofs for suitable conditions where RTUs will be installed.
D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:
A. Roof Curb: Install on roof structure or concrete base, level and secure, according to NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in DIVISION 07. Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.

3.03 FIELD QUALITY CONTROL:
A. 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. Report results in writing.
B. Tests and Inspections:
   1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
   2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   C. Remove and replace malfunctioning units and retest as specified above.

3.04 STARTUP SERVICE:
A. Engage a factory-authorized service representative to perform startup service.
B. Complete installation and startup checks according to manufacturer's written instructions and do the following:
   1. Inspect for visible damage to unit casing.
   2. Inspect for visible damage to furnace combustion chamber.
   3. Inspect for visible damage to compressor, coils, and fans.
   4. Inspect internal insulation.
   5. Verify that labels are clearly visible.
   6. Verify that clearances have been provided for servicing.
   7. Verify that controls are connected and operable.
   8. Verify that filters are installed.
   9. Clean condenser coil and inspect for construction debris.
10. Remove packing from vibration isolators.
11. Verify lubrication on fan and motor bearings.
12. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
13. Adjust fan belts to proper alignment and tension.
14. Start unit according to manufacturer's written instructions.
   a. Start refrigeration system.
   b. Do not operate below recommended low-ambient temperature.
   c. Complete startup sheets and attach copy with Contractor's startup report.
15. Inspect and record performance of interlocks and protective devices; verify sequences.
16. Operate unit for an initial period as recommended or required by manufacturer.
17. Calibrate thermostats.
18. Adjust and inspect high-temperature limits.
19. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
20. Start refrigeration system and measure and record the following when ambient is a minimum of 15°F above return-air temperature:
   a. Coil leaving-air, dry- and wet-bulb temperatures.
   b. Coil entering-air, dry- and wet-bulb temperatures.
   c. Outdoor-air, dry-bulb temperature.
   d. Outdoor-air-coil, discharge-air, dry-bulb temperature.
21. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
22. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.
   a. Supply-air volume.
   b. Return-air volume.
   c. Relief-air volume.
   d. Outdoor-air intake volume.
23. Simulate maximum cooling demand and inspect the following:
   a. Compressor refrigerant suction and hot-gas pressures.
   b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.
24. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
   b. Low-temperature safety operation.
   c. Filter high-pressure differential alarm.
   d. Economizer to minimum outdoor-air changeover.
   e. Relief-air fan operation.
   f. Firestat alarms.
25. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.05 CLEANING AND ADJUSTING:
   A. 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 site during other-than-normal occupancy hours for this purpose.
   B. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

3.06 DEMONSTRATION:
A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain RTUs. Refer to DIVISION 01.

END OF SECTION 237413
SECTION 23 81 26 – SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.01 SUMMARY:
   A. This Section includes split-system air-conditioning units consisting of separate evaporator-fan and compressor-condenser components.

1.02 SUBMITTALS:
   A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
   B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
      1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
      2. Wiring Diagrams: For power, signal, and control wiring.
   C. Samples for Initial Selection: For units with factory-applied color finishes.
   D. Field quality-control reports.
   E. Warranty: Sample of special warranty.
   F. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.
   G. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
      1. Filters: One set for each air-handling unit.
      2. Fan Belts: One set for each air-handling unit fan.

1.03 QUALITY ASSURANCE:
   A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   B. ASHRAE Compliance:
      1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
   C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      2. Lennox International, Inc.
      3. Trane; a business of American Standard companies.
      4. YORK; a Johnson Controls company.

2.02 INDOOR UNITS (DSS-1):
   A. Wall-Mounted, Evaporator-Fan Components:
1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.

2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with AHRI 210/240.

3. Fan: Direct drive, centrifugal.

4. Fan Motors:
   a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 23 05 13 - Common Motor Requirements for HVAC Equipment.
   b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
   c. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in DIVISION 26 Sections.
   d. Mount unit-mounted disconnect switches on exterior of unit.

5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

6. Condensate Drain Pans:
   a. Fabricated with 1% slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
      (1) Length: Extend drain pan downstream from leaving face by one half the vertical dimension of the refrigerant coil.
      (2) Depth: A minimum of 2 inches deep.
   c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
      (1) Minimum Connection Size: NPS 1.
   d. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

7. Air Filters: Permanent, cleanable.

2.03 OUTDOOR UNITS (ACCU-1):

   A. Air-Cooled, Compressor-Condenser Components:

1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gauge ports on exterior of casing.

2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
   a. Compressor Type: Scroll.
   b. Compressors shall be specifically selected to match related evaporator coil.
   c. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
   d. Refrigerant Charge: See Schedule.
   e. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with AHRI 210/240.

3. Fan: Aluminum-propeller type, directly connected to motor.


5. Low Ambient Kit: Permits operation down to 45°F.
2.04 ACCESSORIES:
   A. Thermostat: Low voltage with subbase to control compressor and evaporator fan.
   B. Automatic-reset timer to prevent rapid cycling of compressor.
   C. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.
   D. Drain Hose: For condensate.
   E. Condensate Pump.

PART 3 - EXECUTION

3.01 INSTALLATION:
   A. Install units level and plumb.
   B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
   C. Install compressor-condenser components on restrained, spring isolators with a minimum static deflection of 1 inch. See Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
   D. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.02 FIELD QUALITY CONTROL:
   A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
   B. Perform tests and inspections.
      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. Tests and Inspections:
      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.
   D. Remove and replace malfunctioning units and retest as specified above.
   E. Prepare test and inspection reports.

3.03 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.

3.04 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
SECTION 23 82 39 - UNIT HEATERS

PART 1 - GENERAL

1.01 SUMMARY:
A. This Section includes:
   1. Cabinet unit heaters with centrifugal fans and electric-resistance heating coils.

1.02 DEFINITIONS:
A. CWP: Cold working pressure.
B. PTFE: Polytetrafluoroethylene plastic.
C. TFE: Tetrafluoroethylene plastic.

1.03 SUBMITTALS:
A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.
B. 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. Equipment schedules to include rated capacities, operating characteristics, furnished specialties, and accessories.
C. Field quality-control test reports.
D. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, operation, and maintenance manuals.

1.04 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. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

PART 2 - PRODUCTS

2.01 CABINET UNIT HEATERS:
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Brasch.
   2. Carrier Corporation.
   4. Indeeco.
   5. QMark Electric Heating; a division of Marley Engineered Products.
   6. Trane.
B. Description: A factory-assembled and -tested unit complying with AHRI 440.
C. Coil Section Insulation: ASTM C1071; surfaces exposed to airstream shall be erosion-resistant coating to prevent erosion of glass fibers.
   1. Thickness: 1/2 inch.
   2. Thermal Conductivity (k-Value): 0.26 Btu by in./h by sq. ft. at 75ºF mean temperature.
   3. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E84.
4. Adhesive: Comply with ASTM C916 and with NFPA 90A or NFPA 90B.
5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Cabinet: Steel with baked-enamel finish with manufacturer's standard paint, in color selected by Engineer.
   1. Horizontal Unit, Exposed Bottom Panels: Minimum 0.0528-inch thick, sheet steel, removable panels secured with tamperproof cam fasteners and safety chain.
   2. Recessing Flanges: Steel, finished to match cabinet.
   3. Control Access Door: Key operated.
   4. False Back: Minimum 0.0428-inch thick steel, finished to match cabinet.

E. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with fuses in terminal box for overcurrent protection and limit controls for high-temperature protection. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.

F. Fan and Motor Board: Removable.
   1. Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
   3. Wiring Terminations: Connect motor to chassis wiring with plug connection.

G. Basic Unit Controls:
   1. Control voltage transformer.
   2. Wall-mounting thermostat with the following features.
      b. Fan on-auto switch.
      c. Concealed set point.
      d. Concealed indication.
      e. ºF indication.

H. Electrical Connection: Factory wire motors and controls for a single field connection.

PART 3 - EXECUTION

3.01 EXAMINATION:
   A. Examine areas to receive unit 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 unit heater installation.
   C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:
   A. Install cabinet unit heaters to comply with NFPA 90A.
   B. Suspend cabinet unit heaters from structure with elastomeric hangers. Vibration isolators are specified in Section 23 05 48 - Vibration Controls for HVAC Equipment.

3.03 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 through each stage 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.

3.04 ADJUSTING:
   A. Adjust initial temperature set points.
   B. 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 during other-than-normal occupancy hours for this purpose.

END OF SECTION 23 82 39
SECTION 26 05 10 – BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. This Section specifies general administrative and procedural requirements for electrical installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in DIVISION 01:
      1. Submittals.
      2. Coordination drawings.
      3. Record documents.
      5. Rough-ins.
      6. Electrical installations.
      7. Cutting and patching.
      8. Electrical Demolition.
      9. Touch-up Painting.

1.02 SUMMARY:
   A. This Contract includes, but is not limited to, the following work components:
      1. Furnish and install (including supports) the following equipment as per the Drawings and Specifications:
         a. Electrical Distribution Equipment including, but not limited to, panelboards.
         b. Electric Metering.
         c. Grounding System.
         d. Lightning Protection System.
         e. Interior and Exterior Lighting.
         f. Lighting Controls.

1.03 RELATED REQUIREMENTS:
   A. DIVISION 31 for excavation for electrical installations within the building boundaries and from building to utility connections.
   B. Section 01 78 00 - Contract Closeout.
   A. Section 09 90 00 - Protective Coatings.
   B. Section 23 05 13 - Common Motors Requirements for HVAC Equipment.

1.04 REFERENCE STANDARDS:
   B. National Electrical Contractors Association (NECA).
   C. National Electrical Installation Standards (NEIS): Except where the NEIS requirements specifically deviate from specific requirements of the NEC, the NEC shall take precedence.
   D. National Fire Protection Association (NFPA):
   E. Institute of Electrical and Electronics Engineers (IEEE):
   F. Underwriters Laboratories (UL).

1.05 DEFINITIONS:
   A. EPA: Environmental Protection Agency.
   B. PCB: Polychlorinated biphenyl.
   C. PVC: Polyvinyl Chloride.
1.06 **SUBMITTALS:**
   A. Submit as specified in DIVISION 01.
   B. Refer to each Section of this Division for specific Submittal requirements.
   C. Provide Conforming to Construction Records schematic diagrams and wiring diagrams.
   D. Provide product data on electrical material and products.
   E. Prepare record documents in accordance with the requirements in DIVISION 01. In addition to the requirements specified in DIVISION 01, indicate installed conditions for:
      1. Locations of control devices; distribution and branch electrical circuitry; fuse sizes, circuit breaker sizes and arrangements.
      2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
      3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.
   F. Engage the services of a licensed Land Surveyor or licensed Professional Engineer registered in the state in which the Project is located to record the locations and invert elevations of underground installations.
   G. Prepare maintenance manuals in accordance with Section 01 78 00 - Contract Closeout. In addition to the requirements specified in DIVISION 01, include the following information for equipment items:
      1. Description of function, normal operating characteristics and limitations, performance curves, engineering data, tests, and complete nomenclature and commercial numbers of replacement parts.
      2. Manufacturer's printed operating procedures to include start-up, break-in, routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; lockout/tagout procedures; and summer and winter operating instructions.
      3. Maintenance procedures for routine preventive maintenance and troubleshooting; disassembly, repair, reassembly; aligning and adjusting instructions.
      4. Servicing instructions, lubrication charts and schedules.
      5. "Conforming to Construction Records" schematic and wiring diagrams.

1.07 **DELIVERY, STORAGE, AND HANDLING:**
   A. Deliver products to the Project Site properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

1.08 **PROJECT SITE CONDITIONS:**
   A. Altitude = 6601.71 feet above mean sea level.
   B. Maximum Outdoor Ambient Temperature = 120°F.
   C. Minimum Outdoor Ambient Temperature = 0°F.
   D. Maximum Outdoor Relative Humidity = 100%.
   E. Seismic Factors: See Structural Drawing S001.

1.09 **WARRANTY:**
   A. Provide a minimum one-year warranty on all electrical equipment. Warranty period shall begin when equipment is permanently energized or started unless specified otherwise. Contractor shall provide written notification to Owner's Representative prior to this warranty start date.
PART 2 - PRODUCTS

2.01 PRODUCTS:
   A. Unless indicated otherwise, all equipment and material shall be new, undamaged and meet the
      requirements of Underwriters Laboratories, Inc. (UL). Where UL requirements are not
      applicable, equipment and material shall be identified as such by Contractor and approved by
      Owner before purchase and installation.

2.02 ELECTRONIC EQUIPMENT COMPLIANCE:
   A. Contractor warrants that all equipment, devices, items, systems, software, hardware, or
      firmware provided shall properly, appropriately, and consistently function and accurately
      process date and time data (including without limitation: calculating, comparing, and
      sequencing). This warranty supersedes anything in the Specifications or other Contract
      Documents which might be construed inconsistently. This warranty is applicable whether the
      equipment, device, item, system, software, hardware, or firmware is specified with or without
      reference to a manufacturer's name, make, or model number.

2.03 FINISHES:
   A. For equipment: Equipment manufacturer's paint selected to match installed equipment finish.
   B. Galvanized surfaces: Zinc-rich paint recommended by item manufacturer.
   C. Provide finishes in accordance with Section 09 90 00 - Protective Coatings.

PART 3 - EXECUTION

3.01 ERECTION, INSTALLATION, APPLICATION:
   A. Verify final locations for rough-ins with field measurements and with the requirements of the
      actual equipment to be connected.
   B. Refer to equipment specifications in DIVISIONS 26 and the equipment submittals for rough-in
      requirements.
   C. Sequence, coordinate, and integrate the various elements of electrical systems, materials, and
      equipment. All electrical work and material shall comply with the following requirements:
      1. NFPA 70 - The National Electrical Code (NEC).
         Publication (FIPS).
      3. NECA National Electrical Installation Standards (NEIS) (all except Table 1 of NECA 1).
      4. Coordinate electrical systems, equipment, and materials installation with other building
         components. Equipment motor horsepower sizes and kilowatt sizes shown are
         approximate. If equipment of a different size is furnished by Contractor, Contractor shall
         furnish and install the proper support equipment, motor starter, switchgear, feeders, fuses,
         circuit breaker, disconnect switch, wire, and conduit required for the equipment
         furnished, at no additional cost to Owner.
      5. Verify all existing dimensions by field measurements.
      6. Arrange for chases, slots, and openings in other building components during progress of
         construction to allow for electrical installations.
      7. Coordinate the installation of required supporting devices and sleeves to be set in poured-
         in-place concrete and other structural components as they are constructed.
      8. Sequence, coordinate, and integrate installations of electrical materials and equipment for
         efficient flow of the Work. Give particular attention to large equipment requiring
SECTION 26 05 10 – BASIC ELECTRICAL REQUIREMENTS: continued

positioning prior to closing in the building. Coordinate concrete pads, bases, roof curbs, and related items.

9. Coordinate with all other building trades.

10. Where mounting heights are not specifically detailed, specified, or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.

11. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

12. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Should coordination requirements conflict with individual system requirements, refer conflict to Owner’s Representative in writing.

13. Install systems, materials, and equipment level, plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.

14. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting with minimum of interference with other installations.

15. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

16. All equipment and materials shall be installed in accordance with NFPA 70 - The National Electrical Code (NEC).

17. All equipment conductor termination provisions shall be UL listed for 75ºC conductors.

18. All electrical equipment and installations shall be of adequate strength to withstand, without failure, forces encountered in defined Seismic conditions.

19. Install raceways, cables, wireways, cable trays and busways clear of obstructions and clear of the required working space of equipment.

D. Refer to each section of this Division for specific performance requirements.

E. Disposal of existing fluorescent lamps shall be by Contractor shipping the lamps to an EPA approved recycler for recycling. All shipping and disposal costs will be paid by Contractor at no additional expense to Owner.

F. Existing pre-1980 fluorescent lamp ballasts and ballasts not marked "no PCBs" (or are not dated with manufacturing date) shall be assumed to contain PCBs. Contractor shall dispose of PCB fluorescent ballasts by shipping the ballasts to an EPA approved PCB incineration facility. All shipping and disposal costs will be paid by Contractor at no additional expense to Owner.

3.02 DEMOLITION:

A. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.

B. Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety.

C. Abandoned Work: Cut and remove buried raceway and wiring indicated to be abandoned in place, 2 inches below surface of adjacent construction. Cap raceways and patch surface to match existing surface finish.

D. Remove demolished material from Project Site.
E. Remove, store, clean, re-install, reconnect and make operational components indicated for relocation.

3.03 CUTTING AND PATCHING:
A. General: Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of the trades involved. Perform cutting and patching in accordance with the following requirements:
   1. Perform cutting and patching for electrical equipment and materials required to:
      a. Uncover work to provide for installation of ill-timed work.
      b. Remove and replace defective work.
      c. Remove and replace work not conforming to requirements of the Contract Documents.
      d. Remove samples of installed work as specified for testing.
      e. Install equipment and materials in existing structures.
      f. Upon written instructions from Engineer, uncover and restore work to provide for Engineer's observation of concealed work if installed without using the proper specified procedures.
B. For work in existing installations, the Contractor shall cut, remove, and legally dispose of selected electrical equipment, components, and materials as indicated, including, but not limited to, removal of electrical items indicated to be removed and items made obsolete by the new work.
C. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
D. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
E. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.
F. All penetrations through fire-rated walls, ceilings and floors shall be sealed with a UL listed and FM Global approved sealant system that matches the fire rating of the surface penetrated.
G. Patch existing finished surfaces and building components that must be cut for the electrical installation or are damaged by Contractor using new materials matching existing materials.
H. Patch finished surfaces and building components using new materials specified for the original installation.
I. All cutting, patching, and repairing shall be subject to the supervision and the approval of Owner's Representative.
J. Repair and re-finish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fire proofing where existing fireproofing has been disturbed. Repair and re-finish materials and other surfaces by skilled mechanics of trades involved.

3.04 FINISHES:
A. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit degree of damage at each location.
B. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
C. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
D. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.
E. Repair damage to protective coatings in accordance with Section 09 90 00 - Protective Coatings.
3.05  **CLEANING:**
   A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.

3.06  **PROTECTION:**
   A. Protect equipment and installations and maintain conditions to ensure that coatings, finishes and cabinets are without damage or deterioration at time of Substantial Completion.

3.07  **CLOSEOUT:**
   A. Instructions, training, and manufacturer’s service representative:
      1. Provide on-site instructions and training of Owner's personnel as specified.
      2. Provide on-site services of a manufacturer’s authorized service representative as specified.

END OF SECTION 26 05 10
SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
A. This Section includes the following:
1. Building wires and cables rated 600V and less.
2. Connectors, splices, and terminations rated 600V and less.

1.03 REFERENCE STANDARDS:
A. Applicable Standards (latest edition):
   a. ASTM A53/A53M - Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
   a. 29 CFR - Labor, Chapter XVII - Occupational Safety and Health Administration, Department of Labor, Part 1910 - "Occupational Safety and Health Standards," Subpart A - "General," Section 1910.7 - "Definition and Requirements for a Nationally Recognized Testing Laboratory."
3. The Institute of Electrical and Electronics Engineers, Inc. (IEEE):
5. National Electrical Manufacturers Association (NEMA):
   a. NEMA WC 26 - Binational Wire and Cable Packaging Standard (EEMAC 201).
   b. NEMA WC 70 - Non-Shielded Power Cable 2,000V or less.
7. Underwriters Laboratories Inc. (UL):
   a. UL 4 - Armored Cable.
   b. UL 44 - Thermoset-Insulated Wires and Cables.
   c. UL 486A - Wire Connectors and Soldering Lugs for Use with Copper Conductors.
   d. UL 486B - Wire Connectors for Use with Aluminum Conductors.
   e. UL 493 - Thermoplastic-Insulated Underground Feeder and Branch-Circuit Cables.
   f. UL 83 - Thermoplastic-Insulated Wires and Cables.
   g. UL 854 - Service-Entrance Cables.
   h. UL 1569 - Metal-Clad Cables.

1.04 DEFINITIONS:
A. EPDM: Ethylene-propylene-diene terpolymer rubber.
B. NBR: Acrylonitrile-butadiene rubber.

1.05 SUBMITTALS:
SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES:

continued

A. Product Data: For each type of product indicated.
B. Qualification Data: For testing agency.
C. Field quality-control test reports.

1.06 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 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.
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.

PART 2 - PRODUCTS

2.01 CONDUCTORS AND CABLES:
A. 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:
B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Alcan Products Corporation; Alcan Cable Division.
   3. General Cable Corporation.
   4. Senator Wire & Cable Company.
   5. Southwire Company.
   6. Pyrotenax.
   C. Copper Conductors: Comply with NEMA WC 70.
   D. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN.

2.02 WIRE AND CABLES:
A. General: Provide wire and cable suitable for the location where installed.
B. Conductors: Minimum conductor size shall be #12 AWG. Except #14 AWG stranded can be used for controls unless indicated or specified otherwise. Provide solid conductors for power and lighting circuits No. 10 AWG and smaller unless indicated or specified otherwise. Provide stranded conductors for sizes No. 8 AWG and larger unless indicated or specified otherwise.
C. Conductor Material: Use copper for all sizes.
D. Provide wire and cable numbers that match electrical schematics.
E. Provide stranded hookup wire with appropriate voltage rating and ampere rating inside of all control enclosures.

2.03 CONNECTORS AND SPLICES:
A. 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:
SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES:

continued

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AFC Cable Systems, Inc.
   3. O-Z/Gedney; EGS Electrical Group LLC.
   4. 3M; Electrical Products Division.
   5. Tyco Electronics Corp.

C. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

D. Provide UL-listed factory-fabricated, solderless metal connectors of sizes, ampacity ratings, materials, types and classes for applications and for services indicated. Use connectors with temperature ratings to or greater than those of the wires upon which used. Connectors shall be identified for the conductor material.
   1. Lighting and receptacle circuit connectors for No. 10 AWG and smaller shall be twist-on spring solderless connectors. Provide silicone filled twist-on watertight/raintight connectors for all lighting circuits and receptacles circuits routed outdoors or indoors in wet locations.
   2. Nonlighting and nonreceptacle circuit connectors for No. 12 No. 10 AWG and connectors for No. 8 AWG and larger shall be solderless connectors.
   3. All uninsulated joints shall be taped to provide an insulation value equal to that of the wire.

PART 3 - EXECUTION

3.01 CONDUCTOR MATERIAL APPLICATIONS:
   A. General: Provide wire and cable suitable for the location where installed.
   B. Conductors: Minimum conductor size shall be #12 AWG.
   C. Conductor Material: Use copper for all sizes.
   D. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
   E. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.02 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS:
   A. All areas: Type THHN-THWN, single conductors in raceway

3.03 INSTALLATION OF CONDUCTORS AND CABLES:
   A. General: Install electrical cables, wires, and connectors in compliance with NEC.
   B. Coordinate cable installation with other Work.
   C. Do not pull wire and cable until raceway system is complete. Pull conductors simultaneously where more than one is being installed in same raceway.
   D. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
   E. 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.
   F. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES:

continued

G. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.
H. Support cables according to SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS.
I. Identify and color-code conductors and cables according to SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS.
J. Keep conductor splices to a minimum. All splices shall be made in junction boxes.
K. Provide adequate length of conductors within electrical enclosures and neatly train the conductors to terminal points. Circuits with conductors larger than No. 10 AWG shall be bundled together inside of enclosures. Make terminations so there are no bare conductors visible at the terminal.
L. Table 1:
   1. Insulation Color Coding for Phase Identification:
      2. Color code 600V insulated, service entrance, feeder, and branch circuit conductors with factory-applied colored insulation for No. 8 AWG and smaller (except: No. 6 AWG and smaller for green ground wire); 1-inch band of colored tape at all splices and terminations for No. 6 AWG and larger (except: No. 4 AWG and larger for green ground wire) as follows:
         
         | 240/120 Volts | Phase |
         |--------------|-------|
         | Black        | A     |
         | Red          | B     |
         | White        | Neutral |
         | Green        | Ground |

M. Single phase circuits shall be grouped with one phase conductor, one neutral conductor, and one ground conductor unless indicated or specified otherwise. Shared neutrals for multiwire branch circuit is not allowed.
N. Install wire and cable numbers on all field wiring that matches electrical schematics.
O. Leave 12 inches of each wire in each receptacle and wall switch device box.
P. Install an equipment grounding conductor in all conduits.

3.04 CONNECTIONS:
A. Provide UL-listed factory-fabricated, solderless metal connectors of sizes, ampacity ratings, materials, types and classes for applications and for services indicated.
   1. Lighting and receptacle circuit connectors for No. 10 AWG and smaller shall be twist-on spring solderless connectors. Provide silicone filled twist-on watertight/raintight connectors for all lighting circuits and receptacles circuits routed outdoors or indoors in wet locations.
   2. Nonlighting and nonreceptacle circuit connectors for No. 12 AWG and larger shall be solderless connectors.
   3. All uninsulated joints shall be taped to provide an insolation value equal to that of the wire.
B. 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.

C. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
   1. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.

D. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm) of slack.

3.05 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 44 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLELING.

3.06 FIELD QUALITY CONTROL:
A. Tests and Inspections:
   1. Prior to energizing, test wires and cables for electrical continuity and for short circuits.
   2. Prior to energizing, check all installed feeders and building service wires and cables with insulation megohm meter to determine insulation resistance levels to assure requirements are fulfilled. Record and submit all field test data. Megger 300V cables with 500Vdc megohm meter between each conductor and ground. Megger 600V cables with 1,000Vdc megger between each conductor and ground. Also, megger between adjacent conductors. Megger cables after installation (not on cable reel) with cables disconnected at both ends. The values must be approximately as follows:

<table>
<thead>
<tr>
<th>Conductor Size (AWG or MCM)</th>
<th>Resistance (Megohms-1,000 ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>14-8</td>
<td>200</td>
</tr>
<tr>
<td>6-2/0</td>
<td>100</td>
</tr>
<tr>
<td>3/0-500</td>
<td>50</td>
</tr>
</tbody>
</table>

   3. Do not test wires or cables with an ac test set.
   5. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.
      a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
      b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
      c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

B. Test Reports: Prepare a written report to record the following:
SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: continued

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.

C. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 26 05 19
SECTION 260526 - GROUNDING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. This Section specifies electrical grounding and bonding as indicated on Drawings and schedules and as specified herein. Grounding and bonding work is defined to encompass systems, circuits, and equipment.
   B. Type of electrical grounding and bonding work specified in this Section includes the following:
      1. Solidly grounded. Grounded through a ground connection in which no impedance has been intentionally inserted.
   C. Applications of electrical grounding and bonding work in this Section include the following:
      1. Underground metal piping.
      2. Underground metal water piping.
      3. Metal building frames.
      4. Electrical power systems.
      5. Grounding electrodes.
      6. Counterpoise grounding loops.
      7. Separately derived systems.
      8. Raceways.
      9. Service equipment.
     11. Equipment.
     12. Lighting standards and poles.
     13. Lightning protection systems.
   D. Refer to other DIVISION 26 Sections for wires/cables, electrical raceways, boxes and fittings, and wiring devices which are required in conjunction with electrical grounding and bonding work; not work of this Section.

1.03 RELATED REQUIREMENTS:
   A. SECTION 26 41 13 - LIGHTNING PROTECTION FOR STRUCTURES for lightning protection.

1.04 REFERENCES:
   A. Applicable Standards:
      1. Institute of Electrical and Electronic Engineers (IEEE): Comply with applicable requirements and recommended installation practices of the following IEEE Standards pertaining to grounding and bonding of systems, circuits, and equipment:
         a. 32 - Requirements, Terminology, and Test procedures for Neutral Grounding Devices.
         d. 141 - Recommended Practice for Electric Power Distribution for Industrial Plants.
         e. 142 - Recommended Practice for Grounding Industrial and Commercial Power Systems.
      2. National Fire Protection Association (NFPA):
SECTION 260526 - GROUNDING: continued

a. 70 - National Electrical Code (NEC): Comply with applicable local electrical code requirements of the authority having jurisdiction, and NEC as applicable to electrical grounding and bonding, pertaining to systems, circuits, and equipment.

b. 780 - Lightning Protection Code.

3. Underwriters Laboratories (UL): Comply with applicable requirements of the following standards. Provide grounding and bonding products which are UL-listed and labeled for their intended usage.

a. 467 - Electrical Grounding and Bonding Equipment.

b. 486A - Wire Connectors and Soldering Lugs for Use with Copper Conductors.

c. 869 - Electrical Service Equipment.

1.05 SUBMITTALS:

A. Refer to DIVISION 01 and SECTION 26 05 10 - BASIC ELECTRICAL REQUIREMENTS for administrative and procedural requirements for Submittals.

B. Includes, but not limited to, the following:

1. Product Data: Submit manufacturer's data on grounding and bonding products and associated accessories.

2. Qualification Data: For Qualified Testing Agency and testing agencies field Supervisor.

3. All field test reports.

1.06 QUALITY ASSURANCE:

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Subject to compliance with requirements, provide grounding and bonding products of one of the following (for each type of product):

1. Grounding Products:

   a. Adalet-PLM Div; Scott Fetzer Co.

   b. Anderson/Square D.

   c. Burndy Corporation.

   d. Cadweld Div; Erico Products Inc.

   e. Crouse-Hinds Div; Cooper Industries.

   f. Ideal Industries, Inc.

   g. Joslyn Corporation.

   h. Myers Electric Products, Inc.

   i. O. Z. Gedney Div; General Signal Corp.

   j. Thomas and Betts Corp.

2.02 GROUNDING AND BONDING:

A. Materials and Components:

1. General: Except as otherwise indicated, provide electrical grounding and bonding systems indicated; with assembly of materials, including, but not limited to, cables/wires,
connectors, solderless lug terminals, bonding jumper braid, surge arresters, and additional accessories needed for a complete installation. Where more than one type component product meets indicated requirements, selection is Contractor's code-compliance option. Where materials or components are not indicated, provide products which comply with NEC, UL, and IEEE requirements and with established industry standards for those applications.

2. Conductors: Unless otherwise indicated, provide insulated electrical grounding conductors for equipment grounding conductor connections that match power supply wiring materials and as a minimum are sized according to the NEC. Provide uninsulated, stranded, tinned, copper cable for ground electrode conductors.

3. Service Lightning Arrester:
   a. Service Lightning Arrester: 2-pole, 1-phase, 120/240V, #14 AWG 3-wire including ground, 18-inch leads, with watertight enclosure.

4. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches (6.3 by 100 mm) in cross section, with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600V. Lexan or PVC, impulse tested at 5,000V.

5. Bonding Plates, Connectors, Terminals, and Clamps: Provide electrical bonding plates, connectors, terminals, lugs, and clamps as recommended by bonding plate, connector, terminal, and clamp manufacturers for indicated applications.
   a. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.
   b. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
   c. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless [compression] [exothermic]-type wire terminals and long-barrel, two-bolt connection to ground bus bar.

6. Ground Rods or Ground Electrodes:
   a. Grounding Electrodes: Steel with copper clad exterior, 3/4-inch diameter by 10 feet (minimum) long.
   b. Ground Rods or Grounding Electrodes: Stainless steel, 3/4-inch diameter by 10 feet.
   c. Chemical-Enhanced Grounding Electrodes: Copper tube, straight or L-shaped, charged with nonhazardous electrolytic chemical salts.
      (1) Termination: Factory-attached No. 4/0 AWG bare conductor at least 48 inches (1,200 mm) long.

7. Electrical Grounding Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials, bonding straps, as recommended by accessories manufacturers for type service required or indicated.

8. Field Welding: Provide exothermic welded connections where grounding conductors connect to underground grounding conductors and underground grounding electrodes.

**PART 3 - EXECUTION**

3.01 APPLICATIONS:
   A. Install electrical grounding and bonding systems as indicated, in accordance with manufacturer's instructions and applicable portions of NEC, NECA's "Standard of Installation," and in accordance with recognized industry practices to ensure that products comply with requirements.
B. Conductors: Install solid conductor for No. 8AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

C. Underground Grounding Conductors: Install bare copper conductor, No. 4/0AWG minimum.
   1. Bury at least 24 inches (600 mm) below grade.

D. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

E. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
   1. Install bus horizontally, on insulated spacers 2 inches (50 mm) minimum from wall, 6 inches (150 mm) above finished floor unless otherwise indicated.
   2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down to specified height above floor; connect to horizontal bus.

F. Conductor Terminations and Connections:
   1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
   2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
   3. Connections to Ground Rods at Test Wells: Bolted connectors.
   5. Clean metal contact surfaces of clamp-on connectors to ensure electrical conductivity and circuit integrity.

3.02 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS:

A. Comply with IEEE C2 grounding requirements.

B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.

C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

3.03 EQUIPMENT GROUNDING:

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Terminate feeder and branch circuit insulated equipment grounding conductors with grounding lug on substation, switchgear, switchboard, motor control center, or panelboard ground bus. When conduit enters from below and is not connected to the enclosure, ground equipment grounding conductor on conduit grounding bushing and then bond to ground bus (or grounded enclosure if there is no ground bus).

C. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
SECTION 260526 - GROUNDING: continued

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
5. Flexible raceway and power cords runs.
6. Ground wireway at least once and at 10-foot intervals.

D. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

E. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

F. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.
   1. For telephone, alarm, voice and data, and other communication equipment, provide No.-4-AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
   2. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4- by 4- by 12-inch (6.3- by 100- by 300-mm) grounding bus.
   3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

G. Metal and Wood Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.04 INSTALLATION:
A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

C. Ground Rods: Drive rods until tops are 10 inches below finished floor or final grade unless otherwise indicated. Do not drill or jet. Drive ground rods into unexcavated portions of earth where possible. If rods must be driven into excavated areas, drive rods after compaction of backfill is completed.
   1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
   2. For grounding electrode system, install at least eight rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
   3. At grounding receptacles, drive rods to a depth such that the top of the receptacle is flush with the finished surface.
D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in SECTION 26 05 44 - UNDERGROUND DUCT BANKS AND MANHOLES, and shall be at least 12 inches (300 mm) deep, with cover.
   1. Test Wells: Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
   1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
   2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
   3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

F. Grounding and Bonding for Piping:
   1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
   2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
   3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

G. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

H. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart.

I. Ground Counterpoise Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column, extending around the perimeter of building.
   1. Install tinned-copper conductor not less than No. 4/0 AWG for ground ring and for taps to building steel.
   2. Bury ground ring not less than 24 inches (600 mm from building's foundation).

J. Weld grounding conductors to underground grounding conductors and underground electrodes. Ground electrode conductor shall not contain splices between the ground electrode and the service entrance equipment.

K. Ground electrical service system neutral at service entrance equipment to grounding electrodes.

L. Ground each separately derived system neutral to:
   1. Main building ground system.

M. Bond the system neutral to service entrance equipment enclosures.

N. Ground all exposed noncurrent carrying metal parts of electrical equipment, metal raceway systems, grounding conductors in raceways and cables, receptacle ground conductors, and metallic plumbing systems.

O. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts.
SECTION 260526 - GROUNDING: continued

Where manufacturer's torquing requirements are not indicated, tighten connections to comply with tightening torque values specified in UL 486A to assure permanent and effective grounding.

P. Tuss Conductors: Route grounding connections and conductors to ground and protective devices per manufacturer's instructions. Maintain conductor minimum length requirements.

Q. Apply corrosion-resistant finish to field connections, buried metallic grounding and bonding products, and places where factory applied protective coatings have been destroyed, which are subjected to corrosive action.

3.05 LABELING:
A. Comply with requirements in SECTION 260553 - ELECTRICAL IDENTIFICATION for instruction signs. The label or its text shall be green.
B. Install labels at the telecommunications bonding conductor and grounding equalizer.
   1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

3.06 FIELD QUALITY CONTROL:
A. Perform tests and inspections.
   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.
B. Tests and Inspections:
   1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
   2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
   3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells. Make tests at ground rods before any conductors are connected.
      a. Measure ground resistance no fewer than two full days after last trace of precipitation and without 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.
      b. Perform tests by fall-of-potential method according to IEEE 81.
   4. Prepare dimensioned Drawings locating each test well, 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.
C. Grounding system will be considered defective if it does not pass tests and inspections.
D. Prepare test and inspection reports.
E. Report measured ground resistances that exceed the following values:
   1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10ohms.
   2. Power Distribution Units or Panelboards Serving Electronic Equipment: 1 ohm.
F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526
SECTION 26 05 29 – HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. This Section specifies hangers, supports, anchors, sleeves, and seals for electrical equipment and systems as well as construction requirements for concrete bases as indicated by Drawings and schedules and/or specified in other Division 26 Sections.
   B. Types of hangers, supports, anchors, sleeves, and seals specified in this Section include the following:
      1. Clevis hangers.
      2. Riser clamps.
      3. Steel rod coupling.
      4. C-clamps.
      5. I-beam clamps.
      6. One-hole conduit straps.
      7. Two-hole conduit straps.
      8. Hexagonal nuts.
      9. Round threaded steel rods.
     10. Conduit clamps.
     11. U-bolts.
     12. Lead expansion anchors.
     13. Toggle bolts.
     14. Wall, ceiling, roof and floor seals.
     15. Conduit cable supports.
     16. U-channel strut system.
     17. Fire and smoke stop compounds.

1.03 RELATED REQUIREMENTS:
   A. Concrete materials, reinforcement, and placement requirements are specified in Division 03 – Concrete.
   B. Supports, anchors, sleeves, and seals furnished as part of factory-fabricated equipment, are specified as part of that equipment assembly in other Division 26 Sections.
   C. Section 07 72 36 - Roof Scuttles.
   D. Section 26 05 10 – Basic Electrical Requirements.
   E. Section 26 05 26 – Grounding.

1.04 REFERENCE STANDARDS:
   A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
   B. ASTM International (ASTM):
C. American Welding Society (AWS):
   1. AWS D1.1/D1.1M - Structural Welding Code - Steel.

D. National Fire Protection Association (NFPA):

E. National Electrical Contractors Association (NECA):
   1. NECA 1 – Standard Practice of Good Workmanship In Electrical Construction.

F. Society of Protective Coatings (SSPC):
   1. SSPC-PA 1 - Shop, Field and Maintenance Painting of Steel.

G. Underwriters Laboratories (UL):
   1. Provide electrical devices, components, and fire stops which are UL-listed and labeled.

1.05 PERFORMANCE/DESIGN CRITERIA:

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.

1.06 SUBMITTALS:

A. Refer to Division 01 and Section 26 05 10 - Basic Electrical Requirements for administrative and procedural requirements for submittals.

B. Includes, but not limited to, the following:
   1. Product Data: Submit manufacturer's data on supporting devices including catalog cuts, specifications, and installation instructions, for each type of support, anchor, sleeve, and seal.

C. Shop Drawings: Submit dimensioned drawings of fabricated products, indicating weights, strength, details of fabrication, and details of materials.

1.07 QUALITY ASSURANCE:

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with NFPA 70.

1.08 COORDINATION:

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete specifications.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 07 72 00 - Roof Accessories.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Anchor Manufacturers: Subject to compliance with requirements, provide anchors of one of the following manufacturers.
   1. Hilti, Inc.
2. Ideal Industries, Inc.
4. Eaton/Cooper; McGraw Edison Co.
5. Unistrut; Atkore International.

B. Channel System Manufacturers: Subject to compliance with requirements, provide channel system of one of the following manufacturers.
1. Allied Tube & Conduit Corp.
2. Eaton/Cooper; B-Line Systems, Industries.
3. Erico International Corp.
4. Kindorf; Thomas & Betts Corp.
5. Power-Strut; Power Engineering Co.
6. Unistrut; Atkore International.

C. Fire and Smoke Stop Compounds: Subject to compliance with requirements, provide channel system of one of the following manufacturers.
1. 3M Company.
2. Hilti, Inc.

2.02 MATERIALS:

A. General: Provide supporting devices which comply with manufacturer's standard materials, design, and construction in accordance with published product information, as required for complete installation, and as herein specified. All supports shall be designed for the support of the maximum number of conduits and their maximum conductor weights for maximum conduit loading. Where more than one type of supporting device meets indicated requirements, selection is Contractor's option. Do not use perforated metal straps for supports.

B. Supports: Supporting devices of types, sizes, and materials indicated, and having the following construction features.
1. Clevis Conduit Hangers: For supporting conduit; galvanized steel; with 3/8-, 1/2-, 5/8- or 3/4-inch rod, size of clevis and rod as required.
2. Riser Clamps: For supporting conduit, galvanized steel, with two bolts and nuts.
3. Steel Rod Couplings: Provide 3/8-, 1/2-, 5/8- or 3/4-inch straight rod couplings, size as required.
4. C-Beam Clamps: Malleable iron, 3/8-, 1/2-, 5/8-, or 3/4-inch rod, size as required.
5. I-Beam Clamps: Galvanized steel, with 3/8-, 1/2-, 5/8-, or 3/4-inch rod, size as required;
3/8-inch horizontal "J" hook safety rod that bolts across the flange, flange width as required.
6. One-Hole Conduit Straps: For supporting conduit; stamped plated steel, size as required.
7. Two-Hole Conduit Straps: For supporting conduit, stamped plated steel, size as required.
10. Conduit Clamps: For supporting conduit; galvanized stamped steel, size as required.
11. U-Bolts: For supporting conduit; galvanized, size as required.

C. Anchors: Anchors of types, sizes and materials indicated, with the following construction features.
1. Lead Expansion Anchors: 1/2, 5/8, or 3/4 inch as required.
2. Toggle Bolts: Springhead, 3/16 by 4 inch or larger size as required.
SECTION 26 05 29 – HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS: continued

D. Sleeves and Seals: Sleeves and seals of types, sizes, and materials indicated, with the following construction features:
1. Pipe Sleeves: When penetrating a wall, ceiling roof or floor, provide pipe sleeves of one of the following:
   a. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate sleeves from the following gauge metal: 3 inch and smaller, 20 gauge; 4 inch to 6 inch, 16 gauge; over 6 inches, 14 gauge.
   b. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe; remove burrs.
   c. Iron Pipe: Fabricate from cast iron or ductile-iron pipe; remove burrs.
   d. Plastic Pipe: Fabricate from Schedule 80 PVC plastic pipe; remove burrs.

2. Wall, Roof and Floor Seals: Provide sleeves for conduit which penetrate foundation walls below grade, floors, ceilings, or exterior walls. Caulk between sleeve and conduit with nontoxic, UL-classified caulking material to ensure watertight seal.

3. Provide a fire-rated sleeve and seal equal to or exceeding the fire rating of the ceiling, floor or wall being penetrated.

E. Conduit Cable Supports: Cable supports with insulating wedging plug for nonarmored type electrical cables in risers; construct for rigid metal conduit (size as required) number of wires as required, type wire as specified; construct body of malleable-iron casting with hot-dip galvanized finish.

F. U-Channel Strut Systems: Unless indicated otherwise, U-channel strut system for supporting electrical equipment, 12-gauge steel hot-dip galvanized after fabrication for wet and outdoor locations, 12-gauge standard green paint finish for dry and indoor locations, of types and sizes indicated; construct with 9/16-inch diameter holes, 8 inch o.c. on top surface, and with the fittings as required which mate and match with U-channel.

G. Fire and Smoke Stop Compounds: Provide one of the following:
1. 3M Fire Barrier 2000+
2. Hilti, Inc. FS-ONE MAX

PART 3 - EXECUTION

3.01 ERECTION, INSTALLATION, APPLICATION:

A. Install hangers, anchors, sleeves, and seals as specified, required, indicated, in accordance with manufacturer's written instructions and with recognized industry practices to insure supporting devices comply with requirements. Comply with requirements of NECA and NFPA 70 for installation of supporting devices.

B. Install hangers, supports, clamps, and attachments to support conduit properly from building structure. Arrange for grouping of parallel runs of horizontal conduits to be supported together on trapeze type hangers where possible. Install supports with spacing indicated and as required by NFPA 70 or as indicated when less than NFPA 70 required spacing.

C. Torque sleeve seal nuts, complying with manufacturer's recommended values. Ensure that sealing grommets expand to form watertight seal.

D. Design trapeze type supports, including fasteners to the structure to carry the following loads:
1. Outdoor supports shall have the following added to the calculated load:
   a. Ice weighing 57 pounds per cubic foot to a thickness of 0.5 inches over the projected area of the supports and conduit being supported.
   b. Snow weighing 8 pounds per square foot over the projected area of the conduit being supported.
c. Wind at 25 pounds per square foot acting in a downward direction.

2. The greater of the following:
   a. The total calculated load multiplied by a factor of 4.
   b. The total calculated load +200 pounds.

E. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

F. Repair damage to painted finishes with paint recommended by manufacturer.

G. Install fire and smoke stop compounds at all penetrations of fire rated walls, floors, ceilings and roofs. Install fire and smoke stop compounds in accordance with manufacturer's instructions to provide a fire seal rating equal to or greater than that of the surface penetrated.

1. Testing shall be performed in accordance with ASTM-E814 REV A and applicable local codes.

3.02 CONCRETE BASES:

A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 - Concrete.

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

2. Install anchor bolts to elevations required for proper attachment to supported equipment.

3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.03 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 (0.05 mm).

B. Touchup: Comply with requirements in Division 09 for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION 26 05 29
SECTION 26 05 33 – RACEWAYS, BOXES, SLEEVES, SEALS AND FITTINGS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. This Section specifies the following:
      1. Conduit.
      2. Outlet and device boxes.
      3. Weatherproof boxes.
      5. Pull boxes.
      6. Floor boxes.
      7. Fittings.
      8. Bushings and ground bushings.
      9. Locknuts.
     11. Supports and accessories.
     12. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
     13. Sleeve-seal systems.
     15. Grout.

1.03 RELATED REQUIREMENTS:
   A. Division 07 - Penetration Firestopping for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.
   B. Division 27 - Communications.
   C. Division 31 - Trenching and Backfilling.
   D. Section 26 05 10 - Basic Electrical Requirements for administrative and procedural requirements for submittals.
   E. Section 26 05 26 – Grounding.
   F. Section 26 05 29 - Hangers and Supports for Electrical Systems.
   G. Section 26 05 53 - Electrical Identification.

1.04 REFERENCE STANDARDS:
   A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
   B. National Electrical Contractors Association (NECA):
      1. NECA NEIS 1 - Standard Practice of Good Workmanship in Electrical Construction.
   C. National Electrical Manufacturers Association (NEMA):
      1. NEMA C80.1 - Electrical Rigid Steel Conduit (ERSC).
      2. NEMA C80.3 - Steel Electrical Metallic Tubing (EMT).
      3.     
      4. NEMA TC-2 - Electrical Polyvinyl Chloride (PVC) Conduit.
SECTION 26 05 33 – RACEWAYS, BOXES, SLEEVES, SEALS AND FITTINGS FOR ELECTRICAL SYSTEMS: continued

5. NEMA TC-3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
6. NEMA TC-6 and 8 - Polyvinyl Chloride (PVC) Plastic Utilities for Underground Installation.
8. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports.
9. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports.
10. NEMA 250 - Enclosures for Electrical Equipment (1,000V Maximum).

D. National Fire Protection Association (NFPA):
1. NFPA-70 - National Electrical Code, (NEC). Comply with applicable requirements of NEC pertaining to construction and installation of raceway systems.

E. Underwriters Laboratories (UL):
1. Provide all devices and equipment which are UL listed and labeled.
2. UL 1 - Standards for Flexible Metal Conduit.
3. UL 6 - Electrical Rigid Metal Conduit – Steel.
4. UL 50, 50E - Standard for Enclosures for Electrical Equipment.
5. UL 360 - Standard for Liquid-Tight Flexible Metal Conduit.
6. UL 467 - Grounding and Bonding Equipment.
7. UL 514A - Metallic Outlet Boxes.
8. UL 514B - Conduit, Tubing, and Cable Fittings.
10. UL 651 - Standard for Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings.
11. UL 651A - Schedule 40 and 80 High Density Polyethylene (HDPE) Conduit.
12. UL 797A - Standard for Electrical Metallic Tubing – Aluminum and Stainless Steel.
13. UL 870 - Standard for Wireways, Auxiliary Gutters, and Associated Fittings.

1.05 SUBMITTALS:
A. Refer to Division 01 and Section 26 05 10 - Basic Electrical Requirements for administrative and procedural requirements for submittals.
B. Submittals shall include, but not be limited to, the following:
1. Product Data:
   a. Submit manufacturer’s technical product data, including specifications and installation instructions, for each type of product required. Include data substantiating that materials comply with requirements.
   b. Submit layout drawings of electrical floor, junction and pull boxes showing accurately scaled box layouts and their spatial relationship to associated equipment.
2. Samples: For wireways and surface raceways and for each color and texture specified, 12 inches long.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:
A. Manufacturer:
1. Subject to compliance with requirements, provide each type of raceway from one of the following:
   a. Rigid Steel Conduit:
SECTION 26 05 33 – RACEWAYS, BOXES, SLEEVES, SEALS AND FITTINGS FOR ELECTRICAL SYSTEMS: continued

b. EMT:
   (1) Allied Tube and Conduit; Atkore International.
   (2) Republic Conduit, Inc.
   (3) Wheatland Tube Co.

c. PVC Coated Rigid Steel Conduit:
   (1) Externally Coated:
       (a) Allied Tube and Conduit; Atkore International.
       (b) Calbond; Calpipe Industries, Inc.
       (c) Perma-Cote Coated Conduit; Robroy Industries.
   (2) Externally and Internally Coated:
       (a) Perma-Cote Coated Conduit; Robroy Industries.
       (b) Calbond; Calpipe Industries, Inc.

d. Liquid-Tight, Flexible Metal Conduit:
   (1) AFC Cable Systems; Atkore International.
   (2) Anaconda Sealite; Division of ANAMET Electrical, Inc.
   (3) Electri-Flex Co.
   (4) Southwire Company.

e. Rigid Metal Conduit Fittings:
   (1) Appleton; EGS Electrical Group.
   (2) Raco; Hubbell Company.
   (3) Thomas & Betts Corp.

f. Flexible Metal Conduit Fittings:
   (1) Appleton; EGS Electrical Group.
   (2) Electri-Flex Co.
   (3) O-Z/Gedney; EGS Electrical Group.

g. Liquid-tight Flexible Metal Conduit Fittings:
   (1) Appleton; EGS Electrical Group.
   (2) Electri-Flex Co.
   (3) O-Z/Gedney; EGS Electrical Group.

h. EMT Fittings:
   (1) Appleton; EGS Electrical Group.
   (2) Raco; Hubbell Company.
   (3) Thomas & Betts Corp.

i. Nonmetallic Rigid Conduit and Fittings:
   (1) Carlon; Thomas & Betts Corp.
   (2) Prime Conduit.

j. Conduit Bodies:
   (1) Appleton; EGS Electrical Group.
   (2) Arrow-Hart Div; Cooper Industries.
   (3) Killark; Hubbell Inc.
   (4) O-Z/Gedney; EGS Electrical Group.

k. Interior Boxes:
   (1) Appleton; EGS Electrical Group.
   (2) Bell; Hubbell, Inc.
   (3) O-Z/Gedney; EGS Electrical Group.
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(4) Pass and Seymour; Legrand.
(5) Raco; Hubbell, Inc.
(6) Steel City; Thomas & Betts Corp.

