ADDENDUM NO. 02

DATE: May 24, 2021

PROJECT: BROWN FAMILY AMPHITHEATER
BALL STATE UNIVERSITY
MUNCIE, INDIANA

PROJECT NUMBER: RATIO #20032 / BSU# 2020-041.01 G

OWNER:
Ball State University
2000 West University Ave.
Muncie, Indiana 47306
Phone: (765) 289-1241

ARCHITECT / LANDSCAPE ARCHITECT:
RATIO ARCHITECTS, INC.
101 South Pennsylvania Street
Indianapolis, Indiana 46204-3684
Phone: (317) 633-4040
Fax: (317) 633-4153

STRUCTURAL ENGINEER:
CE Solutions
10 Shoshone Drive
Carmel, Indiana 46032
Phone: (317) 818-1912

MEP ENGINEER:
Applied Engineering Services
5975 Castle Creek Parkway North Drive, Suite 300
Indianapolis, Indiana 46250
Phone: (317) 810-4141

CIVIL ENGINEER:
Cripe
3939 Priority Way South Drive, Suite 200
Indianapolis, Indiana 46240
(317) 844-6777

THEATER PLANNING / LIGHTING DESIGN
Schuler Shook
750 North Orleans, Suite 400
Chicago Illinois 60654
Phone: (312) 944-8230

ACoustics / audio visual design
Threshold Acoustics
141 West Jackson Boulevard, Suite 2080
Chicago Illinois 60604
Phone: MECHANICAL/ELECTRICAL ENGINEER

This Addendum is issued in accordance with the provisions of Contract Documents, and becomes a part of the Contract Documents as provided therein. The information contained herein modifies the original Bidding Documents dated May 07, 2021 and all prior Addenda as applicable. Requirements of the original Bidding Documents and previous Addenda remain in effect except as modified by this Addendum. Acknowledge receipt of this Addendum in the space provided on the Bid Form. Failure to do so may subject the Bidder to disqualification.
PART 1 – GENERAL CLARIFICATIONS

1. None

PART 2 - PROJECT MANUAL CHANGES

1. SECTION 033000 CAST-IN-PLACE CONCRETE (full section attached)
   a. Replaced section in its entirety – revisions include:
      i. Added Preinstallation Meeting requirements
      ii. Added Installed Qualifications
      iii. Added Mockup requirements
      iv. Added Mockup requirements
      v. Edited curing products.
      vi. Added Removing and Reusing Forms paragraphs
      vii. Deleted Smooth-Rubbed and Cork-Floated paragraphs
      viii. Revised Grout-Cleaned finish requirements
      ix. Added curing requirements for exposed concrete walls.
      x. Added Cleaning requirements
      xi. Added Final Acceptance paragraph

2. SECTION 072100 THERMAL INSULATION
   Delete Item 1.2.A.2. and insert the following:
   3. Mineral-wool board insulation.”

   Delete Article 2.2. in its entirety and insert the following:

   “2.3 MINERAL-WOOL BLANKET INSULATION
   A. Mineral-Wool Blanket Insulation, Unfaced: ASTM C665, Type I (blankets without membrane facing); consisting of fibers; passing ASTM E136 for combustion characteristics.
   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. Johns Manville; a Berkshire Hathaway company.
      b. Rockwool International.
      c. Thermafiber, Inc.; an Owens Corning company.
   2. Flame-Spread Index: Not more than 25 when tested in accordance with ASTM E84.
   3. Smoke-Developed Index: Not more than 50 when tested in accordance with ASTM E84.
   4. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches and wider in width.

   2.4 MINERAL-WOOL BOARD INSULATION
   A. Mineral-Wool Board Insulation, Types IA and IB, Unfaced: ASTM C612, Types IA and IB; passing ASTM E136 for combustion characteristics.
   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. Johns Manville; a Berkshire Hathaway company.
      b. Rockwool International.
      c. Thermafiber, Inc.; an Owens Corning company.
   2. Nominal Density: 4 lb/cu. ft..
   3. Flame-Spread Index: Not more than 15 when tested in accordance with ASTM E84.
   4. Smoke-Developed Index: Not more than zero when tested in accordance with ASTM E84.
   5. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches and wider
in width.”

Modify Item 3.6.B.1 as follows:

“1. Mineral-Wool Insulation: Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft.”

3. SECTION 075149 POLYVINYL-CHLORIDE (PVC) ROOFING
Delete Item 1.6.E.1.

Insert Paragraphs 1.6.H. and I. as follows:
“H. Provide FM Global RoofNav Contractor’s Package and a Checklist for Roofing System (Form 2688), providing all the details of the proposed roofing materials including a RoofNav Number to FM Global for review and comment prior to installation. Use components and systems that are FM Approved for use together on the indicated deck.
I. Submit details of the roof edge flashing including manufacturer and type as well as the installation plans to FM Global to confirm that FM Approved flashing is being use.”

Modify Item 1.11.A.2 as follows:
“2. Warranty Period: 20 years from date of Substantial Completion.”

Insert Paragraphs 2.1.H, I and J as follows:
“H. FM Approvals, Property Loss Prevention Data: Provide FM Approved canopy and backstage enclosed roofs’ systems. Details and Installations to conform to FM Global Property Loss Prevention Data Sheet 1-31 “Panel Roof Systems” and Property Loss Prevention Data Sheet 1-29 “Roof Deck Security and Above-Deck Roof Components”.
I. Rain Load: Based on 3.25 inc/hr rainfall in accordance with FM Global Perty Loss Prevention Data Sheet 1-54 “Roof Loads for New Construction”.
J. Snow Loads: As indicated in FM Global Property Loss Prevention Data Sheet 1-54 “Roof Loads for New Construction”. A balanced snow load design of 20 psf based on a 20 psf ground snow load. Do not reduce due to any allowances in local codes. Additional reinforcing should be provided for the lower-level roof areas of the enclosed backstage area where snow drift potential from the canopy exist.”

Insert Paragraph 2.3.I. as follows:
“I. Perimeter Flashing: Provide prefabricated and FM Approved perimeter flashing for at least 90 psf field roof.”

Delete Items 3.1.A.3, 4., and 5.

Delete Paragraph 3.4.C. in its entirety and insert the following:
C. Installation Over Wood Decking:
1. Mechanically fasten slip sheet to roof deck using mechanical fasteners specifically designed and sized for fastening slip sheet to wood decks.
   a. Fasten slip sheet according to requirements in SPRI's Directory of Roof Assemblies for specified Wind Uplift Load Capacity.
   b. Fasten slip sheet to resist specified uplift pressure at corners, perimeter, and field of roof.
2. Install base layer of insulation with joints staggered not less than 24 inches in adjacent rows.
   a. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
   b. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
   c. Make joints between adjacent insulation boards not more than 1/4 inch in width.
   d. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.
1) Trim insulation so that water flow is unrestricted.
e. Fill gaps exceeding 1/4 inch with insulation.
f. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
g. Mechanically attach base layer of insulation using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to wood decks.
   1) Fasten insulation according to requirements in SPRI's Directory of Roof Assemblies for specified Wind Uplift Load Capacity.
   2) Fasten insulation to resist specified uplift pressure at corners, perimeter, and field of roof.
   3) Install upper layers of insulation with joints of each layer offset not less than 12 inches from previous layer of insulation.
      a. Staggered end joints within each layer not less than 24 inches in adjacent rows.
      b. Install with long joints continuous and with end joints staggered not less than 12 inches in adjacent rows.
      c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
      d. Make joints between adjacent insulation boards not more than 1/4 inch in width.
      e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.
      1) Trim insulation so that water flow is unrestricted.
      f. Fill gaps exceeding 1/4 inch with insulation.
      g. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
      h. Adhere each layer of insulation to substrate using adhesive according to SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity and FM Global Property Loss Prevention Data Sheet 1-29, as follows:
         1) Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.”

Insert Paragraph 3.7.F. as follows:
“F. Install all prefabricated and FM Approved perimeter flashing in accordance with FM Global Property Loss Prevention Data Sheet 1-49 “Perimeter Flashing” and the current FM Approval listing.”

4. SECTION 074113.16 STANDING SEAM METAL ROOF
   a. Add section in entirety.
5. SECTION 074213.16 METAL PLATE WALL PANELS
   a. Add section in entirety.
6. SECTION 077253 SNOW GUARDS
   a. Add section in entirety.
7. SECTION 074213.13 FORMED METAL WALL PANELS
   a. Remove section in entirety.
8. SECTION 233300 Air Duct Accessories
   a. Added Manufacturers Section
9. SECTION 233423 HVAC Power Ventilators
   a. Added Manufacturers Section
   b. Added Centrifugal Downblast Fans Section
10. SECTION 233300 Air Diffusers
    a. Added Manufacturers Section
11. SECTION 233300 Registers and Grilles
    a. Added Manufacturers Section
12. SECTION 236313 Air Cooled Refrigerant Condensers
    a. Section is being added for the Fan Coil Unit condenser.
13. SECTION 238126 Split System Air Conditioners
    a. Section has been updated to include new manufacturers.
    b. Section has been updated to include information on Fan Coil Unit.
14. SECTION 261219 Pad Mounted, Liquid Filled, Medium Voltage Transformer
    a. Modified section to reflect transformer ordered by BSU.
b. Added contractor provided surge arrestors to section.

PART 3 - DRAWING CHANGES

1. SHEET C501 UTILITY PLAN
   a. Revised roof drainage location(s) and keynotes
   b. Revised STR 2711 location south 22 inches
   c. Revised to show communications conduit base extents.
   d. Clarified notes 18 and 19 to refer to electric sheets.
   e. Clarified keynote 10 to refer to electrical sheets.
   f. Keynotes 2-4 revised to indicate 1 ½” water services.

2. SHEET C502 UTILITY DETAILS
   a. Add water meter pit detail for 1 1/2” service size. Meter pit detail only attached.

3. SHEET C701 STORM SEWER PLAN AND PROFILE
   a. Revised roof drainage location(s), inverts and labels.
   b. Revised storm sewer profile inverts for pipes between STR 2701 and 2712
   c. Revise STR 2711 location south 22 inches
   d. Revised to show base bid extents of communications conduit and utility crossing.

4. SHEET L-201 SITE FEATURES PLAN
   a. Removal of 05-50-A at stage steps pavement in plan and remove note from schedule.

5. SHEET L-701 SITE DETAILS
   a. Change pavement reinforcement to a W1.4/W1.4 on Details F2, D2, E4 and E5

6. SHEET L-702 SITE DETAILS
   a. Remove Detail A4

7. SHEET S-201 FOUNDATION PLAN
   a. (Full Sheet attached) – Detail 2/SS-201: Revised layout of north wall.
   b. Added clarification that the restroom alternate is Alternate #1.

8. SHEET S-201S SLAB-ON-GRADE PLAN
   a. (Full Sheet attached) – Detail 2/S-201S: Revised layout of north wall.
   b. Added clarification that the restroom alternate is Alternate #1.
   c. Detail 1/S-101S: Added clarification that the resilient flooring alternate is Alternate #3.

9. SHEET S-202 ROOF FRAMING PLAN
   a. (Full Sheet attached) – Detail 2/S-202: Revised layout of north wall.
   b. Added clarification that the restroom alternate is Alternate #1.

10. SHEET A-102 ENLARGED FLOOR PLANS
    a. Add (2) additional Floor Recessed Strong Points as shown on attached A-102.
    b. Add section markers the Alternate No. 01 plan as shown.

11. SHEET A-105 ROOF PLAN

12. SHEET A-202 EXTERIOR ELEVATIONS
    a. The section marker on Detail F7 is off the page and should read 1/A-301.

13. SHEET A-351 EXTERIOR DETAILS
    a. Add details D8 and E8 as shown on attached sheet.

14. SHEET P-100 UNDERSLAB PLUMBING PLAN
    a. Storm drains moved to align with Civil drawings.

15. SHEET P-101 FIRST FLOOR PLUMBING PLAN
    a. Storm drains moved to align with Civil drawings.

16. SHEET P-501 PLUMBING DETAILS AND SCHEDULES
    a. Added stage floor drain detail.

17. SHEET M-101: FIRST FLOOR HVAC PLAN
    a. Modified Equipment Names
    b. Modified Thermostat Positions

18. SHEET M-102: ROOF HVAC PLAN
a. Modified Equipment Names

19. SHEET M-601: MECHANICAL SCHEDULES
   a. Modified Equipment Names
   b. Corrected Errors in Electrical Data
   c. Updated Equipment Selections

20. SHEET M-701: ELECTRICAL SCHEDULES
   a. Modified Control Sequence

21. SHEET E-311: FIRST FLOOR ELECTRICAL POWER PLAN
   a. Modified Electrical Room 102B layout.

22. SHEET E-312: ROOF ELECTRICAL POWER PLAN
   a. Changed name of mechanical roof top equipment.
   b. Changed exhaust fan branch circuits from 20V to 120V.

23. SHEET E-601: ELECTRICAL SCHEDULES
   a. Modified Low Voltage Transformer Schedule.

24. SHEET E-603: ELECTRICAL SCHEDULES
   a. Modified Distribution Panel MDP.
   c. Modified Panel AV1 MCB rating.

25. SHEET E-701: ELECTRICAL RISER DIAGRAMS
   b. Added Plan Note.

PART 4 – GENERAL QUESTIONS

1. QUESTION: Would you consider waiving the ASCI Certification for steel fabrication and installation?
   RESPONSE: This requirement cannot be waived

2. QUESTION: In looking at this project there seems to be a discrepancy with the exterior metal panels. The drawings
   clearly show what looks like ACM or aluminum plate panel. However, the specifications call for a 12” wide flush
   panel. Can you send clarification on what type of product is expected?
   RESPONSE: Please see the updated spec section that aligns with what is shown on the drawings.

3. QUESTION: Should we (PAD bidding section 274116 AV) bid to the Electrical Contractor or the General Contractor?
   RESPONSE: AV will bid directly to the GC

4. QUESTION: Specification 274116, Appendix A, Page 5 of 8 lists a Middle Atlantic equipment rack. Should a rack top
   be provided with thermal management? We suggest MAP BGR-552FT-FC.
   RESPONSE: Yes, this will be added to the equipment list in an upcoming addendum

5. QUESTION: Specification 274116, Appendix A, Page 5 of 8 lists a Middle Atlantic equipment rack. Should a vented,
   locking front door be provided? We suggest MAP VFD-45A
   RESPONSE: Yes, this will be added to the equipment list in an upcoming addendum

6. QUESTION: Drawing AV510 list Hoffman CP1212 as the backbox for A series plug boxes. Please confirm this
   Hoffman box is provided by the Electrical Contractor per Responsibility Matrix on Drawing AV001
   RESPONSE: Yes, the backbox (Hoffman CFM12126) is to be provided and installed by the Electrical Contractor. The
   CP 1212 panel is basis of design for the custom plate within the Hoffman backbox. The custom plate is to be
   provided by the AV contractor.
7. QUESTION: Is it the intent of Ball State University to mount and de-mount the speakers every season? If yes, should easy disconnect/reconnect hardware and cable be provided to facilitate this?
RESPONSE: No, the loudspeakers are a custom, fully weatherized enclosure and intended to stay up year round. All rigging/mounting hardware is to be fully outdoor rated.

8. QUESTION: If it is the intent to de-mount the speakers every season, should covers and carts be provided for storage?
RESPONSE: See response to previous question.

PART 5 – ATTACHMENTS

A. Specification Section:
1. SECTION 033000 Cast-In-Place Concrete
2. SECTION 074113.16 Standing Seam Metal Roof Panels
3. SECTION 074213.16 Metal Plate Wall Panels
4. SECTION 077253 Snow Guards
1. SECTION 233300 SF – Air Duct Accessories
2. SECTION 233423 HVAC Power Ventilators
3. SECTION 233713.13 Air Diffusers
4. SECTION 233713.23 Registers and Grilles
5. SECTION 236313 Air-Cooled Refrigerant Condensers
6. SECTION 238126 Split-System Air-Conditioners
7. SECTION 260961 Theater Stage Lighting Systems
8. SECTION 261219 Pad-Mounted, Liquid-Filled, Medium Voltage Transformers
9. SECTION 274116 APPENDIX A – Major Equipment List

E. Drawings:
2. INAW_singlemeter
3. SHEET C501 UTILITY PLAN
4. SHEET C701 STORM SEWER PLAN AND PROFILE
5. SHEET S-201 FOUNDATION PLAN
6. SHEET S-202 ROOF FRAMING PLAN
7. SHEET S-202 ROOF FRAMING PLAN
8. SHEET A-102 ENLARGED FLOOR PLANS
9. SHEET A-351 EXTERIOR DETAILS
10. SHEET P-100 UNDERSLAB PLUMBING PLAN
11. SHEET P-101 FIRST FLOOR PLUMBING PLAN
12. SHEET M-101: FIRST FLOOR HVAC PLAN
13. SHEET M-102: ROOF HVAC PLAN
14. SHEET M-601: MECHANICAL SCHEDULES
15. SHEET M-701: ELECTRICAL SCHEDULES
16. SHEET E-311: FIRST FLOOR ELECTRICAL POWER PLAN
17. SHEET E-312: ROOF ELECTRICAL POWER PLAN
18. SHEET E-601: ELECTRICAL SCHEDULES
19. SHEET E-603: ELECTRICAL SCHEDULES
20. SHEET E-701: ELECTRICAL RISER DIAGRAMS

END OF ADDENDUM NO.02
SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.

B. Related Requirements:
   1. Section 312323 "Fill" for drainage fill under slabs-on-grade.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
   1. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
      a. Contractor's superintendent.
      b. Independent testing agency responsible for concrete design mixtures.
      c. Ready-mix concrete manufacturer.
      d. Cast-in-place concrete Subcontractor.
   2. Review the following:
      a. Testing and inspecting agency procedures for field quality control.
      b. Construction joints, control joints, isolation joints, and joint-filler strips.
      c. Reinforcement accessory installation.
      d. Cold- and hot-weather concreting procedures.
      e. Concrete finishes and finishing.
      f. Curing procedures.
      g. Forms and form-removal limitations.
      h. Shoring procedures.
      i. Concrete repair procedures.
      j. Protection of cast-in-place concrete.
      k. Initial curing and field curing of field test cylinders (ASTM C31/C31M).
      l. Protection of field-cured field test cylinders.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Design Mixtures: For each concrete mixture.

C. Steel Reinforcement Shop Drawings: Placing Drawings that detail fabrication, bending, and placement.

1.4 INFORMATIONAL SUBMITTALS

A. Material certificates.

B. Material test reports.

C. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer, detailing fabrication, assembly, and support of formwork.

D. Floor surface flatness and levelness measurements indicating compliance with specified tolerances.

E. Minutes of preinstallation conference.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

B. Installer Qualifications: An experienced cast-in-place concrete installer, as evidenced by not less than five consecutive years' experience, specializing in installing cast-in-place concrete similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

1. Provide written evidence of qualifications and experience.
2. Include locations, descriptions, and photographs of completed projects, including name of architect, substantiating the quality of the installer's experience.

C. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

D. Mockups: Before casting concrete, build mockups, using the same procedures, equipment, materials, finishing procedures, and curing procedures that will be used for producing concrete, to demonstrate typical joints, surface finish, color, texture, tolerances, and standard of workmanship. Structural design of the mockups and their support, including but not limited to, foundations, reinforcement, and bracing, shall be by the
Contractor. Build mockups to comply with the following requirements, using materials indicated for the completed Work:

1. Build mockups in the location and of the size indicated in the architectural drawings.
2. Construct mockups to include at least two lifts having heights equal to those anticipated for construction.
3. Demonstrate curing, cleaning, and protecting of cast-in-place concrete, finishes, and contraction joints, as applicable.
4. In presence of Architect, damage part of the exposed-face surface for each finish, color, and texture, and demonstrate materials and techniques proposed for repair to match adjacent undamaged surfaces.
5. In presence of Architect, demonstrate materials and techniques proposed for repair of tie holes and surface blemishes to match adjacent undamaged surfaces.

1.6 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on concrete mixtures.

1.7 FIELD CONDITIONS

A. Cold-Weather Placement: Comply with ACI 306.1.
   1. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

B. Hot-Weather Placement: Comply with ACI 301 (ACI 301M).

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
   1. ACI 301 (ACI 301M).
   2. ACI 117 (ACI 117M).
2.2 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

2.3 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.

B. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.

C. Plain-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, plain, fabricated from as-drawn steel wire into flat sheets.


E. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice."

2.4 CONCRETE MATERIALS

A. Cementitious Materials:
   1. Portland Cement: ASTM C 150/C 150M, Type I or Type III, gray.
   2. Fly Ash: ASTM C 618, Class C.

B. Normal-Weight Aggregates: ASTM C 33/C 33M, graded.
   1. Maximum Coarse-Aggregate Size: 3/4 inch (19 mm) nominal.
   2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Air-Entraining Admixture: ASTM C 260/C 260M.

D. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
   1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
   2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

E. Water: ASTM C 94/C 94M.

2.5 FIBER REINFORCEMENT

A. Synthetic Micro-Fiber: Fibrillated polypropylene micro-fibers engineered and designed for use in concrete, complying with ASTM C 1116/C 1116M, Type III, 1/2 to 1-1/2 inches (13 to 38 mm) long.

2.6 VAPOR RETARDERS

A. Sheet Vapor Retarder: Polyethylene sheet, ASTM D 4397, not less than 10 mils (0.25 mm) thick.

2.7 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) when dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

F. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering.

G. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.
2.8 RELATED MATERIALS


2.9 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301 (ACI 301M).

B. Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing, high-range water-reducing, or plasticizing admixture in concrete, as required, for placement and workability.
2. Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a w/c ratio below 0.50.

2.10 CONCRETE MIXTURES FOR BUILDING ELEMENTS

A. Normal-Weight Concrete: As indicated.

2.11 FABRICATING REINFORCEMENT

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

2.12 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.
PART 3 - EXECUTION

3.1 FORMWORK INSTALLATION

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

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117 (ACI 117M).

C. Chamfer exterior corners and edges of permanently exposed concrete.

3.2 EMBEDDED ITEM INSTALLATION

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

3.3 VAPOR-RETARDER INSTALLATION

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.
   1. Lap joints 6 inches (150 mm) and seal with manufacturer's recommended tape.

3.4 STEEL REINFORCEMENT INSTALLATION

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
   1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

3.5 REMOVING AND REUSING FORMS

A. Formwork for sides of beams, walls, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations, and curing and protection operations need to be maintained.
1. Schedule form removal to maintain surface appearance that matches approved mockups.
2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

B. Clean and repair surfaces of forms to be reused in the Work.
   1. Split, frayed, delaminated, or otherwise damaged form-facing material are unacceptable for exposed surfaces.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints.
   1. Align and secure joints to avoid offsets.
   2. Do not use patched forms for cast-in-place concrete surfaces.

3.6 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
   1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch (3.2 mm). Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
   2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3.2-mm-) wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

3.7 WATERSTOP INSTALLATION

A. Waterstops: Install in construction joints and at other locations indicated, according to manufacturer's written instructions.
3.8 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections are completed.

B. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

1. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301 (ACI 301M).

3.9 FINISHING FORMED SURFACES

A. Rough-Formed Finish, ACI 301 Surface Finish SF-1.0: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces not exposed to public view.

B. Smooth-Formed Finish, ACI 301 Surface Finish SF-3.0: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces exposed to public view, to receive a rubbed finish, or to be covered with a coating or covering material applied directly to concrete.

C. Rubbed Finish: Apply the following to smooth-formed-finished as-cast concrete where indicated:

1. Grout-Cleaned Rubbed Finish:

   a. Clean concrete surfaces after contiguous surfaces are completed and accessible.
   b. Do not clean concrete surfaces as Work progresses.
   c. Mix 1 part portland cement to 1-1/2 parts fine sand, complying with ASTM C144 or ASTM C404, by volume, with sufficient water to produce a mixture with the consistency of thick paint. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces.
   d. Wet concrete surfaces.
   e. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap, and keep surface damp by fog spray for at least 36 hours.
f. Maintain required patterns or variances as shown on Drawings or to match mockups.

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

3.10 FINISHING FLOORS AND SLABS

A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch (6 mm) in one direction.

1. Apply scratch finish to surfaces indicated, to receive concrete floor toppings, and to receive mortar setting beds for bonded cementitous floor finishes.

C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.

1. Apply float finish to surfaces indicated to receive trowel finish.

D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.

1. Apply a trowel finish to surfaces indicated, exposed to view, or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.

2. Finish and measure surface, so gap at any point between concrete surface and an unleveled, freestanding, 10-ft.- (3.05-m-) long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/8 inch (3.2 mm).

E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces indicated and where ceramic or quarry tile is to be installed by either thickset or thinset method. While concrete is still plastic, slightly scarify surface with a fine broom.

1. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.
1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

3.11 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 (ACI 301M) for hot-weather protection during curing.

B. For exposed concrete wall surfaces, curing recommendations described in ACI 303R-12 Chapter 9 shall be followed to provide a uniform, consistent color. Use identical curing procedures to that used for mockups.

C. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

D. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for remainder of curing period.

E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period, using cover material and waterproof tape.

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

   a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound does not interfere with bonding of floor covering used on Project.

4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial
application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.12 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair/patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

B. Match repairs to color, texture, and uniformity of surrounding surfaces and to repairs on approved mockups.

3.13 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

3.14 CLEANING

A. Clean exposed cast-in-place concrete surfaces after finish treatment to remove stains, markings, dust, and debris.

B. Wash and rinse surfaces in accordance with concrete finish applicator's written instructions.

1. Protect other Work from staining or damage due to cleaning operations.
2. Do not use cleaning materials or processes that could change the appearance of cast-in-place concrete finishes.

3.15 PROTECTION

A. Protect corners, edges, and surfaces of cast-in-place concrete from damage; use guards and barricades.

B. Protect cast-in-place concrete from staining, laitance, and contamination during remainder of construction period.

3.16 FINAL ACCEPTANCE

A. Final acceptance of completed concrete Work will be determined by Architect by comparing approved mockups with installed Work, when viewed at a distance of 10 feet.
SECTION 074113.16 - STANDING-SEAM METAL ROOF PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Standing-seam metal roof panels.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
   1. Meet with Owner, Architect, Owner’s insurer if applicable, metal panel Installer, metal panel manufacturer’s representative, structural-support Installer, and installers whose work interfaces with or affects metal panels, including installers of roof accessories and roof-mounted equipment.
   2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
   3. Review methods and procedures related to metal panel installation, including manufacturer's written instructions.
   4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
   5. Review structural loading limitations of deck during and after roofing.
   6. Review flashings, special details, drainage, penetrations, equipment curbs, and condition of other construction that affect metal panels.
   7. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
   8. Review temporary protection requirements for metal panel systems during and after installation.
  10. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.
1.4 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 each type of panel and accessory.

B. Shop Drawings:
   1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
   2. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches.

C. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.
   1. Metal Panels: 12 inches long by actual panel width. Include clips, fasteners, closures, and other metal panel accessories.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For each product, for tests performed by a qualified testing agency.

C. Field quality-control reports.

D. Sample Warranties: For special warranties.

E. Provide FM Global RoofNav Contractor’s Package and a Checklist for Roofing System (Form 2688), providing all the details of the proposed roofing materials including a RoofNav Number to FM Global for review and comment prior to installation. Use components and systems that are FM Approved for use together on the indicated deck.

F. Submit details of the roof edge flashing including manufacturer and type as well as the installation plans to FM Global to confirm that FM Approved flashing is being use.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal panels to include in maintenance manuals.
1.7 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. UL-Certified, Portable Roll-Forming Equipment: UL-certified, portable roll-forming equipment capable of producing metal panels warranted by manufacturer to be the same as factory-formed products. Maintain UL certification of portable roll-forming equipment for duration of work.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.

B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Retain strippable protective covering on metal panels during installation.

1.9 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

1.10 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

B. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.
1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Structural failures including rupturing, cracking, or puncturing.
   b. Deterioration of metals and other materials beyond normal weathering.

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

B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show 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 Delta E 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: 20 years from date of Substantial Completion.

C. Special Weathertightness Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that fail to remain weathertight, including leaks, within specified warranty period.

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Energy Performance: Provide roof panels that are listed on the EPA/DOE's ENERGY STAR "Roof Product List" for steep-slope roof products.

B. Energy Performance: Provide roof panels according to one of the following when tested according to CRRC-1:

1. Three-year, aged solar reflectance of not less than 0.55 and emissivity of not less than 0.75.
2. Three-year, aged Solar Reflectance Index of not less than 64 when calculated according to ASTM E1980.

C. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E1592:
   1. Wind Loads: As indicated on Drawings.
   2. Other Design Loads: As indicated on Drawings.
   3. Deflection Limits: For wind loads, no greater than 1/240 of the span.

D. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. when tested according to ASTM E1680 or ASTM E283 at the following test-pressure difference:
   1. Test-Pressure Difference: 1.57 lbf/sq. ft.

E. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E1646 or ASTM E331 at the following test-pressure difference:

F. Hydrostatic-Head Resistance: No water penetration when tested according to ASTM E2140.

G. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.
   1. Uplift Rating: UL 90.

H. FM Global Listing: Provide metal roof panels and component materials that comply with requirements in FM Global 4471 as part of a panel roofing system and that are listed in FM Global's "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Global markings.
   1. Fire/Windstorm Classification: Class 1A-90.
   2. Hail Resistance: SH.

I. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing 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 (Range): 120 deg F, ambient; 180 deg F, material surfaces.

J. FM Approvals, Property Loss Prevention Data: Provide FM Approved canopy and backstage enclosed roofs’ systems. Details and Installations to conform to FM Global Property Loss Prevention Data Sheet 1-31 “Panel Roof Systems” and Property Loss Prevention Data Sheet 1-29 “Roof Deck Securement and Above-Deck Roof Components.”
K. Rain Load: Based on 3.25 in/hr rainfall in accordance with FM Global Property Loss Prevention Data Sheet 1-54 “Roof Loads for New Construction.”

L. Snow Loads: As indicated in FM Global Property Loss Prevention Data Sheet 1-54 “Roof Loads for New Construction”. A balanced snow load design of 20 psf based on a 20 psf ground snow load. Do not reduce due to any allowances in local codes. Additional reinforcement should be provided for the lower-level roof areas of the enclosed backstage area where snow drift potential from the canopy exist.

2.2 STANDING-SEAM METAL ROOF PANELS

A. Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.

1. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E1514.

2. Aluminum Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E1637.

B. Vertical-Rib, Snap-Joint, Standing-Seam Metal Roof Panels: Formed with vertical ribs at panel edges and a flat pan between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels, engaging opposite edge of adjacent panels, and snapping panels together.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AEP Span; A BlueScope Steel Company.
   b. ATAS International, Inc.
   c. IMETCO.
   d. McElroy Metal, Inc.
   e. Merchant and Evans.
   f. Metal Sales Manufacturing Corporation.
   g. PAC-CLAD; Petersen Aluminum Corporation; a Carlisle company.
   h. Firestone.

2. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A653/A653M, G90 coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A792/A792M, Class AZ50 coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A755/A755M.
   a. Nominal Thickness: 0.028 inch (22 gage).
   c. Color: As selected by Architect from manufacturer's full range.
3. Clips: One-piece fixed to accommodate thermal movement.
   a. Material: 0.0625-inch- thick, stainless steel sheet.


5. Panel Height: 1.5 inches minimum.

2.3 UNDERLAYMENT MATERIALS

A. Self-Adhering, High-Temperature Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of 30 mils thick, consisting of slip-resistant, polyethylene-film top surface laminated to a layer of butyl or SBS-modified asphalt adhesive, with release-paper backing. Provide primer when recommended by underlayment manufacturer.
   2. Low-Temperature Flexibility: Passes after testing at minus 20 deg F; ASTM D1970.

B. Slip Sheet: Manufacturer's recommended slip sheet, of type required for application.

2.4 MISCELLANEOUS MATERIALS

A. Miscellaneous Metal Subframing and Furring: ASTM C645; cold-formed, metallic-coated steel sheet, ASTM A653/A653M, G90 coating designation or ASTM A792/A792M, Class AZ50 coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, Mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.
   1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal panels.
   2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
   3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch-thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed
openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.

D. Perimeter Flashing: Provide prefabricated and FM Approved perimeter flashing for at least 90 psf field roof.

E. Gutters: Formed from same material as roof panels, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch-long sections, of size and metal thickness according to SMACNA's "Architectural Sheet Metal Manual." Furnish gutter supports spaced a maximum of 36 inches o.c., fabricated from same metal as gutters. Provide wire ball strainers of compatible metal at outlets. Finish gutters to match metal roof panels.

F. Downspouts: Formed from same material as roof panels. Fabricate in 10-foot-long sections, complete with formed elbows and offsets, of size and metal thickness according to SMACNA's "Architectural Sheet Metal Manual." Finish downspouts to match gutters.

G. Panel Fasteners: Self-tapping screws designed to withstand design loads.

H. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
   1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
   2. Joint Sealant: ASTM C920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.

2.5 FABRICATION

A. Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate according to equipment manufacturer's written instructions and to comply with details shown.

C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
D. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

E. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
2. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
3. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
4. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
5. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.

   a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal panel manufacturer for application, but not less than thickness of metal being secured.

2.6 FINISHES

A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. 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 same piece are unacceptable. 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.

C. Steel Panels and Accessories:

1. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.

1. Examine primary and secondary roof framing to verify that rafters, purlins, angles, channels, and other structural panel support members and anchorages have been installed within alignment tolerances required by metal roof panel manufacturer.

2. Examine solid roof sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal roof panel manufacturer.

   a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C754 and metal panel manufacturer's written recommendations.

3.3 INSTALLATION OF UNDERLayment

A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply at locations indicated below, wrinkle free, in shingle fashion to shed water, and 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 with roller. Cover underlayment within 14 days.

   1. Apply over the entire roof surface.

B. Slip Sheet: Apply slip sheet over underlayment before installing metal roof panels.
C. Flashings: Install flashings to cover underlayment to comply with requirements specified in Section 076200 "Sheet Metal Flashing and Trim."

3.4 INSTALLATION OF STANDING SEAM METAL ROOF PANELS

A. Install metal panels according to manufacturer’s written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Shim or otherwise plumb substrates receiving metal panels.
2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
3. Install screw fasteners in predrilled holes.
4. Locate and space fastenings in uniform vertical and horizontal alignment.
5. Install flashing and trim as metal panel work proceeds.
6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
7. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.

B. Fasteners:

1. Steel Panels: Use stainless steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.

C. Anchor Clips: Anchor metal roof panels and other components of the Work securely in place, using manufacturer’s approved fasteners according to manufacturers’ written instructions.

D. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.

E. Standing-Seam Metal Roof Panel Installation: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended in writing by manufacturer.

1. Install clips to supports with self-tapping fasteners.
2. Install pressure plates at locations indicated in manufacturer’s written installation instructions.
3. Snap Joint: Nest standing seams and fasten together by interlocking and completely engaging factory-applied sealant.
4. Watertight Installation:
a. Apply a continuous ribbon of sealant or tape to seal joints of metal panels, using sealant or tape as recommend in writing by manufacturer as needed to make panels watertight.

b. Provide sealant or tape between panels and protruding equipment, vents, and accessories.

c. At panel splices, nest panels with minimum 6-inch end lap, sealed with sealant and fastened together by interlocking clamping plates.

F. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal roof panel manufacturers; or, if not indicated, types recommended by metal roof panel manufacturer.

G. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and achieve waterproof and weather-resistant performance.

2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

H. Install all prefabricated and FM Approved perimeter flashing in accordance with FM Global Property Loss Prevention Data Sheet 1-49 “Perimeter Flashing” and the current FM Approval listing.

I. Gutters: Join sections with riveted and soldered or lapped and sealed joints. Attach gutters to eave with gutter hangers spaced not more than 36 inches o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.

J. Downspouts: Join sections with telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch away from walls; locate fasteners at top and bottom and at approximately 60 inches o.c. in between.

1. Provide elbows at base of downspouts to direct water away from building.

2. Connect downspouts to underground drainage system indicated.
3.5 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align metal panel units within installed tolerance of 1/4 inch in 20 feet on slope and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect metal roof panel installation, including accessories. Report results in writing.

B. Remove and replace applications of metal roof panels where tests and inspections indicate that they do not comply with specified requirements.

C. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.

D. Prepare test and inspection reports.

3.7 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

B. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 074113.16
SECTION 074213.16 - METAL PLATE WALL PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes the following:
   1. Metal plate wall panels.
   2. Thermally broken, rainscreen attachment system.

B. Related Sections:
   1. Section 072100 “Thermal Insulation” for insulation.

1.3 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 each type of panel and accessory.

B. Shop Drawings:
   1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment assembly, trim, flashings, closures, and accessories; and special details.
   2. Submit connection details to the cladding manufacturer, showing interface of rainscreen attachment system to substrate and panels with adjacent construction, signed and sealed by Professional Engineer.
   3. Accessories: Include details of the flashing, trim, and anchorage, at a scale of not less than 1-1/2 inches per 12 inches.

C. Test Reports for Rainscreen Attachment System:
   1. Test to the following standards and provide written test reports by a third party:
      a. AAMA TIR-A8-[04]: Structural Performance of Composite Thermal Barrier Framing Systems – Section 7.2
      b. Gravity load test report, performed by IAS accredited third party
2. Comprehensive three-dimensional thermal modeling report indicating framing systems impact on exterior insulation rated R-value.

D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.

1. Metal Panels: 12 inches long by actual panel width. Include fasteners, closures, and other metal panel accessories.

E. Delegated-Design Submittal: For thermally broken, rainscreen attachment system, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data:

1. For Installer.
2. For professional engineer’s experience with providing delegated-design engineering services of the kind indicated, including documentation that engineer is licensed in the jurisdiction in which Project is located.

B. Product Test Reports: For each product, tests performed by a qualified testing agency.

C. Sample Warranties: For special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal panels to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Engineer Qualifications: Registered professional engineer experienced in the design of curtain wall systems, anchors, fasteners and licensed to practice engineering in the jurisdiction where Project is located.

C. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Build mockup of typical metal panel assembly as shown on Drawings, including corner, supports, attachments, and accessories.
2. Water-Spray Test: Conduct water-spray test of mockup of metal panel assembly, testing for water penetration according to AAMA 501.2.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.

B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Retain strippable protective covering on metal panels during installation.

1.8 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

1.9 COORDINATION

A. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Structural failures including rupturing, cracking, or puncturing.
   b. Deterioration of metals and other materials beyond normal weathering.
2. Warranty Period: Two years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer’s standard form in which manufacturer agrees to repair finish or replace metal panels that show 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 D 2244.
   
   b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
   
   c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E 330:

1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: As indicated on Drawings.
3. Deflection Limits: For wind loads, no greater than 1/240 of the span.

B. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. when tested according to ASTM E 283 at the following test-pressure difference:

1. Test-Pressure Difference: 1.57 lbf/sq. ft..

C. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E 331 at the following test-pressure difference:

1. Test-Pressure Difference: 6.24 lbf/sq. ft..

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing 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 (Range): 120 deg F, ambient; 180 deg F, material surfaces.
2.2 METAL PLATE WALL PANELS

A. Metal Plate Wall Panels: Provide factory-formed, metal plate wall panels fabricated from single sheets of metal formed into profile for installation method indicated. Include attachment assembly components, and accessories required for weathertight system.

1. Products: Subject to compliance with requirements, provide one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide NorthClad AL-DI Series wall panel system or comparable product by one of the following:
   a. Centria
   b. Dri-Design
   c. American Metalcraft
   d. Northclad.

B. Panel Depth: 1 inches.

C. Panel Size: As indicated on Drawings.

D. Panel Thickness: 0.063 inches.

      a. Color: Custom, as selected by Architect.

F. Attachment Assembly: Rainscreen-principle system.
   1. Basis of Design: Knightwall or approved equivalent.
      a. 1-1/2 inches vertically oriented only.

2.3 MISCELLANEOUS MATERIALS

A. Miscellaneous Metal Subframing and Furring: ASTM C 645, cold-formed, metallic-coated steel sheet, ASTM A 653/A 653M, G90 coating designation or ASTM A 792/A 792M, Class AZ50 aluminum-zinc-alloy coating designation unless otherwise indicated. Provide manufacturer’s standard sections as required for support and alignment of metal panel system.

B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.
C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.

D. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal panels by means of plastic caps or factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.

E. Panel Sealants: ASTM C 920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer. Provide sealant types that are compatible with panel materials, are nonstaining, and do not damage panel finish.

2.4 THERMALLY BROKEN RAINSCREEN ATTACHMENT SYSTEM

A. General:
   1. No framing component may penetrate the layer of continuous exterior insulation other than thermally isolated fasteners.
   2. Frequency, spacing and fastening of girts as indicated by manufacture in project specific engineering package.

B. Performance Requirements:
   1. Rainscreen Attachment System Performance: Comply with ANSI/ASHRAE 90.1-2013 definition of continuous insulation (c.i.).
   2. No thermal bridges other than fasteners and service openings.
   3. Thermal Performance:
      a. Full constructed assembly must have a minimum 95% EFFECTIVE R-value when compared to the exterior continuous insulations rated R-Value.
      b. Continuous framing profiles (including C- or Z-shaped sections or furring) penetrating insulation not allowed.
      c. Perform effective R-Value calculation or modeling in accordance with ASHRAE guidelines.
   4. Gravity load (dead load) performance
      a. Attachment system must demonstrate resistance to deflection under shear loading, applied parallel to the wall assembly and directly to the attachment system. Testing must be conducted using calibrated equipment by an IAS accredited third party laboratory. Deflection not to exceed 0.050 inches at 150 pounds per square foot.
   5. Framing Members:
      a. Test framing components to AAMA TIR- A8-[04] – Section 7.2 to determine structural performance and effective moment of inertia for each perforated component. Minimum Effective Moment of Inertia: 0.0066 in^4.
b. Localized bending stress for eccentrically loaded framing members must be evaluated with the maximum effective length of resisting element not more than 12 inches.