1. Weatherproof Boxes:
   (1) Appleton; EGS Electrical Group.
   (2) Arrow Hart; Eaton.
   (3) Hubbell, Inc.
   (4) O-Z/Gedney; EGS Electrical Group.
   (5) Pass and Seymour; Legrand.

2. Junction and Pull Boxes:
   (1) Appleton; EGS Electrical Group.
   (2) Arrow Hart; Eaton.
   (3) Bell Electric, Square D Company.
   (5) O-Z/Gedney; EGS Electrical Group.

3. Poke Throughs & Floor Boxes:
   (1) Arrow Hart; Eaton.
   (2) FSR, Inc.
   (3) Hubbell, Inc.
   (4) MonoSystems.
   (5) Steel City; Thomas & Betts Corp.
   (6) Wiremold; Legrand.

4. Bushings, Grounding Bushings and Locknuts:
   (1) Arrow Hart; Eaton.
   (2) Appleton; EGS Electrical Group.
   (3) O-Z/Gedney; EGS Electrical Group.
   (4) Raco; Hubbell, Inc.
   (5) Steel City; Thomas & Betts Corp.

5. Electrical Enclosures:
   (1) Hoffman; Pentair Equipment Protection.
   (2) Wiegmann; Hubbell, Inc.

6. Sleeve-Heat Systems:
   (1) Advance Products & Systems, Inc.
   (2) CALPICO, Inc.
   (3) Metraflex Company (The).
   (4) Pipeline Seal and Insulator, Inc.
   (5) Proco Products, Inc.

7. Sleeve-Heat Fittings:
   (1) Link-Seal.
   (2) Presealed Systems.

2.02 METAL CONDUIT AND TUBING:

A. General: Provide metal conduit, tubing, and fittings of types, grades, sizes, and weights (wall thicknesses) for each service indicated. Where types and grades are not specified or indicated, provide proper selection to fulfill specified requirements, and comply with applicable portions of NEC for raceways. Minimum size shall be 3/4 inch, unless indicated or specified otherwise.

1. Factoy-applied, closed-end thread protectors.
SECTION 26 05 33 – RACEWAYS, BOXES, SLEEVES, SEALS AND FITTINGS FOR ELECTRICAL SYSTEMS: continued

B. Rigid Steel Conduit: Rigid steel, zinc coated, threaded type conforming to UL 6A.
   1. Zinc coating fused to inside and outside walls.

C. Intermediate Steel Conduit: Rigid intermediate grade (IMC) hot-dip galvanized conforming to UL 1242.

D. Electrical Metallic Tubing (EMT): UL 797.

E. Flexible Metal Conduit: UL 1. Formed from continuous length of spirally-wound, interlocked zinc-coated strip steel. Minimum size shall be 1/2 inch unless indicated or specified otherwise. Approved as a grounding path for circuits rated 20 amperes or less and in lengths of 6 feet and less.

F. Liquid-Tight, Flexible Metal Conduit: Liquid-tight flexible metal conduit; construct of single strip, flexible, continuous, interlocked, and double-wrapped steel; galvanized inside and outside; coat with (oil-resistant,) liquid-tight thermoplastic jacket. Approved as a grounding path in conduit sizes 1-1/4 inch and smaller and in lengths 6 feet or less when protected as follows:
   1. 3/8 inch and 1/2 inch protected at 20 amperes or less.
   2. 3/4 inch, 1 inch and 1-1/4 inch protected at 60 amperes or less.

G. Rigid Metal Conduit Fittings: Threaded cast-malleable iron, galvanized or cadmium plated, conforming to UL 514B.
   1. Provide steel fittings for steel conduit.
   2. Provide aluminum fittings for aluminum conduit.

H. Liquid-Tight Flexible Metal Conduit Fittings: Provide cadmium plated, malleable-iron fittings with compression type steel ferrule and neoprene gasket sealing rings, with insulated or noninsulated throat. Fittings shall be approved for grounding in conduit sizes 1-1/4 inch and smaller per NFPA 70 Article 350.60.

I. EMT Fittings: Steel compression type.

J. Conduit Bodies: Galvanized cast-metal conduit bodies of types, shapes, and sizes as required to fulfill job requirements and NFPA-70 requirements. Construct conduit bodies with threaded conduit entrance ends, removable covers, either cast or of galvanized steel, and corrosion-resistant screws.

K. Conduit and Tubing Accessories: Provide conduit and tubing accessories of types, sizes, and materials, complying with manufacturer's published product information which mate and match conduit and tubing.

L. Conduit Bushings: Provide insulated throat for all bushings. Grounding bushings shall have an integral copper set-screw type cable grounding lug.

2.03 NONMETALLIC CONDUIT AND FITTINGS:

A. General: Provide nonmetallic conduit, ducts, and fittings of types, sizes, and weights for each service indicated. Where types and grades are not indicated, provide proper selection determined by installer to fulfill wiring requirements which comply with provisions of NFPA 70 for raceways. Minimum size shall be 3/4 inch, unless indicated otherwise.

B. Electrical Plastic Conduit:
   1. Heavy-Wall Conduit: Schedule 40, 90ºC, UL rated, constructed of polyvinyl chloride and conforming to NEMA TC-2, for direct burial or normal aboveground use, UL listed, and in conformity with NFPA 70 Article 352.
   2. Extra-Heavy-Wall Conduit: Schedule 80, 90ºC, UL rated, constructed of polyvinyl chloride compound C 200 PVC, and UL listed in accordance with NFPA 70 Article 352 for direct burial or aboveground use.
SECTION 26 05 33 – RACEWAYS, BOXES, SLEEVES, SEALS AND FITTINGS FOR ELECTRICAL SYSTEMS: continued

C. PVC Conduit Fittings: NEMA TC-3, mate and match to conduit or tubing type and material.

D. Underground PVC Plastic Utilities Duct: (NEMA TC-6 and -8, Type EB-20 for encased burial in concrete, Type DB-60 for direct burial, Type EB-35 for encased burial in concrete, Type DB-120 for direct buried.)

E. PVC and ABS Plastic Utilities Duct Fittings: NEMA TC-9, mate and match to duct type and material.

F. Conduit and Tubing Accessories: Provide conduit, tubing, and duct accessories of types, sizes, and materials, complying with manufacturer's published information which mate and match conduit and tubing.

2.04 FABRICATED MATERIALS:

A. Outlet Boxes: Galvanized, coated, flat rolled, sheet-steel outlet wiring boxes, of shapes, cubic inch capacities, and sizes, including box depths as required, indicated, and specified, suitable for installation at respective locations. Construct outlet boxes with mounting holes and with conduit knockout openings in bottom and sides. Provide boxes with threaded screw holes for grounding screws, fastening devices, box covers, and for equipment grounding. Minimum box size shall be 4-inch by 4-inch by 1.5 inches, provide larger box if required, specified or indicated otherwise.

B. Device Boxes: Galvanized, coated, flat rolled, sheet-steel gangable device boxes, of shapes, cubic inch capacities, and sizes, including box depths as required, indicated, and specified, suitable for installation at respective locations. Construct device boxes for flush mounting with mounting holes, with conduit knockout openings in bottom and sides, and with threaded screw holes for fastening devices and box covers. Provide corrosion-resistant screws for equipment grounding. Minimum box size shall be 4-inch by 4-inch by 1.5 inches, provide larger box if required, specified or indicated otherwise.

1. Device Box Accessories: Provide as required for each installation, including mounting brackets, device box extensions, switch box supports, plaster ears, and plaster board expandable grip fasteners (use only in existing walls) which are compatible with device boxes being utilized to fulfill installation requirements for individual wiring situations. Choice of accessories is Contractor's code-compliance option.

C. Weatherproof Boxes: Corrosion-resistant, cast-metal, weatherproof, outlet wiring boxes, of types, shapes, and sizes, including depth of boxes as required with threaded conduit hubs for fastening electrical conduit. Provide cast-metal face plates with spring-hinged, watertight caps suitably configured for each application, including face plate gaskets and corrosion-resistant fasteners.

D. Junction and Pull Boxes: Galvanized, code-gage sheet steel junction and pull boxes, with screw-on covers; of types, shapes, and sizes, to suit each respective location and installation; with welded seams and equipped with manufacturer's standard corrosion resistant steel nuts, bolts, screws and washers.

E. Floor Boxes: Cast-iron, raintight, adjustable floor boxes as indicated, with threaded-conduit-entrance ends and vertical adjusting rings, gaskets, brass floor plates with flush screw-on covers with ground flange and stainless steel cover screws.

1. Floor Boxes Accessories: Flush type, duplex, 2-pole, 3-wire, grounding, 125V, 20 ampere, floor-type receptacles with flanges.

F. Bushings: Provide threaded, nylon insulated metallic bushings. Provide steel bushings for conduit sizes 1.5 inches and smaller. Provide malleable iron bushings for conduit sizes 2 inches and larger.
SECTION 26 05 33 – RACEWAYS, BOXES, SLEEVES, SEALS AND FITTINGS FOR ELECTRICAL SYSTEMS: continued

G. Grounding Bushings: Provided where indicated, specified and required by NEC. Provide threaded, insulated, malleable iron bushing with lay-in screw clamp lug.

H. Locknuts: Provide steel locknuts for conduit sizes 2 inches and smaller. Provide malleable iron for conduit sizes 2.5 inches and larger.

I. Sealing Hub: Provide watertight, threaded, insulated sealing hub connectors for all outdoor and indoor wet locations where conduit enters into enclosures. Sealing hub threaded lengths shall be adequate to allow installation of bushing.

J. Knockout Closures: Provide steel press-in knockout seals for all unused punched out knockouts 2 inches and smaller. Provide steel two-piece bolt on knockout seals for all unused punched out knockouts 2.5 inches and larger.

K. Fittings: Provide all threaded nipples, insulated short elbows, offset nipples, offset connectors, enlargers and reducers as required. Provide EMT compression type connectors with insulated throat. Provide EMT compression type insulated short elbows as required. Provide EMT setscrew type offset connectors as required.

2.05 SLEEVES:

A. Wall Sleeves:
   2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. PVC-Pipe Sleeves: ASTM D1785, Schedule 40.

D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

F. Sleeves for Rectangular Openings:
   2. Minimum Metal Thickness:
      a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
      b. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.06 SLEEVE-SEAL SYSTEMS:

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
   1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   2. Pressure Plates: Carbon steel
   3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating length required to secure pressure plates to sealing elements.
SECTION 26 05 33 – RACEWAYS, BOXES, SLEEVES, SEALS AND FITTINGS FOR ELECTRICAL SYSTEMS: continued

2.07 SLEEVE-SEAL FITTINGS:
   A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

2.08 GROUT:
   A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
   C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
   D. Packaging: Premixed and factory packaged.

2.09 SILICONE SEALANTS:
   A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
      1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
   B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.01 INSTALLATION OF RACEWAYS:
   A. General:
      1. Install raceways as indicated in accordance with manufacturer's written installation instructions and in compliance with NEC. Install raceways plumb and level, and maintain NEC recommended clearances. Provide raceway supports in accordance with the NEC and Section 26 05 29 - Hangers and Supports for Electrical Systems.
   B. Coordinate with other work including wires/cables, boxes, and panel work as necessary to interface installation of electrical raceways and components with other work.

3.02 INSTALLATION OF CONDUITS:
   A. General: Install concealed conduits in new construction work - in walls, in slabs, or above suspended ceilings. Run conduits concealed in existing work where practicable. Where conduits cannot be concealed in finished areas, use surface metal raceways only where indicated. Provide holes for conduit in all boxes, panels and enclosures as required.
      1. All conduit installed above grade (including exposed and concealed above removable suspended ceilings) that contains emergency power and emergency lighting conductors shall be identified in accordance with Section 26 05 53 – Electrical Identification.
      2. Mechanically fasten together metal conduits, enclosures, and raceways to form continuous electrical conductor. Connect to electrical boxes, fittings, and cabinets to provide electrical continuity and firm mechanical assembly.
3. Avoid use of dissimilar metals throughout system to eliminate possibility of galvanic corrosion. Where dissimilar metals are in contact, coat surfaces with corrosion inhibiting compound before assembling.

4. Install miscellaneous fittings such as reducers, close nipples, 3 piece unions, split couplings, and plugs that have been specifically designed and manufactured for their particular application. Install telescoping type linear expansion fittings in raceways every 200 foot linear run and wherever structural expansion joints are crossed.

5. Use roughing-in dimensions of electrically powered units furnished by unit manufacturer. Set conduit and boxes for connection to units only after receiving dimensions and after checking location with other trades.

6. Test conduits (witnessed by the Owner’s representative) required to be installed but left empty with ball mandrel. Clear any conduit which rejects ball mandrel. Pay costs involved for restoration of conduit and surrounding surfaces to original condition. Provide 200-pound tensile strength nylon conduit fish line throughout the entire length of all empty conduits. Leave 12 inches of slack at each end.

7. Do not install conduit in front of covers of new and existing electrical equipment, pull boxes, and junction boxes.

8. Provide all openings in floors, walls, ceilings and roofs for passage of conduit. Fire ratings of walls, floors, ceiling and roofs shall be maintained when passing through them by providing fire seals in accordance with Section 26 05 29 - Hangers and Supports for Electrical Systems.

9. Where different conduits contain circuits of different noise levels the horizontal and vertical spacing in inches between the outside surfaces of the conduits (or conduit to cable tray) shall not be less than indicated below (unless specified otherwise, indicated otherwise, or required otherwise by the equipment manufacturer):
   a. Noise Level 1 Circuits: Analog circuits less than 50V, digital circuits less than 12V or telephone circuits.
   b. Noise Level 2 Circuits: Analog circuits greater than 50V or digital circuits greater than 12V.
   c. Noise Level 3 Circuits: 120Vac or dc circuits operating at less than 20 amperes.
   d. Noise Level 4 Circuits: Ac or dc circuits less than 800V operating with currents less than 800 amperes.
   e. Noise Level 5 Circuits: Circuits over 800Vac or dc and/or over 800 amperes.
10. Provide a weatherproof duct seal compound between the conductors and the inner walls of all conduit that are routed to NEMA 3, 3R, 3S, 4 and 4X enclosures to prohibit moisture and/or humid air from entering the raceway and condensing.

11. Repair damage to galvanized finishes with a zinc-rich paint recommended by the manufacturer.

12. Repair damage to PVC finishes with matching touch-up coating recommended by the manufacturer.

13. Where metallic conduit leaves cast-in-place concrete (to air, to earth or to compacted fill) coat the conduit 2 inches on either side of the line formed by the finished concrete surface with a bitumastic asphalt coating.

B. Conduit Installation: Provide rigid steel zinc-coated conduit where embedded in cast-in-place concrete, in hazardous locations, routed below floor slabs, when containing circuits over 600V ac, routed through cast-in-place masonry, or installed outdoors. Follow minimum requirements in other areas as follows:

1. Use rigid steel zinc-coated conduit in mechanical equipment rooms, electrical equipment rooms, penthouses where exposed to physical damage, crawl spaces, tunnels, service splines, kitchens and cafeterias, and in warehouse spaces below 18 feet-0 inches height, and for 240 V feeder circuits to panelboards.

2. Use steel zinc-coated EMT for interior 240V branch circuits, interior concealed 120V power, lighting, alarms, controls, and communications in offices, corridors, toilets, lunchroom areas, lab areas, ceiling plenum areas, and in warehouse spaces above 18 feet-0 inches height.

3. Use flexible steel conduit only in movable partitions and from outlet boxes to interior recessed lighting fixtures (Maximum of 6 feet long and a minimum of 4 feet long in nonenvironmental air plenums. Maximum length in environmental air plenums shall be 4 feet long), and final 24 inches of connection to motors, transformers, and control items. Provide where subject to movement and vibration where connections are in dry, nonhazardous, interior locations. Provide in cells of precast concrete panels. Provide a "green" insulated equipment ground wire suitably sized per NEC 250.122 unless indicated otherwise in all flexible steel conduit. Except equipment ground wire is not required on control circuits rated 20 amperes or less where flexible steel conduit 6 feet or
less in length is used only for vibration elimination purposes and not for purposes of providing flexibility for movement.

4. Use liquid-tight flexible conduit in nonhazardous locations, length shall not exceed 6 feet, unless indicated otherwise, where subjected to movement and vibration where connections are subjected to one or more of the following conditions:
   a. Exterior location.
   b. Moist or humid atmosphere where condensation can be expected to accumulate.
   c. Corrosive atmosphere.
   d. Subjected to water spray or dripping oil, water or grease.
   e. Connected to a motor driving a nonsubmerged pump.

5. Provide a "green" insulated equipment ground wire suitably sized per NEC 250.122 unless indicated otherwise in all liquid-tight flexible conduit.

6. Cut conduits straight, properly ream, and cut threads for threaded conduit deep and clean.

7. Field-bend conduit with benders designed for purpose so as not to distort nor vary internal diameter.

8. Size conduits as indicated, unless no size is indicated then size per NEC, except no conduit smaller than 3/4 inch shall be embedded in concrete or masonry.


10. Conduits shall not cross pipe shafts, access openings or ductwork openings.

11. Keep conduits a minimum distance of 6 inches from parallel runs of flues, hot water pipes or other sources of heat. Wherever possible, install horizontal raceway runs above water and steam piping.

12. Support riser conduit at each floor level with clamp hangers.

13. Use of running threads at conduit joints and terminations is prohibited. Where required, use 3-piece union or split coupling.


15. Use externally PVC coated (and internally urethane coated) rigid steel conduit on all 90 bends into buildings and where specified or indicated.

16. Conduit installed above suspended ceilings shall comply with the following:
   a. Install exposed conduits and extensions from concealed conduit systems neatly and parallel with or at right angles to walls of building or structure.
   b. Install exposed conduit work so as not to interfere with ceiling inserts, windows, doors, lights, ventilation ducts or outlets.
   c. Support exposed conduits by use of hangers, clamps, or clips. Support conduits on each side of bends and on spacing not to exceed NEC requirements.

C. Concealed Conduits:

1. Metallic raceways in floors below grade or outside are to have conduit threads painted with corrosion inhibiting compound before couplings are assembled. Draw up coupling and conduit sufficiently tight to ensure watertightness.

2. For floors-on-grade, install PVC externally coated rigid steel conduit under concrete slabs. Provide only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduit.

3. Install underground conduits a minimum of 24 inches below finished grade.

D. Conduits in Concrete Slabs:

1. Place conduits between bottom reinforcing steel and top reinforcing steel.

2. Place conduits either parallel or at 90 degrees to main reinforcing steel.
3. Separate conduits by not less than the outside diameter of the largest conduit to ensure proper concrete bond.
4. Conduits crossing in slab must be reviewed for proper cover by the Owner's Representative.
5. Embedded conduit outside diameter shall not exceed 1/3 of slab thickness.

E. Install conduits so as not to damage or run through solid structural members. Avoid horizontal or cross runs in building partitions or side walls.

F. Exposed Conduits:
1. Install exposed conduits and extensions from concealed conduit systems neatly and parallel with or at right angles to walls of building or structure.
2. Install exposed conduit work so as not to interfere with ceiling inserts, windows, doors, lights, ventilation ducts or outlets.
3. Support exposed conduits by use of hangers, clamps, or clips. Support conduits on each side of bends and on spacing not to exceed NEC requirements.
4. Run conduit for outlets on waterproof walls exposed. Set anchors for supporting conduit on waterproof wall in waterproof cement.
5. Above requirements for exposed conduits also apply to conduits installed in space above suspended ceilings and in crawl spaces.

G. Nonmetallic Conduits:
1. Provide only where indicated. Do not install in hazardous locations.
2. Make solvent cemented joints in accordance with recommendations of manufacturer.
3. Install PVC conduits in accordance with NEC and in compliance with local utility practices.
4. All duct banks shall be a minimum of 3 feet below grade. Conduit in duct banks shall have a minimum of 3 inches of concrete cover in all directions. There shall be a minimum of 2 inches of concrete separation between all conduit.
5. All conduit risers from buried conduit or duct banks shall be made with (internally urethane coated and) externally PVC coated galvanized rigid steel conduit elbows.

H. Conduit Fittings:
1. Provide locknuts for securing conduit to metal enclosures with a sharp edge for digging into metal and ridged outside circumference for proper fastening. Standard locknuts are not acceptable.
2. Provide threaded, nylon insulated bushings for terminating conduits which have flared bottom and ribbed sides, with smooth upper edges to prevent injury to cable insulation.
3. Provide threaded, grounding bushings of insulated type with copper set screw clamp type lay-in grounding terminal where required by NEC, where indicated or specified.
4. Provide miscellaneous fittings such as reducers, close nipples, 3 piece unions, split couplings, and plugs as required which are specifically designed for their particular application.
5. Provide grounding in accordance with Section 26 05 26 - Grounding.
6. Provide rain-tight hubs on all outdoor conduit that are terminated in a non-threaded enclosure hole.
7. Provide identification of all raceways as specified in Section 26 05 53 - Electrical Identification.
8. EMT shall have galvanized compression type box connectors at all boxes.
9. Provide raceway sealing fittings at suitable, approved, accessible locations and fill them with UL listed sealing compound. For concealed raceways, install each fitting in a flush
SECTION 26 05 33 – RACEWAYS, BOXES, SLEEVES, SEALS AND FITTINGS FOR ELECTRICAL SYSTEMS: continued

steel box with a blank cover plate having a finish similar to adjacent wall plate or surfaces. Provide sealing fittings where:

a. Conduit enters or leaves hazardous locations.
b. Where conduit passes from warm locations to cold locations, such as boundaries of refrigerated spaces and air-conditioned spaces.

3.03 INSTALLATION OF SURFACE METAL RACEWAYS AND WIREWAYS:
A. General: Mechanically assemble metal enclosures and surface metal raceways for conductors to form continuous electrical conductor, and connect to electrical boxes, fittings, and cabinets to provide effective electrical continuity and rigid mechanical assembly.
   1. Provide only where indicated. Avoid use of dissimilar metals throughout system to eliminate possibility of galvanic corrosion. Where dissimilar metals are in contact, coat all surfaces with corrosion inhibiting compound before assembling.
   2. Install expansion fittings in all raceways, surface metal raceways, and wireways wherever structural expansion joints are crossed.
   3. Make changes in direction of surface metal raceway and wireway with proper fittings supplied by raceway manufacturer. No field bends of surface metal raceway or wireway sections will be permitted.
   4. Properly support and anchor surface metal raceways for their entire length with structural materials. Surface metal raceways are not to span any space unsupported.
   5. Use boxes as supplied by surface metal raceway manufacturer wherever junction, pull or devices boxes are required. Standard electrical "handy" boxes, etc. shall not be permitted for use with surface metal raceway installations.
   6. Provide identification of all raceways as specified in Section 26 05 53 – Electrical Identification.
   7. Provide tap location nameplates for wireways when used as auxiliary gutters as specified in Section 26 05 53 – Electrical Identification.
   8. Ground wireways at 10-foot intervals per Section 26 05 26 – Grounding.

3.04 INSTALLATION OF ELECTRICAL BOXES AND FITTINGS:
A. General: Install electrical boxes, bushings, locknuts, nipples, connectors, sealing hubs, and fittings as required, indicated, in accordance with applicable requirements of NEC and in accordance with recognized industry practices to fulfill project requirements.
B. Coordinate installation of electrical boxes and fittings with wire/cable, wiring devices, and raceway installation work.
C. Provide weatherproof boxes for interior and exterior locations exposed to weather or moisture.
D. All boxes containing emergency power and lighting circuits shall be identified as specified in Section 26 05 53 – Electrical Identification.
E. Provide (oil-tight) knockout closures to cap unused knockout holes where blanks have been removed.
F. Install electrical boxes in only those locations which ensure ready accessibility to enclosed electrical wiring.
G. Maximum box size in a fire-rated wall shall be 4 inches by 4 inches square. Do not install boxes back-to-back in walls. In nonfire-rated and nonacoustic-rated walls, provide not less than 6 inches (150 mm) horizontal separation between boxes installed in opposite sides of wall. Provide not less than 24 inches (610 mm) horizontal separation between boxes installed in opposite sides of fire-rated and acoustic-rated walls.
H. Do not install aluminum products in concrete.
I. Position recessed outlet boxes accurately to allow for surface finish thickness.
J. Set floor boxes level and flush with finish flooring material.
K. Fasten electrical boxes firmly and rigidly to the surfaces to which attached, structural surfaces to which attached, or solidly embed them in concrete or masonry.
L. Box support must be independent of conduit.
M. Provide electrical connections for installed boxes.
N. Subsequent to installation of boxes, protect boxes from construction debris and damage.

3.05 **GROUNDING:**
A. Properly ground electrical boxes and demonstrate compliance with NEC requirements. Bond all non-isolated equipment grounding conductors to all electrical boxes.

3.06 **SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS:**
A. Comply with NECA 1.
B. Comply with NECA VE-2 for cable tray and cable penetrations.
C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
   1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
      a. a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07, Section "Joint Sealants".
      b. b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
   2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
   3. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed [or unless seismic criteria require different clearance].
   4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
   5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level. Install sleeves during erection of floors.
D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
   1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
   2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using [steel] [cast-iron] pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing sleeve-seal system.
3.07 **SLEEVE-SEAL-SYSTEM INSTALLATION:**
   A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
   B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.08 **SLEEVE-SEAL-FITTING INSTALLATION:**
   A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
   B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
   C. Secure nailing flanges to concrete forms.
   D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 26 05 33
SECTION 26 05 44 - UNDERGROUND DUCT BANKS AND MANHOLEs

PART 1 - GENERAL

1.01 SUMMARY:
   A. This Section includes the following:
      1. Complete underground duct systems consisting of banks of nonmetallic ducts encased in
         plain and reinforced concrete, and reinforced concrete manholes.
      2. All necessary earth and rock excavation and backfill.
      3. Removal and disposal of all excess excavation material.
   B. Related Work Specified Elsewhere:
      3. Concrete: DIVISION 3.

1.02 REFERENCES:
   A. Applicable Standards:
      1. National Electrical Manufacturer's Association (NEMA):
         a. TC-2: Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80).
         c. TC-8: Extra-Strength PVC Plastic Utilities Duct for Underground Installation.
      3. Federal Specifications:
      4. Underwriters Laboratories, Inc. (UL):
         a. 651 - Schedules 40 and 80 Rigid PVC Conduit.
         b. 651A - Type EB and a Rigid PVC Conduit and HDPE Conduit.

PART 2 - PRODUCTS

2.01 DUCTS:
   A. Conduit Types for Concrete Encasement:
      1. Type EB:
         a. Tested to Underwriters' Laboratories, Inc. (UL) Standard UL 651A.
         b. Type EB20, Standard Wall, Thickness conforming to NEMA TC-6 and ASTM F512.
         c. Type EB35, Heavy Wall, Thickness conforming to NEMA TC-8 and ASTM F512.
      2. Type Schedule 40 Polyvinyl Chloride (PVC):
         a. Underwriters' Laboratories, Inc. (UL) Listed.
   B. Rated for use with 90°C conductors.
   C. Complete with all necessary end bells, couplings, offset couplings, elbows, and other fittings.
   D. Sizes as indicated.
   E. Long radius elbows for all duct termination risers.
   F. Interlocking type plastic duct spacers for duct spacing as indicated.

2.02 REINFORCING STEEL: Provide as specified in DIVISION 3.
SECTION 260544 – UNDERGROUND DUCT BANKS AND MANHOLES: continued

2.03 CONCRETE: Provide as specified in DIVISION 3.

2.04 MASONRY: Provide as specified in DIVISION 4.

2.05 HARDWARE:
   A. Manhole frames and covers of type, size and load capacity as indicated.
   B. Pulling irons, steps, inserts, cable racks and additional hardware as indicated.
   C. Grounding as indicated or as specified in SECTION 26 05 26.

2.06 "PULLING IN" ROPE:
   A. Nylon.

PART 3 - EXECUTION

3.01 EXCAVATION AND TRENCHING FOR DUCT BANKS AND MANHOLES: Perform as specified in DIVISION 31.

3.02 INSTALLATION:
   A. Duct Banks:
      1. Ducts:
         a. Assemble as follows:
            (1) On spacers to maintain horizontal and vertical separation indicated.
            (2) With joints in adjacent ducts staggered.
            (3) All joints watertight by application of joint sealer compound furnished by duct manufacturer.
            (4) No reinforcing steel or other ferrous material between individual ducts.
         b. Securely tie overall at 5-foot or closer intervals as required.
         c. Secure to anchors after assembling to prevent flotation when placing concrete.
         d. Slope as indicated with a minimum continuous slope of 1/2 percent.
         e. Align ducts for each 100 feet not greater than 4 inches horizontal.
         f. Install end bells flush with face of concrete at each manhole and termination point unless indicated otherwise.
         g. Immediately after cleaning, install a "pulling in" rope in each duct as indicated, and plug each end of all ducts.
      2. Reinforcing: Place as specified in DIVISION 3.
      3. Concrete:
         a. Do not place prior to inspection and approval of duct and reinforcing installation by Engineer.
         b. Place as specified in DIVISION 3.
   B. Manholes:
      1. Construction:
         a. Construct with formed roof and walls to the dimensions and at locations indicated.
         b. Install the following as indicated:
            (1) Inserts.
            (2) Pulling irons.
            (3) Steps.
            (4) Other hardware items.
            (5) Conduit.
SECTION 260544 – UNDERGROUND DUCT BANKS AND MANHOLES: continued

(6) Cable tray.
(7) Cable racks.
(8) Supports
(9) Holes
(10) Sleeves.
(11) Openings.

c. Place forming, reinforcing and concrete as specified in DIVISION 3.
d. Provide ground rods and ground connections to all metal items as indicated or as specified in SECTION 26 05 26.

3.03 CLEANING: Rod and clean all ducts with suitable cleaners, swabs and mandrels after completion of the duct bank.

3.04 BACKFILLING: Backfill as specified in DIVISION 31.

END OF SECTION 26 05 44
SECTION 26 05 53 – ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. This Section specifies electrical identification work including the following:
      1. Buried cable and duct bank warnings.
      2. Electrical power, control, and communication conductors (and raceways).
      3. Operational instructions and warnings.
      4. Danger, caution and warning signs.
      5. Equipment/system identification nameplates.

1.03 REFERENCE STANDARDS:
   A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
   B. Applicable Standards: Comply with the applicable requirements of the following standards.
      1. The American Society of Mechanical Engineers (ASME):
      2. ASTM International (ASTM):
      3. National Electrical Manufacturers Association (NEMA):
         a. 70 - National Electrical Code (NEC), as applicable to installation of identifying labels and markers for wiring and equipment.
         b. 70E – Standard For Electrical Safety In The Workplace.
      5. Occupational Safety and Health Administration (OSHA):
      6. Underwriters Laboratories (UL), pertaining to electrical identification systems:

1.04 SUBMITTALS:
   A. Refer to Division 01 and Section 26 05 10 - Basic Electrical Requirements for administrative and procedural requirements for submittals.
   B. Includes, but not limited to, the following:
      1. Product Data: Submit manufacturer's data on electrical identification materials and products.
      2. Samples: Submit samples of each color, lettering style, and other graphic representation required for each identification material or system.

1.05 QUALITY ASSURANCE:
SECTION 26 05 53 – ELECTRICAL IDENTIFICATION: continued

B. Comply with NFPA 70.
D. Comply with NEMA Z535.4 – Product Safety Signs and Labels.
E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.06 COORDINATION:
A. Coordinate identification names, abbreviations, colors, and other features with requirements in other sections requiring identification applications, Drawings, 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

2.01 MANUFACTURERS:
A. Subject to compliance with requirements, provide electrical identification products of one of the following (for each type marker):
   1. Brady Worldwide, Inc.
   2. Panduit Corp.
   4. Thomas & Betts Corp.

2.02 ELECTRICAL IDENTIFICATION MATERIALS:
A. General: Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than single type is specified for an application, selection is Installer's option; but provide single selection for each application.
B. Orange "Emergency" Conduit, Equipment, Box, and Cable Tray Markers:
   1. General: Self-adhesive vinyl tape marker not less than 3 mils thick. Provide 1-1/8 inch wide by 4-1/2 inch long marker for 2 inch and smaller conduit. Provide 2-1/4 inch wide by 9 inch long marker for 2-1/2 inch and larger conduit and all cable tray. Except as otherwise indicated, provide black lettering which indicates highest voltage of cables(s) in conduit or cable tray. Provide black lettering that indicates "Emergency" power circuit is in conduit or cable tray.
   2. Colors: Unless otherwise indicated or required by governing regulations, provide orange background tape marker.
C. Underground Type Plastic Line Marker:
   1. General: Permanent, bright-colored, continuous-printed plastic tape marker, intended for direct-burial service; not less than 6 inches wide by 4 mils thick. Provide tape marker with printing which most accurately indicates type of service of buried cable or duct bank. (Provide embedded continuous metallic strip or core.)
D. Wire/Cable Identification Bands:
   1. General: Vinyl-cloth self-adhesive cable/conductor markers of wrap-around type, either prenumbered plastic coated type or write-on type with clear plastic self-adhesive cover flap; numbered to show circuit identification number indicated on Drawings or Shop Drawings.
SECTION 26 05 53 – ELECTRICAL IDENTIFICATION: continued

E. Plasticized Tags:
   1. General: Preprinted or partially preprinted accident-prevention and operational tags, on plasticized card stock with matt finish suitable for writing, approximately 3-1/4 inches by 5-5/8 inches, with brass grommets and wire fasteners, and with appropriate preprinted wording, including large-size primary wording, e.g., "DANGER, DO NOT OPERATE." Tags shall comply with OSHA requirements.

F. Self-Adhesive Plastic Signs:
   1. General: Self-adhesive or pressure-sensitive, preprinted, flexible vinyl signs for operational instructions or warnings; of sizes suitable for application areas and adequate for visibility, with proper wording for each application, e.g., "EXHAUST FAN."
      a. Colors: Unless otherwise indicated or required by governing regulations, provide white signs with black lettering.

G. Baked Enamel "Danger" Signs:
   1. "DANGER" signs of baked enamel finish on 20-gauge steel (unless specified otherwise); of standard safety red, safety black, and safety white; 14 inches by 10 inches size, except where 10 inches by 7 inches is the largest size which can be applied where needed, and except where larger size is needed for adequate vision; with recognized standard explanation wording, e.g., "_____VOLTS, KEEP AWAY." Sign shall conform to OSHA and NEMA Z535.4.

H. Baked Enamel "Caution" Signs:
   1. "CAUTION" signs of baked enamel finish on 20 gauge steel (unless specified otherwise); of standard safety yellow with safety black letters; 14 inches by 10 inches size, except where 10 inches by 7 inches is the largest size which can be applied where needed, and except where larger size is needed for adequate vision; with recognized standard explanation wording, e.g., "Caution for Ear Protection Required in this Area."

I. Based Enamel "WARNING" Signs:
   1. "WARNING" signs of baked enamel finish on 20 gauge steel (unless specified otherwise); of standard safety orange with safety black letters; 14 inches by 10 inches size, except where 10 inches by 7 inches is largest size that can be applied where needed and except where larger size is needed for adequate vision; with recognized standard explanation wording. Sign shall conform to OSHA and NEMA Z535.4.

J. Engraved Plastic-Laminate Nameplates:
   1. General: Engraving stock melamine plastic laminate nameplates, in sizes (minimum height of characters shall be 1/8 inch) and thicknesses specified or indicated, engraved with engraver's standard letter style of sizes and wording indicated, white face and black core plies (letter color) except as otherwise indicated, specified or required. Colors shall comply with OSHA and NEMA Z535.1. Nameplate shall be punched for mechanical fastening except where adhesive mounting is necessary because of surface it is mounted to.
      a. Thickness: 1/16-inch, for units up to 20 square inches or 8 inch length; 1/8-inch for larger units.
      b. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate surface it is mounted to.
   2. Lettering and Graphics:
      a. Coordinate names, abbreviations, and other designations used in electric identification work with corresponding designations shown, specified, or scheduled. Provide numbers, lettering, and wording as indicated or, if not otherwise indicated, as recommended by manufacturer or as required for proper identification and operation/maintenance of electrical systems and equipment. Comply with ASME.
A13.1 pertaining to minimum sizes for letters and numbers. Comply with OSHA and NEMA Z535.4 requirements.

PART 3 - EXECUTION

3.01 APPLICATION AND INSTALLATION:

A. General Installation Requirements:
   1. Install electrical identification products as indicated, in accordance with manufacturer's written instructions and requirements of NEC.
   2. Coordination: Where identification is to be applied to surfaces which require finish painting, install identification after completion of painting.
   3. Regulations: Comply with governing regulations and requests of governing authorities for identification of electrical work.

B. Conduit and Cable Tray Identification Markers:
   1. General: Where electrical conduit is exposed, apply identification markers on electrical conduit at 20 foot intervals (visible from the floor) and within 3 feet of all panelboards, switchboards, switchgear, automatic transfer switches, emergency generators, substations, switches, devices, and circuit breakers (readily visible when standing in front of equipment). Identification on cable tray shall be on outside of both sidewalls at 20 foot intervals.

C. Underground Cable, Conduit, and Duct Bank Identification Marker:
   1. General: During back-filling/top-soiling of each exterior underground direct buried electrical, signal or communication cable, conduit and duct bank, install continuous underground-type plastic line marker, located directly over the direct buried cable, conduit or duct bank at 12 inches below finished grade. Where multiple small direct buried cables are buried in a common trench and do not exceed an overall width of 16 inches, install a single line marker.
   2. Install line marker for every cable below grade, regardless of whether direct-buried, protected in conduit, or conduit in duct bank.

D. Wire/Cable Identification Bands:
   1. General: Apply cable/conductor identification bands, including circuit number, on each wire/cable in each box/enclosure/cabinet where wires of more than one circuit or communication/signal system are present. Match identification with marking system used in panelboards, shop drawings, contract documents, and similar previously established identification for project's electrical work.

E. Operational Identification and Warning Plasticized Tags and Metal Signs and Plastic Signs:
   1. General: Wherever reasonably required to ensure safe and efficient operation and maintenance of electrical systems, and electrically connected mechanical systems and general systems and equipment, including prevention of misuse of electrical facilities by unauthorized personnel, install signs with instruction or warnings. When signs are installed on switches, outlets, controls, devices and covers of electrical enclosures they may be self-adhesive vinyl or plastic. Where detailed instructions or explanations are needed, provide plasticized tags with clearly written messages adequate for intended purposes.

F. Danger Signs:
   1. General: In addition to installation of danger signs specified, indicated, and required by governing regulations and authorities, install appropriate danger signs at locations
indicated and at locations subsequently identified by Installer of electrical work as constituting similar dangers for persons in or about Project.

2. Critical Switches/Controls: Install danger signs on switches and similar controls, regardless of whether concealed or locked up, where untimely or inadvertent operation (by anyone) could result in significant danger to persons or damage to or loss of property.

3. Provide the following danger signs on the doors leading to the equipment indicated:
   a. "Danger Hearing Protection Required" on all emergency generator room doors.
   b. "Danger: No Smoking, Matches or Open Flames" on all emergency generator room doors, personnel doors opening into aircraft hangar, and battery room doors.

G. Warning Signs:
1. Provide an orange background sign with black letters reading "WARNING: LOAD SIDE OF SWITCH MAY BE ENERGIZED BY BACKFEED" on all tie switches and tie circuit breakers.
2. Provide cable tray warning signs with 1-1/2-inch high black letters on an orange background that reads: "Warning! Not to be used as a walkway, ladder or support for ladders for personnel." Provide on each side of cable tray at 10-foot intervals, visible from the floor below.
3. Provide Arc Flash Warning signs on electrical equipment such as switchboards, switchgear, panelboards, transfer switches, industrial control panels, motor control centers and meter socket enclosures that are likely to require examination, adjustment, servicing, or maintenance while energized. Marking shall be permanently affixed and of a durable nature to withstand the environment within which it is installed.
4. Provide Available Fault Current Warning signs on electrical equipment as specified in Section 26 05 73. Label shall include possible incident energy exposure within arc flash boundary in front of equipment as well as meet NFPA 70E for additional content.

H. Caution Signs:
1. Provide yellow background caution signs with black letters on the doors leading to the equipment indicated:
   a. "Caution Ear Protection Required in this Area" on all emergency generator room doors.
2. Provide the following yellow background caution sign with black letters on all panelboards, substations, switches, circuit breakers, and switchboards where turning off a circuit will automatically start an emergency generator:
   a. "Caution Turning Off this Circuit will Automatically Start Emergency Generator XX"
3. Provide the following yellow background caution sign with black letters on all automatic transfer switches, switches, circuit breakers, equipment, and emergency panelboards that are energized by the emergency power system:

I. Equipment/System Identification Nameplates:
1. General: Install engraved plastic-laminated nameplates on each major unit of electrical equipment in the building; including central or master unit of each electrical system including communication/control/signal/alarm systems, unless unit is specified with its own self-explanatory identification or signal system. Except as otherwise indicated, provide single line of text, 1/2-inch high lettering on 1-1/2-inch high sign (2 inches high were two lines are required), black lettering on white field. Provide text matching terminology and numbering of the contract documents and shop drawings. Nameplate shall include unit designation, normal source circuit number ("Fed from..."), circuit voltage, and other data specifically indicated. Nameplate shall indicate normal source
SECTION 26 05 53 – ELECTRICAL IDENTIFICATION: continued

circuit number ("Fed from...") and emergency source circuit number ("Fed from...")
when the equipment is a transfer switch or fed directly from a transfer switch. Provide
nameplates for each unit of the following categories of electrical work:
a. Switchboards, panelboards, electrical cabinets, and enclosures. (Include main bus
ampacity on the nameplate.)
b. Access panel/doors to electrical facilities.
c. Disconnect switch.
d. Push buttons, selector switches, indicating lights. (Circuit number and voltage not
required on nameplate).
e. Lighting control equipment and contactors.
f. Remote controlled switches, dimmer modules, and control devices.
g. Transformers (Include primary voltage, secondary voltage, number of phases,
feeder, and panelboards or equipment supplied by the secondary.)
h. Power generating units.
i. Provide "EMERGENCY" conduit markers on all conduit and pullboxes that contain
emergency power conductors.

2. Install markers, tags, nameplates, and signs at locations indicated or, where not otherwise
indicated, at location for best convenience of viewing without interference with operation
and maintenance of equipment. Secure the identification with fasteners, except use
adhesive where fasteners should not or cannot penetrate surface.

END OF SECTION 26 05 53
SECTION 260923 - LIGHTING CONTROL EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. Types of lighting control equipment specified in this Section include the following:
      1. Photo sensor controls.
      2. Indoor occupancy sensors.
      4. Integrated, multipreset modular dimming controls.

1.03 RELATED REQUIREMENTS:
   A. DIVISION 26 Sections for wires/cables, electrical boxes, fittings, and wiring devices which are required in conjunction with lighting control equipment work.
   B. SECTION 262416 for lighting distribution panels with integral lighting control.
   C. SECTION 262726 - WIRING DEVICES.

1.04 REFERENCE STANDARDS:
   A. Applicable Standards: Comply with applicable requirements of following standards.
      1. Electronic Industries Association (EIA):
         a. RS-232 - Interface between data terminal and equipment data communication equipment employing serial binary data interchange.
         b. RS-453 - Dimensional, Mechanical, and Electrical Characteristics Defining Phone Plugs and Jacks.
         a. Provide telephone equipment with FCC labels indicating applicable FCC registration and numbering of equipment.
      3. National Electrical Manufacturers’ Association (NEMA):
         a. 70 - National Electrical Code (NEC): Comply with applicable local electrical code requirements of the authority having jurisdiction and NEC as applicable to construction and installation of lighting control and communications equipment.
      5. Underwriters Laboratories (UL): Provide lighting control equipment and components which are UL-listed and labeled.
         a. 486A - Wire Connectors and Soldering Lugs for Use with Copper Conductors.

1.05 SUBMITTALS:
   A. Refer to DIVISION 01 and SECTION 26 05 10 - BASIC ELECTRICAL REQUIREMENTS for administrative and procedural requirements for submittals.
   B. Includes, but not limited to, the following:
      1. Product Data: Submit manufacturer’s data on lighting control equipment and components.
      2. For modular dimming controls; include elevation, dimensions, features, characteristics, ratings, and labels.
3. Device plates and plate color and material.
4. Ballasts and lamp combinations compatible with dimmers.
6. Shop Drawings: Submit dimensioned drawings of lighting control equipment and components including, but not necessarily limited to, programmable controllers, transceivers, printers, relays, sensors, contactors, and switches. Provide floor plans that clearly identify each controlled zone, including the address code of each zone.
7. Wiring Diagrams: Submit wiring diagrams for lighting control equipment and components showing control wiring and interconnection wiring, including connections to equipment components and electrical power. Differentiate between portions of wiring that are manufacturer factory installed and portions that are field installed.
8. Agreement to Maintain: Prior to time of final acceptance, the Contractor shall submit four copies of an agreement for continued service and maintenance of lighting control equipment for Owner's possible acceptance. Offer terms and conditions for furnishing parts and providing continued testing and servicing, including replacement of materials and equipment, for a one year period with an option for renewal of the Agreement by the Owner.
9. Operation and Maintenance Manuals: Furnish maintenance manuals which contain equipment cuts, operating instructions, shop drawings, wiring diagrams, troubleshooting procedures, and spare parts list for equipment. Ensure that the manual includes operating instructions in addition to instructions for revising the system's software package.

C. Samples for Initial Selection: For master and remote-control stations, and faceplates with factory-applied color finishes and technical features.
D. Samples for Verification: For master and remote-control stations, and faceplates with factory-applied color finishes and technical features.

1.06 DELIVERY, STORAGE, AND HANDLING:
A. Deliver lighting control equipment and components in factory-fabricated type containers or wrappings that properly protect equipment from damage.
B. Store lighting control equipment in original packaging and protect from weather and construction traffic. Wherever possible, store indoors; where necessary to store outdoors, store above grade and enclose with watertight wrapping.
C. Handle lighting control equipment carefully to prevent physical damage to equipment and components. Do not install damaged equipment; remove from site and replace damaged equipment with new.

1.07 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

2.01 MANUFACTURERS:
A. Subject to compliance with requirements, provide lighting control equipment of one of the following (for each type of equipment):
   1. Cestron.
   2. Cooper Industries, Inc.
SECTION 260923 - LIGHTING CONTROL EQUIPMENT: continued

5. General Electric Co.
6. Hubbell Building Automation, Inc.
7. Intermatic, Inc.
8. Leviton Manufacturing Company, Inc.
9. Lighting Control and Design; Acuity Lighting Group, Inc.
10. Lightolier Controls.
11. Lithonia Lighting; Acuity Lighting Group, Inc.
12. Lutron Electronics, Inc.
13. RAB Lighting.
14. Sensor Switch, Inc. (Square D Co.; a brand of Schneider Electric).
15. NSi Industries LLC; TORK Products.
16. Watt Stopper.

2.02 INDOOR OCCUPANCY SENSORS:
A. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
   3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
   4. Power Pack: Dry contacts rated for 20-A ballast load at 120 and 277Vac, for 13-A tungsten at 120Vac, and for 1 hp at 120Vac. Sensor has 24Vdc, 150-mA, Class 2 power source, as defined by NFPA 70.
   5. Mounting:
      a. Sensor: Suitable for mounting in any position on a standard outlet box.
      b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
      c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
   6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
   7. Bypass Switch: Override the "on" function in case of sensor failure.
   8. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lux); turn lights off when selected lighting level is present.
B. PIR Type: Ceiling mounted; detect occupants in coverage area by their heat and movement.
   1. Detector Sensitivity: Detect occurrences of 6 inch- (150 mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. inches (232 sq. cm).
   2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1,000 sq. ft. (93 sq. m) when mounted on a 96 inch- (2440 mm-) high ceiling.
   3. Detection Coverage (Corridor): Detect occupancy within 90 feet (27.4 m) when mounted on a 10 foot- (3 m-) high ceiling.
C. Ultrasonic Type: Ceiling mounted; detect occupants in coverage area through pattern changes of reflected ultrasonic energy.
SECTION 260923 - LIGHTING CONTROL EQUIPMENT: continued

1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).

2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. (56 sq. m) when mounted on a 96 inch- (2440 mm-) high ceiling.

3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1,000 sq. ft. (93 sq. m) when mounted on a 96 inch- (2440 mm-) high ceiling.