6. Fasteners:
   a. Minimum Safety Factor of 3 for both tension and shear values
   b. Combined tension and shear shall be evaluated according to an interaction formula. Sum of terms shall not exceed 1.0.

C. Comply with ANSI/ASHRAE 90.1-2013 definition of continuous insulation (c.i.).

   1. ASTM A653 Galvanized steel is not acceptable.

E. Steel Classification: Structural Steel (SS), Grade 50, 50 ksi Yield.

F. Spacing: Comply with manufacturer’s Professional Engineers calculations.

G. Vertical CI-Girt: Vertical girt with pre-punched attachment holes, directly attached on top of rigid insulation directly to substrate at regular spacing, with engineered thermally isolated washer assembly and fasteners.
   1. Steel Thickness: Minimum 0.046-inch thick (18 gauge).
   2. Profile Depth: 0.75 inches.
   3. Girt Fastening Face, Width: 2-inches.
   4. Finish: Painted black at open joint panel assemblies.
   6. Or approved equal.

H. Fasteners:
   1. Sufficient length to provide solid attachment through insulation to structure as required by manufacturer.
   2. Thermal Isolating Washers: Minimum 0.125 inch thick Polyoxymethylene copolymer (POM) washers with integral centering lip to act as a thermal break between wall anchor fasteners and girt.
      a. Tensile Yield Strength: 9.57 ksi per ISO 527
      b. Melting Temperature: 329 degrees Fahrenheit per ISO 3146
      d. Or approved equal.
   3. Steel stud framing substrate: Self-drill hex-washer-head stainless steel with 1,000 hour salt-spray rated thermoset polyester coating.
      a. Embedment depth: 0.625 inches or three full threads minimum, whichever is greater.
      b. Minimum ultimate pull-out capacity from 18 gauge steel: 570 pounds.
I. Accessories:

1. Galvanic Protection: Utilize tapes and other methods as necessary to separate and prevent contact between dissimilar metals.

2.5 FABRICATION

A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

C. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
3. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
4. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
5. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.

   a. Size: As recommended by SMACNA’s "Architectural Sheet Metal Manual" or metal wall panel manufacturer for application but not less than thickness of metal being secured.

2.6 FINISHES

A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
B. 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 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.

C. Aluminum Panels and Accessories:

1. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.

1. Examine wall framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal wall panel manufacturer.
2. Examine wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal wall panel manufacturer.
   a. Verify that air- or water-resistant barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C 754 and metal panel manufacturer's written recommendations.
3.3 RAINSCREEN ATTACHMENT SYSTEM INSTALLATION

A. Rainscreen-Principle Installation: Install using manufacturer's standard assembly with vertical channel that provides support and secondary drainage assembly, draining at base of wall. Notch vertical channel to receive support pins. Install vertical channels supported by channel brackets or adjuster angles and at locations, spacings, and with fasteners recommended by manufacturer. Attach metal plate wall panels by inserting horizontal support pins into notches in vertical channels and into flanges of panels. Leave horizontal and vertical joints with open reveal.

1. Install metal plate wall panels to allow individual panels to be installed and removed without disturbing adjacent panels.
2. Do not apply sealants to joints unless otherwise indicated.

B. Verify vertical girt does not cantilever past rigid insulation.

C. Install vertical girts in vertical orientation in strict accordance with manufacturer’s installation instructions.

D. Do not use shims to plumb the wall between the vertical girt and insulation.

E. Minimum length of installed cut girt is 24-inches and shall be attached with at least two (2) fasteners.

F. Mount box girts, fastened up to 24 inches on center (as determined by the manufactures engineering calculations) over installed rigid insulation, using one wall anchor per pre-punched attachment hole at spacing indicated on engineering calculations.

1. Check plumb of vertical girts both parallel and perpendicular to the structure.
2. Tighten screws that attach vertical girt through insulation to substructure to a snug tight condition and not stripped. Do not over-torque beyond manufacturer’s recommendation. If installed using hand tools, verify for each installer at beginning of project using snug-tight criteria. Do not use stripped holes.
3. Where obstructions are present and unavoidable (i.e. window openings), use laser or chalk line to restart girt.
4. Locate vertical girt at jamb conditions and outside corner conditions.
5. Use shearing instruments (i.e. snips, nibbler, etc.) for cutting metal framing components. Saws are not recommended, as the sparks produced during cutting will damage the anti-corrosion coating. If sparks are generated during cutting, be sure the portion of the component to be installed on the building is protected from sparks and that any stockpile near the cutting station is also protected.
6. The systems components should not be cut while installed on the building, unless using a shearing instrument.
7. Replace thermal isolator pieces that break during installation.
8. Provide a 3/8 inch – 1/2 inch gap between girts for expansion when multiple lengths of vertical girts are installed.

G. Attach secondary horizontal rails to vertical girts plumb, straight and square.
1. Tighten screws to a snug tight conditions and not stripped. Do not use stripped holes or screws.
2. Shims can be used between horizontal rail and vertical girt or cladding panel and horizontal rail (if approved by cladding manufacturer). Shims cannot be used between vertical girt and insulation.
3. Both flanges/edges of stiffened horizontal rail must be attached to vertical girt.

3.4 METAL PANEL INSTALLATION

A. General: Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Shim or otherwise plumb substrates receiving metal panels.
2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
3. Install screw fasteners in predrilled holes.
4. Locate and space fastenings in uniform vertical and horizontal alignment.
5. Install flashing and trim as metal panel work proceeds.
6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
7. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.

B. Fasteners:

1. Aluminum Panels: Use aluminum or stainless-steel fasteners for surfaces exposed to the exterior; use aluminum or galvanized-steel fasteners for surfaces exposed to the interior.

C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.

D. Attachment Assembly, General: Install attachment assembly required to support metal plate wall panels and to provide a complete weathertight wall system, including subgirts, perimeter extrusions, tracks, drainage channels, panel clips, and anchor channels.

1. Include attachment to supports, panel-to-panel joinery, panel-to-dissimilar-material joinery, and panel-system joint seals.
E. Installation: Attach metal plate wall panels to supports at locations, spacings, and with fasteners recommended by manufacturer to achieve performance requirements specified.

1. Rainscreen Systems: Do not apply sealants to joints unless otherwise indicated.

F. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal panel manufacturer; or, if not indicated, provide types recommended in writing by metal panel manufacturer.

G. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that are permanently watertight.

1. Install exposed flashing and trim that is without buckling and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof performance.

2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

3.5 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align metal plate wall panel units within installed tolerance of 1/4 inch in 20 feet, non-accumulative, on level, plumb, and location lines as indicated, and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing agency to perform field tests and inspections.

B. Water-Spray Test: After installation, test area of assembly as directed by Architect for water penetration according to AAMA 501.2.
C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect completed metal wall panel installation, including accessories.

D. Remove and replace metal wall panels where tests and inspections indicate that they do not comply with specified requirements.

E. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.

F. Prepare test and inspection reports.

3.7 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

B. After metal panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.

C. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 074213.16
SECTION 077253 - SNOW GUARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Rail-type, seam-mounted snow guards.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product, include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: Include roof plans showing layouts and attachment details of snow guards.

1. Include details of rail-type snow guards.

C. Samples:

1. Rail-Type Snow Guards: Bracket, 12-inch- long rail, and installation hardware.

a. For units with factory-applied finishes, submit specified color to match metal roof.

D. Delegated-Design Submittal: For snow guards, include analysis reports signed and sealed by the qualified professional engineer responsible for their preparation.

1. Include calculation of number and location of snow guards.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer’s experience with providing delegated design engineering services of the kind indicated, including documentation that the engineer is licensed in the state in which the Project is located.
B. Product Test Reports: For each type of snow guard, for tests performed by a qualified testing agency, indicating load at failure of attachment to roof system identical to roof system used on this Project.

1.5 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit adhesive-mounted snow guards to be installed, and adhesive cured, according to adhesive manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design snow guards, including attachment to roofing material and roof deck, as applicable for attachment method, based on the following:

1. Roof snow load.
2. Snow drifting
3. Roof slope.
4. Roof type.
5. Roof dimensions.
6. Roofing substrate type and thickness.
7. Snow guard type.
8. Snow guard fastening method and strength.
10. Coefficient of Friction Between Snow and Roof Surface: 0.
11. Factor of Safety: 3.

B. Performance Requirements: Provide snow guards that withstand exposure to weather and resist thermally induced movement without failure, rattling, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

C. Structural Performance: Snow guards shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.

1. Snow Loads: As indicated on Drawings.
2.2 RAIL-TYPE SNOW GUARDS

A. Rail-Type, Seam-Mounted Snow Guards:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Alpine SnowGuards, a division of Vermont Slate & Copper Services, Inc.
   b. Berger Building Products, Inc.
   c. Sno-Gem.
   d. Snow Shield.
   e. Sieger Snow Guards.

2. Description: Snow guard rails fabricated from metal pipes, bars, or extrusions, anchored to brackets and equipped with two rails.


   a. Profile: Round.

5. Seam clamps: ASTM B221 aluminum extrusion or ASTM B85/B85M aluminum casting with stainless steel set screws incorporating round nonpenetrating point; designed for use with applicable roofing system to which clamp is attached.


PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, snow guard attachment, and other conditions affecting performance of the Work.

   1. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean and prepare substrates for bonding snow guards.

B. Prime substrates according to snow guard manufacturer's written instructions.
3.3 INSTALLATION

A. Install snow guards according to manufacturer's written instructions.
   1. Space rows as indicated on Shop Drawings.

B. Attachment for Standing-Seam Metal Roofing:
   1. Do not use fasteners that will penetrate metal roofing or fastening methods that void metal roofing finish warranty.
   2. Rail-Type, Seam-Mounted Snow Guards:
      a. Install brackets to vertical ribs in straight rows.
      b. Secure with stainless steel set screws, incorporating round nonpenetrating point, on same side of standing seam.
      c. Torque set screw according to manufacturer's instructions.
      d. Install cross members to brackets.

END OF SECTION 077253
SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Backdraft and pressure relief dampers.
   3. Flange connectors.
   4. Turning vanes.
   5. Duct-mounted access doors.
   6. Duct access panel assemblies.
   7. Flexible connectors.
   8. Duct accessory hardware.

B. Related Requirements:
   1. Section 233346 "Flexible Ducts" for insulated and non-insulated flexible ducts.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. For duct silencers, include pressure drop, dynamic insertion loss, and self-generated noise 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, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor-damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
      e. Duct security bars.
      f. Include diagrams for power, signal, and control wiring.
1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, or BIM model, drawn to scale, and coordinated with each other, using input from installers of the items involved.

B. Source quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 90A and NFPA 90B.

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.

2.2 BACKDRAFT AND PRESSURE RELIEF DAMPERS

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

2. Nailor Industries Inc.
3. NCA Manufacturing, Inc.
4. Ruskin Company.
5. POTTORFF

B. Description: Gravity balanced.

C. Performance:

1. Maximum Air Velocity: 1000 fpm.
2. Maximum System Pressure: 2 inches wg.
3. AMCA Certification: Test and rate in accordance with AMCA 511.
4. Leakage:
   a. Class II: Leakage shall not exceed 10 cfm/sq. ft. against 1-inch wg differential static pressure.
D. Construction:

1. Frame:
   a. Hat shaped.
   b. 16-gauge-thick, galvanized sheet steel, with welded or mechanically attached corners and mounting flange.

2. Blades:
   a. Multiple single-piece blades.
   b. Center pivoted, maximum 6-inch width, 0.050-inch-thick aluminum sheet with sealed edges.


E. Blade Seals: Neoprene, mechanically locked.

F. Blade Axles:

1. Material: Nonmetallic.
2. Diameter: 0.20 inch.

G. Tie Bars and Brackets: Aluminum.

H. Return Spring: Adjustable tension.

I. Bearings: synthetic pivot bushings.

J. Damper Actuator - Electric:

1. Electric - 24 V ac.
2. UL 873 plenum rated.
3. Fully modulating.
   a. Sufficient motor torque to drive damper fully closed with adequate force to achieve required damper seal.
   b. Minimum 90-degree drive rotation.

4. Clockwise or counterclockwise drive rotation as required for application.
5. Environmental Operating Range:
   a. Temperature: Minus 40 to plus 130 deg F.
   b. Humidity: 5 to 95 percent relative humidity noncondensing.

7. Actuator to be factory mounted and provided with a single-point wiring connection.
K. Controllers, Electrical Devices, and Wiring:

1. Comply with requirements for electrical devices and connections specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
2. Electrical Connection: 24 V, 60 Hz.

L. Accessories:

1. Adjustment device to permit setting for varying differential static pressure.
2. Counterweights and spring-assist kits for vertical airflow installations.
3. Chain pulls.
4. Screen Mounting:
   a. Front mounted in sleeve.
      1) Sleeve Thickness: 20 gauge minimum.
      2) Sleeve Length: 6 inches minimum.

5. Screen Material: Aluminum.
6. Screen Type: Bird.
7. 90-degree stops.

2.3 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Greenheck Fan Corporation.
   b. Nailor Industries Inc.
   c. Ruskin Company.
   d. POTTORFF
   e. NCA Manufacturing, Inc.

2. Performance:
   a. Leakage Rating Class III: Leakage not exceeding 40 cfm/sq. ft. against 1-inch wg differential static pressure.

3. Construction:
   a. Linkage out of airstream.
   b. Suitable for horizontal or vertical airflow applications.

4. Frames:
a. Hat-shaped, 16-gauge-thick, galvanized sheet steel.
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; 16 gauge thick.


7. Bearings:
   a. Molded synthetic.
   b. Dampers mounted with vertical blades to have thrust bearing at each end of every blade.

8. Tie Bars and Brackets: Galvanized steel.

9. Locking device to hold damper blades in a fixed position without vibration.

B. Jackshaft:
   1. Size: 0.5-inch diameter.
   2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
   3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

C. Damper Hardware:
   2. Include center hole to suit damper operating-rod size.
   3. Include elevated platform for insulated duct mounting.

2.4 CONTROL DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. Nailor Industries Inc.
   3. NCA Manufacturing, Inc.
   4. Ruskin Company.
   5. POTTORFF.
B. General Requirements:

   1. Unless otherwise indicated, use parallel-blade configuration for two-position control, equipment isolation service, and when mixing two airstreams. For other applications, use opposed-blade configuration.
   2. Factory or field assemble multiple damper sections to provide a single damper assembly of size required by the application.

C. Performance:

   1. AMCA Certification: Test and rate in accordance with AMCA 511.
   2. Leakage:
      a. Class II: Leakage shall not exceed 10 cfm/sq. ft. against 1-inch wg differential static pressure.
   3. Pressure Drop: 0.05 inch wg at 1500 fpm across a 24-by-24-inch damper when tested in accordance with AMCA 500-D, Figure 5.3.
   4. Velocity: Up to 1000 fpm.
   5. Temperature: Minus 25 to plus 180 deg F.
   6. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.

D. Construction:

   1. Linkage out of airstream.
   2. Suitable for horizontal or vertical airflow applications.
   3. Frames:
      a. Hat, U, or angle shaped.
      b. 16-gauge-thick, galvanized sheet steel.
      c. Mitered and welded corners.
      d. Flanges for attaching to walls and flangeless frames for installing in ducts.
   4. Blades:
      a. Multiple blade with maximum blade width of 6 inches.
      b. Opposed-blade design.
      c. Galvanized steel.
      d. 16-gauge-thick single skin.
   5. Blade Edging Seals:
      a. Replaceable Closed-cell neoprene.
      b. Inflatable seal blade edging, or replaceable rubber seals.

9. Bearings:
   a. Molded synthetic.
   b. Dampers mounted with vertical blades to have thrust bearings at each end of every blade.

E. Damper Actuator - Electric:

1. Electric - 24 V ac.
2. UL 873, plenum rated.
3. Fully modulating.
   a. Sufficient motor torque to drive damper fully open and fully closed with adequate force to achieve required damper seal.
   b. Minimum 90-degree drive rotation.

4. Clockwise or counterclockwise drive rotation as required for application.

5. Environmental Operating Range:
   a. Temperature: Minus 40 to plus 130 deg F.
   b. Humidity: 5 to 95 percent relative humidity noncondensing.

7. Actuator to be factory mounted and provided with a single-point wiring connection.

F. Controllers, Electrical Devices, and Wiring:

1. Comply with requirements for electrical devices and connections specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
2. Electrical Connection: 24 V, 60 Hz.

2.5 FLANGE CONNECTORS

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

1. Ductmate Industries, Inc.
2. DynAir; a Carlisle Company.
3. Ward Industries; a brand of Hart & Cooley, Inc.

B. Description: Add-on or roll-formed, factory fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.
D. Gauge and Shape: Match connecting ductwork.

2.6 TURNING VANES

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

1. Aero-Dyne Sound Control Co.
2. Ductmate Industries, Inc.
3. DynAir; a Carlisle Company.

B. Manufactured Turning Vanes for Metal Ducts: Fabricate curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.


C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figure 4-3, "Vanels and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

E. Vane Construction:

1. Single wall.
2. Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.7 DUCT-MOUNTED ACCESS DOORS

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

1. Cesco Products; a division of MESTEK, Inc.
2. Ductmate Industries, Inc.
3. Duro Dyne Inc.
4. Ruskin Company.
5. Ward Industries; a brand of Hart & Cooley, Inc.
B. Duct-Mounted Access Doors: Fabricate access panels in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figure 7-2 (7-2M), "Duct Access Doors and Panels," and Figure 7-3, "Access Doors - Round Duct."

1. Door:
   a. Double wall, rectangular.
   b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
   c. 24-gauge-thick galvanized steel door panel.
   d. Vision panel.
   e. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
   f. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
   a. 24-gauge-thick galvanized steel or 0.032-inch-thick aluminum frame.

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: Two hinges and two sash locks.
   c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles.
   d. Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

C. Pressure Relief Access Door:

1. Door and Frame Material: Galvanized sheet steel.
   a. 24-gauge-thick galvanized steel door panel.

2. Door: Double wall with insulation fill with metal thickness applicable for duct pressure class.

3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.

4. Factory set at 3.0 to 8.0 inches wg.

5. Doors close when pressures are within set-point range.

6. Hinge: Continuous piano.

7. Latches: Cam.

8. Seal: Neoprene or foam rubber.

9. Insulation Fill: 2-inch-thick, fibrous-glass or polystyrene-foam board.
2.8 DUCT ACCESS PANEL ASSEMBLIES

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

1. CL WARD & Family Inc.
2. Ductmate Industries, Inc.

B. Access panels used in cooking applications:

1. Labeled compliant to NFPA 96 for grease duct access doors.
2. Labeled in accordance with UL 1978 by an NRTL.


D. Fasteners: Carbon steel. Panel fasteners shall not penetrate duct wall.

E. Gasket: Comply with NFPA 96, grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.

F. Minimum Pressure Rating: 10 inches wg positive or negative.

2.9 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. DynAir; a Carlisle Company.

B. Fire-Performance Characteristics: Adhesives, sealants, fabric materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested in accordance with ASTM E84.

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Materials: Flame-retardant or noncombustible fabrics.

E. Coatings and Adhesives: Comply with UL 181, Class 1.
F. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.


1. Minimum Weight: 26 oz./sq. yd..
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.


1. Minimum Weight: 24 oz./sq. yd..
2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
3. Service Temperature: Minus 50 to plus 250 deg F.

I. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.

1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.10 DUCT ACCESSORY HARDWARE

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

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. DynAir; a Carlisle Company.
4. Hardcast; a Carlisle Company.
5. Ward Industries; a brand of Hart & Cooley, Inc.
B. 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.

C. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

2.11 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A653/A653M.
   2. Exposed-Surface Finish: Mill phosphatized.

B. Stainless Steel Sheets: Comply with ASTM A480/A480M, Type 304, and having a No. 2 finish for concealed ducts and No. 2 finish for exposed ducts.

C. Aluminum Sheets: Comply with ASTM B209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, one-side bright finish for exposed ducts.

D. Extruded Aluminum: Comply with ASTM B221, Alloy 6063, Temper T6.

E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless steel ducts.

F. 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.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories in accordance with applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116 for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless steel accessories in stainless steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
D. Where multiple damper sections are necessary to achieve required dimensions, provide reinforcement to fully support damper assembly when fully closed at full system design static pressure.

E. 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.
2. Install aluminum volume dampers in aluminum ducts.

F. Set dampers to fully open position before testing, adjusting, and balancing.

G. Install test holes at fan inlets and outlets and elsewhere as indicated and as needed for testing and balancing.

H. Install fire dampers in accordance with UL listing.

I. 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. At each change in direction and at maximum 50-ft. spacing.
8. Upstream and downstream from turning vanes.
9. For grease ducts, install at locations and spacing as required by NFPA 96.
10. Control devices requiring inspection.
11. Elsewhere as indicated.