4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2,000 sq. ft. (186 sq. m) when mounted on a 96 inch- (2440 mm-) high ceiling.

5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet (27.4 m) when mounted on a 10 foot- (3 m-) high ceiling in a corridor not wider than 14 feet (4.3 m).

D. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.

2. Detector Sensitivity: Detect occurrences of 6 inch- (150 mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. inches (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).

3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1,000 sq. ft. (93 sq. m) when mounted on a 96 inch- (2440 mm-) high ceiling.

2.03 CONDUCTORS AND CABLES:
A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES.

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES.

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES.

2.04 GENERAL DIMMING DEVICE REQUIREMENTS:
A. Compatibility: Dimming control components shall be compatible with other elements of lighting fixtures, ballasts, transformers, and lighting controls.

B. Dimmers and Dimmer Modules: Comply with UL 508.

1. Audible Noise and Radio-Frequency Interference Suppression: Solid-state dimmers shall operate smoothly over their operating ranges without audible lamp or dimmer noise or radio-frequency interference. Modules shall include integral or external filters to suppress audible noise and radio-frequency interference.

2. Dimmer or Dimmer-Module Rating: Not less than 125% of connected load unless otherwise indicated.

PART 3 - EXECUTION

3.01 SENSOR INSTALLATION:
SECTION 260923 - LIGHTING CONTROL EQUIPMENT: continued

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, smoke detectors, fire-suppression systems, and partition assemblies.
B. Install and aim sensors in locations to achieve not less than 90% coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.02 CONTACTOR INSTALLATION:
A. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.03 WIRING INSTALLATION:
A. Wiring Method: Comply with SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES. Minimum conduit size is 1/2 inch (13 mm).
B. Wiring within Enclosures: Comply with NECA 1. 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.

3.04 GROUNDING:
A. Provide equipment ground connections for lighting control equipment. Tighten connectors to comply with tightening torques specified in UL 486A to assure permanent and effective grounding.

3.05 IDENTIFICATION:
A. Provide equipment grounding connections for lighting control equipment. Tighten connectors to comply with tightening torques specified in UL 486A to assure permanent and effective grounding.
B. Identify components and power and control wiring according to SECTION 26 05 53 - ELECTRICAL IDENTIFICATION.
1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
C. Label time switches and contactors with a unique designation.
D. Label each dimmer module with a unique designation.
E. Label each scene control button with approved scene description.

3.06 FIELD QUALITY CONTROL:
A. Perform the following tests and inspections:
   1. Continuity tests of circuits.
   2. Operational Test: Set and operate controls to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions.
      a. Include testing of modular dimming control equipment under conditions that simulate actual operational conditions. Record control settings, operations, cues, and functional observations.
   3. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
SECTION 260923 - LIGHTING CONTROL EQUIPMENT: continued

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
B. Lighting control devices will be considered defective if they do not pass tests and inspections.
C. Remove and replace malfunctioning modular dimming control components and retest as specified above.
D. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.
E. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

3.07 ADJUSTING:
A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.08 PERSONNEL TRAINING:
A. Building Operational Personnel on-site Training: Train Owner’s building operating personnel on-site in procedures for starting-up, testing, operating, trouble shooting, servicing and preventive maintenance of the lighting control system equipment for a minimum period of eight hours.

END OF SECTION 260923
SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. This Section specifies panelboards and mini-power centers, including cabinets and boxes, as indicated by drawings and schedules, and as specified herein.
   B. Types of panelboards and enclosures required for the project include the following:
      1. Service entrance panelboards.
      2. Lighting and appliance branch-circuit panelboards.

1.03 RELATED REQUIREMENTS:
   A. Wires/cables, electrical boxes, fittings, and raceways required in conjunction with the installation of panelboards and enclosures: Other DIVISION 26 Sections.
   B. SECTION 26 05 26 - GROUNDING for grounding.
   C. SECTION 26 05 53 – ELECTRICAL IDENTIFICATION for electrical identification.

1.04 REFERENCE STANDARDS:
   A. National Electrical Manufacturers Association (NEMA):
      1. 250 - Enclosures for Electrical Equipment (1,000V Maximum).
      2. PB1 - Panelboards.
      3. PB1.1 - Instructions for Safe Installation, Operation, and Maintenance of Panelboards Rated 600V or Less.
   B. National Fire Protection Association (NFPA):
      1. 70 - National Electrical Code (NEC): Comply with applicable local code requirements of the authority having jurisdiction and NEC as applicable to installation and construction of electrical panelboards and enclosures.
   C. Underwriters Laboratories (UL): Provide panelboard units which are UL listed and labeled.
      1. 50 - Electrical Cabinets and Boxes.
      2. 67 - Electrical Panelboards.
      3. 486A - Wire Connectors and Soldering Lugs for Use with Copper Conductors.
      4. 489 - Molded Case Circuit Breakers and Circuit Breaker Enclosures.
      5. 869A - Service Equipment.
      6. 1053 - Ground-Fault sensing and Relaying Equipment.
      7. 1283 - Electromagnetic Interference Filters.
      8. 1449 - Transient Voltage Surge Suppressors.
      9. Special Use Markings: Provide panelboards constructed for special use with appropriate UL markings which indicate that they are "Suitable for Use as Service Equipment."

1.05 PERFORMANCE REQUIREMENTS:
   A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
      1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

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1.06 **SUBMITTALS:**

A. Refer to DIVISION 01 and SECTION 26 05 10 - BASIC ELECTRICAL REQUIREMENTS for administrative and procedural requirements for submittals.

B. Includes, but not limited to, the following:

1. **Product Data:** Submit manufacturer’s data on panelboards and enclosures.
   a. Panelboard dimensions and weight.
   b. Complete data on circuit breakers and fuses. Submit time - current characteristic curves of all devices.
   c. Panelboard short-circuit interrupting capacity, and information on buses: phase, neutral, and ground.
   d. Information on whether panelboard is fed from top or bottom.
   e. Data on maximum and minimum incoming and outgoing feeder and branch circuit wire size.
   f. Data on door, locks, and mounting: surface or flush.
   g. Data on total number of poles and number of unused poles that are available for future use.

1.07 **MAINTENANCE MATERIAL SUBMITTALS:**

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. **Keys:** Two spares for each type of panelboard cabinet lock.

2. **Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types:** Two spares for each panelboard.

3. **Fuses for Fused Switches:** Equal to 10% of quantity installed for each size and type, but no fewer than three of each size and type.

4. **Fuses for Fused Power-Circuit Devices:** Equal to 10% of quantity installed for each size and type, but no fewer than three of each size and type.

1.08 **QUALITY ASSURANCE:**

A. **Testing Agency Qualifications:** Member company of NETA or an NRTL.

1. **Testing Agency’s Field Supervisor:** Currently certified by NETA to supervise on-site testing.

B. **Source Limitations:** Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. **Product Selection for Restricted Space:** Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. **Electrical Components, Devices, and Accessories:** Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with NEMA PB 1.

F. Comply with NFPA 70.

1.09 **DELIVERY, STORAGE, AND HANDLING:**

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NECA 407.

1.10 **PROJECT CONDITIONS:**

A. **Environmental Limitations:**
EVALUATIONS: continued

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   a. Ambient Temperature: Not exceeding -23°F to +104°F.
   b. Altitude: Not exceeding 6,600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
   1. Ambient temperatures within limits specified.
   2. Altitude not exceeding 6,600 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 Owner no fewer than two days in advance of proposed interruption of electric service.
   2. Do not proceed with interruption of electric service without Owner’s written permission.
   3. Comply with NFPA 70E.

1.11 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, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.12 WARRANTY:
   A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:
   A. Subject to compliance with requirements, provide panelboard and mini-power center products of one of the following (for each type and rating of panelboard and enclosure):
      1. Cooper Crouse-Hinds.
      2. Eaton Cutler-Hammer.
      5. Square D, a brand of Schneider Electric.

2.02 GENERAL REQUIREMENTS FOR PANELBOARDS:
   A. Except as otherwise indicated, provide panelboards, enclosures, and ancillary components of types, size, and ratings indicated, which comply with manufacturer’s standard materials and with the design and construction in accordance with published product information.
   B. Where types, sizes, or ratings are not indicated, comply with NEC, UL, and established industry standards for those applications indicated.
EVALUATIONS: continued

C. Equip with proper number of panelboard switching and protective devices as required for complete installation.

D. Provide ground fault circuit interrupter type circuit breakers where indicated.

E. Enclosures: Flush- and surface-mounted cabinets as indicated.
   1. Provide enclosures fabricated by same manufacturer as panelboards which mate and match properly with panelboards.
   2. Rated for environmental conditions at installed location. Provide NEMA type as described below, unless indicated or specified otherwise.
      a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
      b. Outdoor Locations: NEMA 250, Type 3R.
   4. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Front doors shall have flush locks with three keys per panelboard, all panelboard enclosures keyed alike.
   5. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
   6. Finishes:
      a. Color: Enamel finish over a rust inhibitor coating.
      b. 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.

F. Phase, Neutral, and Ground Buses:
   1. Bus shall be braced to withstand available short circuit currents as indicated.
   2. Provide suitable lugs on neutral bus for incoming and outgoing feeders requiring neutral connections.
   3. Equipment Ground Bus: Bare, uninsulated, adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
   4. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box. Provide as indicated.
   5. Extra-Capacity Neutral Bus and Lugs: Neutral bus and lugs rated 200% of phase bus and UL listed as suitable for nonlinear loads. Provide as indicated.

G. Conductor Connectors: Suitable for use with conductor material and sizes.
   2. Main and Neutral Lugs: Compression type.
   3. Ground Lugs and Bus-Configured Terminators: Compression type.
   4. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
   5. Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
   6. Gutter-Tap Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
   7. Extra-Capacity Neutral Lugs: Rated 200% of phase lugs mounted on extra-capacity neutral bus.
   8. Provide terminals UL rated for 75°C (Minimum) conductors.
EVALUATIONS: continued

H. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

I. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include size and type of allowable upstream and branch devices, listed and labeled for series-connected short-circuit rating by an NRTL.

J. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals as indicated.

2.03 PANELBOARDS:

A. General: Except as otherwise indicated, provide panelboards, enclosures, and auxiliary components of types, size, and ratings indicated, which comply with manufacturer's standard materials and with the design and construction in accordance with published product information. Equip with proper number of panelboard switching and protective devices as required for complete installation. Main circuit breakers, when indicated on drawings, specified or required, shall be placed ahead of the main panelboard bus. Backfeeding a branch circuit device for a main circuit breaker is not acceptable. Provide terminals UL rated for 75°C (Minimum) conductors. All bus shall be tin plated copper. Ground bars shall be copper. Bus shall be braced to withstand available short circuit currents indicated. Series rated panelboards and circuit breakers are not acceptable. Provide ground fault circuit interrupter type circuit breakers where indicated. Where types, sizes, or ratings are not indicated, comply with NEC, UL, and established industry standards for those applications indicated.

B. Lighting and Small Power Panelboards: Dead-front, safety type, 240/120V (voltage rating as required), 1-phase, 3-wire, 60-hertz main, lighting and small power panelboards as indicated, with switching and protective devices in quantities, ratings, types, and arrangements shown; with anti-turn solderless pressure type lug connectors approved for use with copper conductors; construct unit for connecting incoming feeder at top or bottom of panel as required; Equip with full-sized neutral bar, with bolt-on type, heavy-duty, quick-make, quick-break, single- and multi-pole circuit breakers, with toggle handles that indicate when tripped. Where multiple-pole breakers are indicated, provide common trip for all poles. Provide suitable lugs on neutral bus for each incoming and outgoing feeder required; and provide bare uninsulated grounding bars suitable for bolting to enclosures. Provide insulated ground bus for isolated ground circuits that terminate in or pass through the panelboard, as indicated. Provide enclosures fabricated by same manufacturer as panelboards, which mate and match properly with panelboards. Provide double neutral where indicated.

C. Panelboard Enclosures: Galvanized sheet steel cabinet type enclosures, in sizes required, NEMA type 1 on all indoor applications (unless indicated or specified otherwise) and code gage (minimum 16-gage) thickness. NEMA type 3R on all outdoor applications (unless indicated or specified otherwise). Construct with multiple knockouts and wiring gutters. Provide fronts with adjustable trim clamps and front doors with flush locks and three keys per panelboard, all panelboard enclosures keyed alike, with concealed piano front door hinges. Equip with interior circuit directory frame and removable card with clear plastic covering. Provide baked gray enamel finish over a rust inhibitor coating. Design enclosures for recessed or surface mounting as indicated. Provide enclosures which are fabricated by same manufacturer as panelboards, which mate and match properly with panelboards to be enclosed.

D. Molded-Case Circuit Breakers: Circuit breakers shall be manufactured by the panelboard manufacturer and shall be U.L. listed to be installed in the panelboard. Factory-assembled, bolt-on, molded-case circuit breakers of frame sizes, characteristics, voltage, poles, RMS symmetrical interrupting ratings indicated and other ratings indicated. The minimum
interrupting rating for 120Vac, and 240Vac circuit breakers shall be 10,000 amperes, rms symmetrical unless indicated otherwise. All circuit breakers applied at 208 or 240Vac shall be rated 240Vac. Provide breakers with thermal and instantaneous magnetic trip, with fault-current limiting protection when required and ampere ratings as indicated. Provide fixed, noninterchangeable trips for circuit breakers rated 15-400A. Provide fixed, interchangeable magnetic and thermal trips for circuit breakers rated higher than 400A. Construct with over center, trip free, toggle-type operating mechanisms with quick-make, quick-break action and positive handle trip indication. Construct breakers for mounting and operating in any physical position, and operating in an ambient temperature of 40°C. Provide breakers with mechanical screw type removable connector lugs, AL/CU rated.

E. Accessories: Provide panelboard accessories and devices including, but not necessarily limit to circuit breaker handle locks, etc., as recommended by panelboard manufacturer for ratings and applications indicated. Provide circuit breaker handle locks on all circuits that supply night lights, exit signs, emergency lights, emergency power, energy management and control system (EMCS) panels, and fire alarm panels.

PART 3 - EXECUTION

3.01 EXAMINATION:
A. Receive, inspect, handle, and store panelboards according to NECA 407.
B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF PANELBOARDS:
A. Install panelboards, mini-power centers, and enclosures as indicated, providing NEC required working space, in accordance with manufacturer's written instructions, applicable requirements of NEC and in compliance with recognized industry practices to ensure that products fulfill requirements.
B. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A.
C. Fasten enclosures firmly to walls and structural surfaces, ensuring that they are permanently and mechanically anchored.
D. Provide properly wired electrical connections for panelboards within enclosures.
E. Install numbers on all circuit breakers, and type the panelboard's circuit directory card upon completion of installation work. Clearly identify the load on each circuit and the circuit number.

3.03 GROUNDING:
A. Provide equipment grounding connections for panelboard enclosures as indicated and as required by NEC. Tighten connections to comply with tightening torques specified in UL 486A to assure permanent and effective grounds. Provide grounding as specified in SECTION 26 05 26 - GROUNDING.

3.04 IDENTIFICATION:
EVALUATIONS: continued

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with SECTION 26 05 53 – ELECTRICAL IDENTIFICATION.

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in SECTION 26 05 53 – ELECTRICAL IDENTIFICATION.

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified SECTION 26 05 53 – ELECTRICAL IDENTIFICATION.

3.05 FIELD QUALITY CONTROL:
A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Acceptance Testing Preparation:
1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

D. Prior to energization of electrical circuitry, check all accessible connections to manufacturer's tightening torque specifications.

E. Prior to energization, check panelboard circuits for short circuits, electrical continuity of circuits, enclosure grounding and neutral grounding at service entrance and at incoming derived source transformer.

F. Prior to energization of panelboards, check with insulation resistance tester: phase-to-phase and phase-to-ground insulation resistance levels of each phase bus to ensure requirements are fulfilled. Record and submit test results.

3.06 ADJUSTING AND CLEANING:
A. Set all adjustable trip settings to values provided by the Manufacturer.

B. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

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% between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

D. Upon completion of installation, clean interior and exterior of panelboards. Remove paint splatters, spots, dirt and debris.

E. Touch-up scratched or marred surfaces to match original finishes.

F. Adjust transformer taps of mini-power centers.

3.07 PROTECTION:
EVALUATIONS: continued

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

3.08 DEMONSTRATION:
A. Subsequent to wire and cable hook-ups, energize panelboards and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

3.09 PROTECTION:
A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 262416
SECTION 26 27 13 - ELECTRICITY METERING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary
      Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. This Section includes equipment for electricity metering by utility company and electricity
      metering by Owner.

1.03 REFERENCED STANDARDS:
   A. National Electrical Contractors Association (NECA).
      1. 1 – Standard Practice of Good Workmanship in Electrical Construction.
      2. 400 – Installing and Maintaining Switchboards.
   B. National Electrical Manufacturers Association (NEMA).
      1. 250 – Enclosures for Electrical Equipment (1000V Maximum).
   C. National Fire Protection Association (NFPA):
      1. 70 - National Electrical Code (NEC).
   D. Underwriters Laboratories (UL).
      1. UL 1244 – Electrical or Electronic Measuring or Testing Equipment.

1.04 DEFINITIONS:
   A. KY Pulse: Term used by the metering industry to describe a method of measuring
      consumption of electricity that is based on a relay opening and closing in response to the
      rotation of the disk in the meter.
   B. PC: Personal computer.

1.05 SUBMITTALS:
   A. Product Data: For each type of product indicated.
   B. Shop Drawings: For electricity-metering equipment.
      1. Dimensioned plans and sections or elevation layouts.
      2. Wiring Diagrams: For power, signal, and control wiring. Identify terminals and wiring
         designations and color-codes to facilitate installation, operation, and maintenance.
         Indicate recommended types, wire sizes, and circuiting arrangements for field-installed
         wiring, and show circuit protection features.
   C. Field quality-control reports.

1.06 QUALITY ASSURANCE:
   A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70,
      by a qualified testing agency, and marked for intended location and application.

1.07 DELIVERY, STORAGE, AND HANDLING:
   A. Receive, store, and handle modular meter center according to NECA 400.

1.08 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:
SECTION 262713 - ELECTRICITY METERING: continued

1. Notify Owner no fewer than two days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Owner's written permission.

1.09 COORDINATION:
A. Electrical Service Connections: Coordinate with utility companies and components they furnish as follows:
   1. Comply with requirements of utilities providing electrical power services.
   2. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.

PART 2 - PRODUCTS

2.01 EQUIPMENT FOR ELECTRICITY METERING BY UTILITY COMPANY:
A. Meters will be furnished by utility company.
B. Current-Transformer Cabinets: Comply with requirements of electrical-power utility company.
C. Meter Sockets: Comply with requirements of electrical-power utility company.

PART 3 - EXECUTION

3.01 INSTALLATION:
A. Comply with equipment installation requirements in NECA 1.
B. Install meters furnished by utility company. Install raceways and equipment according to utility company's written requirements. Provide empty conduits for metering leads and extend grounding connections as required by utility company.
C. Install modular meter center according to NECA 400 switchboard installation requirements.

3.02 IDENTIFICATION:
A. Comply with requirements for identification specified in DIVISION 26, Section "Electrical Identification."
   1. Series Combination Warning Label: Self-adhesive type, with text as required by NFPA 70.
   2. Equipment Identification Labels: Adhesive film labels with clear protective overlay. For residential meters, provide an additional card holder suitable for printed, weather-resistant card with occupant's name.

3.03 FIELD QUALITY CONTROL:
A. Perform tests and inspections.
B. Tests and Inspections:
   1. Connect a load of known kilowatt rating, 1.5 kW minimum, to a circuit supplied by metered feeder.
   2. Turn off circuits supplied by metered feeder and secure them in off condition.
   3. Run test load continuously for eight hours minimum, or longer, to obtain a measurable meter indication. Use test-load placement and setting that ensures continuous, safe operation.
SECTION 262713 - ELECTRICITY METERING: continued

4. Check and record meter reading at end of test period and compare with actual electricity used, based on test-load rating, duration of test, and sample measurements of supply voltage at test-load connection. Record test results.

C. Electricity metering will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 262713
SECTION 26 27 26 – WIRING DEVICES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
A. Drawings and general provisions of the Contract, including General and Supplementary
Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
A. This Section specifies the following:
1. Straight Blade Duplex Receptacles.
2. Weather-Resistant Receptacles.
4. Wall Plates.
5. Floor Receptacles.

1.03 RELATED REQUIREMENTS:
A. Section 26 05 10 - Basic Electrical Requirements: General electrical requirements that are
common to more than one section of this Division.
B. Section 26 05 26 – Grounding: Grounding for Safety and Electrical Systems.
C. Section 26 05 53 – Electrical Identification: Electrical identification requirements for
identification to be engraved on wall plates.
D. Section 26 09 23 - Lighting Control Equipment: Controls for dimmers other than those covered
by this Section.
E. Section 26 28 16 – Circuit and Motor Disconnect Switch: Devices other than snap switches and
plug/receptacle sets used as disconnects for motors.
F. Section 27 10 00 - Structured Cabling System: Telecommunications wiring devices.

1.04 REFERENCE STANDARDS:
A. Publication Dates: Comply with standards in effect as of date of the Contract Documents
unless otherwise indicated.
B. National Electrical Manufacturers Association (NEMA):
1. FB-11 - Plugs, Receptacles and Connectors of the Pin and Sleeve Type for Hazardous
Locations.
2. WD-1 - General Color Requirement for Wiring Devices.
3. WD-6 - Dimensions for Wiring Devices.
C. National Fire Protection Association (NFPA):
1. - National Electrical Code (NEC).
2. 99 - Healthcare Facilities.
D. Underwriters Laboratories (UL):
1. 20 - General Use Snap Switches.
2. 94 - Standard for Safety of Flammability of Plastic Materials for Parts in Devices and
Appliances Testing.
3. 486A-486B - Wire Connectors.
5. 943 - Ground-Fault Circuit Interrupters.
6. 1010 - Receptacle-Plug Combinations for Use in Hazardous (Classified) Locations.
7. 1310 - Class 2 Power.
EVALUATIONS: continued

E. National Electrical Contractors Association (NECA):
   1. NECA 1 - Standard for Good Workmanship in Electrical Construction.
   2. NECA 130 - Standard for Installing and Maintaining Wiring Devices.

F. Federal Specifications (FS):
   1. W-C-596 - Connector, Electrical, Power, General Purpose.
   2. W-S-896 - Switches, Toggle (Toggle and Lock), Flush Mounted.

1.05 SUBMITTALS:
   A. Refer to Division 01 and Section 26 05 10 - Basic Electrical Requirements for administrative and procedural requirements for submittals.
   B. Includes, but not limited to, the following:
      1. Product data for each type of product specified.
      2. Samples of those products indicated for Sample submission for Engineer's comments.
         Include color and finish Samples of device plates and other items per Engineer's request.

1.06 QUALITY ASSURANCE:
   A. Conform to the requirements of NFPA 70.
   B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this Section with minimum 3 years documented experience.

1.07 DELIVERY, STORAGE, AND PROTECTION:
   A. Store in a clean, dry space in original manufacturer's packing until ready for installation.

1.08 SEQUENCE AND SCHEDULING:
   A. Schedule installation of wall plates after the surface upon which they are installed has received the final finish.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:
   A. Subject to compliance with requirements, provide wiring devices from the following:
      1. Cooper Industries.
      3. Hubbell Inc.
      4. Leviton.
   B. Source Limitation: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.02 WIRING DEVICES:
   A. General: Provide wiring devices, in types, characteristics, heavy duty, specification grades, colors, and electrical ratings for applications indicated which are UL listed and which comply with NEMA WD-1, WD-6, and other applicable UL standards. Provide wall plates as specified except as otherwise indicated. Verify color selections with Engineer.
   B. Receptacles: As scheduled in Specifications and on Drawings. Comply with UL 498 and NEMA WD-1. Receptacles shall have thermoplastic faces and bodies. Receptacles shall comply with UL 498, NEMA WD-1, NEMA WD-6 and FS W-C-596.
      1. Straight Blade Duplex Receptacle: Heavy-duty, specification grade, 20A, 125Vac, 2-pole, 3-wire, grounding type receptacle, straight blade type and NEMA configuration 5-20R unless otherwise indicated. Receptacles shall have only side wiring screw.
EVALUATIONS: continued

terminals. Back-wired receptacles are not acceptable. Device color shall be White. Controlled receptacles shall comply with requirement in this Division Section.

2. Weatherproof receptacles must be UL listed for wet locations with cord and plug connected. Provide as grade and ampacity in accordance with straight-blade requirements. Comply with UL 498 Supplement SE. Device color shall be Black.

3. Ground-Fault Circuit Interrupter (GFCI) Receptacles: "Feed-through" type, 20A ground-fault circuit interrupter, with integral heavy-duty NEMA 5-20R duplex receptacles arranged to protect connected downstream receptacles on same circuit. Receptacles shall have only side wiring screw terminals. Provide unit designed for installation in a 2-3/4-inch deep outlet box without adapter, grounding type, Class A, Group 1, per UL Standard 943. Receptacles used in hospitals or healthcare facilities shall comply with hospital grade requirements. Tamper-resistant GFCI receptacles shall comply with tamper-resistant duplex receptacle requirements in this Division Section. Weatherproof GFCI receptacles shall comply with weatherproof receptacle requirements in this Division Section. Device color shall be Black.

C. Snap Switches: 20-ampere, 120-277Vac, quiet type, AC switches. Single-pole, double-pole, three-way, four-way, as indicated. Switch handle and switch body shall be high strength nylon. Switches shall have only side wiring screw terminals. Comply with UL 20 and NEMA WD1.

2.03 WIRING DEVICE ACCESSORIES:
A. Wall Plates: One-piece cover, single and combination, types shall match corresponding devices. Provide metal screws for securing plates to devices with screw heads colored to match finish of plates. Provide wall plates with engraved legend where indicated. Conform to requirements of Section 26 05 53 - Electrical Identification. Provide plates possessing the following additional construction features:
   1. Finished Rooms (unless indicated or specified otherwise):
      a. Material and Finish: Smooth, 0.32-inch thick, Type 302/304, satin finished stainless steel.
   2. Weatherproof cover plates for wet locations: NEMA 250.
      a. Comply with type 3R, weather resistant.
      b. Gasketed thermoplastic with hinged lockable cover and corrosion-resistant screws; listed as suitable for use in wet locations while in use with attachment plugs connected and identified as extra-duty type.

2.04 FLOOR RECEPTACLES:
A. Modular, flush type service outlets and fittings of types and ratings indicated in Division 26. Service fittings shall be compatible with floor boxes provided in Section 26 05 33. Use design compatible with floor outlet wiring methods indicated on Drawings. Provide 20-ampere, 125V, 2-pole, 3-wire, grounding, gray quadplex receptacles, NEMA configuration 5-20R. Provide with 3/4-inch knock-out for power and 1-inch NPT, 1-inch long, locking nipple for telecommunication conduit installation.
B. Compartments: Barrier separation between power and voice/data cabling and devices.
C. Service Plate: Rectangular with satin finish.
D. Reference Division 27 for telecommunication voice and data outlets.
E. Tile Rings: Finish to match covers; configuration as required to accommodate specified covers.
F. Carpet Flanges: Finish to match covers; configuration as required to accommodate specified covers.
**EVALUATIONS**: continued

**PART 3 - EXECUTION**

3.01 **INSTALLATION:**

A. Perform Work in a neat and workmanlike manner in accordance with NECA 1 and NECA 130, including mounting heights listed in the standards, unless otherwise indicated.

B. Coordinate with other trades:
   1. Protect installed devices and boxes from damage. Do not place wall finish materials over device boxes. Do not cut holes for boxes with routers that are guided by riding against outside of boxes. Replace damaged items prior to final acceptance.
   2. Keep outlet boxes free of debris, dirt, plastic, dry wall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
   3. When installing wiring device in brick or block wall, install shelf that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
   4. Install wiring devices in accordance with manufacturer's instruction and after wire pulling and wall penetrations are complete.
   5. Install wall plate after painting work is complete.

C. Install wiring devices and accessories as indicated in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to fulfill Project requirements.
   1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
   2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
   3. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
   4. Do not connect more than one conductor to wiring device terminals.
   5. Connect wiring devices by wrapping conductor clockwise 2/3 to 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-activated binding.
   6. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
   7. Where split-wired duplex receptacles are indicated, remove tabs connecting top and bottom receptacles.
   8. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.
   9. When conductors larger than No. 12 AWG are installed on 15 or 20A circuits, splice No. 12 AWG pigtails for device connections.
   10. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plate in lieu of meeting this requirement.

D. Coordinate with other work, including painting, electrical boxes, and wiring installations, as necessary to interface installation of wiring devices with other work.

E. Coordinate locations of outlet boxes provided under Section 26 05 33 as required for installation of wiring devices provided under this Section.

   1. Receptacles: 18 inches (450 mm) above finished floor; 6 inches (150 mm) above counter.
   2. Snap Switches: 48 inches (1.2 m) above finished floor.
EVALUATIONS: continued

3. Dimmer Switches: 48 inches (1.2 m) above finished floor.
F. GFCl and Isolated Ground Receptacles and Service Suppression:
   1. Provide GFCl receptacles with integral GFCl protection at each location indicated. Do not use feed-through wiring to protect downstream devices.
   2. For isolated ground receptacles, connect wiring device grounding terminal only to identified branch circuit isolated equipment grounding conductor. Do not connect grounding terminal to outlet box or normal branch circuit equipment grounding connector.
   3. Circuits connected to isolated ground receptacles, GFCl receptacles, or surge suppression receptacles shall have a dedicated neutral conductor that is not shared with any other branch circuits.
G. Wall Switches and Dimmers:
   1. Install wall switches with "off" position down.
   2. Install wall dimmers to achieve full rating specified and indicated after derating for gauging as instructed by manufacturer.
   3. Do not share neutral conductor on line and load side of dimmers.
   4. Group adjacent switches under single, multigang wall plate.
   5. If dimmer yoke does not automatically ground the metal wall plate, bond the yoke to ground such that the metal wall plate is grounded when connected to yoke.
H. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for wiring devices. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A-486B. Use properly scaled torque-indicating hand tool.
I. Install wall-mounted vertical convenience receptacles with ground pin down and horizontal convenience receptacles with ground pin to the left.

3.02 IDENTIFICATION:
   A. Comply with Section 26 05 53 - Electrical Identification.
   B. Identify each receptacle with panelboard identification and circuit number. Use hot stamped or engraved machine printing with Black-filled lettering on face of plate and durable wire markers or tags inside outlet boxes.
   C. Controlled receptacles shall be identified with controlled receptacle marking symbol complying with requirements in NFPA 70.

3.03 FIELD QUALITY CONTROL:
   A. Testing: Prior to energizing circuits, test wiring for electrical continuity and for short-circuits. Ensure proper polarity of connections is maintained. Subsequent to energizing, test wiring devices and demonstrate compliance with requirements.
   B. Test each receptacle with a receptacle tester to ensure proper polarity. Insure that the phase rotation is identical on all multiphase receptacles of each rating type.
   C. Inspect each wiring device for damage and defects.
   D. Operate each wall switch and wall dimmer with circuit energized to verify proper operation.
   E. Test ground-fault circuit interrupter operation with both local test button and remote ground-fault simulation with receptacle tester.
EVALUATIONS: continued

3.04 CLEANING:
   A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION 26 27 26
SECTION 262730 - ELECTRICAL CONNECTIONS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. This Section specifies electrical connections as required or indicated by drawings and schedules. Electrical connections are hereby defined to include connections used for providing electrical power or control to Equipment.
   B. Applications of electrical connections are specified in this Section include the following:
      1. To resistance type heaters.
      2. From electrical source to motor starters.
      3. From motor starters to motors.
      4. To lighting fixtures and wiring devices.
      5. To converters, rectifiers, transformers, specified in this Division, inverters, switchgear, switchboards, panelboards, generators, and similar equipment specified in this Division.
      6. To grounds including ground electrode connections.
      7. Splices.
      8. Terminations.
      9. Equipment furnished in other divisions (unless indicated otherwise).
     10. All controls.

1.03 RELATED REQUIREMENTS:
   A. Electrical connections for Equipment not furnished as integral part of Equipment are specified in DIVISIONS 21, 22, 23, and other DIVISION 26 Sections.
   B. Motor starters and controllers not furnished as integral part of Equipment: Applicable DIVISION 26 Sections.
   C. DIVISIONS 21, 22, and 23 - Motor starters and controllers furnished integrally with Equipment:
   D. DIVISIONS 23 and 25 - Temperature control system wiring.
   E. SECTION 260519 - LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES - wires/cables required for connecting motors and other electrical units of equipment.
   F. SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS - Junction boxes and disconnect switches required for connecting motors and other electrical units of Equipment: Applicable DIVISION 26 Sections.
   G. SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS - electrical identification for wire/cable conductors.
   H. SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS - disconnect switches required for connecting motors and other electrical units of equipment.
   I. Electrical connections to all Equipment in other divisions unless specifically indicated otherwise.

1.04 REFERENCE STANDARDS:
   A. American National Standards Institute (ANSI):
      1. ANSI C119.1 - Sealed Insulated Underground Conductor Systems Rated 600V.
      2. ANSI C119.4/NEMA CC3 - Connectors for Use between Aluminum-to-Aluminum or Aluminum-to-Copper Conductors.
EVALUATIONS: continued

3. ANSI/NEMA CC1 - Electric Power Connection for Substations.

B. Institute of Electrical and Electronic Engineers (IEEE):

C. National Fire Protection Association (NFPA):
   1. 70 - National Electrical Code (NEC) - Comply with applicable requirements of NEC as to type of products used and installation of electrical power connections (terminals and splices), junction boxes, motor starters, and disconnect switches.

D. Underwriters Laboratories (UL) Compliance - Provide electrical connection products and materials which are UL-listed and labeled. Comply with applicable requirements of the following standards:
   1. 486A - 486B - Wire Connectors.
   2. 486C - Splicing Wire Connectors.
   3. 486D - Sealed Wire Connector Systems.
   4. 486E - Equipment Wiring Terminals for use with Aluminum and/or Copper Conductors.

1.05 SUBMITTALS:
A. Refer to DIVISION 01 and SECTION 260510 - BASIC ELECTRICAL REQUIREMENTS for administrative and procedure requirements for Submittals.
B. Includes, but not limited to, the following:
   1. Product Data: Submit manufacturer's data on electrical connections for equipment products and materials.

1.06 DELIVERY, STORAGE, AND HANDLING:
A. Deliver electrical connection products wrapped in proper factory-fabricated type containers.
B. Store electrical connection products in original cartons and protect from weather, construction traffic, and debris.
C. Handle electrical connection products carefully to prevent breakage, denting, and scoring finish.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:
A. Subject to compliance with requirements, provide products of one of the following (for each type of product).
   1. Cable connectors, terminations, termination kits and splice kits:
      a. AMP Netconnect, Tyco Electronics.
      b. Appleton Electric.
      c. Arrow-Hart, Cooper Wiring Devices.
      d. Burndy Corporation.
      e. Hubbell Wiring Device-Kellems.
      f. Ideal Industries, Inc.
      g. King Innovation.
      h. Minnesota Mining and Manufacturing (3M).
      i. OZ Gedney.
      j. Panduit.
      k. Raychem, TE Connectivity.
      l. Square D.
EVALUATIONS: continued

m. Thomas and Betts.

2. Tape:
   a. 3M.
   b. Nitto Denko.

3. Terminal Blocks:
   a. AMP Netconnect, Tyco Electronics.
   b. Cooper Bussmann.
   c. General Electric.
   e. Square D.
   f. States Division, Megger.

2.02 MATERIALS AND COMPONENTS:

A. General: For each electrical connection provide complete assembly of materials, including, but not necessarily limited to, pressure connectors, terminals (lugs), electrical insulating tape, electrical solder, electrical soldering flux, heat-shrinkable insulating tubing, cable ties, stress cones, splice kits, termination kits, solderless wirenuts, and other items and accessories as needed to complete splices and/or terminations of types indicated or recommended for use by accessories manufacturers for type services indicated. Electrical connectors shall be marked for the suitable conductor material. All Equipment conductor terminations shall be UL listed for 75°C conductors.

B. Connectors and Terminals: Provide UL-listed factory-fabricated electrical connectors and terminals which mate and match, including sizes and ampacity ratings, with Equipment terminals and which are recommended by Equipment manufacturer for intended applications. Provide insulated compression ring lugs for all control wire terminations. Wirenut splices shall only be used for No. 10 AWG and No. 12 AWG lighting circuits, receptacle circuits, motor terminal box connections size 10 AWG and smaller and control devices with size 10 AWG and smaller factory wired leads. Provide silicone filled watertight/raintight wirenuts for receptacle circuits and light fixture circuits installed outdoors and in wet locations. Provide compression connectors for all power conductors #8 AWG and larger.

C. Use connectors with temperature ratings equal to or greater than those of the wires being used.

D. Power Connectors (sizes 8-3 AWG) 600V and Below:
   1. Noninsulated ring-tongue type.
   2. Ring tongue sized to match terminal stud size.
   4. Application tooling designed to crimp the wire barrel [conductor grip] with a one-step crimp.

E. Power Connectors (sizes 2 AWG - 500 kcmil) 600V and Below:
   1. Noninsulated one-hole rectangular tongue for sizes 2 AWG through 3/0 AWG and two-hole rectangular tongue for 4/0 AWG through 500 kcmil.
   2. Application tooling shall be hydraulic operated.

F. Power Connectors (sizes 2 AWG - 500 kcmil) above 600V:
   1. Noninsulated one-hole rectangular tongue for sizes 2 AWG through 3/0 AWG and two-hole rectangular tongue for 4/0 AWG through 500 kcmil.
   2. Voltage rating equal or greater than that of the cable being used.

G. Motor Lead Termination/Splice (Low-Voltage, 600V and Below, Power Cable):
   1. Splices shall be made using compression-type connectors bolted together. The compression-type connectors shall be properly sized for the cables. Reference acceptable connector manufacturer’s cross-reference chart.
EVALUATIONS: continued

2. Splice to be covered with heat-shrinkable tubing connector insulators.

H. Terminal Blocks:
1. For Mounting in Terminal Boxes (TBs):
   a. Designed and sized for the cables being terminated.
   b. Thermoplastic block rated 600V.
   c. Solderless box lug type terminals for power cables and flat terminal connectors with wire clamp for control and instrument cables.
   d. Rated current carrying capacity equal to or greater than the cable being terminated.
   e. Marking strip.

2. For Mounting in Cabinets, Panels, Control Boards, etc.:
   a. Designed and sized for the cables being terminated.
   b. Thermoplastic block rated 600V.
   c. Solderless box lug type terminals for power cables. Flat terminal connectors for current transformer circuits. Sliding link type flat terminal connectors with wire clamp for control and instrument cables.
   d. Rated current carrying capacity equal to or greater than the cable being terminated.
   e. Marking strip on blocks for power cables, control and instrument cables.
   f. Short-circuit straps with one shorting screw for each terminal for current transformer circuits.

PART 3 - EXECUTION

3.01 INSPECTION:
   A. Inspect area and conditions under which electrical connections for Equipment are to be installed. If unsatisfactory conditions exist, do not proceed with the work until they have been corrected.

3.02 INSTALLATION OF ELECTRICAL CONNECTIONS:
   A. Install electrical connections as indicated, as required and as specified. Provide in accordance with Equipment manufacturer's written instructions and with recognized industry practices, and complying with applicable requirements of UL and NEC to ensure that products fulfill requirements.
   B. All medium voltage splices and terminations above 600V shall be made by a certified cable splicer/terminator.
   C. Connect electrical power supply conductors to Equipment conductors in accordance with Equipment manufacturer's written instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed Equipment.
   D. Maintain existing electrical service and feeders to occupied areas and operational facilities, unless otherwise indicated or when authorized otherwise in writing by Owner or Engineer. Provide temporary service during interruptions to existing facilities. When necessary, schedule momentary outages to replace existing wiring systems with new wiring systems. When that "cutting-over" has been successfully accomplished, remove temporary wiring and existing wiring as indicated.
   E. Cover splices with electrical insulating material equivalent to, or of greater insulation rating, than electrical insulation rating of those conductors being spliced.
   F. Prepare cables and wires by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated.
Evaluator: continued

Exercise care to avoid cutting through tapes which will remain on conductors. Also avoid "ringing" copper conductors while stripping insulation from wire.

G. Trim cables and wires as short as practicable and arrange routing to facilitate inspection, testing, and maintenance.

H. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for Equipment connectors. Accomplish tightening by utilizing proper torquing tools, including torque screwdriver, beam-type torque wrench, and ratchet wrench with adjustable torque settings. Where manufacturer's torquing requirements are not available, tighten connectors and terminals to comply with torquing values contained in UL 486A-486B.

I. Adjust overhead door and coiling door travel limit switches and torque switches in accordance with the manufacturer's instructions.

J. Connect all nonisolated ground conductors to equipment ground bus, equipment ground lug, or equipment enclosure (where no other equipment grounding provisions are available).

K. Control conductor terminations made on terminal blocks or terminal strips shall comply with the following:
   1. All current transformer terminations shall be made with insulated, compression type, ring lugs.
   2. All control terminations shall be made with insulated, compression type, ring lugs.
      Provide one lug per conductor.
   3. All control terminations shall be made by inserting the striped, bare, conductor under the flat terminal wire clamp. No more than two wires shall be terminated under one wire clamp connection point.

L. Keep conductor splices to a minimum.

M. Install splice and tap connectors which possess equivalent or better mechanical strength and insulation rating than conductors being spliced.

N. Use splice and tap connectors which are compatible with conductor material.

O. In-line splices shall not be accepted unless provided in a junction box.

3.03 FIELD QUALITY CONTROL:

A. Upon completion of installation of electrical connections, and after circuitry has been energized with rated power source, test connections to demonstrate capability and compliance with requirements. Ensure that direction of rotation of each motor is correct. Correct improper motor rotation, then retest to demonstrate compliance.

END OF SECTION 26 27 30
SECTION 26 28 13 – FUSES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. This Section specifies fuse work as indicated by Drawings and by requirements of this Section. Types of fuses specified in this section include the following:
      2. Class L current-limiting and time-delay.
      3. Class L current-limiting and fast-acting.
      4. Class RK1 current-limiting and time-delay.
      5. Class RK1 and Class J current-limiting.
      6. Class RK5 current-limiting and time-delay.
      7. Cable Limiters.

1.03 RELATED REQUIREMENTS:
   A. Section 26 28 16 – Circuit and Motor Disconnect Switch.

1.04 REFERENCE STANDARDS:
   A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
   B. Applicable Standards: Comply with applicable requirements of following standards.
      1. American National Standards Institute (ANSI):
         a. C97.1 - Low-Voltage Cartridge Fuses 600V or Less.
      2. National Electrical Manufacturer's Association (NEMA):
         a. FU1 - Low-Voltage Cartridge Fuses.
         a. 70 - National Electrical Code (NEC). Comply with NEC as applicable to construction and installation of fusible devices.
      4. Underwriters Laboratories (UL): Provide overcurrent protective devices which are UL-listed and labeled.
         b. 248-8 - Low-Voltage Fuses - Part 8: Class J Fuses.
         c. 248-10 - Low-Voltage Fuses - Part 10: Class L Fuses.
         d. 248-12 - Low-Voltage Fuses - Part 12: Class R Fuses.

1.05 SUBMITTALS:
   A. Refer to DIVISION 01 and Section 26 05 10 - Basic Electrical Requirements, for administrative and procedural requirements for Submittals.
   B. Includes, but not limited to, the following:
      1. Product Data: Submit manufacturer's technical product data on fuses, including specifications, electrical characteristics, and time current curves.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:
   A. Subject to compliance with requirements, provide fuses of one of the following:
SECTION 26 28 13 – FUSES: continued

1. Eaton’s Bussmann Business, Inc.
2. Mersen.
3. Littelfuse, Inc.

2.02 FUSES:
A. General: Except as otherwise indicated, provide fuses of types, sizes, ratings, and average melting-time-current and peak let-through current characteristics which comply with manufacturer's standard design and materials, are constructed in accordance with published product information, and constructed with industry standards and configurations.
B. For applications less than or equal to 600A: Class RK1 Current-Limiting and Time-Delay Fuses.
   1. UL Class RK1 time-delay fuses rated 250 or 600V (voltage rating as required), 60 hertz, amperes as indicated, with 200,000 RMS amperes symmetrical interrupting current rating for protecting motors, transformers, and circuit breakers.
C. For applications less than or equal to 600A: Class RK1 Current-Limiting and Fast-Acting Fuses.
   1. UL Class RK1 current-limiting fuses rated 250 or 600V (voltage rating as required), 60 hertz, amperes as indicated, with 200,000 RMS amperes symmetrical interrupting current rating for protecting service entrances and feeder circuit breakers.
D. For applications less than or equal to 600A: Class J Fast-Acting Current-Limiting Fuses.
   1. UL Class J current-limiting fuses rated 600V, 60 hertz, amperes as indicated with 200,000 RMS amperes symmetrical interrupting current rating.
E. For applications less than or equal to 600A: Class RK5 Current-Limiting and Time-Delay Fuses.
   1. UL Class RK5 time-delay fuses rated 250 or 600V (voltage rating as required), 60 hertz, amperes as indicated, with 200,000 RMS amperes symmetrical interrupting current rating for protecting motors.

2.03 CABLE LIMITERS:
A. Cable Limiters: Rated 600V, 60 hertz, 100,000 RMS amperes symmetrical interrupting current rating with tubular compression type terminals for copper cable, cable size as indicated.

2.04 ACCESSORIES:
A. Clip-clamps sized for fuse clip and manufactured by the fuse manufacturer.
B. Fuse reducers manufactured by the fuse manufacturer.

2.05 SPARE FUSES:
A. Maintenance Stock Fuses: For types and ratings required, furnish additional fuses, amounting to two units for every ten installed units, but not less than one set of three of each type and rating.
B. Provide one wall-mounted, gray enamel, 18-gage steel spare fuse cabinet for each room containing a switchboard, switchgear, panelboard, or motor control center that utilizes fused devices. Cabinet shall be large enough to contain 20% of the fuses used in that room. The words "SPARE FUSES" shall be stenciled in 1-1/2-inch high black letters on the door.
SECTION 26 28 13 – FUSES: continued

PART 3 - EXECUTION

3.01 EXAMINATION:
   A. Examine areas and conditions under which fuses are to be installed. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF FUSES:
   A. Install fuses as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to ensure that protective devices comply with requirements. Comply with NEC and NEMA standards for installation of fuses.
   B. Fuses shall not be installed until equipment is ready to be energized.
   C. Install fuses in fused switches.
   D. All fuses in each switch (or circuit breaker) shall be the same rating, same type, and from the same manufacturer.
   E. Install fuses in disconnect switches as required to provide protection as indicated on packaged HVAC equipment nameplates. Fuse sizes indicated on Drawings are approximate. Install fuse size as indicated on packaged HVAC equipment nameplates.
   F. Install fuse clip-clamps on all fuses which are mounted on mechanical equipment subject to vibration.
   G. Install fuse reducers as required.
   H. Install fuse cabinets on wall adjacent to fused equipment; coordinate location with all building trades. Stock all spare fuses in fuse cabinets in proportion to their use in that room.
   I. Provide typewritten label on the inside of the door of each fused switch indicating replacement fuse type, class and ampere rating.

3.03 FIELD QUALITY CONTROL:
   A. Prior to energization of fusible devices, test fuses and fused switches for continuity and for short-circuits. Replace malfunctioning units with new units, and then demonstrate compliance with requirements.

END OF SECTION 26 28 13
SECTION 262816 - CIRCUIT AND MOTOR DISCONNECT SWITCH

PART 1  -  GENERAL

1.01  RELATED DOCUMENTS:
       A. Drawings and general provisions of the Contract, including General and Supplementary
          Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02  SUMMARY:
       A. This Section specifies circuit and motor disconnects.

1.03  RELATED REQUIREMENTS:
       A. SECTION 26 05 53 - ELECTRICAL IDENTIFICATION.
       B. SECTION 26 27 26 - WIRING DEVICES for manual switches used as motor disconnects.
       C. SECTION 26 28 13 - FUSES.

1.04  REFERENCE STANDARDS:
       A. National Electrical Manufacturers Association (NEMA):
          1. 250 - Enclosures for Electrical Equipment (1,000V maximum).
          2. KS 1 - Enclosed Switches.
       B. National Fire Protection Association (NFPA):
          1. 70 - National Electrical Code (NEC).
       C. Underwriters Laboratories (UL):
          1. 869 - Electrical Service Equipment.

1.05  SUBMITTALS:
       A. Refer to DIVISION 01 and SECTION 26 05 10 - BASIC ELECTRICAL REQUIREMENTS
          for administrative and procedural requirements for submittals.
       B. Includes, but not limited to, the following:
          1. Product data for each type of product specified.
          2. Ampere rating and fused switch short-circuit interrupting ratings.
          3. Maintenance data for circuit and motor disconnects for inclusion in Operation and
             Maintenance Manual specified in DIVISION 01 and SECTION 26 05 10 - BASIC
             ELECTRICAL REQUIREMENTS.

PART 2  -  PRODUCTS

2.01  MANUFACTURES:
       A. Subject to compliance with requirements, provide products by one of the following:
          2. Cutler-Hammer Inc.
          4. General Switch Corp.
          5. Siemens Energy and Automation, Inc.
          7. Westinghouse Electric Corp.