J. Install access doors with swing against duct static pressure.

K. Access Door Sizes:

1. One-Hand or Inspection Access: 8 by 5 inches.
2. Two-Hand Access: 12 by 6 inches.

L. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

M. Install flexible connectors to connect ducts to equipment.

N. For fans developing static pressures of 5 inches wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

O. Install duct test holes where required for testing and balancing purposes.

P. 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.

3.2 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 size and location of access doors are adequate to perform required operation.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation, and verify that vanes do not move or rattle.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 233300
SECTION 233423 - HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Ceiling-mounted ventilators.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
   2. Rated capacities, operating characteristics, and furnished specialties and accessories.
   3. Certified fan performance curves with system operating conditions indicated.
   4. Certified fan sound-power ratings.
   5. Motor ratings and electrical characteristics, plus motor and electrical accessories.
   6. Material thickness and finishes, including color charts.
   7. Dampers, including housings, linkages, and operators.
   8. Prefabricated roof curbs.

B. Shop Drawings:
   1. Include plans, elevations, sections, and attachment details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, or BIM model, drawn to scale, showing the items described in this Section and coordinated with all building trades.
B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For HVAC power ventilators to include in normal and emergency operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 CEILING-MOUNTED VENTILATORS

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

1. Broan-NuTone LLC.
2. Greenheck Fan Corporation.
3. Loren Cook Company.
4. PennBarry.

B. Housing: Steel, lined with acoustical insulation.

C. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel removable for service.

D. Back-draft damper: Integral.

E. Grille: Plastic or Painted aluminum, louvered grille with flange on intake and thumbscrew or spring retainer attachment to fan housing.

F. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

G. Accessories:
   1. Isolation: Rubber-in-shear vibration isolators.
   2. Manufacturer’s standard roof jack or wall cap, and transition fittings.

2.2 CENTRIFUGAL VENTILATORS - ROOF DOWNBLAST

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.
3. Loren Cook Company.
5. PennBarry.

B. Housing: Downblast; removable spun-aluminum dome top and outlet baffle; square, one-piece aluminum base with venturi inlet cone.

C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades Type C.

D. Belt Drives:
   1. Resiliently mounted to housing.
   2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
   4. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
   5. Motor Pulleys: Adjustable pitch for use with motors through 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than 5 hp.
   6. Fan and motor isolated from exhaust airstream.

E. Accessories:
   1. Variable-Frequency Motor Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
   2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
   3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
   4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
   5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
   7. Mounting Pedestal: Galvanized steel with removable access panel.

F. Prefabricated 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.

   2. Overall Height: 24 inches.
   3. Sound Curb: Curb with sound-absorbing insulation.
   4. Hinged sub-base to provide access to damper or as cleanout for grease applications.
   5. Pitch Mounting: Manufacture curb for roof slope.
   7. Mounting Pedestal: Galvanized steel with removable access panel.
2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "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.

2.4 SOURCE QUALITY CONTROL

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. AMCA Certification: Fans shall comply with AMCA 11 and bear the AMCA-Certified Ratings Seal.

C. Fan Sound Ratings: Comply with AMCA 311, and label fans with the AMCA-Certified Ratings Seal. Sound ratings shall comply with AMCA 301. The fans shall be tested according to AMCA 300.

D. Fan Performance Ratings: Comply with AMCA 211 and label fans with AMCA-Certified Rating Seal. The fans shall be tested for air performance - flow rate, fan pressure, power, fan efficiency, air density, speed of rotation, and fan efficiency - according to AMCA 210/ASHRAE 51.

E. Operating Limits: Classify according to AMCA 99.

F. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

PART 3 - EXECUTION

3.1 INSTALLATION OF HVAC POWER VENTILATORS

A. Install power ventilators level and plumb.

B. Ceiling Units: Suspend units from structure; use steel wire or metal straps.

C. Install units with clearances for service and maintenance.

D. Label units according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."
3.2 DUCTWORK CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

3.3 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.
   1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
   2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.4 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections.

E. 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 there is adequate maintenance and access space.
4. Verify that cleaning and adjusting are complete.
5. 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.
6. Adjust belt tension.
7. Adjust damper linkages for proper damper operation.
8. Verify lubrication for bearings and other moving parts.
9. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
10. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
11. Shut unit down and reconnect automatic temperature-control operators.
12. Remove and replace malfunctioning units and retest as specified above.

F. Test and adjust controls and safeties. Controls and equipment will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

3.6 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Comply with requirements in Section 230593 "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.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain centrifugal fans.

END OF SECTION 233423
SECTION 233713.13 - AIR DIFFUSERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Rectangular and square ceiling diffusers.

B. Related Requirements:
   1. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
   2. Diffuser Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

B. Samples: For each exposed product and for each color and texture specified. Actual size of smallest diffuser indicated.

C. Samples for Initial Selection: For diffusers with factory-applied color finishes. Actual size of smallest diffuser indicated.

D. Samples for Verification: For diffusers, in manufacturer's standard sizes to verify color selected. Actual size of smallest diffuser indicated.

1.4 INFORMATIONAL SUBMITTALS

A. 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 assembly 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.
5. Duct access panels.

B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 RECTANGULAR AND SQUARE CEILING DIFFUSERS

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

1. Carnes Company.
2. Krueger-HVAC; brand of Johnson Controls International plc, Global Products.
3. METALAIRE, Inc.
4. Nailor Industries Inc.
5. Price Industries.
6. Titus; brand of Johnson Controls International plc, Global Products.
7. Tuttle & Bailey; brand of Johnson Controls International plc, Global Products.

B. Devices shall be specifically designed for variable-air-volume flows.

C. Material: Aluminum.

D. Finish: Baked enamel, white.

E. Face Size: 24 by 24 inches.

F. Face Style: Four con.

G. Mounting: T-bar.

H. Pattern: Adjustable.

I. Dampers: Radial opposed blade.

J. Accessories:
   1. Equalizing grid.
2.2 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers are 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.

3.2 INSTALLATION

A. Install diffusers 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 with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713.13
SECTION 233713.23 - REGISTERS AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Fixed face grilles.

B. Related Requirements:
   1. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to registers and grilles.
   2. Section 233713.13 "Air Diffusers" for various types of air diffusers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
   2. Register and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

PART 2 - PRODUCTS

2.1 GRILLES

A. Fixed Face Grille:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Carnes Company.
      b. Krueger-HVAC, a division of Air System Components; Johnson Controls, Inc.
      c. Nailor Industries Inc.
      d. Price Industries.
e. Titus, a division of Air System Components; Johnson Controls, Inc.
f. Tuttle & Bailey, a division of Air System Components; Johnson Controls, Inc.
g. Metalaire

3. Finish: Baked enamel, white.
5. Face Arrangement: Perforated core.
7. Frame: 1 inch wide.
8. Mounting: Lay in.

2.2 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate registers and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where registers and grilles are 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.

3.2 INSTALLATION

A. Install registers and grilles level and plumb.
B. Outlets and Inlets Locations: 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 registers and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust registers and grilles to air patterns indicated, or as directed, before starting air balancing.
PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Packaged air-cooled refrigerant condensers.

1.2 ACTION SUBMITTALS
A. Product Data: For each air-cooled refrigerant condenser.
B. Shop Drawings: For air-cooled refrigerant condensers.
   1. Include plans, elevations, sections, and mounting details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Plans, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

1.4 CLOSEOUT SUBMITTALS
A. Operation and maintenance data.

1.5 COORDINATION
A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 033000 "Cast-in-Place Concrete."
B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."
C. Coordinate location of refrigerant piping and electrical rough-ins.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Carrier Global Corporation.
2. Trane.
3. YORK; brand of Johnson Controls International plc, Building Solutions North America.

2.2 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. Fabricate and label refrigeration system according to ASHRAE 15 and ASHRAE 34.

C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

2.3 PACKAGED AIR-COOLED REFRIGERANT CONDENSERS

A. Description: Factory assembled and tested; consisting of casing, condenser coils, condenser fans and motors, and unit controls.

B. Refrigerant: R-410A.

C. Condenser Coil: Factory tested at 425 psig.

1. Tube: 1/2-inch-diameter seamless copper.
2. Coil Fin: Aluminum.
3. Motors: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   a. Enclosure Type: Open, drip-proof (ODP).
   b. 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.
   c. Mount unit-mounted disconnect switches on exterior of unit.

4. Comply with Section 230546 "Coatings for HVAC" for corrosion-resistant coating. See Drawings for condensers requiring a corrosion-resistant coating.

5. Coating, Coils: Corrosion resistant.
6. Coating, Fans: Corrosion resistant
7. Coating, Casing: Corrosion resistant.
8. Circuit: To match compressors.

D. Condenser Fans and Drives:

1. Directly driven propeller fans with aluminum or galvanized-steel fan blades, for vertical air discharge; manufactured with permanently lubricated ball-bearing motors with integral current- and thermal-overload protection.

2. Fan Motors:
   a. Weather-proof motors with rain shield and shaft slinger.
   b. Open-drip proof (ODP).
   c. Constant speed.

E. Operating and Safety Controls: Include condenser fan motor thermal and overload cutouts; 24-V control transformer, if required; magnetic contactors for condenser fan motors and a nonfused factory-mounted and -wired disconnect switch for single external electrical power connection.

1. Fan Cycling Control: Head pressure switches.

F. Casings: Galvanized-steel or zinc-coated-steel treated and finished with manufacturer's standard paint coating, designed for outdoor installation with weather protection for components and controls, and with the following:

1. Removable panels for access to controls, condenser fans, motors, and drives.
2. Coating: Corrosion resistant.
4. Lifting holes.

2.4 MATERIALS

A. Steel:

1. ASTM A36/A36M for carbon structural steel.
2. ASTM A568/A568M for steel sheet.

B. Galvanized Steel: ASTM A653/A653M.

C. Aluminum: ASTM B209.

D. Corrosion-Resistant Coating: Coat with a corrosion-resistant coating capable of withstanding a 500-hour salt-spray test according to ASTM B117.

1. Standards:
a. ASTM B117 for salt spray.
b. ASTM D2794 for minimum impact resistance of 100 in-lb.
c. ASTM B3359 for cross hatch adhesion of 5B.

3. Thickness: 1 mil.
4. Gloss: Minimum gloss of 60 on a 60 degree meter.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb, firmly anchored in locations indicated; maintain manufacturer's recommended clearances.

B. Equipment Mounting:

1. Install air-cooled condenser refrigerant condensers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

C. Maintain manufacturer's recommended clearances for service and maintenance.

D. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.

3.2 PIPING CONNECTIONS

A. Piping installation requirements are specified in Section 232300 "Refrigerant Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Refrigerant Piping: Where indicated on Drawings, connect piping to unit with pressure-relief, service valve, filter-dryer, and moisture indicator on each refrigerant-circuit liquid line.

D. Apply labels to refrigerant lines in accordance with Section 230553, "Identification for HVAC Piping and Equipment."

3.3 ELECTRICAL CONNECTIONS

A. Install field power to each condenser unit electrical power connection.
B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

D. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

E. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

   1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."

3.4 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

C. Install nameplate for each control connection, indicating field control panel designation and I/O control designation feeding connection.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

   1. Complete installation and startup checks according to manufacturer’s written instructions and perform the following:

      a. Inspect for physical damage to unit casing.
      b. Verify that access doors move freely and are weathertight.
      c. Clean units and inspect for construction debris.
      d. Verify that all bolts and screws are tight.
      e. Adjust vibration isolation and flexible connections.
      f. Verify that controls are connected and operational.

   2. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.
   3. Adjust fan belts to proper alignment and tension.
   4. Start unit according to manufacturer’s written instructions and complete manufacturer’s startup checklist.
   5. Measure and record airflow and air-temperature rise over coils.
   6. Verify proper operation of capacity control device.
7. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections with the assistance of a factory-authorized service representative.

B. Tests and Inspections:
   1. Perform electrical test and visual and mechanical inspection.
   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 motor rotation and unit operation. Complete manufacturer's starting checklist.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   5. Verify proper airflow over coils.

C. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

D. Air-cooled refrigerant condensers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain air-cooled refrigerant condensers.

END OF SECTION 236313
PART 1 - GENERAL

1.1 SUMMARY

A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

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.

1.3 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 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."

2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Procedures," and Section 7 - "Construction and System Start-up."

C. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.
1.6 WARRANTY

A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:
   a. For Compressor: Five year(s) from date of Substantial Completion.
   b. For Parts: One year(s) from date of Substantial Completion.
   c. For Labor: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Mitsubishi, Inc.
B. Sanyo
C. Daikin International
D. Toshiba
E. Carrier
F. Trane
G. York
H. Magicaire

2.2 INDOOR UNITS (5 TONS OR LESS)

A. Concealed Evaporator-Fan Components:

1. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
2. Insulation: Faced, glass-fiber duct liner.
4. Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch; leak tested to 300 psig underwater; with a two-position control valve.

6. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.

7. Fan Motors:
   a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
   c. Wiring Terminations: Connect motor to chassis wiring with plug connection.

8. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.


10. Condensate Drain Pans:
    a. Fabricated with two percent 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 to comply with ASHRAE 62.1.
       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. Pan-Top Surface Coating: Asphaltic waterproofing compound.
    e. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

B. Floor-Mounted, Evaporator-Fan Components:

1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect.
   a. Discharge Grille: Steel with surface-mounted frame.
   b. Insulation: Faced, glass-fiber duct liner.
   c. Drain Pans: Galvanized steel, with connection for drain; insulated.
2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.


5. Fan Motors:
   a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   b. Multitapped, multispeed with internal thermal protection and permanent lubrication.

6. Air Filtration Section:
   a. General Requirements for Air Filtration Section:
      1) Comply with NFPA 90A.
      2) Minimum MERV according to ASHRAE 52.2.
      3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.
   b. Extended-Surface, Disposable Panel Filters:
      1) Factory-fabricated, dry, extended-surface type.
      2) Thickness: 2 inches.
      3) MERV according to ASHRAE 52.2: 8.
      4) Media: Fibrous material formed into deep-V-shaped pleats and held by self-supporting wire grid.
      5) Media-Grid Frame: Nonflammable cardboard.
      6) Mounting Frames: Welded, galvanized steel, with gaskets and fasteners; suitable for bolting together into built-up filter banks.

C. 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 ARI 206/110.
5. Fan Motors:
   a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
   c. Enclosure Type: Totally enclosed, fan cooled.
   d. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
   e. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
   f. Mount unit-mounted disconnect switches on interior of unit.

6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

7. Condensate Drain Pans:
   a. Fabricated with two percent 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 to comply with ASHRAE 62.1.
      2) Depth: A minimum of 1 inch 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.

8. Air Filtration Section:
   a. General Requirements for Air Filtration Section:
      1) Comply with NFPA 90A.
      2) Minimum MERV according to ASHRAE 52.2.
      3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.
   b. Disposable Panel Filters:
      1) Factory-fabricated, viscous-coated, flat-panel type.
      2) Thickness: 1 inch.
      3) MERV according to ASHRAE 52.2: 8.
      4) Media: Interlaced glass fibers sprayed with nonflammable adhesive.
5) Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, and hinged; with pull and retaining handles.

2.3 OUTDOOR UNITS (5 TONS OR LESS)

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 gage 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 or Inverter.
   b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
   c. Refrigerant: R-410A.
   d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.
4. Fan: Aluminum-propeller type, directly connected to motor.
5. Motor: Permanently lubricated, with integral thermal-overload protection.
6. Low Ambient Kit: Permits operation down to 45 deg F.

2.4 ACCESSORIES

A. Thermostat: Wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:

1. Compressor time delay.
2. 24-hour time control of system stop and start.
3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
4. Fan-speed selection including auto setting.

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. Monitoring:
1. Monitor constant and variable motor loads.
3. Monitor economizer cycle.
4. Monitor cooling load.
5. Monitor air distribution static pressure and ventilation air volumes.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer’s standard mounting devices securely fastened to building structure.

C. Install roof-mounted, compressor-condenser components on equipment supports specified in Section 077200 "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.

D. Equipment Mounting:

1. Install ground-mounted, compressor-condenser components on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Install ground-mounted, compressor-condenser components on polyethylene mounting base.
3. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
4. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

E. Install and connect precharged refrigerant tubing to component’s quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

1. Water Coil Connections: Comply with requirements specified in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Connect hydronic piping to supply and return coil connections with shutoff-duty valve and union or flange on the supply connection and with throttling-duty valve and union or flange on the return connection.
2. Remote, Water-Cooled Condenser Connections: Comply with requirements specified in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Connect hydronic piping to supply and return connections with shutoff-duty valve and union or flange on the supply connection and with throttling-duty valve and union or flange on the return connection.

B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

C. Duct Connections: Duct installation requirements are specified in Section 233113 "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Section 233300 "Air Duct Accessories."

3.3 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. 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.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 238126
SECTION 260961 - THEATRE STAGE LIGHTING SYSTEM

PART 1 - GENERAL

1.1 SCOPE

All materials, components, and services necessary to provide a complete system indicated in this Section, as specified herein and shown on related Drawings, including:

A. Preparation and submission of complete shop drawings and samples for review prior to fabrication.

B. Verification of dimensions and conditions at the job site.

C. Shipment of equipment to the job site and the secured storage of all non-fixed equipment.

D. Installation and completion in accordance with these Specifications, related Drawings, the Equipment Manufacturer's recommendations, established trade criteria, and all applicable code requirements.

E. The observation, demonstration, and necessary adjustment of the completed installation by the Manufacturer's engineering personnel.

F. Preparation and submission of complete record drawings and operational and maintenance data and certificates.

1.2 WORK INCLUDED

A. Stage lighting control consoles and control accessories.

B. Remote control panels and receptacles.

C. Network data system.

D. Dimmers.

E. Wiring devices.

The above is for reference only and is not intended to define the limits of the work for a complete installation.
1.3 RELATED WORK IN OTHER SECTIONS

A. General requirements for all electrical work.
B. Electrical service
C. General lighting system.
D. Theatrical rigging system.
E. Theatrical sound and communications system.
F. Theatrical luminaires and accessories.

1.4 QUALIFICATIONS

A. All dimming and control system equipment shall be provided by qualified Stage Lighting Manufacturers.
B. The Manufacturers shall have at least ten (10) years experience in the fabrication of similar equipment.
C. If requested, the Manufacturers shall submit a representative list of installations during the above period.
D. Subject to the above requirements, the equipment indicated herein shall be by one of the following manufacturers:
   1. Dimming and control
      a. Electronic Theatre Controls, Middleton, Wisconsin
   2. Wiring devices
      a. Electronic Theatre Controls, Middleton, Wisconsin
      b. LEX Products, Stamford, Connecticut
      c. Southeast Stage Rigging & Curtains, Greenville, South Carolina
      d. TMB, New York, New York
      e. Union Connector, West Babylon, New York
E. Other manufacturers may be considered with the prior review of the Theatre Consultant. Manufacturers seeking review must contact the Theatre Consultant not later than fourteen (14) days prior to bid date.
F. The dimming and control system shall be provided by a qualified theatrical dealer, who shall have at least five (5) years experience in the sales and installation of similar systems and who shall be factory certified to provide warranty service for all of the equipment in this Section. Dealer shall be a Business member, accredited as
a Dealer/Retailer, of the entertainment service organization Entertainment Services and Technology Association (ESTA).

G. Dealer shall be responsible for the integration, operation, and performance of all elements of the system described in this Section. Dealer shall provide all warranty work and equipment upgrades as called for in this Section. The dealer shall be available for product service onsite within (24) hours of a call for service.

H. Subject to the above requirements, the equipment indicated herein shall be provided by one of the following dealers:

1. Grand Stage, Chicago, Illinois  312-332-5611
2. Indianapolis Stage, Indianapolis, Indiana  317-635-9430
5. Vincent Lighting Systems, Solon, Ohio  216-475-7600
6. **Beck Studios, Milford, Ohio  513-831-6650**

Other dealers may be considered with the prior review of the Theatre Consultant. Dealers seeking review must contact the Theatre Consultant not later than fourteen (14) days prior to bid date.

1.5 **SUBMITTALS**

A. With bid.

1. Identification of qualified Theatrical Dealer providing system.
2. All deviations and exceptions from specification must be revealed with bid. Deviations and exceptions from specification submitted after this time shall not be accepted.
3. Manufacturer shall indicate any additional infrastructure that is not shown in the Drawings and is required to install Manufacturer's system.

B. Shop drawings. Within sixty (60) days of receipt of order, the Manufacturer shall submit drawings and equipment data sheets to the Architect for distribution to the Theatre Consultant for review and action prior to fabrication:

1. Dimensions, components, and finishes of all equipment and accessories.
2. All system assemblies and major sub-assemblies, cabinets, and enclosures, including notation of type and manufacture of switches, pilot lights, locks, hardware, and electrical and electronic connectors.
3. Block schematics of system internal wiring and system element interconnection.
4. Full size samples of labeling styles for all wiring device types.
5. Quantities of each component and sub-assembly.
6. Indication by boxed caption of any and all variations from contract Drawings and Specifications, whether or not these variations have been formally or informally accepted by the Theatre Consultant.