2.02  CIRCUIT AND MOTOR DISCONNECT SWITCHES:
       A. General: Provide 3-pole circuit and motor disconnect switches in types, sizes, duties, features,
          ampere ratings, short-circuit interrupting ratings, energy withstand ratings, and enclosures as
          indicated. Provide NEMA 1 enclosure for indoor dry locations. For outdoor disconnect
EVALUATIONS: continued

Switches and other indicated wet locations, provide NEMA 3R enclosures with raintight hubs. Switch mechanism shall be interlocked with door mechanism to prevent door from opening when switch is closed and to prevent switch from being closed when door is. Switch mechanism shall have provisions for pad locking in the open or closed position. For motor and motor starter disconnect switches, provide units with horsepower ratings suitable for the loads. Provide 60-hertz, 600V (and 240V units as required by application). Provide terminals UL rated for 75°C (minimum) conductors. Provide equipment ground conductor lug. Provide solid neutral assemblies when indicated, specified, or required. Provide only load-break rated motor disconnect switches.

B. Fusible Single-Throw Disconnect Switches: 240Vac General-duty switches, with fuses of classes, current ratings and interrupting ratings indicated. See SECTION 26 28 13 - FUSES for specifications. Where current limiting fuses are specified or indicated, provide switches with noninterchangeable rejection feature suitable only for current limiting type fuses.

C. Service Disconnect Switches: Heavy-duty fusible disconnect switches. UL listed for use as service equipment under UL 98 or 869.

D. Accessories:
1. Special Enclosure Material: Provide special enclosure material as follows for disconnect switches when indicated.
   a. Heavy cast steel.

PART 3 - EXECUTION

3.01 INSTALLATION OF CIRCUIT AND MOTOR DISCONNECTS:
A. General: Provide circuit and motor disconnect switches as indicated or required. Provide fused type disconnect switches on all packaged mechanical equipment such as HVAC units, condensing units, air-conditioning units, and other items., that require fuse protection as listed on the unit nameplate or as required for equipment short-circuit protection. Install fuse type and size as indicated on unit nameplate. Comply with NEC and disconnect switch manufacturers' printed installation instructions. Where practicable, install switch at an elevation such that the centerline of the switch operator is 5 feet-6 inches above the finished floor. Tighten connectors and terminals in accordance with manufacturer's instructions. All fuses in each disconnect switch shall be of the same type and from the same manufacturer. Where switches can be backfed provide a warning sign reading: "Warning: Load side of switch may be energized by backfeed" per SECTION 260553.

3.02 FIELD QUALITY CONTROL:
A. Testing: Inspect all contacts and clean, if required. Inspect all arc chutes if provided on switches. Subsequent to completion of installation of electrical disconnect switches, energize circuits and demonstrate capability and compliance with requirements. Do not test switches by operating them under load. However, demonstrate switch operation through six opening/closing cycles with circuit deenergized. Open each switch enclosure for inspection of interior, mechanical and electrical connections, fuse installation (if required on switch), and for verification of power on load side of fuse (fuse has not blown), fuse type and rating of fuses installed (if required on switch). Correct deficiencies then retest to demonstrate compliance. Remove and replace defective units with new units and retest.

END OF SECTION 262816
SECTION 26 41 13 – LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. Section includes lightning protection for structures.

1.03 REFERENCED STANDARDS:
   A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
   B. NFPA
   C. Underwriters Laboratories Inc.
      1. UL 96-2005: Lightning Protection Components (ANSI)
      2. UL 96A-2007: Installation Requirements for Lightning Protection Systems (ANSI)

1.04 SUBMITTALS:
   A. Product Data: For each type of product indicated.
   B. Shop Drawings: For air terminals and mounting accessories.
      1. Layout of the lightning protection system, along with details of the components to be used in the installation.
      2. Include indications for use of raceway, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.
   C. Qualification Data: For qualified Installer and manufacturer. Include data on listing or certification by UL.
   D. Field quality-control reports.
   F. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features, including the following:
      1. Ground rods.
      2. Ground loop conductor.

1.05 QUALITY ASSURANCE:
   A. Installer Qualifications: Certified by UL or LPI as a Master Installer/Designer, trained and approved for installation of units required for this Project.
   B. System Certificate:
      1. UL Master Label.
   C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 780, "Definitions" Article.

1.06 COORDINATION:
   A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.
SECTION 26 41 13 – LIGHTNING PROTECTION FOR STRUCTURES: continued

B. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.
C. Flashings of through-roof assemblies shall comply with roofing manufacturers' specifications.

PART 2 - PRODUCTS

2.01 LIGHTNING PROTECTION SYSTEM COMPONENTS:
A. Comply with UL 96 and NFPA 780.
B. Roof-Mounted Air Terminals: NFPA 780, Class I, aluminum unless otherwise indicated.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      (a) East Coast Lightning Equipment Inc.
      (b) ERICO International Corporation.
      (c) Harger.
      (d) Heary Bros. Lightning Protection Co. Inc.
      (e) Independent Protection Co.
      (f) Preferred Lightning Protection.
      (g) Robbins Lightning, Inc.
      (h) Thompson Lightning Protection, Inc.
C. Air Terminals More than 24 Inches (600 mm) Long: With brace attached to the terminal at not less than half the height of the terminal.
D. Main and Bonding Conductors: Copper.
E. Ground Loop Conductor: The same size and type as the main conductor except tinned.
F. Ground Rods: Copper-clad steel, sectional type; 3/4 inch (19 mm) in diameter by 10 feet (3 m) long.

PART 3 - EXECUTION

3.01 INSTALLATION:
A. Install lightning protection components and systems according to UL 96A and NFPA 780.
B. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends.
C. Conceal the following conductors:
   1. Down conductors.
   2. Interior conductors.
D. Conductors within normal view of exterior locations at grade within 200 feet (60 m) of building.
E. Cable Connections: Use exothermic-welded connections for all conductor splices and connections between conductors and other components.
   1. Exception: In single-ply membrane roofing, exothermic-welded connections may be used only below the roof level.
F. Air Terminals on Single-Ply Membrane Roofing: Comply with roofing membrane and adhesive manufacturer's written instructions.

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G. Bury ground ring not less than 24 inches (600 mm) from building foundation.
   1. Bond ground terminals to the ground loop.
H. Bond grounded building systems to the ground loop conductor within 12 feet (3.6 m) of grade level.

3.02 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 DIVISION 26 Section "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.03 CORROSION PROTECTION:
A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.
B. Use conductors with protective coatings where conditions cause deterioration or corrosion of conductors.

3.04 FIELD QUALITY CONTROL:
A. Notify Architect at least 48 hours in advance of inspection before concealing lightning protection components.
B. UL Inspection: Meet requirements to obtain a UL Master Label for system.
C. LPI System Inspection: Meet requirements to obtain an LPI System Certificate.

END OF SECTION 26 41 13
SECTION 26 50 00 – INTERIOR LIGHTING FIXTURES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary
      Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. This Section specifies interior lighting fixture work as indicated on drawings and schedules.
   B. Types of interior lighting fixtures in this Section include the following:
      1. Light Emitting Diode (LED):

1.03 REFERENCE STANDARDS:
   A. Applicable Standards: Comply with applicable requirements of the following standards.
      1. American National Standards Institute (ANSI)/Institute of Electrical and Electronic
         Engineers (IEEE):
         a. IEEE C62.41-1991 - Recommended Practice for Surge Voltages in Low-Voltage
            A.C. Power Circuits.
      2. National Electrical Manufacturers Association (NEMA):
         a. 70 - National Electrical Code (NEC). Comply with applicable local code
            requirements of the authority having jurisdiction and the NEC.
      4. Underwriters Laboratories (UL): Provide interior lighting fixtures and components
         which are UL-listed and labeled.
         a. 57 - Electric Lighting Fixtures.
         b. 506 - Specialty Transformers.
         c. 486A - Wire Connectors and Soldering Lugs for Use with Copper Conductors.
         d. 542 - Lampholders, Starters, and Starter Holders for Fluorescent Lamps.

1.04 SUBMITTALS:
   A. Refer to Division 01 and Section 26 00 00 – “Basic Electrical Requirements” for administrative
      and procedural requirements for submittals.
   B. Includes, but not limited to, the following:
      1. Product Data: Submit manufacturer’s product data and installation instructions on each
         type of interior building lighting fixture, lamp, and component. Submit fluorescent lamp
         color in degrees Kelvin, color rendering index (CRI), and average lamp efficacy in
         lumens per watt
      2. Shop Drawings: Submit fixture shop drawings in booklet form with a separate sheet for
         each fixture, assembled in "luminaire type" alphabetical or numerical order, with
         proposed fixture, lamp type, and accessories clearly indicated on each sheet. Submit
         details indicating compatibility with ceiling grid system.
      3. Wiring Diagrams: Submit wiring diagrams for interior lighting fixtures showing
         connections. Differentiate between portions of wiring which are manufacturer factory-
         installed and portions which are field-installed.
      4. Illumination Data: Provide fixture efficiency and coefficients of utilization. Provide
         recommended maximum spacing-to-mounting ratio. Provide candelepower distribution
         curves (drawn to scale such that candelepower can be scaled at different angles) or provide
         candelepower data in tabular form at 100 increments. For recessed fluorescent lights
         provide visual comfort probability data for a 100 footcandle room with reflectances of
         80% ceiling, 50% wall, and 20% floor in a 20 foot by 20 foot room with 10 foot ceiling
         and luminaries lengthwise.
SECTION 265000 – INTERIOR LIGHTING FIXTURES: CONTINUED

5. Maintenance Data: Submit maintenance data and parts list for each interior lighting fixture and accessory; include "trouble-shooting" maintenance guide. Include in this data, product data and shop drawings in a maintenance manual, in accordance with general requirements of Division 01.

1.05 DELIVERY, STORAGE AND HANDLING:
A. Deliver interior lighting fixtures in factory-fabricated containers or wrappings that properly protect fixtures from damage.
B. Store interior lighting fixtures in original packaging. Store inside well-ventilated area, protected from weather, moisture, soiling, extreme temperatures, humidity. Lay flat and block off of floor.
C. Handle interior lighting fixtures carefully to prevent damaging, breaking, or scoring finishes. Do not install damaged units or components; replace with new.

1.06 SEQUENCING AND SCHEDULING:
A. Sequence interior lighting installation with other work to minimize possibility of interference with pipes, ductwork, and conduit. Protect light fixtures from damage and soiling during remainder of construction.

1.07 MAINTENANCE:
A. Extra stock:
   1. Furnish stock or replacement lamps amounting to 15%, but not less than four lamps in each case, of each type and size lamp used in each type of fixture on the project. Deliver replacement stock, as directed, to Owner's storage space and obtain receipt.

PART 2 - PRODUCTS

PRODUCTS

2.01 MANUFACTURERS:
A. Subject to compliance with requirements, provide products as indicated on drawings or approved equal.
B. General: Provide lighting fixtures of sizes, types, and ratings indicated, complete with, but not limited to, housings, high power factor ballasts, energy-efficient lamps, lamp holders, reflectors, energy efficient ballasts, starters, and wiring. Light fixture catalog numbers indicated in the light fixture schedule do not necessarily denote required mounting hardware, equipment or accessories. Provide mounting hardware, equipment and accessories as required. Ship fixtures factory-assembled, with those components required for a complete installation. Design fixtures with concealed hinges and catches, with metal parts grounded as common unit, and constructed to dampen ballast generated noise. All equipment and materials shall bear the UL label.
C. LED sources shall meet the following requirements:
   1. Operating temperature rating shall be between -40 degrees F to 120 degrees F.
   2. Correlated Color Temperature (CCT): 3500K.
   3. Color Rendering Index (CRI): greater than or equal to 80.
   4. The manufacturer shall have performed Joint Electron Devices Engineering Council (JEDEC) reliability tests on the LEDs as follows: High Temperature Operating Life (HTOL), Room Temperature Operating Life (RTOL), Low Temperature Operating Life (LTOL), Powered Temperature Cycle (PTMCL), Non-Operating Thermal Shock (TMSK), Mechanical Shock Variable Vibration Frequency, and Solder Heat Resistance (SHR).
SECTION 265000 – INTERIOR LIGHTING FIXTURES: CONTINUED

C. LED Drivers:
   1. LED drivers shall meet the following requirements:
      a. Drivers shall have a minimum efficiency of 85%
      b. Starting Temperature: -40 degrees F.
      c. Input Voltage: 120 to 277V (plus or minus 10%)
      d. Power supplies: Class I or II output.
      e. Surge Protection: The system must survive 250 repetitive strikes of "C Low" (C Low: 6kV/1.2 by 50 microsec, 10kA/8 by 20 microsec) waveforms at 1-minute intervals with less than 10% degradation in clamping voltage. "C Low" waveforms are as defined in IEEE/ANSI C62.41.2-2202, Scenario 1 Location Category C.
      f. Power Factor (PF): greater than or equal to 0.90.
      g. Total Harmonic Distortion (THD): Less than or equal to 20%.
      h. Comply with FCC Title 47 CFR Part 18 Non-consumer RFI/EMI Standards.
      i. Drivers shall be reduction of hazardous substances (ROHS) compliant.

D. Interior Lighting Fixture Types:
   1. General: Various fixture types required are listed on the fixture schedule on the drawings. Fixtures must comply with minimum requirements as stated herein. Review architectural drawings and specifications to verify ceiling types, modules, suspension systems appropriate to installation.

E. Interior Lighting Fixture Types:
   1. General: Various fixture types required are listed on the fixture schedule on the drawings. Fixtures must comply with minimum requirements as stated herein. Review architectural drawings and specifications to verify ceiling types, modules, suspension systems appropriate to installation.

PART 3 - EXECUTION

3.01 EXAMINATION:
   A. Examine the mounting surface for supporting lighting fixtures and the areas and conditions under which lighting fixtures are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF INTERIOR LIGHTING FIXTURES:
   A. Provide fixtures and/or fixture outlet boxes with hangers to properly support fixture weight. Submit design of hangers and method of fastening, other than that which is indicated or specified herein, for review by Engineer.
   B. Install flush mounted fixtures properly to eliminate light leakage between fixture frame and finished surface.
   C. Provide plaster frames for recessed fixtures installed in other than suspended grid type acoustical ceiling systems. Brace frames temporarily to prevent distortion during handling.
   D. Fasten fixtures securely to structural supports and ensure that pendant fixtures are plumb and level. Provide individually mounted fluorescent pendant fixtures with pendants longer than 2 feet with twin stem hangers. Provide all pendant stem hangers with ball aligners and provisions for minimum 1 inch vertical adjustment. Mount continuous rows of fixtures with an additional stem hanger greater than the number of fixtures in the row.
   E. All recessed light fixtures supported by suspended ceilings shall be securely attached (from a minimum of 4 points) to the structural steel above by four diagonally opposite, adequately sized safety chains.
   F. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where
SECTION 265000 – INTERIOR LIGHTING FIXTURES; CONTINUED

manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A and the National Electrical Code.
G. Support surface mounted fixtures greater than 2 feet in length at a point in addition to the outlet box fixture stud.

3.03 FIELD QUALITY CONTROL:
A. At the Date of Substantial Completion, replace lamps in interior lighting fixtures which are observed to be noticeably dimmed as judged by Engineer, after Contractor's use and testing.
B. Refer to Division 01 for the replacement/restoration of lamps in interior lighting fixtures where used for temporary lighting prior to Date of Substantial Completion.

3.04 ADJUSTING AND CLEANING:
A. Clean interior lighting fixtures of dust, dirt, and construction debris upon completion of installation. Clean fingerprints and smudges from lenses.
B. Protect installed fixtures from damage during the remainder of the construction period.
C. All light fixtures which can be aimed (flood lights, etc.) shall be aimed as indicated and shall be reaimed as directed by the Engineer during nighttime lighting demonstrations. Redemonstrate lighting at night after all adjustments have been made.

3.05 GROUNDING:
A. Provide equipment grounding connections for interior lighting fixtures as indicated and specified. Tighten connections to comply with tightening torques specified in UL 486A to assure permanent and effective grounds.

3.06 DEMONSTRATION:
A. Upon completion of the installation of interior lighting fixtures, and after building circuitry has been energized, apply electrical power to demonstrate capability and compliance with requirements. All interior lighting shall be demonstrated during nighttime lighting demonstrations. Where possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting.

END OF SECTION 26 50 00
SECTION 26 52 00 - EMERGENCY LIGHTING

PART 1 - GENERAL

1.01 SUMMARY:
   A. This Section specifies emergency lighting as indicated by drawings and schedules.
   B. Types of self-contained emergency lighting fixtures in this section include the following:
      1. Unitized battery powered fixtures.
      2. Illuminated exit sign fixtures.

1.02 REFERENCES:
   A. Applicable Standards: Comply with applicable requirements of the following standards.
      1. National Electrical Manufacturers' Association (NEMA):
         a. 1B 4 - Determination of Amperhour and Watthour Capacity of Lead-Acid Industrial Storage Batteries for Stationary Service.
         b. 1B 5 - Life Testing of Lead-Acid Industrial Storage Batteries for Stationary Service.
         c. 1B 7 - Testing Arrester Vents Used on Lead-Acid Industrial Storage Batteries for Stationary Service.
      2. National Fire Protection Association (NFPA):
         a. 70 - National Electrical Code (NEC).
      3. Underwriters Laboratories (UL) Compliance: Provide emergency lighting fixtures which are UL listed and labeled.
         a. 57 - Electric Lighting Fixtures.
         b. 924 - Emergency Lighting and Power Equipment

1.03 SUBMITTALS:
   A. Refer to DIVISION 1 and SECTION 26 05 10 - BASIC ELECTRICAL REQUIREMENTS for administrative and procedural requirements for submittals.
   B. Includes, but not limited to, the following:
      1. Product Data: Submit manufacturer's technical product data on emergency lighting fixtures. Provide scaled candlepower distribution curves for light fixtures.
      2. Shop Drawings: Submit fixture shop drawings in booklet form with separate sheet for each fixture, assembled in luminaire "type" alphabetical or numerical order, with proposed fixture and accessories clearly indicated on each sheet.
      3. Maintenance Data: Submit maintenance data and parts list for each emergency lighting fixture and accessory, including "troubleshooting" maintenance guide. Include this data, product data and shop drawings in maintenance manual, in accordance with requirements of DIVISION 1.

1.04 DELIVERY, STORAGE, AND HANDLING:
   A. Handle lighting fixtures carefully to prevent damage, breaking, and scoring. Do not install damaged fixtures or components; replace with new.
   B. Store lighting fixtures in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:
EVALUATIONS:  continued

A. Subject to compliance with requirements, provide products as indicated on drawings or approved equal.

2.02 EMERGENCY LIGHTING FIXTURES:

A. General: Provide lighting fixtures, of sizes, types, and ratings specified and indicated.

B. Unitized Battery Powered Fixtures:

1. Emergency Units: Battery powered, self-contained units with solid-state, fully automatic charger and transfer/brownout circuit and low-voltage battery disconnect. Provide enclosure constructed in accordance with NEMA 1 standards. Supply maintenance-free lead-calcium battery for 12V operation. Provide two unit mounted 12V, 25 watt sealed beam light fixtures.
   a. Battery: Provide 12V lead-calcium battery capable of supplying connected load for period of 1-1/2 hours to end voltage of 87-1/2% of nominal battery voltage.
   b. Charger: Provide automatic battery charger with full recharging capability within UL recharging standards, or less after full discharge.
   c. Unit shall have "Ready Light" and test switch.
   d. Accessories: Provide following accessories mounted on unit cabinet:
      (1) Voltmeter.
      (2) Ammeter.
      (3) AC "ON" pilot light.
      (4) Battery life expectancy alarm.
      (5) Wire guard.
      (6) Heavy-duty wall mounting bracket.
      (7) Three foot long cord with plug.
      (8) Fifteen minute retransfer time delay.

2. Illuminated Exit Sign Fixtures - Emergency Powered: Surface, wall, or ceiling mounted fixtures, as required. Provide 120Vac unit with extruded aluminum fixture with no external hardware, satin aluminum exterior finish and white baked enamel interior, with capability for adjusting face panel for: no arrow, left arrow and/or right arrow. Provide internal 6Vdc battery.
   a. Plastic Face Panels: White panels with permanent, red letters 6" high, 3/4" stroke. Provide single or double face as indicated.
   b. Furnish battery powered unit with 12-hour automatic charger, complete with nickel-cadmium battery which automatically connects 6V lamps to (1-1/2 hour) (20 hour) battery upon normal power loss and disconnects upon restoration of normal AC supply. Low voltage disconnect shall prevent damage to the battery.

PART 3 - EXECUTION

3.01 INSPECTION:

A. Examine areas and conditions under which emergency lighting is to be installed and substrate which will support lighting fixtures. Do not proceed with work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF EMERGENCY LIGHTING FIXTURES:

A. Install emergency lighting fixtures at locations and heights as indicated, in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation," NEMA standards, and with recognized industry practices to ensure that the lighting fixtures fulfill requirements.
EVALUATIONS: continued

B. All emergency lighting conductors shall be routed in conduit separate from the normal power circuits.

3.03 ADJUSTING AND CLEANING:
A. Clean emergency lighting fixtures of dirt and debris upon completion of installation.
B. Protect installed fixtures from damage during remainder of construction period.
C. Aim adjustable lighting heads as directed by the Engineer in a night time test.

3.04 GROUNDING:
A. Provide equipment grounding connections for emergency lighting fixtures as indicated. Tighten connections to comply with tightening torques specified in UL 486A to assure permanent and effective grounds.

3.05 FIELD QUALITY CONTROL:
A. Upon completion of the installation of emergency lighting fixtures, and after building circuitry has been energized with the normal power source for a minimum of 12 hours, perform a night time test by turning off the normal power source for 90 minutes to demonstrate operation, capability, and compliance with requirements under emergency conditions. Realign adjustable lighting heads as directed by the Engineer during a night-time demonstration. Redemonstrate again at night after the readjustments have been made. Where possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting.

END OF SECTION 265200
SECTION 26 56 10 – EXTERIOR LIGHTING FIXTURES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary
      Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. This Section specifies exterior lighting fixture work as indicated by drawings, schedules, and
      as specified herein.
   B. Types of exterior lighting fixtures in this Section include the following:
      1. Light Emitting Diode (LED).
   C. Applications of exterior lighting fixtures required for this Project include the following:
      1. Outdoor area lighting.
      2. Pole mounted lighting

1.03 REFERENCE STANDARDS:
   A. Applicable Standards: Comply with applicable requirements of the following standards.
      1. National Electrical Manufacturers' Association (NEMA): Comply with applicable
         requirements of NEMA Stds Pub/No. LE2 pertaining to lighting equipment.
      2. National Fire Protection Association (NFPA):
         a. 70 - National Electrical Code (NEC). Comply with applicable local code
            requirements of the authority having jurisdiction and the NEC.
         b. 780 - Lightning Protection Code. Comply with applicable requirements pertaining
            to installation of exterior lighting fixtures.
      3. Underwriters Laboratories (UL): Provide exterior lighting fixtures and components
         which are UL listed and labeled. Comply with applicable requirements of the following
         standards:
         a. 57 - Electric Lighting Fixtures.

1.04 SUBMITTALS:
   A. Refer to Division 01 and Section 26 05 10 – Basic Electrical Requirements for administrative
      and procedural requirements for Submittals.
   B. Includes, but not limited to, the following:
      1. Product Data: Submit manufacturer's product data and installation instructions on each
         type of exterior building lighting fixture.
      2. Shop Drawings: Submit fixture Shop Drawings in booklet form with a separate sheet for
         each fixture, assembled in "luminaire type" alphabetical or numerical order with
         proposed fixture, lamp type, voltage, complete illumination data (as specified below), and
         accessories clearly indicated on each sheet.
      3. Wiring Diagrams: Submit wiring diagrams for exterior lighting fixtures showing
         connections. Diagrams shall differentiate between portions of wiring which are
         manufacturer factory-installed and portions which are field installed.
      4. Illumination Data: Provide fixture lumen efficiency. Provide recommended maximum
         spacing-to-mounting height. Provide isofootcandle (isolux) plot diagram of footcandles
         on horizontal pavement surface which shows composite values of illuminance projected
         from the arrangement of light sources from indicated fixture locations and heights. Show
         on the graphic plots the locations, spacings, and heights of luminaries. Provide
SECTION 26 56 10 – EXTERIOR LIGHTING FIXTURES: continued

candlepower distribution curves (drawn to scale such that candlepower can be scaled at different angles) or provide candlepower data in tabular form at 10 degree increments. When the Contractor proposes a light fixture substitution other than the one the Engineer used for design, the Contractor shall also submit a computer printout of the area with horizontal and vertical maintained footcandles (and aiming criteria where applicable) indicated on a 10 foot x 10 foot grid for the exterior space being illuminated.

5. Maintenance Data: Submit maintenance data and parts list for each exterior lighting fixture and accessory, including "troubleshooting" maintenance guide. Include in this data, product data and shop drawings in a maintenance manual in accordance with requirements of Division 01.

1.05 DELIVERY, STORAGE, AND HANDLING:
   A. Deliver exterior lighting fixtures in factory-fabricated containers or wrappings which properly protect fixtures from construction debris and physical damage.
   B. Store exterior fixtures in original wrappings in a clean dry space. Protect from weather, dirt, fumes, water, construction debris, and damage.
   C. Handle exterior lighting fixtures carefully to prevent damage, breaking, and scoring. Do not install damaged fixtures or components; remove units from Site and replace with new.

1.06 SEQUENCING AND SCHEDULING:
   A. Sequence exterior lighting installation with other work to reduce possibility of damage and soiling of fixtures during the remainder of construction period.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:
   A. Subject to compliance with requirements, provide products as indicated on drawings or approved equal.

2.02 EXTERIOR LIGHTING FIXTURES:
   A. General: Provide lighting fixtures of sizes, types, and ratings indicated; complete with, but not limited to, housings, high power factor ballasts, energy efficient ballasts, lamps, starters, and wiring. All equipment and materials shall bear the UL label.
   B. LED sources shall meet the following requirements:
      1. Operating temperature rating shall be between -40 degrees F to 120 degrees F.
      2. Correlated Color Temperature (CCT): 3500K.
      3. Color Rendering Index (CRI): greater than or equal to 80.
      4. The manufacturer shall have performed Joint Electron Devices Engineering Council (JEDEC) reliability tests on the LEDs as follows: High Temperature Operating Life (HTOL), Room Temperature Operating Life (RTOL), Low Temperature Operating Life (LTOL), Powered Temperature Cycle (PTMCL), Non-Operating Thermal Shock (TMSK), Mechanical Shock Variable Vibration Frequency, and Solder Heat Resistance (SHR).
   C. LED Drivers:
      1. LED drivers shall meet the following requirements:
         a. Drivers shall have a minimum efficiency of 85%
         b. Starting Temperature: -40 degrees F.
         c. Input Voltage: 120 to 277V (plus or minus 10%)
         d. Power supplies: Class I or II output.
SECTION 26 56 10 – EXTERIOR LIGHTING FIXTURES: continued

   e. Surge Protection: The system must survive 250 repetitive strikes of "C Low" (C Low: 6kV/1.2 by 50 microsec, 10kA/8 by 20 microsec) waveforms at 1-minute intervals with less than 10% degradation in clamping voltage. "C Low" waveforms are as defined in IEEE/ANSI C62.41.2-2202, Scenario 1 Location Category C.

   f. Power Factor (PF): greater than or equal to 0.90.

   g. Total Harmonic Distortion (THD): Less than or equal to 20%.

   h. Comply with FCC Title 47 CFR Part 18 Non-consumer RFI/EMI Standards.

   i. Drivers shall be reduction of hazardous substances (ROHS) compliant.

   D. Provide integral 2-50 footcandle adjustable photocell control when indicated. Photo control shall have internal 2-minute time delay.

   2.03 EXTERIOR LIGHTING FIXTURE TYPES:
   A. General: Various fixture types are indicated on the fixture schedule on the drawings. Fixtures shall comply with the minimum requirements as stated on the schedule.

   2.04 LIGHTING POLES AND STANDARDS:
   A. Metal Lighting Standards: Metal, raceway-type, lighting poles and standards, of sizes and types indicated, comprised of shafts and tenon joints. Equipment with grounding connections readily accessible from handhold or transformer base with vandal-resistant access doors; and constructed of the following materials and additional construction features.
   1. Material:
      a. Stainless steel.

   2. Configuration:
      a. Embedded-type base and reinforcing sleeve with hand and cable entrance holes (where indicated).

   3. Metal Lighting Standard Accessories: Include anchor bolts, as recommended by the lighting standard manufacturer, of sizes and materials needed to meet erection and loading application requirements.

   B. Metal Poles: Galvanized steel, tapered, tubular, seamless shaft poles, of sizes and types indicated, with 1/4-inch bearing plates and ground sleeves for direct embedment. (Provide removable step bolts 3/4 inch diameter and 6 inches long with threaded steel lugs welded to pole beginning 12 ft. above finished grade. Space step bolts at 15 inch intervals on alternating sides of the pole, continuing to the top.) Provide pole with adequately sized reinforced handhold complete with matching cover and located on climbing side of pole, 18 inches above grade level. Weld 1/2-inch grounding stud on shaft with accessibility from handhold. Design poles to withstand loads developed by 100 mph wind pressure, as adjusted for height above ground level, structural shapes loading and cable/wire loading. Construct poles whose total length is greater than 40 ft. in two sections for shipping purposes.

   C. Metal Pole Accessories: Include crossarms, bolts, lifting eyes, and nuts as recommended by pole manufacturer, of sizes and materials needed to meet erection and loading application requirements

PART 3 - EXECUTION

3.01 EXAMINATION:
   A. Examine areas and conditions under which lighting fixtures are to be installed and the substrate which will support lighting fixtures. Do not proceed with the Work until unsatisfactory conditions have been corrected.
SECTION 26 56 10 – EXTERIOR LIGHTING FIXTURES: continued

3.02 INSTALLATION OF EXTERIOR LIGHTING FIXTURES:
A. Install exterior lighting fixtures at locations and heights as indicated, in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation," NEMA standards, and with recognized industry practices to ensure that lighting fixtures fulfill requirements.
B. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A and the National Electrical Code.
C. Fasten electrical lighting fixtures and brackets securely to structural supports, including poles/standards; ensure that installed fixtures are plumb and level.
D. All exterior lighting shall be demonstrated during night-time tests.
E. All light fixtures which can be aimed (floodlights, etc.) shall be aimed as indicated and shall be re-aimed as directed by Engineer during night time lighting demonstrations. Demonstrate lighting at night after all adjustments have been made.

3.03 GROUNDING:
A. Provide equipment grounding connections for exterior lighting fixtures as indicated. Tighten connections to comply with tightening torques specified in UL 486A to assure permanent and effective grounds.

3.04 FIELD QUALITY CONTROL:
A. At the Date of Substantial Completion, replace lamps in exterior lighting fixtures which are observed to be noticeably dimmed after Contractor's use and testing as judged by Engineer.
B. Refer to Division 01 Sections for the replacement/restoration of lamps in exterior lighting fixtures where used for temporary lighting prior to Date of Substantial Completion.

3.05 ADJUSTING AND CLEANING:
A. Aim adjustable lighting fixtures and lamps in night test of system. Verify that measured illuminance values comply with submitted isolux plot diagram values.
B. Clean lighting fixtures of dirt and debris upon completion of installation.
C. Protect installed fixtures from damage during construction period.
D. Photoelectric Controls:
   1. Aim "north."
   2. Adjust to actuate "on" at 3.0 footcandles.
   3. Provide FAA listed photoelectric controls for control of aviation obstruction lighting.

3.06 DEMONSTRATION:
A. Upon completion of installation of exterior lighting fixtures and associated electrical supply circuitry, apply electrical power to circuitry to demonstrate capability and compliance with requirements. All exterior lighting demonstrations shall be performed at night. Verify light fixture grouping (verify circuiting as indicated on Drawings) and controls. Where possible, correct malfunctioning units at Site, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting.

END OF SECTION 26 56 10
SECTION 48 14 13 – SOLAR ENERGY COLLECTORS

PART 1 - GENERAL

1.01 SUMMARY:
A. This Section specifies Solar Energy Systems as indicated by Drawings and schedules, and is hereby defined to include, but not by way of limitation, photovoltaic modules, monitoring system, mounting equipment, and accessories. Installation of the Photovoltaic array involves mechanically mounting the modules, attaching the electrical interconnection, and checking performance.

1.02 REFERENCE STANDARDS:
A. NFPA 70 National Electrical Code.
B. Underwriters Laboratory (UL):
   2. UL 746C - Polymeric Materials - Use in Electrical Equipment Evaluations.
   3. UL 854 - Service Entrance Cables.
   4. UL 1703 - Standard of Safety of Flat-Plate Photovoltaic Modules and Panels.
   6. UL 4703 - Photovoltaic Wire.
C. International Electrotechnical Commission (IEC):
   1. IEC 61215 - Crystalline Silicon Terrestrial Photovoltaic (PV) Modules.
   2. IEC 61646 - Thin-Film Terrestrial Photovoltaic (PV) Modules.

1.03 RELATED REQUIREMENTS:
B. Basic Electrical Requirements - Section 26 05 10.
C. Wiring – Section 26 05 19.
D. Electrical Identification - Section 26 05 33.
E. Raceways and Boxes - Section 26 05 33.
F. Commissioning of Electrical Systems - Section 26 08 00.
G. Static Inverter: Specified in Section 48 19 16.
H. Identification for Electrical Systems – Section 26 05 53

1.04 COORDINATION:
A. The Contractor shall coordinate the system requirements with other divisions and contractors as necessary to undertake the Work described.

1.05 ABBREVIATIONS:
A. kWh - Kilowatt Hour.
B. kWp - Kilowatt Peak.
C. STC - Standard Test Conditions.
D. Adc - Amps Direct Current.
E. Vdc - Volts Direct Current.

1.06 CONTRACTOR QUALIFICATIONS:
A. Contractor shall be trained and certified with manufacture components. Contractor shall submit personnel qualified to perform the Work based on overall electrical experience.
B. Contractor shall be NABCEP certified or demonstrate equal experience.
1.07 **SUBMITTALS:**

A. Refer to Division 01 and Section 26 05 10 - Basic Electrical Requirements for administrative and procedural requirements for submittals.

B. Includes but not limited to, the following:

1. **Product Data:** Submit Manufacturer's data on Photovoltaic Modules and components. Include manufacturer's standard product warranty, for duration of not less than 20 years, for replacement of materials and equipment used in photovoltaic system.

2. **Shop Drawings:** Submit dimensioned Drawings of photovoltaic system and accessories including, but not limited to, cable tray, wiring, mounting hardware, data, and monitoring. Drawings shall list weights, clearances, disconnects for equipment isolation, field connection points, and nameplate data.

3. **Wiring Diagrams:** Submit wiring diagrams for Photovoltaic Modules, Data monitoring, and disconnects. Clearly differentiate between portions of wiring that are manufacturer factory installed and portions that are field installed.

4. **Certifications:** Provide photovoltaic array certified test record of the following final production tests.
   a. **Total Array Output.**
   b. **Inverter Commissioning.**
   c. **Voltage and Array Output at STC.**
      (1) Test shall extrapolate from no less than 600 W/m² day of insulation.

5. Operation and maintenance manuals.

6. Factory and all field test data.

7. Contractor qualifications and certificates.

8. Interconnection agreement with utility.

1.08 **DELIVERY, STORAGE, AND HANDLING:**

A. All photovoltaics shall be stored in a protected area and handled with care.

B. Upon delivery, modules shall be inspected and tested for output voltage, cracks, defects, and discoloration.

**PART 2 - PRODUCTS**

2.01 **SYSTEM REQUIREMENTS:**

A. The system shall be fixed axis roof-mounted system capable of providing minimum 8 kW of DC. Rate all electrical equipment for the current and voltage ratings appropriate for the application. The system must be rated for outdoor installation. Provide system equipment capable of operating under the location's maximum and minimum documented temperatures during summer and winter times. The entire system must be rated and warranted to withstand and operate under these conditions.

2.02 **INSTALLERS:**

A. Apollo Energy.

B. Sopris Solar.

C. Or approved alternate.

2.03 **MANUFACTURERS:**

A. Subject to compliance with requirements, provide photovoltaic modules and products of one of the following (for each type and rating of module):

1. **Mono-crystalline:**
   a. Sanyo.
b. Sun Power.
c. Suntech.
d. Or approved equal.

2. Poly-crystalline:
   a. Kyocera.
   b. Schott.
   c. Suntech.
   d. Or approved equal.

3. Thin film:
   a. Q-Cell.
   b. Suntech.
   c. Sharp.
   d. Or approved equal.

2.04 PHOTOVOLTAIC MODULES:
A. General: Except as otherwise indicated. Provide modules, racking equipment, and ancillary components of types, sizes, and ratings indicated which comply with manufacturer's standard materials and with the design and construction in accordance with published product information. Where types, sizes, and ratings are not indicated, comply with NEC, UL, and established industry standards for those applications indicated.

B. Modules shall have minimum one bypass diode per two rows of cells, with minimum of two diodes.

C. Provide surge protectors with at least 5 kA peak current rating for inverter protection.

D. Modules shall be mounted at 20 degrees from horizontal. Apron shall run parallel to building.

E. Array shall be configured as shown on Drawings unless approved by Engineer, or Owner.

F. Strings shall have an open circuit voltage as determined in NEC 690.7 at STC, and a short circuit current of no more than 10 Adc at STC as determined in NEC 690.8. Strings shall be sized to operate within inverter operating voltage.

G. Photovoltaic module wiring, connections, and terminations:
   1. Modules shall be equipped with 12 AWG, single core, XLP USE-2 cables with lockable MC-4 quick-connect terminations for module string connections.
   2. Connectors shall comply with UL 498 and UL 1977.

H. Modules shall be UL 1703 and CEC listed and comply with IEC 61215 or 61646 as appropriate.

I. Module junction box shall comply with UL 746C.

PART 3 - EXECUTION

3.01 GROUNDING:
A. Provide grounding conductor for all modules. Equipment grounding conductors shall comply with manufacturer's recommendations and all applicable codes.

B. Non-current carrying conductive parts (e.g., metal supports/framework, etc.) should be earthed with a suitable bonding conductor in accordance with NEC before PV modules are mounted.

C. All equipment within Array must have same equipment ground conductor and comply to NEC.

3.02 INSTALLATION OF PHOTOVOLTAIC ARRAY:
A. Modules shall be mounted using UNI RAC heavy-duty SolarMount rail, or approved equal and coordinated with the roof structure. Rack system must be certified by manufacturer and guaranteed for performance on Site. Manufacturer shall provide 3-year warranty for parts and maintenance.
B. Install photovoltaic modules as indicated, in accordance with the equipment manufacturer's written instructions, and with recognized industry practices, to ensure that modules fulfill requirements.

C. Coordinate with other work, including raceways, electrical boxes, fittings, and accessories, as necessary to interface installation of photovoltaic array with other Work.

D. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in applicable codes.

E. Connect conduit, combiners, disconnects, and inverter as indicated on Drawings and comply with the manufacturer's installation instructions.

F. Open circuiting, or opaque covering shall be used to disable an array for installation or service.

3.03 IDENTIFICATION: PROVIDE PROPER IDENTIFICATION OF SYSTEM COMPONENTS:

A. All junction boxes for strings shall indicate name of string, combiner, and building location, to which the modules are connected.

B. All junction boxes shall be labeled with the following words or equivalent:

THIS BOX CONTAINS LIVE PARTS WHICH CANNOT BE DEACTIVATED.

C. All disconnects shall be labeled with string or equipment it isolates.

D. Combiners and disconnects shall be labeled with the following words or equivalent:

WARNING
ELECTRIC SHOCK HAZARD
DO NOT TOUCH TERMINALS.
TERMINALS ON BOTH THE LINE AND LOAD SIDE MAY BE ENERGIZED IN THE OPEN POSITION.

E. All test points shall be clearly labeled with their expected readings given.

3.04 ACCESSORIES:

A. Provide one set of opaque mats with capability of covering one string of modules.

3.05 FACTORY TESTING:

A. Modules shall be rated and tested to STC.

B. Quality tests on glass impact/shatter quality.

C. Test all panels for shorts and earth faults.

3.06 FIELD QUALITY CONTROL:

A. Start-Up Testing:
   1. Check all equipment and grounding to ensure continuity of connection. Notify Engineer of excessive resistance.
   2. Find and remove all ground faults. Provide one year of ground fault repair service.
   3. Upon completion of installation, demonstrate capability and compliance of system with requirements. Where possible, correct malfunctioning units at Site, then retest to demonstrate compliance; otherwise remove and replace with new units and proceed with retesting. Initial testing and retesting to be at no cost to Owner.
3.07 **COMMISSIONING:**

A. System shall be tested and commissioned in the normal manner in accordance with NEC and industry standards.

B. A minimum irradiation level of 600 Wm² shall be used to ensure accurate extrapolation to STC.

C. Test that must be performed:
   1. Electrical performance test on PV array.
   2. Test on inverter efficiency and power quality.
   3. Long-term output monitoring.

D. Contracting Representative must be present for the following tests:
   1. Synchronization with the grid.
   2. Safety interlocks.
   3. Warning labels check.
   4. Protection to isolate the inverter from supply network when:
      a. Operating voltage falls outside acceptable range.
      b. Operating frequency falls outside acceptable range.
      c. Mains supply is lost.

3.08 **AGREEMENT TO MAINTAIN:**

A. Prior to time of final acceptance, the Installer shall submit four copies of an agreement for continued service and maintenance of PV Modules for Owner. Furnish ports and provide continued testing and servicing, including replacement of materials and equipment for a three-year period after Substantial Completion. Maintenance in Contract shall be provided by a local contractor. Provide an option for renewal of the agreement by Owner.

END OF SECTION 48 14 13
SECTION 48 19 16 – GRID-TIE UTILITY INTERACTIVE INVERTERS

PART 1 - GENERAL

1.01 SUMMARY:
   A. This Section specifies the grid-tie utility interactive inverters and accessories to be provided as specified herein and where shown on the associated Drawings and manuals.

1.02 REFERENCE STANDARDS:
   A. Underwriters Laboratory (UL):
      1. UL 1741 - Inverters, converters, controllers, and interconnection system equipment for use with distributed energy resources.
   B. Institute of Electrical and Electronic Engineers (IEEE):
      1. IEEE 519 - IEEE recommended practices and requirements for harmonic control in electrical power systems.
      2. IEEE 1547 - IEEE standard for interconnecting distributed resources with electric power systems.
   D. CSA C22.2 No. 107.01 - General-use power supplies.

1.03 RELATED REQUIREMENTS:
   A. Basic Electrical Requirements - Section 26 05 10.
   B. Wiring – Section 26 05 19.
   C. Electrical Identification - Section 26 05 53.
   D. Raceways - Section 26 05 33.
   E. Electrical Systems Commissioning - Section 26 08 00.
   F. Solar Energy Collectors - Section 48 14 13.

1.04 COORDINATION:
   A. The Contractor shall coordinate the system requirements with other Divisions and contractors as necessary to undertake the Work described.

1.05 SUBMITTALS:
   A. Submit wiring diagrams showing connections to ac system and dc system. Differentiate between portions of wiring that are manufacturer installed and portions that are field installed.
   B. Submit manufacturer's Planning and Installation Manual which includes outline dimensions, connection and support points, weight, cooling air requirements, and specified ratings.
   D. Submit manufacturer's test record of specific inverter.
   E. Refer to Division 01 and Section 26 00 00 - Basic Electrical Requirements for administrative and procedural requirements for submittals.
   F. Product Data: Submit manufacturer's data on grid-tie utility interactive inverter and components. Include manufacturer's standard product warranty, for duration of not less than seven years, for replacement of materials and equipment used in inverter systems.
   G. Shop Drawings: Submit dimensioned drawings of grid-tie utility interactive inverters and accessories including, but not limited to, AC Disconnects, control panel, DC disconnects, and instrumentation. Drawings shall list weights, cooling air requirements, noise criteria, field connection points, and nameplate data. Show adequate clearance space for removal of inverter elements for maintenance purposes. Provide center-of-gravity information for seismic-rated equipment.
H. Wiring Diagrams: Submit wiring diagrams for Utility Interactive inverter units, control panel, and power monitoring showing connections to electrical power system, automatic transfer switches, and ancillary equipment. Clearly differentiate between portions of wiring that are manufacturer factory installed and portions that are field installed.

I. Agreement to Maintain: Prior to time of final acceptance, the Installer shall submit four copies of an Agreement for continued service and maintenance of utility interactive inverter for Owner. Furnish parts and provide continued testing and servicing, including replacement of materials and equipment for a three-year period after Substantial Completion. Provide an option for renewal of the Agreement by Owner.

J. Certifications: Provide Grid-tie utility interactive inverter set certified test record of the following final production tests.
   1. Provide efficiency testing.
   2. Transient and steady-state governing.
   3. Safety shutdown device testing.
   4. Voltage regulation.
   5. Rated power.
   6. Maximum power.
   7. Provide certified test record prior to inverter being shipped from factory to Project location.

K. Operation and Maintenance Manuals.

L. Factory and all field test data.

1.06 DELIVERY STORAGE AND HANDLING:
   A. Deliver grid-tie inverters properly packaged and mounted on pallets to facilitate handling. Utilize factory-fabricated wrappings and protective caps to protect equipment from damage.
   B. Store grid-tie inverters in original packaging and protect from weather and construction traffic. Wherever possible, store indoors; where necessary to store outdoors, store above grade in manufacturer's wrappings.
   C. Handle grid-tie inverters carefully to prevent physical damage to equipment and components. Do not install damaged equipment; remove from Site and replace damaged equipment with new.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:
   A. Subject to compliance with requirements provided grid-tie utility interactive inverters of one of the following manufacturers:
      1. Advanced Energy.
      2. SMA.
      3. Or approved equal.

2.02 GRID-TIE UTILITY INTERACTIVE INVERTERS:
   A. General: Except as otherwise indicated. Provide inverters, disconnects, and ancillary components of types, sizes, and ratings indicated, which comply with manufacturer's standard materials and with the design and construction in accordance with published product information. Where types, sizes, and ratings are not indicated, comply with NEC, UL, and established industry standards for those applications indicated.
   B. Provide grid-tie utility interactive inverters listed to UL 1741 and IEEE 1547.
   C. Provide inverters rated with an ac output as indicated on Contract Drawings, ac line voltage at 120V, 60 Hz, greater than 0.99 power factor. DC input voltage shall be 250Vdc to 1500Vdc or less and output tracking voltage shall be 250Vdc to 1500Vdc or less.
D. Provide inverter configured for monopolar arrays. Array shall be grounded inside the inverter enclosure using a Ground Fault Detection and Interruption (GFDI) system. The inverter shall be configured for negative or positive ground coordinate with manufacturer of photovoltaic modules.

E. Maximum back feed current shall be 0 Adc to prevent additional over current protection requirements in the dc system.

F. Inverter shall be supplied with a night-time disconnect to reduce tare loss to below 100 W and a soft-start circuit to reduce inrush currents.

G. Enclosure shall be NEMA 3R and suitable for indoor or outdoor use. Provide stainless-steel hardware.

H. Inverter shall be supplied with an integrated isolation transformer, integrated dc disconnect and output ac circuit breaker.

I. Inverter shall be provided with a front panel display. The display will provide read capability for all parameters and password protected write capability.

J. Inverters shall meet FCC Part 15 for harmonic content.

K. Inverter shall have ground fault protection with capability of:
   1. Detects an earth fault.
   2. Indicates that a ground fault has occurred.
   3. Automatically disconnects all conductors or causes the inverter to automatically cease serving power to output circuits.

L. Inverter shall be capable of interface and control through BMS.

M. Inverter shall be compliant with CSA C22.2 No. 107.01.

N. Inverter shall have Short Circuit Withstand Rating (SSCR) indicated on Drawings.

2.03 ACCESSORIES:

A. Provide a remote communications interface that allows for RS485/Modbus communication and is required for owner/third party monitoring.

B. Provide an array sub-combiner to be integrated in the inverter enclosure. Fuse ratings and quantities shall be coordinated with photovoltaic module manufacturer and NEC.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine areas and conditions under which grid-tie inverters are to be installed. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF GRID-TIE INVERTER:

A. Install the grid-tie inverter in accordance to the manufacturer's Planning and Installation Manual and applicable NFPA Standards.

B. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in applicable codes.

3.03 GROUNDING:

A. Provide grounding conductor for grid-tie inverter units as indicated. Tighten connections to comply with tightening torques specified in NEC and IEEE to ensure permanent and effective grounding.
3.04 **FIELD QUALITY CONTROL:**

A. Visual Inspection of Mechanical Connections.
   1. Ensure that the ac and dc disconnect switches, as well as any utility interconnect circuit breakers or main disconnect switches, are opened.
   2. Ensure all anchor bolts and any required seismic bracing is properly tightened and in place.
   3. Remove the latches and open the doors of the ac and dc interface and inspect.
   4. Verify all wire conduit fittings and connections are properly tightened.

B. Visual Inspection of Electrical Connections.
   1. Ensure that the ac disconnect and dc disconnect switches, as well as any utility interconnect circuit breakers or main disconnect switches, are opened.
   2. Ensure all conductors and wiring connections interfacing with the inverter are tightened to the correct torque value. For specific torque values, see the manufacturer's Planning and Installation Manual.
   3. Verify the ac power conductors terminated at the inverter within the ac interface are terminated correctly and properly sequenced.
   4. Verify the dc power conductors terminated at the inverter within the dc interface are terminated correctly and properly polarized.

C. Commissioning Procedure.
   1. Begin the inverter commissioning procedure as described in detail further in the Operations and Maintenance Manual. The steps are summarized below.
      a. Record the serial number.
      b. Inspect the inverter enclosure.
      c. Verify ac and dc voltages.
      d. Apply grid voltage.
      e. Check the front panel display.
      f. Confirm operational parameters (ac, dc and power tracker).
      g. Apply dc voltage.
      h. Perform the matrix test.
      i. Operate inverter.

END OF SECTION 48 19 16