7. Submittal Review:
   a. All shop drawing information shall be submitted at the same time; no partial submittals will be reviewed.
   b. Review and approval shall not relieve the Manufacturer/Dealer of responsibility for meeting all functional, operational, and safety requirements of the project as set forth in this Specification and related Sections. Review does not relieve the Contractor of responsibility to verify field conditions; nor does it relieve the contractor of responsibility for errors, omissions, or deviations in submittals.

C. Samples. Within sixty (60) days of receipt of order, the Manufacturer shall submit to the Architect for review prior to fabrication samples of any equipment component requested by the Theatre Consultant. Samples shall not be included in quantities of equipment specified but shall be returned.

D. Final submittal. Within thirty (30) days of final tests, and as a condition for final review, the Manufacturer shall submit to the Architect:
   1. Three (3) sets to the Architect and one (1) set on electronic media to the Theatre Consultant. Format of sets shall be compliant with Division One of this Specification.
      a. Receipts for delivery of all non-installed items, i.e., all items designated, "deliver to Owner."
      b. "As built and approved" drawings and equipment data sheets showing all systems and components as installed, including all field modifications.
      c. Documentation of Data Network system, noting system layout, all panel locations, and all wire lengths. Documents shall indicate the device IP address, MAC/NIC address, Hub Number, and Port number, where applicable. Subnet Masks and Subnet documentation shall be provided where applicable. Provide cable analyzer printouts of all tests performed as required in this Section, labeled by cable number.
      d. Operating and maintenance manuals.
      e. Parts lists.
      f. Training videos as noted below.
      g. Certificates of warranty, as set forth below.

1.6 TESTING AND INSTRUCTION
A. Upon completion of all installation work, the Contractor and Dealer shall certify in writing to the Architect that the work is complete and ready for final observation.
Final observation shall be scheduled by the Owner, the Architect, and the Theatre Consultant within fourteen (14) days following the Contractor's notice of completion.

B. System testing shall include testing of control data network, documenting traffic utilization within the Network Data System requirements noted below in this Section. Testing shall also include verification of Wireless Handheld Remotes operational range as required in Part 2 of this Section.

C. After system checkout and adjustment, the Dealer's factory certified technician shall operate the system for the review of the Owner, the Architect, and the Theatre Consultant.

D. Necessary adjustments or modifications shall be made as required.

E. As a condition of final completion, the Dealer's factory certified technician shall instruct the Owner's staff or representatives, under the observation of the Architect and Theatre Consultant, in the operation and maintenance of the system.

1. Initial Instruction: This instruction session shall be scheduled for a minimum duration of six (6) hours. While it may be possible to schedule this instruction session to coincide with the system checkout, such coincidence shall not be assumed. Instruction shall be scheduled by the Owner, the Architect, and the Theatre Consultant to occur within fourteen (14) days following the Contractor's written notice.

   a. Provide to Users at time of training a copy of the circuit termination schedule that has been revised by the Dealer and Electrical Contractor to reflect the installed circuit terminations for the Owner's use and reference. This document shall not supplant any other requirements contained in this Specification.

2. Follow-up Instruction: This instruction session shall take place not less than thirty (30) days nor more than six (6) months from the initial instruction. This instruction shall be scheduled by the Owner, shall be scheduled for a minimum duration of four (4) hours and will cover topics requested by the Owner.

F. The Dealer shall provide to the Owner video instructions on the operation and maintenance of the system. Information contained in video will cover all points of operation and maintenance covered in the instruction session with Owner's staff. A video recording of the actual instruction session is acceptable. Provide four (4) full copies of video instruction. Video format shall be electronic media in a MP4 file format.

1.7 GENERAL REQUIREMENTS

A. General Conditions of the project contract, work schedules, and site regulations apply to this work. Refer to Division One.
B. This work shall comply with local codes and applicable standards as established by NEC and approved testing agencies, and all components shall carry pertinent labels by approved testing agencies.

C. For all requirements not otherwise addressed by this Specification, the work shall be at a minimum compliant with the requirements of the following standards:

5. ANSI E1.24 – 2012 (R2017) Entertainment Technology – Dimensional Requirements for Stage Pin Connectors
7. ANSI E1.27-2 - 2009 (R2019) – Entertainment Technology - Recommended Practice for Permanently Installed Control Cables for Use with ANSI E1.11 (DMX512-A) and USITT DMX512/1990 Products
8. ANSI E1.30 Series of Documents level equipment interoperability for control of commonly encountered entertainment technology devices using E1.17.
11. ANSI E1.37 Series of Documents Additional Message Sets for ANSI E1.20 (RDM)

D. The Contractor shall provide full insurance against loss or damage during shipment, storage, installation, and testing. Certification of such coverage shall be furnished to the Architect within thirty (30) days of award of contract.

E. Warranty

1. The Dealer shall unconditionally warrant all equipment and systems provided under this Section to be free from defects in materials and workmanship for a period of at least twelve (12) months from the date of final acceptance of all work of this Section. Lamps and normal wear and tear are exempted.
2. Appropriate additional equipment to replace equipment removed for service shall be provided at the job site at no expense to the Owner to replace any and all equipment which must be removed for service. Replacement control console(s) must of the same model as those removed for service.

3. All warranty service shall be performed by technicians factory certified for the installed equipment.

4. For a period of two (2) years following acceptance, the Dealer shall provide and install, at no cost to the Owner, software upgrades to all control system components of all control systems including consoles and architectural lighting controllers. Thereafter the Dealer shall notify the Owner of all software upgrades for the life of the control system(s). The Dealer shall keep Owner’s name and address in a database for this purpose. All upgrades shall include a full written description of operational modifications. Software upgrades shall be designed so as to allow existing data, configurations and show files to be maintained, accessed and edited in the future.

F. State-of-the-art assurance: All products specified shall be the Manufacturer’s most recent iteration and most recent product. No products shall be accepted if they have been discontinued or superseded at the time of shipment. Should the Manufacturer develop products of comparable function above and beyond the specification of the listed product, the Dealer shall make the newly developed product available to the project at no additional cost. The Dealer shall notify the Architect and the Theatre Consultant of any developments to the specified products, and shall note any change in the requirements of building infrastructure(s) to support the developments. The Architect and Theatre Consultant shall then determine whether upgraded products shall be accepted.

PART 2 - PRODUCTS

2.1 GENERAL

A. All components shall be new, in good condition, and under warranty.

B. All components shall bear labels from approved testing agencies and labels identifying the manufacturer, model number, and serial number. All such labels shall be permanently attached in a conspicuous location.

C. All control and receptacle faceplates not otherwise described in this Specification shall be black anodized aluminum or black painted steel, and all labels and legends shall be permanently engraved directly into the faceplate. Engravings shall be filled with white paint except where specifically noted. Minimum text height if not specified elsewhere shall be 3/16-inch. No other labeling techniques shall be used except where specifically noted. All faceplates shall have beveled edges and rounded corners.
D. Control signal protocols and connector types
   1. All control signal protocol and connector types shall comply with the standards noted in Item 1.7 of this Section.
   2. All components shall be compatible within the Stage Lighting Manufacturer’s network data system.
   3. All control, signal, and video connectors shall be of substantial construction and shall be of the locking or latching type. All plate-mounted connectors shall be bolted to faceplates. Rivets shall not be acceptable.

E. Provide a total of (2) keys for each keyed device.

F. Where specification allows for “approved equal,” substitutions shall be proposed to the Theatre Consultant at least ten (10) days prior to bid date.

2.2 NETWORK DATA SYSTEM

A. The Network Data System shall provide for the interconnection of devices used solely for stage lighting and special effects.

B. The network shall consist of receptacle panels, connecting wiring, patch bay(s), patch cables, routers, and switches.

C. Provide all materials, components, and services necessary to provide a complete network data system indicated in this Section. Dealer shall be responsible for performance of the complete system.

D. Network capacity shall be determined by the following simultaneous usage criteria. System shall allow all the data below to be sent simultaneously, within the traffic and collision maximums noted in Item L below.
   1. Control Consoles – quantity one (1)
   2. Power control panels - as shown in the Drawings.
   3. Remote video displays – quantity four (4) in use, in two separate locations
   4. Architectural Lighting Control System as shown in the Drawings.
   5. Wireless Handheld remote controls as shown in the Drawings.
   6. Distributed sACN signal – sixteen (16) 512-address universes for connection to lighting and effects devices. Network shall be designed for the quantity of addresses specified herein and a 50% future expansion of addresses.
   7. DMX Gateways – as specified herein and a 50% future expansion of DMX gateways.
E. The system shall utilize one of the following wiring methodologies:

1. The wiring to the end-point receptacles of the system shall utilize unshielded twisted pair (UTP) wiring. UTP wiring shall be 4 pair #24 AWG minimum unshielded twisted pair wiring.

2. Fiber optic wiring is permissible for "backbone" wiring runs.

3. All elements of the system shall meet the following requirements:
   a. Institute of Electrical & Electronic Engineers Standard 802.3.

4. All permanent network wiring shall terminate in receptacles in panels. All equipment shall be connected to receptacles via "patch cables" with RJ45 connectors. No installed wire shall terminate directly to network equipment. The use of male RJ45 pigtails shall not be permitted.

F. All system elements shall be provided from a qualified network hardware manufacturer. The manufacturer shall have at least five (5) years experience in the fabrication of network hardware. Subject to the above requirements, the equipment indicated herein shall be by one of the following manufacturers:

1. Cisco Systems
2. Dell Systems.
3. HPE
4. Approved Equals.

G. Network terminations shall be provided at panels and devices as shown in the Drawings and Schedules:

H. Electrical requirements

1. All UTP wiring segments shall be of continuous runs of not more than 250 feet. The Contractor shall coordinate and submit all conduit runs for review, verifying the maximum length of each wiring run. If a wiring run exceeds the noted maximum footage, Contractor shall notify the Architect of all issues and coordinate with Manufacturer to bring the segment wiring to the stated maximum run. Manufacturer shall provide repeaters and system elements as necessary. Contractor shall provide and install such elements as part of the work of this Section. All elements shall be provided with uninterruptible power supplies. Such equipment shall be located in a location mutually agreed upon by the Theatre Consultant and Architect.

2. All cable shall meet the standards for TIA/EIA-568-B Category 5e, or highest rated category wiring in use for this project at the time of installation.

3. All cable shall be tested for continuity, attenuation, near end crosstalk, mutual capacitance, cable impedance, cable resistance, cable length, structural return loss and pair mapping. The Contractor shall use a current generation 100Mhz or higher network/cable analyzer to perform testing on the cable plan and shall test all data pairs. All testing will be performed by certified cable technicians.
a. Cable Testing shall meet the following minimum requirements:
   i. TIA/EIA Bulletin TSB-95 for field-testing of Category 5e cabling.
   ii. TIA/EIA 568-B.2-1 for field-testing of Category 6 cabling.

4. All terminations shall meet the requirements of TIA/EIA-T586B Technical Bulletin.
5. All cable and installation shall support 100BASE-TX minimum.
6. The system shall be designed for maximum 40% traffic utilization.
7. All Layer 2 switches shall provide for IGMP version 3 snooping to accommodate IP multicast events.
8. System to incorporate Power over Ethernet via IEEE 802.3at compliant Power over Ethernet switches.

I. Patch cables
   1. Cables shall have a Category rating to match rating of installed wiring.
   2. Cables shall include RJ45 plugs at each end, for proper mating to receptacle panels and node devices. Each cable shall be protected by a rubber boot of a diameter sufficient to extend beyond the plug connection tab.
   3. Quantities as sufficient to fully patch the network.
   4. Deliver to Owner.

J. Uninterruptable power supply.
   1. Capable of sustaining operating voltage to supported devices for a minimum of ten (10) minutes in the event of a loss of power.
   2. Capable of filtering spikes, surges, and noise from power source.
   3. Conditioner shall provide continuity of earth ground from source to the utilization equipment.
   4. Shall include test switch to confirm battery charge.
   5. Shall include battery end-of-life indicator.
   6. Shall be rack mounted.
   7. UPS shall be sized to provide rated power supply for supported devices.
   8. Eaton Powerware Series 5 or approved equal.

2.3 SIGNAL PROCESSING RACK

A. The Signal Processing Rack shall be 19" equipment mounting rack(s) with a hinged front door.

B. The Rack shall be surface wall mounted and completely wired internally. Rack shall include hinged “swing-away” mounting for rear access. Design and configuration as shown in the Drawings.
C. All wires shall be identified at the jacket with separate numbers.

D. The rack shall contain the following elements as shown in the Drawings:
   1. Network Patch Panel(s)
      a. Patch panel(s) shall include sufficient patching for all network receptacles, plus (12) spare receptacles.
         i. The Panel(s) shall include wire management panel(s) as manufactured by Panduit or approved equal.
         ii. The Panel(s) shall include engraved labeling of each receptacle.
   2. Network Switch
      a. Network Switch(es) shall include sufficient patching for all network ports, plus (12) spare ports.
   3. Cable Management.
   4. Signal Translation node, if required.
   5. Uninterruptable Power Supply.
   7. 0-10v Lighting Control Gateway(s)
   8. Centralized DMX Distribution

E. Install as shown in the Drawings.

2.4 CENTRALIZED DMX GATEWAYS

A. The Gateways shall provide for the translation of network control data into discrete DMX512 data streams to the termination points indicated on the drawings and schedules. The system shall be designed with the following functionality:
   1. The device(s) shall be capable of accepting the following lighting control network data: sACN and RDM.
   2. The device(s) shall use a dedicated multiplexed signal conforming to the ANSI E1.11 – 2008 (R2018) DMX512-A standard.
   3. DMX512 data streams shall be optically isolated.
   4. Each discrete DMX512 data stream shall be programmable to provide data within the specified DMX512 Universe(s).

B. Wiring between Centralized DMX Gateways and indicated termination points, per the drawings and schedules, shall:
   1. Meet the standards for TIA/EIA-568-B Category 5e, or highest rated category wiring in use for this project at the time of installation.
   2. Cable length shall be limited to 250 feet.
3. Follow all recommended practices, unless otherwise noted above, of ANSI E1.27-2 - 2009 (R2019) – Recommended Practice for Permanently Installed Control Cables for Use with ANSI E1.11 (DMX512-A) and USITT DMX512/1990 Products.

C. All wires shall be identified at the jacket with separate numbers.

D. Provide one discrete input or output for each termination point in the system, as shown in the Drawings and Schedules, plus four (4) spares. Provide rear-mounted terminals for the connection of all DMX wiring.

E. Multiple DMX receptacles on a single input or output cable shall not be accepted.

F. The system described above is based upon general performance criteria common to the products listed below. No other system shall be considered unless specifically approved by Theatre Consultant at least ten (10) days prior to the bid date:
   1. Electronic Theatre Controls “Net3 Four Port Gateway.”
   2. Pathway Connectivity “Pathport Quattro Node.”
   3. Pathway Connectivity “Pathport Octo Node.”

G. Install in the Signal Processing Rack.

2.5 PORTABLE NODE DEVICES

A. The Node(s) shall provide for the translation of network control data into discrete DMX512 data streams. Node devices shall be portable, for the connection of equipment at receptacle panels.
   1. The device(s) shall be capable of accepting the following lighting control network data: sACN and RDM.
   2. The device(s) shall use a dedicated multiplexed signal conforming to the ANSI E1.11 – 2008 (R2018) DMX512-A standard.
   3. DMX512 data streams shall be optically isolated.
   4. Each discrete DMX512 data stream shall be programmable to provide data within the specified DMX512 Universe(s).

B. Nodes shall have receptacles for connection of network cables and at least two (2) DMX cables.

C. Nodes shall be provided with a C-Clamp and a safety cable.

D. Nodes shall have black enclosure.

E. Receptacles for device connection.
   1. Network connectors shall be Neutrik “Ethercon” type connectors or approved equal.
2. DMX connectors shall be equal to 4-pin or 5-pin XLR, Switchcraft.
3. Smaller or less substantial connectors shall not be acceptable.

F. Unless noted otherwise the Dealer shall configure all nodes to have DMX out receptacles.

G. Quantities per schedule. Provide scheduled quantity in addition to any nodes required for basic system operation.

H. Deliver to Owner.

I. Approved Manufacturers:
   1. Electronic Theatre Controls
   2. Pathway Connectivity
   3. Approved equal.

2.6 NETWORK CABLES

A. Cables shall have a Category rating to match rating of installed wiring.

B. Cables shall include RJ45 plugs at each end, for proper mating to receptacle panels and node devices.
   1. Connectors shall be Neutrik “Ethercon” type connectors or approved equal.

C. Cables shall be of type “ProPlex” as manufactured by TMB, Carlstadt, NJ or approved equal.

D. Quantities per schedule.

E. Deliver to Owner.

2.7 THEATRE ARCHITECTURAL LIGHTING CONTROL SYSTEM

A. The Theatre Architectural Lighting Control System shall be a comprehensive lighting control system designed to control dimming racks, relay panels, and lighting fixtures as shown in the Schedules.

B. The system shall be comprised of individual control panels as shown in the Drawings. Each panel shall contain one or more of the following control elements:
   1. Controls, quantities and labeling as noted in the Drawings.
   2. Rear-illuminated liquid crystal display touchscreen shall display available presets and programming information.
      a. It shall be possible to limit control and access to the screen through the use of passcode controls.
b. It shall be possible to program fade times for each preset

c. The panel shall be capable of controlling assigned control channels in the system.

d. Control zone numbers and names as noted in the Drawings.

3. Master Override Controls

a. **Panic switch.** Rear-illuminated pushbutton switch. Color: Red. Operation: Push On / Lock. Panic switch shall bring designated architectural lighting zones on to full power overriding all other controls. The designated zones shall be locked at this state until deactivation of this switch. This switch shall function regardless of the operating status of other control system elements.

b. **Night Light switch.** Rear-illuminated pushbutton switch. Color: Blue. Operation: Push On / Push Off. Night Light switch shall activate a preset of house lights and work lights for use when the theatre is unoccupied. The Night Light preset shall only be activated and deactivated with this switch. All other houselight controls and worklight switches, including Entry Panels, will continue to operate while the Night Light preset is engaged, but their action shall not affect any channels being controlled by the Night Light preset.

c. **Entry Panel Lockout Switch.** Recessed rear-illuminated pushbutton switch. Color: White. Lockout switch shall address all designated Entry Panels. Switch shall be able to lock out local control.

4. Sliders - Linear sliders for individual control of zones.

5. Pushbuttons. Operation: Push On / Push Off. Each button shall incorporate or have associated with it a status indicating LED.


a. Pushbuttons to activate separate presets.

b. UP and DOWN pushbuttons to raise and lower channel levels, and to program presets in setup mode.

C. The following systems shall be acceptable:

1. ETC "Paradigm"

D. **Auxiliary Control Console**

1. The Auxiliary Control Console shall be a separate console, totally enclosed, portable, and completely wired internally.

2. The face of the panel shall contain the control Panels as shown in the Drawings.

3. The console elements shall retain their memory regardless of connection status to system power.

4. Design and configuration as shown in the Drawings.

5. The Auxiliary Control Console shall include a vinyl dust cover or case lid as appropriate, and one (1) 25-foot multi-conductor cable terminating in a locking
connector appropriate for mating with Control Receptacle Panels as required by the Drawings.

E. Entry Panels

1. Entry Panels shall be mounted as shown in the Drawings and Schedules, and completely wired internally, with terminals of the proper rating for all external wiring.

2. The faceplate shall contain pushbuttons or sliders. Quantity, labeling, and circuits controlled per Drawings.

3. Enclosed entry panels.
   a. The faceplate of the panel shall be recessed and covered by a hinged latching cover with a clear view panel.
   b. All entry panel enclosures mounted in audience areas shall be a custom color per the Architect’s specifications. All faceplates shall be a color from manufacturer’s standard finish selections as selected by the Architect.

4. The panels shall retain their memory regardless of connection status to system power.

5. Install as shown in the Drawings.

F. All labels and legends shall be permanently engraved directly into the faceplate, or the surrounding faceplate of the panel’s enclosure. Engravings shall be filled with paint of a contrasting color.

2.8 0-10V CONTROL GATEWAY

A. The Gateway shall provide for the translation of network control data into discrete 0-10V control to the termination points indicated on the schedules. The system shall be designed with the following functionality:

1. The gateway shall support multiple input protocols including:
   a. ANSI E1.17 Architecture for Control Networks (ACN)
   b. ANSI E1.31 Streaming ACN (sACN)

2. The gateway shall support an input for use in Emergency Systems

3. The gateway shall have a backlit display for identification, status reporting and configuration.

4. Each gateway shall have power and network activity indicators on the front of the gateway

B. Provide one discrete input or output for each termination point in the system, as shown in the Schedules, plus four (4) spares. Provide terminal-strip style connectors for connection of all 0-10v control circuits.
C. The Input for Emergency Systems shall support:
   1. A dry contact input shall provide triggering of an emergency condition
   2. A three-position switch shall set the input as Normally Open (NO) Normally Closed (NC), or Off

D. Configuration
   1. The gateway shall be field configurable.
   2. The gateway shall support a configurable start address from 1 to 512 and use consecutive addresses.
   3. The gateway shall support three configurable dimming curves with each channel independently assignable. Supported curves shall be linear, mod-square and custom.
   4. Multiple sACN sources may be combined with a priority may be assigned to each source sending data to the gateway

E. Acceptable products:
   1. “Response 0-10V Gateway” as manufactured by Electronic Theatre Controls.
   2. Approved equal

G. Install as shown in the Drawings.

F. Quantities per Drawings & Schedules.

2.9 STAGE LIGHTING CONSOLES

A. Specifications
   1. DMX Outputs: 4,096
   2. Control Channels: 32,000
   3. Encoders: 4
   4. Touchscreens: 1
   5. Removable Media recording for show file storage
   6. 5 Submaster Faders with bump buttons and status-indicating LEDs

B. Console shall include:
   1. One (1) flat-screen color monitor. Monitor shall provide SXGA-minimum resolution and shall be no larger than 21-inches, measured diagonally.
   2. One (1) flat-screen color multi-touch monitor. Monitor shall provide SXGA-minimum resolution and shall be no larger than 21-inches, measured diagonally.
   3. Two (2) Removable Media for show file storage.
4. One (1) set of 25-foot control cables terminating in locking connectors appropriate for mating with the Control Receptacle Panel and the console.
   a. Connectors for connection to Control Receptacle Panel shall be Neutrix EtherCon or equivalent.

5. Vinyl dust covers for the console and video displays.

6. Offline Editing Software. Software for off-line editing of show information from main control console. Software shall enable user to load show information directly from main control console, view, edit, and print all show data, and re-load information back into main control console for playback.

C. Acceptable products.
   1. ETC “GIO @5 - 4K”
   No other system shall be considered unless specifically approved by the Theatre Consultant at least 10 days prior to bid date.

D. Deliver to Owner.

2.10 CONTROL ACCESSORIES

A. Uninterruptable power supply.
   1. Capable of sustaining operating voltage to control console and video display(s) for a minimum of ten (10) minutes in the event of a loss of power.
   2. Capable of filtering spikes, surges, and noise from power source.
   3. Conditioner shall provide continuity of earth ground from source to the console.
   4. Shall include test switch to confirm battery charge.
   5. Shall include battery end-of-life indicator.
   6. Shall be sized to provide rated power supply for control console, external display(s), and any console-mounted work light.
   7. Eaton Powerware Series 5 or approved equal.

B. Wireless Handheld Remotes.
   1. Unit(s) shall be capable of calling up channels, adjusting levels, calling up cues, running cues, and performing dimmer check.
   2. Provide all portable transmitter(s)/access point(s) required for a complete and functioning system.
      a. System shall provide for continuous operation from all points within the auditorium chamber and stage house including but not limited to the gridiron, stage floor, dimmer room, auditorium catwalks, control rooms, and auditorium.
3. The following transmission protocol methodologies shall be acceptable:
   a. IEEE 802.11 b/g, commonly known as Wi-Fi technology.
   b. UHF radio transmission. Systems utilizing UHF radio transmission shall be in compliance with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules.

4. Systems requiring line-of-sight technology shall not be accepted.

5. Units shall be capable of four (4) hours of continuous use on a single battery charge.

C. **Extension control cable.** Two (2) 100'-0" extension cable for control console, neoprene outer jacket.
   1. Connectors for connection to Control Receptacle Panel shall be Neutrik EtherCon or equivalent.

D. **Rolling Table/Stand.** All-metal construction, of sufficient size to carry control console, video monitor, and power conditioner. Video monitor may be carried on a higher shelf than control console, and power conditioner may be carried on a lower shelf. Stand shall be mounted on substantial locking rubber casters.

E. **Road Cases.** Of substantial plywood construction, with steel reinforced corners and flush locking latches. Interior shall be molded foam conforming to shape of console, with spaces provided for all dedicated peripherals. Provide wheeled cases for any equipment weighing more than fifty (50) pounds, inclusive of case. Provide road cases for the following equipment:
   1. Main Control Console.
   2. Main Control Console video monitors.

F. Deliver to Owner.

2.11 REMOTE CONTROLLED RELAY PANELS

A. The Relay Panels shall be totally enclosed and completely wired internally, with hinged locking doors.

B. Each panel shall provide circuit quantities as noted in the Drawings. Racks shall be required to accommodate multiple voltages in the same enclosure.

C. All relays shall be individually addressable and controlled by the stage lighting network.

D. Each relay shall meet or exceed the characteristics defined in NEMA-410-2015 Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts.
E. Panel shall accept a 3-phase, 4-wire mains feed and shall provide a mains feed circuit breaker sized for said feed.

1. Panel shall have a fault current rating of not less than 35,000 AIC.

F. An engraved lamicoid label shall be bolted or riveted to the front of the rack, to read:

   RELAY PANEL (Number)
   RELAYS (Beginning no.)—(End no.)/
   CHANNEL NUMBER (Beginning no.)-(End no.)

Schuler Shook Theatre Planners, Chicago, IL
(Year of Commissioning)

G. Acceptable products:

1. “ECHO Relay Panel” as manufactured by Electronic Theatre Controls.
2. Approved equal

H. Provide and deliver to Owner spare modules of each module type in the panel. See Schedule of Quantities.

I. Install as shown in the Drawings.

2.12 REMOTE ZONE CONTROLLERS

A. General

1. All controls shall be fully accessible when the Controller is mounted.
2. Each zone provided by the controller shall be individually addressable and controlled by the stage lighting network.
3. The controller shall provide integral passive heat management sized to the thermal requirements of the device.
4. The controller shall be available in configurations that support either a 120V or 277V power input.

B. Phase-Adaptive Dimmer

1. The Phase-Adaptive Dimmer shall be fully rated for loads up to 600 watts and shall operate with a minimum load of 1 watt.
2. The Phase-Adaptive dimmer shall support two dimming modes:
   a. Auto (default) - Phase-Adaptive dimmers shall automatically detect the required dimming mode based on connected loads and lock the mode in at power-up
   b. Forward-Phase – manually or remotely configure the dimmer to forward-phase operation
3. The Phase-Adaptive Dimmer shall support tungsten/ incandescent, 2-wire fluorescent, line-drive LED, and electronic transformer loads.

4. All Phase-adaptive dimmers shall have the following remotely configurable parameters.
   a. Device Label – configure a name for the device
   b. DMX Start Address – set the starting DMX address of the Zone Controller to a value from 1-512
   c. Curve and Mode – configure the dimming mode and dimming curve: Auto, Mod-Square; Auto, Linear; Forward-Phase, Mod-Square; Forward-Phase, Linear
   d. Output Response Time – configure the response time of the dimmer between instant, 800µs (default), and 1,000µs

5. The following systems shall be acceptable:
   a. Unison Foundry Series Phase Adaptive Dimmer by ETC, Inc.

C. Relay Controller
   1. All Relay Controllers shall provide fully rated 20A normally open relay switching.
   2. All Relay Controllers shall have the following remotely configurable parameters.
      a. Device Label – configure a name for the device
      b. DMX Start Address – set the starting DMX address of the Zone Controller to a value from 1-512

3. The following systems shall be acceptable:
   a. Unison Foundry Series Relay Controller by ETC, Inc.

D. 0-10V Controllers
   1. All 0-10V Controllers shall provide fully rated 20A normally open relay switching.
   2. 0-10V Controller output(s) shall support 0-10V sink for dimming of LED drivers and ballasts.
      a. All 0-10V output(s) shall be fully isolated from ground to 2500V RMS.
   3. All 0-10V Controllers shall have the following remotely configurable parameters.
      a. Device Label – configure a name for the device.
      b. DMX Start Address – set the starting DMX address of the Zone Controller to a value from 1-512.

4. The following systems shall be acceptable:
   a. Unison Foundry Series 0-10V Dimming Controller by ETC, Inc.

E. Install as shown in the Drawings.

F. Quantities per Drawings & Schedules.
2.13 400A COMPANY SWITCH (SP-1)

A. The Company Switch shall be wall mounted, deadfront, substantially framed, and fabricated of aluminum or steel. All parts shall be properly cleaned prior to painting and then painted with a rust inhibiting primer. The finish paint shall be baked enamel. **Color: Black**

B. The panel shall be completely wired internally, and terminals of the proper rating shall be provided for all external connections.

C. Panel shall provide the following connections
   1. Single Pole Connectors.
   2. Bare end cable connectors.

D. Panel shall operate on 400A, 3Ø, 5-wire, 120/208 V service with connection through conduit to lugs on main breaker. Panel shall include one (1) 400A, 3-pole main breaker.
   1. **Panel shall have a fault current rating of not less than 35,000 AIC.**

E. Panel shall include one of the following options:
   1. A system requiring all plugged connections to be made before panel delivers power.
   1. A lockable access door that provides access to the wiring chamber denying access to mated connections when locked. This door shall engage the shunt-trip mechanism of the main breaker so that connections may not be made or broken under load.

F. Panel shall contain a neon lamp to indicate voltage present on each phase leg and a neon lamp to indicate ground integrity.

G. Panel shall be one of the following:
   1. “Power Safe” as manufactured by Electronic Theatre Controls, Middleton, Wisconsin.
   3. "SafeCam" cabinet, as manufactured by the Union Connector Co., Inc., Roosevelt, N.Y.
   4. “Series 600” as manufactured by Stagecraft Industries, Inc, Portland, OR.

H. Label the panel with permanently engraved Lamicoid labels riveted to the disconnect panel, with white lettering not less than 1/2 inch high. Label to read, "Company Switch, 400A, 3Ø, 5-wire, plus ground. FOR STAGE EQUIPMENT USE ONLY."

---

05/19/2021  BSU BROWN FAMILY AMPHITHEATER  20032.000
BID DOCUMENTS  BSU No. 2020-041.01G
2.14 STAGE LIGHTING CONNECTORS

A. PARALLEL BLADE AND GROUND
   1. 20-Ampere devices
      a. Connectors shall be 20 ampere, 2 wire plus ground with nylon bodies and casings, and integral cable clamp. Configuration shall be NEMA 5-20.
      b. The following manufacturer's devices shall be acceptable:
         i. Hubbell
         ii. Leviton

B. TWIST-LOCK
   1. 20-Ampere devices
      a. Connectors shall be 20 ampere, 2 wire plus ground, locking, with nylon bodies and casings, and integral cable clamp. Configuration shall be NEMA L5-20.
      b. The following manufacturer's devices shall be acceptable:
         i. Hubbell
         ii. Leviton
   2. 20-Ampere 208V devices
      a. Connectors shall be 20 ampere, 2 wire plus ground, locking, with nylon bodies and casings, and integral cable clamp. Configuration shall be NEMA L6-20.
      b. The following manufacturer's devices shall be acceptable:
         i. Hubbell
         ii. Leviton

C. 20-AMPERE 6-CIRCUIT MULTI-PIN
   1. A threaded coupling 19-pin cylindrical connector for theatrical lighting applications
   2. All multi-conductor connectors shall be wired in accordance with the recommended practice RP-1 as published by the U. S. Institute for Theatre Technology.
   3. The following manufacturer's devices shall be acceptable:
      a. Veam
      b. Socapex
      c. LEX Products
   4. All products shall be compatible with Socapex 419 Series connectors.
D. SINGLE POLE LOCKING CONNECTORS

1. Connectors shall be 400 ampere, single wire, locking with Thermoplastic Elastomer casing, with nylon retaining screw. Body shall be brass with double set screw termination. Configuration shall be compliant with UL 1691.

2. Connectors shall accept wire sizes from 4Ø to 2Ø.

3. Acceptable Products:
   a. Hubbell Single Pole Devices
   b. Crouse-Hinds Cam-Lok
   c. Leviton Rhino-Hide

E. Quantities per Drawings & Schedules.

2.15 WIRING DEVICES

A. General Requirements

1. All device number and letter labeling shall be provided with matching character fonts.

2. 20-ampere pigtails shall be 12-3 type S cord, length per Drawings, secured by cushioned strain reliefs or nylon "Heyco" bushings.

3. Connectors for circuits other than standard 20-amp stage circuits shall have covers that correspond to the label color.

4. Device labeling
   a. Circuit numbers on all devices shall be engraved into the face plate in letters not less than one inch high and filled with white epoxy paint for standard stage circuit numbers and epoxy paint, color as noted, for all other numbers per the Drawings.

5. All multi-pin receptacles shall include a removable threaded cover with retaining chain.

6. Receptacle configuration as shown in the Drawings.

7. Exterior finish shall be flat black baked enamel (for steel) or black anodized (for aluminum) unless noted otherwise.

8. Devices with multiple voltages shall provide continuous voltage barriers separating each voltage.

9. All components requiring external electrical connections of more than eight (8) conductors shall include barrier-type terminal strips properly sized and permanently labeled.
   a. For drop boxes the terminal strips shall be sized to accept a range of wire from #10 to 12.
   b. For all other devices the terminal strips shall be sized to accept a range of wire from #12 to #6
10. Units shall be UL listed and carry a UL label.

B. Control Receptacle Panels

1. The Control Receptacle Panels shall be mounted as indicated in the Drawings, and completely wired internally, with terminal strips of the proper rating for all external connections.

2. The face of each panel shall contain receptacles as indicated in the Drawings. These receptacles shall be of the locking type and shall be sized for the proper number and capacity of conductors as indicated in the Drawings.
   a. Receptacles for device connection.
      i. All Category connectors shall be RJ45. All female RJ45 connectors shall be individual connectors of matching catalog number.
      ii. All fiber optic connectors shall be ST style connectors.
      iii. Control connectors shall be equal to 4-pin or 5-pin XLR, Switchcraft.
      iv. Smaller or less substantial connectors shall not be acceptable.
   b. Engraved Lamicoid label(s) with the following information:
      i. Designation of wire destination
      ii. Maximum length of patch cable permissible from the receptacle.
   c. Faceplate engraving of device name and receptacles as shown in Drawings.

3. Initial programming of DMX Receptacles shall be as follows:
   a. If one (1) DMX INPUT then: DMX INPUT shall be 1-512 and control house dimmers unless noted otherwise.
   b. If two (2) DMX INPUT then: first DMX INPUT shall be 1-512 and control house dimmers unless noted otherwise; second DMX INPUT shall be 513-1024.
   c. If one (1) DMX OUTPUT then: DMX OUTPUT shall be 513-1024.
   d. If two (2) DMX OUTPUT then: first DMX OUTPUT shall be 1-512; second DMX OUTPUT shall be 513-1024.
   e. If three (3) or more DMX INPUT or OUTPUT then DMX Receptacle shall be initially programmed for the next sequential DMX Universe.

4. Install as shown in the Drawings.

C. Plug boxes

1. Plug boxes shall be constructed of 16-gauge steel or extruded aluminum. Knockouts shall be provided on all sides of the back box.

D. Locations, quantities, sizes and circuits as shown in the Drawings.

E. Install as shown in the Drawings.
### 2.16 SCHEDULE OF QUANTITIES

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.2</td>
<td>Network Data system</td>
<td>as required</td>
</tr>
<tr>
<td></td>
<td>Network patch cables</td>
<td>8 additional</td>
</tr>
<tr>
<td>2.3</td>
<td>Signal Processing Rack</td>
<td>Per Drawings</td>
</tr>
<tr>
<td>2.4</td>
<td>Centralized DMX Gateways</td>
<td>Per Drawings</td>
</tr>
<tr>
<td>2.5</td>
<td>Portable Node devices: DMX Translation</td>
<td>4</td>
</tr>
<tr>
<td>2.6</td>
<td>Network cables:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10-foot</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>25-foot</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>50-foot</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>100-foot</td>
<td>2</td>
</tr>
<tr>
<td>2.7 D</td>
<td>Auxiliary Control Console, cable and dust cover</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Entry Panels</td>
<td>Per Drawings</td>
</tr>
<tr>
<td>2.8</td>
<td>0-10V Control Gateway</td>
<td>Per Drawings</td>
</tr>
<tr>
<td>2.9</td>
<td>Control Console</td>
<td>1</td>
</tr>
<tr>
<td>B1</td>
<td>Flat-screen Color Monitor</td>
<td>1</td>
</tr>
<tr>
<td>B2</td>
<td>Flat-screen Color Multi-Touch Monitor</td>
<td>1</td>
</tr>
<tr>
<td>B3</td>
<td>Removable Storage Media</td>
<td>2</td>
</tr>
<tr>
<td>B4</td>
<td>Control Cables</td>
<td>1 set</td>
</tr>
<tr>
<td>B5</td>
<td>Dust covers, console and monitors</td>
<td>1 set</td>
</tr>
<tr>
<td>B6</td>
<td>Off-Line Editing Software</td>
<td>1</td>
</tr>
<tr>
<td>Section</td>
<td>Description</td>
<td>Quantity</td>
</tr>
<tr>
<td>---------</td>
<td>-------------</td>
<td>----------</td>
</tr>
<tr>
<td>2.10</td>
<td>A Uninterruptible Power Supply</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>B Hand-held remote control and cable</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>C Extension Control Cable</td>
<td>1 set</td>
</tr>
<tr>
<td></td>
<td>D Rolling Stand</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>E Road Cases</td>
<td>1 set</td>
</tr>
<tr>
<td>2.11</td>
<td>Remote Controlled Relay Panels</td>
<td>Per Drawings</td>
</tr>
<tr>
<td>H</td>
<td>Spare rack components</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Control Electronics Module</td>
<td>1 set</td>
</tr>
<tr>
<td></td>
<td>120V/20A relay module</td>
<td>1 set</td>
</tr>
<tr>
<td></td>
<td>208V/20A relay module</td>
<td>1 set</td>
</tr>
<tr>
<td>2.12</td>
<td>Remote Zone Controllers</td>
<td>Per Drawings</td>
</tr>
<tr>
<td>2.13</td>
<td>Company Switch – 400A</td>
<td>Per Drawings</td>
</tr>
<tr>
<td>2.15</td>
<td>Wiring Devices</td>
<td>Per Drawings</td>
</tr>
<tr>
<td></td>
<td>B Control Receptable Panels</td>
<td>Per Drawings</td>
</tr>
</tbody>
</table>

PART 3 - EXECUTION

3.1 FABRICATION

A. Racks and cabinets shall be welded assemblies of sheet steel or aluminum or bar size angles, channels, and tees or aluminum extrusions forming rigid enclosures to support internal components.

B. Operating elements shall be mechanically safe and electrically "dead."

C. All steel parts and panels shall be cleaned and primed with rust inhibiting primer. Exterior finishes shall be epoxy resin or baked enamel in matte black, or in Manufacturer’s standard color where not specified.

D. All internal wiring shall be factory completed. All wiring shall be in harnesses and bound. No loose or randomly routed wires shall be permitted.
E. All wire sizes and insulations shall comply with NEC, UL, and local codes and meet or exceed electronics industry standards.

3.2 PACKING AND SHIPPING

A. Equipment shall be wrapped and sealed in polyethylene and substantially crated for shipment. Crates shall clearly indicate equipment contained, nature of components, and theatre site allocation.

B. Electronics shall be packages and shipped in dust and static proof packaging.

C. All materials shall be delivered to the site in clean, undamaged operational condition.

3.3 INSTALLATION

A. Install all items in conformity with Project Documents, standard trade practices and Manufacturer’s recommendations.

B. Consult and coordinate work with trades doing adjoining work.

C. Position all items accurately as indicated in the Drawings, and true to plumb line and level. Maintain maximum headroom and clearance at all points.

D. Do not uncrate, unpack, unwrap, or install control console, video monitor(s), remote controls, or other auxiliary control components until construction is complete and environment is clean and dust-free.

3.4 SYSTEMS INTEGRATION AND PROGRAMMING

A. Stage Lighting Dealer shall provide addressing for all LED fixtures and any other DMX controlled fixture. Stage Lighting Dealer to provide Division 26 contractor a list of DMX address numbers prior to installation of fixtures. At time of commissioning Stage Lighting Dealer to patch all DMX controlled fixtures and test to ensure proper functionality.

B. Stage Lighting Dealer shall install the most current LED fixture profiles at each control console and train the owner to add and update fixture profiles during the Owner training required herein.

C. Stage Lighting Dealer, at the direction of Theatrical Consultant and/or owner’s representative, will adjust all programmable components of the lighting and control system to meet the design intent of the project. Programmable devices include lighting controls (including the layout and design of all touchscreen control panels), addressable lighting fixtures, and user interfaces.
D. Stage Lighting Dealer to coordinate any connection to A/V system with A/V contractor and work with A/V programmer to provide desired cross platform functionality.

END OF SECTION 260961
SECTION 261219 - PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This specification addresses the installation of an Owner furnished Contractor installed Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase distribution transformers as referenced in IEEE Standard C57.12.34.

1.2 SUMMARY

A. Section includes description of Owner furnished pad-mounted, liquid-filled, medium-voltage distribution transformers, with primary and secondary bushings within or without air-terminal enclosures.

B. Section includes Contractor provided surge arrestors.

1.3 DEFINITIONS

A. BIL: Basic Impulse Insulation Level.

B. Bushing: An insulating structure including a central conductor, or providing a central passage for a conductor, with provision for mounting on a barrier, conducting or otherwise, for the purpose of insulating the conductor from the barrier and conducting current from one side of the barrier to the other.

C. Bushing Elbow: An insulated device used to connect insulated conductors to separable insulated connectors on dead-front, pad-mounted transformers and to provide a fully insulated connection. This is also called an "elbow connector."

D. Bushing Insert: That component of a separable insulated connector that is inserted into a bushing well to complete a dead-front, load break or nonload break, separable insulated connector (bushing).

E. Bushing Well: A component of a separable insulated connector, either permanently welded or clamped to an enclosure wall or barrier, having a cavity that receives a replaceable component (bushing insert) to complete the separable insulated connector (bushing).
1.4 DELIVERY, STORAGE AND HANDLING

A. Store transformers protected from weather and so condensation will not form on or in units. Provide temporary heating according to manufacturer’s written instructions.

B. Contractor shall pickup transformer from location on BSU campus and move to project site. Contractor to include all cost associated with loading, transporting and off loading at site.

1.5 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

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. Comply with IEEE C2.

C. Comply with IEEE C57.12.00.


F. IEEE C57.12.26 – Pad-Mounted, Compartmental Type, Self-Cooled, Three-Phase Distribution Transformers for Use with Separable Insulated High-Voltage Connectors.

   A. National Electrical Manufacturers Association (NEMA)
   B. American Society of Testing and Materials (ASTM)
H. All Codes and Standards referenced above shall be the latest revisions in effect at the time the proposals are received.

2.2 PERFORMANCE REQUIREMENTS

A. Windings Material: Aluminum or Copper.

B. Surge Arresters: Comply with IEEE C62.11, Distribution Class; metal-oxide-varistor type, fully shielded, separable-elbow type, suitable for plugging into the inserts provided in the high-voltage section of the transformer. Connected in each phase of incoming circuit and ahead of any disconnecting device.

C. Winding Connections: The connection of windings and terminal markings shall comply with IEEE C57.12.70.

D. Efficiency: Comply with 10 CFR 431, Subpart K.

E. Insulation: Transformer kVA rating shall be as follows: The average winding temperature rise above a 30 deg C ambient temperature shall not exceed 65 deg C and 80 deg C hottest-spot temperature rise at rated kVA when tested according to IEEE C57.12.90, using combination of connections and taps that give the highest average winding temperature rise.

F. Tap Changer: External handle, for de-energized operation.

G. Tank: Sealed, with welded-on cover. Designed to withstand internal pressure of not less than 7 psi (50 kPa) without permanent distortion and 15 psig (104 kPa) without rupture. Comply with IEEE C57.12.36.

H. Enclosure Integrity: Comply with IEEE C57.12.28 for pad-mounted enclosures that contain energized electrical equipment in excess of 600 V that may be exposed to the public.

I. Mounting: An integral skid mounting frame, suitable to allow skidding or rolling of transformer in any direction, and with provision for anchoring frame to pad.

J. Insulating Liquids: Mineral Oil.

A. Less-Flammable Liquids:

   a. Edible Seed-Oil Based Dielectric: Listed and labeled by an NRTL as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D92. Liquid shall be biodegradable and nontoxic, having passed the Organisation for Economic Co-operation and Development G.L.203 with zero mortality, and shall be certified by the U.S. Environmental Protection
Agency as biodegradable, meeting Environmental Technology Verification requirements.

b. Biodegradable and Nontoxic Dielectric: Listed and labeled by an NRTL as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D92.

K. Sound level shall comply with NEMA TR 1 requirements.

L. Corrosion Protection:
   A. Transformer coating system shall be factory applied, using manufacturers standard process, in manufacturer's standard color green.

2.3 THREE-PHASE TRANSFORMERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   A. ABB, Power Grids Division.
   B. Cooper Industries, Inc.
   C. ELSCO

B. Description:
   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.

C. Compartment Construction:
   A. Double-Compartment Construction: Individual compartments for high- and low-voltage sections, formed by steel isolating barriers that extend full height and depth of compartments, with hinged, lift-off doors and three-point latching, with a stop in the open position and provision for padlocking.

D. Primary Fusing: Designed and rated to provide thermal protection of transformer by sensing overcurrent and high liquid temperature.
   A. 150-kV BIL current-limiting fuses, conforming to requirements of IEEE C37.47.
   B. Interrupting Rating: 50,000 rms A symmetrical at system voltage.
   C. Fuse Assembly: Bayonet-type, liquid-immersed, expulsion fuses in series with liquid-immersed, partial-range, current-limiting fuses. Bayonet fuse shall sense both high currents and high oil temperature to provide thermal protection to the transformer.
D. Provide bayonet fuse assembly with an oil retention valve and an external drip shield inside the housing to eliminate or minimize oil spills. Valve shall close when fuse holder is removed and an external drip shield is installed.
   a. Standard “load sensing” type bayonet fusing shall be provided. Three spare fuse elements shall be supplied with each transformer.
E. Provide a conspicuously displayed warning adjacent to bayonet fuse(s), cautioning against removing or inserting fuses unless transformer has been de-energized and tank pressure has been released.

E. High-Voltage Section: Dead-front design.

A. To connect primary cable, use separable insulated connectors; coordinated with and complying with requirements of Section 260513 "Medium-Voltage Cables." Bushings shall be one-piece units, with ampere and BIL ratings the same as connectors.
B. Bushing inserts and feed-through inserts:
   a. Conform to the requirements of IEEE 386.
   b. Rated at 200 A.
C. Bushing wells configured for loop-feed application.
D. Provide six parking stands for mounting accessory equipment.
E. Access to liquid-immersed fuses.
F. All bushing inserts and one set of three M.O.V.E. arrestors per transformer with required accessories shall be supplied with transformer.
   a. Arrestors shall be elbow type complete with grounding cable.
   b. Equal to Elastimold 167-ESA-10 or Cooper 3238018C10M.
G. Tap-changer operator.

H. Ground pad.

I. Parking stand bushings, elbows and other miscellaneous equipment will be supplied by others.

F. Low-Voltage Section:

A. Bushings with spade terminals drilled for terminating the number of conductors indicated on the Drawings, and the lugs that comply with requirements of Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

G. Capacities and Characteristics:

A. Power Rating (kVA): As scheduled on the drawings.
B. Voltage Ratings: 12,470V - 208Y/120 as scheduled on the drawings.
C. Taps: Comply with IEEE C57.12.26 requirements.
D. Transformer BIL (kV): Comply with IEEE C57.12.26 requirements.
E. Minimum Tested Impedance (Percent at 85 deg C):
   a. Up to 300KVA – Manufacturers standard.
   b. 500KVA and larger – 5.75.
F. Comply with UL listing requirements for combination classification and listing for transformer and less-flammable insulating liquid.
G. Transformer shall be provided with factory installed low voltage side circuit breaker. Breaker line side shall be bussed to the transformer low voltage bushings and accept a load side cabling of a minimum 4 sets of 500 kcmil copper conductors (four per phase). Breaker shall be 1200A, 3 pole electronic trip circuit breaker with LSI adjustable trips. Breaker shall be suitable for use in outdoor enclosure and within the transformer secondary compartment. Acceptable manufacturers are Square D, Siemens, Eaton and ABB (EMax-2 Series).

H. Transformer Accessories:
   A. Drain and filter connection.
   B. Filling and top filter press connections.
   C. Pressure-vacuum gauge.
   D. Dial-type analog thermometer with alarm contacts.
   E. Magnetic liquid level indicator with high and low alarm contacts.
   F. Automatically resetting pressure-relief device. Device flow shall be as recommended by manufacturer.
   G. Stainless-steel ground connection pads.
   H. Machine-engraved nameplate, made of anodized aluminum or stainless steel.

2.4 SERVICE CONDITIONS
A. Transformers shall be suitable for operation under service conditions specified as usual service conditions in IEEE C57.12.00.

2.5 WARNING LABELS AND SIGNS
A. Comply with requirements for labels and signs specified in Section 260553 "Identification for Electrical Systems."
   A. High-Voltage Warning Label: Provide self-adhesive warning signs on outside of high-voltage compartment door(s). Sign legend shall be "DANGER HIGH VOLTAGE" printed in two lines of nominal 2-inch- (50-mm-) high letters. The word "DANGER" shall be in white letters on a red background and the words "HIGH VOLTAGE" shall be in black letters on a white background.
   B. Arc Flash Warning Label: Provide self-adhesive warning signs on outside of high-voltage compartment door(s), warning of potential electrical arc flash hazards and appropriate personal protective equipment required.
2.6 SOURCE QUALITY CONTROL

A. Provide manufacturer's certificate that the transformer design tests comply with IEEE C57.12.90.

A. Perform the following factory-certified routine tests on each transformer for this Project:

a. Resistance.
b. Turns ratio, polarity, and phase relation.
c. Transformer no-load losses and excitation current at 100 percent of ratings.
d. Transformer impedance voltage and load loss.
e. Operation of all devices.
f. Lightning impulse.
g. Low frequency.
h. Leak.

2.7 CONTRACTOR PROVIDED MATERIAL

A. Provide and install one set of three M.O.V.E arrestors. Arrestors shall be elbow type complete with grounding cable.

B. Equal to Elastimold 167-ESA-10 or Cooper 3238018C10M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine pad-mounted, liquid-filled, medium-voltage transformers upon delivery.

A. Upon delivery of transformers and prior to unloading, inspect equipment for any damage that may have occurred during shipment or storage.

B. Verify that tie rods and chains are undamaged and tight, and that all blocking and bracing is tight. Verify that there is no evidence of load shifting in transit, and that readings from transportation shock recorders, if equipped, are within manufacturer's recommendations.

C. Verify that there is no indication of external damage and no dents or scratches in doors and sill, tank walls, radiators and fins, or termination provisions.

D. Verify that there is no evidence of insulating-liquid leakage on transformer surfaces, at weld seams, on high- or low-voltage bushing parts, and at transformer base.

E. Verify that there is positive pressure or vacuum on tank. Check pressure gauge; it is required to read other than zero.
F. Compare transformers and accessories received with bill of materials to verify that shipment is complete. Verify that transformers and accessories conform with manufacturer’s quotation and shop drawings. If shipment is incomplete or does not comply with Project requirements, notify manufacturer in writing immediately.

G. Verify presence of polychlorinated biphenyl content labeling.

H. Unload transformers carefully, observing all packing label warnings and handling instructions.

I. Open termination compartment doors and inspect components for damage or displaced parts, loose or broken connections, cracked or chipped insulators, bent mounting flanges, dirt or foreign material, and water or moisture.

B. Handling:

A. Handle transformers carefully, in accordance with manufacturer recommendations, to avoid damage to enclosure, termination compartments, base, frame, tank, and internal components. Do not subject transformers to impact, jolting, jarring, or rough handling.

B. Protect transformer termination compartments against entrance of dust, rain, and snow.

C. Transport transformers upright, to avoid internal stresses on core and coil mounting assembly and to prevent trapping air in windings. Do not tilt or tip transformers.

D. Verify that transformer weights are within rated capacity of handling equipment.

E. Use only manufacturer-recommended points for lifting, jacking, and pulling. Use all lifting lugs when lifting transformers.

F. Use jacks only at corners of tank base plate.

G. Use nylon straps of same length to balance and distribute weight when handling transformers with a crane.

H. Use spreaders or a lifting beam to obtain a vertical lift and to protect transformer from straps bearing against enclosure. Lifting cable pull angles may not be greater than 15 degrees from vertical.

I. Exercise care not to damage tank base structure when handling transformer using skids or rollers. Use skids to distribute stresses over tank base when using rollers under large transformers.

C. Storage:

A. Store transformers in accordance with manufacturer’s recommendations.

B. Transformers may be stored outdoors. If possible, store transformers at final installation locations on concrete pads. If dry concrete surfaces are unavailable, use pallets of adequate strength to protect transformers from direct contact with ground. Ensure transformer is level.

C. Ensure that transformer storage location is clean and protected from severe conditions. Protect transformers from dirt, water, contamination, and physical damage. Do not store transformers in presence of corrosive or explosive gases. Protect transformers from weather when stored for more than three months.

D. Store transformers with compartment doors closed.
E. Regularly inspect transformers while in storage and maintain documentation of storage conditions, noting any discrepancies or adverse conditions. Verify that an effective pressure seal is maintained using pressure gauges. Visually check for insulating-liquid leaks and rust spots.

D. Examine areas and space conditions for compliance with requirements for pad-mounted, liquid-filled, medium-voltage transformers and other conditions affecting performance of the Work.

E. Examine roughing-in of conduits and grounding systems to verify the following:
   
   A. Wiring entries comply with layout requirements.
   B. Entries are within conduit-entry tolerances specified by manufacturer, and no feeders will cross section barriers to reach load or line lugs.

F. Examine concrete bases for suitable conditions for transformer installation.

G. Pre-Installation Checks:
   
   A. Verify removal of any shipping bracing after placement.
   B. Remove a sample of insulating liquid according to ASTM D923. Insulating-liquid values shall comply with NETA ATS, Table 100.4. Sample shall be tested for the following:
      
      b. Acid Neutralization Number: ASTM D974.

H. Verify that ground connections are in place and that requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at transformer location.

I. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install transformers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

B. Transformer shall be installed level and plumb and shall tilt less than 1.5 degrees while energized.

C. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and IEEE C2.
3.3 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
   
   A. For counterpoise, use tinned bare copper cable not smaller than No. 4/0 AWG, buried not less than 30 inches (765 mm) below grade interconnecting the grounding electrodes. Bond surge arrester and neutrals directly to transformer enclosure and then to grounding electrode system with bare copper conductors, sized as shown. Keep lead lengths as short as practicable, with no kinks or sharp bends.
   
   B. Make joints in grounding conductors and loops by exothermic weld or compression connector.
   
   C. Terminate all grounding and bonding conductors on a common equipment grounding terminal on transformer enclosure.
   
   D. Complete transformer tank grounding and lightning arrester connections prior to making any other electrical connections.

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
   
   A. Maintain air clearances between energized live parts and between live parts and ground for exposed connections in accordance with manufacturer recommendations.
   
   B. Bundle associated phase, neutral, and equipment grounding conductors together within transformer enclosure. Arrange conductors such that there is not excessive strain that could cause loose connections. Allow adequate slack for expansion and contraction of conductors.

C. Terminate medium-voltage cables in incoming section of transformers according to Section 260513 "Medium-Voltage Cables."

3.4 SIGNS AND LABELS

A. Comply with installation requirements for labels and signs specified in Section 260553 "Identification for Electrical Systems."

B. Install warning signs as required to comply with 29 CFR 1910.269.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

   A. General Field-Testing Requirements:
b. Perform each visual and mechanical inspection and electrical test. Certify compliance with test parameters.
c. After installing transformer but before primary is energized, verify that grounding system at the transformer is tested at specified value or less.
d. After installing transformer and after electrical circuitry has been energized, test for compliance with requirements.
e. Visual and Mechanical Inspection:

1) Verify equipment nameplate data complies with Contract Documents.
2) Inspect bolted electrical connections for high resistance using one of the following two methods:
   a) Use a low-resistance ohmmeter to compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
   b) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In absence of manufacturer's published data, use NETA ATS, Table 100.12.

f. Remove and replace malfunctioning units and retest.
g. Prepare test and inspection reports. Record as-left set points of all adjustable devices.

B. Medium-Voltage Surge Arrester Field Tests:

a. Visual and Mechanical Inspection:

1) Inspect physical and mechanical condition.
2) Verify arresters are clean.
3) Verify that ground lead on each device is individually attached to a ground bus or ground electrode.

END OF SECTION 261219
<table>
<thead>
<tr>
<th>Location</th>
<th>System</th>
<th>ID#</th>
<th>QTY</th>
<th>Manufacturer/Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stage</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Loudspeaker System</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TA 1</td>
<td>Custom Loudspeaker Rigging</td>
<td>1</td>
<td>1</td>
<td>D&amp;B Audio Z0795.900</td>
<td>Hardware &amp; Labor As Required</td>
</tr>
<tr>
<td>TA 2</td>
<td>D&amp;B Audio Z1611.900</td>
<td>2</td>
<td>2</td>
<td>KSLi-SUB Subwoofer SV, HWR</td>
<td></td>
</tr>
<tr>
<td>TA 3</td>
<td>D&amp;B Audio Z1619.900</td>
<td>4</td>
<td>4</td>
<td>24S-D loudspeaker SV, HWR</td>
<td></td>
</tr>
<tr>
<td>TA 4</td>
<td>D&amp;B Audio Z5409.000</td>
<td>2</td>
<td>2</td>
<td>10S-D loudspeaker SV, HWR</td>
<td></td>
</tr>
<tr>
<td>TA 5</td>
<td>D&amp;B Audio Z5553.000</td>
<td>4</td>
<td>4</td>
<td>24S Flying bracket</td>
<td></td>
</tr>
<tr>
<td>TA 6</td>
<td>D&amp;B Audio Z5744.000</td>
<td>1</td>
<td>1</td>
<td>KSLi SUB mounting frame</td>
<td></td>
</tr>
<tr>
<td><strong>Infrastructure</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TA 8</td>
<td>Custom A01 Outdoor AVP Plugbox</td>
<td>2</td>
<td>2</td>
<td>Outdoor Rated Connection Plate (Reference AV Plate Detail Drawings)</td>
<td></td>
</tr>
<tr>
<td>TA 9</td>
<td>Custom A02 Outdoor AVP Plugbox</td>
<td>2</td>
<td>2</td>
<td>Outdoor Rated Connection Plate (Reference AV Plate Detail Drawings)</td>
<td></td>
</tr>
<tr>
<td>TA 10</td>
<td>Custom A03 Outdoor AVP Plugbox</td>
<td>1</td>
<td>1</td>
<td>Outdoor Rated Connection Plate (Reference AV Plate Detail Drawings)</td>
<td></td>
</tr>
<tr>
<td>TA 11</td>
<td>Custom A04 Outdoor AVP Plugbox</td>
<td>4</td>
<td>4</td>
<td>Outdoor Rated Connection Plate (Reference AV Plate Detail Drawings)</td>
<td></td>
</tr>
<tr>
<td>TA 12</td>
<td>Custom A05 Ceiling Outdoor AVP Plugbox</td>
<td>2</td>
<td>2</td>
<td>Outdoor Rated Connection Plate (Reference AV Plate Detail Drawings)</td>
<td></td>
</tr>
<tr>
<td>TA 13</td>
<td>Custom S01 Outdoor AVP Plugbox</td>
<td>2</td>
<td>2</td>
<td>Outdoor Rated Connection Plate (Reference AV Plate Detail Drawings)</td>
<td></td>
</tr>
<tr>
<td>TA 14</td>
<td>Custom S02 Outdoor AVP Plugbox</td>
<td>1</td>
<td>1</td>
<td>Outdoor Rated Connection Plate (Reference AV Plate Detail Drawings)</td>
<td></td>
</tr>
<tr>
<td>TA 15</td>
<td>Custom T01 Outdoor AVP Plugbox</td>
<td>1</td>
<td>1</td>
<td>Outdoor Rated Connection Plate (Reference AV Plate Detail Drawings)</td>
<td></td>
</tr>
<tr>
<td>TA 16</td>
<td>Custom T02 Outdoor AVP Plugbox</td>
<td>1</td>
<td>1</td>
<td>Outdoor Rated Connection Plate (Reference AV Plate Detail Drawings)</td>
<td></td>
</tr>
<tr>
<td><strong>FOH</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Infrastructure</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TA 17</td>
<td>Custom A06 Outdoor AVP Plugbox</td>
<td>1</td>
<td>1</td>
<td>Outdoor Rated Connection Plate (Reference AV Plate Detail Drawings)</td>
<td></td>
</tr>
</tbody>
</table>
## Location

<table>
<thead>
<tr>
<th>System</th>
<th>QTY</th>
<th>Manufacturer/Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOH: Dressing Room 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distributed Audio System</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TA 18</td>
<td>1</td>
<td>Atlas Sound AT100-PA</td>
<td>Deluxe Priority, Rack Mounted 100W Attenuator W/Priority Relay, 3dB Steps</td>
</tr>
<tr>
<td>TA 19</td>
<td>2</td>
<td>ElectroVoice EVID C4.2</td>
<td>4-inch two-way coaxial ceiling loudspeaker</td>
</tr>
<tr>
<td>Production Intercom</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TA 20</td>
<td>1</td>
<td>Clear-Com KB-702</td>
<td>2-Channel Select Flush Mount Headset/Speaker Station</td>
</tr>
<tr>
<td>BOH: Dressing Room 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distributed Audio System</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TA 21</td>
<td>1</td>
<td>Atlas Sound AT100-PA</td>
<td>Deluxe Priority, Rack Mounted 100W Attenuator W/Priority Relay, 3dB Steps</td>
</tr>
<tr>
<td>TA 22</td>
<td>2</td>
<td>ElectroVoice EVID C4.2</td>
<td>4-inch two-way coaxial ceiling loudspeaker</td>
</tr>
<tr>
<td>Production Intercom</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TA 23</td>
<td>1</td>
<td>Clear-Com KB-702</td>
<td>2-Channel Select Flush Mount Headset/Speaker Station</td>
</tr>
<tr>
<td>BOH: Green Room</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distributed Audio System</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TA 24</td>
<td>1</td>
<td>Atlas Sound AT100-PA</td>
<td>Deluxe Priority, Rack Mounted 100W Attenuator W/Priority Relay, 3dB Steps</td>
</tr>
<tr>
<td>TA 25</td>
<td>1</td>
<td>ElectroVoice EVID C4.2</td>
<td>4-inch two-way coaxial ceiling loudspeaker</td>
</tr>
<tr>
<td>Simple Presentation System</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TA 26</td>
<td>1</td>
<td>Dynacord TPC-1</td>
<td>Touch Panel Controller 5.7&quot;</td>
</tr>
<tr>
<td>Production Intercom</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TA 27</td>
<td>1</td>
<td>Clear-Com KB-702</td>
<td>2-Channel Select Flush Mount Headset/Speaker Station</td>
</tr>
</tbody>
</table>
# Location

<table>
<thead>
<tr>
<th>System</th>
<th>QTY</th>
<th>Manufacturer/Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOH: Storage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distributed Audio System</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TA 28</td>
<td>1</td>
<td>Atlas Sound AT100-PA</td>
<td>Deluxe Priority, Rack Mounted 100W Attenuator W/Priority Relay, 3dB Steps</td>
</tr>
<tr>
<td>TA 29</td>
<td>1</td>
<td>ElectroVoice EVID-S5.2TB</td>
<td>Quick install Speaker 5&quot; cabinet 70/100V black. IP54. Sold only in pairs.</td>
</tr>
</tbody>
</table>
## BOH: IDF/Dimmer AV Rack Room

### Loudspeaker System

<table>
<thead>
<tr>
<th>ID#</th>
<th>QTY</th>
<th>Manufacturer/Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TA 30</td>
<td>3</td>
<td>D&amp;B Audio Z2830.500</td>
<td>40D Amplifier US / CA / KR</td>
</tr>
</tbody>
</table>

### Distributed Audio System

<table>
<thead>
<tr>
<th>ID#</th>
<th>QTY</th>
<th>Manufacturer/Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TA 31</td>
<td>1</td>
<td>AtlasIED AT100-PARM</td>
<td>Deluxe Priority, Rack Mounted 100W Attenuator W/Priority Relay, 3dB Steps</td>
</tr>
<tr>
<td>TA 32</td>
<td>1</td>
<td>ElectroVoice EVID-S5.2TB</td>
<td>Quick install Speaker 5&quot; cabinet 70/100V black. IP54. Sold only in pairs.</td>
</tr>
<tr>
<td>TA 33</td>
<td>1</td>
<td>ElectroVoice PA 2250T 120V</td>
<td>Dual Channel Class AB Commercial Power Amplifier, 2 x 270 watts at 4 ohms, 70V/100V or Low Impedance Operation, Compact 2RU Chassis, 110/120 vac operation</td>
</tr>
</tbody>
</table>

### Simple Presentation System

<table>
<thead>
<tr>
<th>ID#</th>
<th>QTY</th>
<th>Manufacturer/Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TA 34</td>
<td>1</td>
<td>Dynacord MXE5</td>
<td>DSP Matrix Mix Engine 24 x 24 Channels</td>
</tr>
<tr>
<td>TA 35</td>
<td>1</td>
<td>Dynacord TPC-1</td>
<td>Touch Panel Controller 5.7&quot;</td>
</tr>
<tr>
<td>TA 36</td>
<td>4</td>
<td>Shure SB900A</td>
<td>Rechargeable Lithium-Ion Battery</td>
</tr>
<tr>
<td>TA 37</td>
<td>1</td>
<td>Shure SBC200-US</td>
<td>Dual Docking Charger with Power Supply</td>
</tr>
<tr>
<td>TA 38</td>
<td>2</td>
<td>Shure ULXD2/B58</td>
<td>Handheld transmitter with Beta58 capsule</td>
</tr>
<tr>
<td>TA 39</td>
<td>1</td>
<td>Shure ULXD4D</td>
<td>Dual digital wireless receiver with internal power supply, 1/2 wave antenna and rack mounting hardware</td>
</tr>
</tbody>
</table>

### Assisted Listening System

<table>
<thead>
<tr>
<th>ID#</th>
<th>QTY</th>
<th>Manufacturer/Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TA 40</td>
<td>1</td>
<td>Listen Technologies LA-122</td>
<td>Universal Antenna Kit (72 and 216 MHz)</td>
</tr>
<tr>
<td>TA 41</td>
<td>2</td>
<td>Listen Technologies LA-303</td>
<td>Multi-Lingual Assistive Listening Notification Sign</td>
</tr>
<tr>
<td>TA 42</td>
<td>1</td>
<td>Listen Technologies LA-381-01</td>
<td>Intelligent 12-Unit Charging Tray</td>
</tr>
<tr>
<td>TA 43</td>
<td>1</td>
<td>Listen Technologies LP-41-072-01</td>
<td>Intelligent DSP RF Receiver 12-Pack (72 MHz)</td>
</tr>
<tr>
<td>TA 44</td>
<td>1</td>
<td>Listen Technologies LT800</td>
<td>72 or 216 MHz ALS Transmitter</td>
</tr>
</tbody>
</table>

### Production Intercom

<table>
<thead>
<tr>
<th>ID#</th>
<th>QTY</th>
<th>Manufacturer/Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TA 45</td>
<td>1</td>
<td>Clear-Com MS-704</td>
<td>Headset/speaker main station, 4 channel, 4 Amp power supply, 2RU</td>
</tr>
</tbody>
</table>

## Production Intercom

<table>
<thead>
<tr>
<th>ID#</th>
<th>QTY</th>
<th>Manufacturer/Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TA 45</td>
<td>1</td>
<td>Clear-Com MS-704</td>
<td>Headset/speaker main station, 4 channel, 4 Amp power supply, 2RU</td>
</tr>
</tbody>
</table>
## Location

<table>
<thead>
<tr>
<th>Location</th>
<th>System</th>
<th>ID#</th>
<th>QTY</th>
<th>Manufacturer/Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TA 46</td>
<td>4</td>
<td>Camplex HF-OCL2M-0003</td>
<td>Camplex 2-Channel opticalCON DUO LITE Mult-Mode Fiber Tactical Patch Cable (3')</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TA 47</td>
<td>4</td>
<td>Camplex HF-OCL2S-0003</td>
<td>Camplex 2-Channel opticalCON DUO LITE Single-Mode Fiber Tactical Patch Cable (3')</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TA 48</td>
<td>1</td>
<td>Custom Equipment Rack AV Panels</td>
<td>Equipment Rack Connection Panel (Reference AV Panel Detail Drawings)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TA 49</td>
<td>1</td>
<td>Custom Equipment Rack Completion</td>
<td>All Vertical &amp; Horizontal Lacing Bars, Brush Grommets, Blank Panels, &amp; Power Raceways Needed To Complete Rack To Bid Spec</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TA 50</td>
<td>6</td>
<td>Entertainment Manufacturing Group CBL-CAT6AS-003-B</td>
<td>CAT6A - Solid - XLRnet (etherCon compatible) Connectors shielded - Black - Uses: 7XLANCAT6AUFPU Cable (.325 OD) Black 03'</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TA 51</td>
<td>6</td>
<td>Entertainment Manufacturing Group CBL-CAT6AS-005-B</td>
<td>CAT6A - Solid - XLRnet (etherCon compatible) Connectors shielded - Black - Uses: 7XLANCAT6AUFPU Cable (.325 OD) Black 05'</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TA 52</td>
<td>6</td>
<td>Entertainment Manufacturing Group CBL-MIC-MK201X-003</td>
<td>Microphone - Touring, Neutrik XX BAG Connectors Uses: MK201X, Black - 03'</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TA 53</td>
<td>6</td>
<td>Entertainment Manufacturing Group CBL-MIC-MK201X-005</td>
<td>Microphone - Touring, Neutrik XX BAG Connectors Uses: MK201X, Black - 05'</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TA 54</td>
<td>1</td>
<td>Entertainment Manufacturing Group FN-TW1-I-010</td>
<td>Fanout - W1 - 12 CH. - M-Line Mount to F-XLR's NC3FXX Uses: 8.5' Multi Pair EM12F, 1.5' TechFlex - Numbered # 1-12. -10'</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TA 55</td>
<td>4</td>
<td>Entertainment Manufacturing Group FN-TW1-O-010</td>
<td>Fanout - W1 - 12 CH. - F-Line Mount to M-XLR's NC3MXX Uses: 8.5' Multi Pair EM12F, 1.5' TechFlex - Numbered # 1-12. -10'</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TA 56</td>
<td>1</td>
<td>Middle Atlantic BGR-4532</td>
<td>BGR series gangable rack, 45 space</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TA 57</td>
<td>1</td>
<td>Middle Atlantic BGR-552FT-FC</td>
<td>Fan Top, 552 CFM, w/Controller, BGR Series</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TA 58</td>
<td>1</td>
<td>Middle Atlantic BSPN-45-32</td>
<td>BGR series 45 space side panel</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TA 59</td>
<td>1</td>
<td>Middle Atlantic VFD-45A</td>
<td>VENTED FRONT DOOR, 45 RU RACKS, CURVED</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TA 60</td>
<td>1</td>
<td>Netgear AXM761-10000S</td>
<td>Gigabit Ethernet 10GBase-LRM Fiber SFP+/ LC/GBIC</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TA 61</td>
<td>1</td>
<td>Netgear AXM764-10000S</td>
<td>10GBase-LR LITE single mode LC duplex connector up to 2km (1.2 mile)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TA 62</td>
<td>1</td>
<td>Netgear GSM4230PX</td>
<td>26G4XF-PoE+ Switch, L3 managed, 24 x 10/100/1000 (PoE+) + 2 x 10/100/1000 + 4 x 1 Gigabit / 10 Gigabit SFP+</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TA 63</td>
<td>18</td>
<td>Neutrik NO2-4FDW-1-A</td>
<td>opticalCon DUO Chassis Connector</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TA 64</td>
<td>1</td>
<td>Neutrik NZPF3RU</td>
<td>3RU opticalCON panel frame</td>
<td></td>
</tr>
<tr>
<td>ID#</td>
<td>QTY</td>
<td>Manufacturer/Model</td>
<td>Description</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----</td>
<td>-----</td>
<td>--------------------</td>
<td>-----------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TA 65</td>
<td>9</td>
<td>Neutrik NZPFD-2</td>
<td>Plate can be loaded with two opticalCON DUO or QUAD chassis connectors.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TA 66</td>
<td>18</td>
<td>Neutrik SCDP-x</td>
<td>Color coding rings for Optical Con connectors</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## MAJOR EQUIPMENT LIST

### Location

#### System

<table>
<thead>
<tr>
<th>ID#</th>
<th>QTY</th>
<th>Manufacturer/Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TA 67</td>
<td>4</td>
<td>Clear-Com CC-300-X4</td>
<td>single-ear headset</td>
</tr>
<tr>
<td>TA 68</td>
<td>4</td>
<td>Clear-Com RS-701</td>
<td>Single-channel analog beltpack with XLR-3 line connector</td>
</tr>
<tr>
<td>TA 69</td>
<td>1</td>
<td>Gator Cases GTSA-UTL203008</td>
<td>Utility Case</td>
</tr>
</tbody>
</table>

#### Infrastructure

<table>
<thead>
<tr>
<th>ID#</th>
<th>QTY</th>
<th>Manufacturer/Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TA 70</td>
<td>2</td>
<td>Entertainment Manufacturing Group CBL-OPTICON-DUOMM-328R</td>
<td>Cable - OpticalCON - Duo - Fiber Optic - MM - Multi Mode - Assembly - With Shill GT-310 reel - 328' [100meter]</td>
</tr>
<tr>
<td>TA 71</td>
<td>8</td>
<td>Entertainment Manufacturing Group CBL-PWR-ED-025</td>
<td>Edison L5-15P - L5-15R 15A W/ SOOW 12 AWG, 3 Circuit, Black - 25'</td>
</tr>
<tr>
<td>TA 72</td>
<td>4</td>
<td>Entertainment Manufacturing Group CBL-PWR-ED-050</td>
<td>Edison L5-15P - L5-15R 15A W/ SOOW 12 AWG, 3 Circuit, Black - 50'</td>
</tr>
<tr>
<td>TA 73</td>
<td>3</td>
<td>Entertainment Manufacturing Group CBL-PWR-L2130-010</td>
<td>Twist-Lock - L21-30R - L21-30P 30A, 10/5 SOOW, Black 10'</td>
</tr>
<tr>
<td>TA 75</td>
<td>2</td>
<td>Entertainment Manufacturing Group CBL-PWR-L2130-150</td>
<td>Twist-Lock - L21-30R - L21-30P 30A, 10/5 SOOW, Black 150'</td>
</tr>
<tr>
<td>TA 76</td>
<td>1</td>
<td>Entertainment Manufacturing Group FN-TW1-O-025</td>
<td>Fanout - W1 - 12 CH. - F-Line Mount to M-XLR's NC3MX2 Uses: 23.5' Multi Pair EM12F, 1.5' TechFlex - Numbered # 1-12. -25'</td>
</tr>
<tr>
<td>TA 77</td>
<td>4</td>
<td>Entertainment Manufacturing Group MPS-IHH-D6-Y3</td>
<td>MPS - Stringer - L21/30 - Inlet/Outlet (2815/2816), LED indicators, 6x 20A Duplex Outlets, Breaked via (3) 20 Amp Single Pole Breakers- ETL listed.</td>
</tr>
<tr>
<td>TA 78</td>
<td>4</td>
<td>Entertainment Manufacturing Group MP-TW1-025</td>
<td>Multipair - W1 - 12 Ch. - M-F- In-Line TW1 Connectors - Uses: EM12F Shielded Audio Cable Wire Mesh Strain Relief. W/Dust Cap. 25'</td>
</tr>
<tr>
<td>TA 79</td>
<td>4</td>
<td>Entertainment Manufacturing Group MP-TW1-050</td>
<td>Multipair - W1 - 12 Ch. - M-F- In-Line TW1 Connectors - Uses: EM12F Shielded Audio Cable Wire Mesh Strain Relief. W/Dust Cap. 50'</td>
</tr>
</tbody>
</table>
| TA 80 | 4 | Entertainment Manufacturing Group SB-12-TW1 | Sub-Box - W1 - 12 CH.- TW1CM Connector - NC3FDL-1 Panel Mount FXLR's. #1-12 - Black **** color badges option RED, YELLOW , BLUE , GREEN ***

---

**THRESHOLD ACOUSTICS**  
Ball State University Amphitheater
<table>
<thead>
<tr>
<th>Location</th>
<th>System ID</th>
<th>QTY</th>
<th>Manufacturer/Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ball State University Amphitheater</td>
<td>TA 81</td>
<td>3</td>
<td>R&amp;R R&amp;R-BSUGLA-TRUNKS</td>
<td>30 x 48 x 30 tall trunks with 2 lift out trays, 2 short dividers underneath trays and 1 tall divider in the center 3/8&quot; Standard Series, Black, Gray Colson Performa Series 4x2 casters, Stacking cups, McLoone write on/off label</td>
</tr>
</tbody>
</table>
SINGLE WATER SERVICE CONNECTION

NOTES:
1. CORPORATION STOP WITH STRAIGHT COUPLING NUT. SERVICE SADDLES WILL BE USED FOR ALL TAPS IN A/C, PVC OR CONCRETE MAINS. SIDEWALL FUSED SADDLES FOR ALL TAPS ON HDPE MAINS.
2. METER PITS PER SPECIFICATION 15200.
3. METER PIT LOCATION TO BE DETERMINED BY LOCAL AUTHORITY AND INAWC.
4. SERVICE LINE AND METER PIT OWNERSHIP VARIES BY LOCAL TARIFF.
5. CONNECTIONS BETWEEN PIPE LENGTHS SHALL BE COMPRESSION OR FLARE AND MAY DEPEND ON LOCAL PLUMBING REQUIREMENT.

STANDARD DETAIL
SINGLE WATER SERVICE

DATE: JANUARY, 2018  DRAWN BY: S. FORD
LATEST REV: JANUARY, 2018  APP’D BY: E.N.
GENERAL NOTES:
1. WC - WATER CLOSET 4" W, 2" V.
2. L - LAVATORY 2" W, 1 1/2" V.
3. MOP BASIN 3" W, 1 1/2" V.
4. FD - FLOOR DRAIN 2" W.
5. FD - FLOOR DRAIN 4" W.
6. CONTRACT LIMIT LINE.
7. 6" SANITARY SEWER I.E. - 4' - 0". SEE SITE/CIVIL DRAWINGS.
8. MAIN CW SHUT OFF VALVE IN ROADBOX BY SITE/CIVIL.
9. CONNECT NEW 4" WASTE TO EXISTING SANITARY BY SITE/CIVIL.
10. 1 1/2" INCOMING WATER SERVICE WITH NO BURIED JOINTS.
11. DF - DRINKING FOUNTAIN 2" W, 1 1/2" V.
12. STR 2712. SEE SITE/CIVIL DRAWING C701 FOR MORE INFORMATION.
13. 2" W UP TRANSITIONS TO 1 1/2" V.
14. EXISTING STRUCTURE 2703. SEE SITE/CIVIL DRAWINGS.
15. FCO, SEE DETAIL 1/P-501.

PLAN NOTES:
1. SEE DRAWING P-001 FOR SYMBOLS & ABBREVIATIONS.
2. VERIFY ALL INVERT ELEVATIONS AND COORDINATE ALL UNDERSLAB UTILITIES & STRUCTURE BEFORE INSTALLATION.
3. COORDINATE WITH ALL OTHER TRADES.

GENERAL NOTES:
1. WC - WATER CLOSET 4" W, 2" V.
2. L - LAVATORY 2" W, 1 1/2" V.
3. MOP BASIN 3" W, 1 1/2" V.
4. FD - FLOOR DRAIN 2" W.
5. FD - FLOOR DRAIN 4" W.
6. CONTRACT LIMIT LINE.
7. 6" SANITARY SEWER I.E. - 4' - 0". SEE SITE/CIVIL DRAWINGS.
8. MAIN CW SHUT OFF VALVE IN ROADBOX BY SITE/CIVIL.
9. CONNECT NEW 4" WASTE TO EXISTING SANITARY BY SITE/CIVIL.
10. 1 1/2" INCOMING WATER SERVICE WITH NO BURIED JOINTS.
11. DF - DRINKING FOUNTAIN 2" W, 1 1/2" V.
12. STR 2712. SEE SITE/CIVIL DRAWING C701 FOR MORE INFORMATION.
13. 2" W UP TRANSITIONS TO 1 1/2" V.
14. EXISTING STRUCTURE 2703. SEE SITE/CIVIL DRAWINGS.
15. FCO, SEE DETAIL 1/P-501.

GENERAL NOTES:
1. WC - WATER CLOSET 4" W, 2" V.
2. L - LAVATORY 2" W, 1 1/2" V.
3. MOP BASIN 3" W, 1 1/2" V.
4. FD - FLOOR DRAIN 2" W.
5. FD - FLOOR DRAIN 4" W.
6. CONTRACT LIMIT LINE.
7. 6" SANITARY SEWER I.E. - 4' - 0". SEE SITE/CIVIL DRAWINGS.
8. MAIN CW SHUT OFF VALVE IN ROADBOX BY SITE/CIVIL.
9. CONNECT NEW 4" WASTE TO EXISTING SANITARY BY SITE/CIVIL.
10. 1 1/2" INCOMING WATER SERVICE WITH NO BURIED JOINTS.
11. DF - DRINKING FOUNTAIN 2" W, 1 1/2" V.
12. STR 2712. SEE SITE/CIVIL DRAWING C701 FOR MORE INFORMATION.
13. 2" W UP TRANSITIONS TO 1 1/2" V.
14. EXISTING STRUCTURE 2703. SEE SITE/CIVIL DRAWINGS.
15. FCO, SEE DETAIL 1/P-501.
FIRST FLOOR PLUMBING PLAN

GENERAL NOTES:
1. ALL VERTICAL PLUMBING CONSTRUCTIONS ARE TO BE BUILT OUT IF ALTERNATE BID IS PUBLIC RESTROOMS 3/4" HOT WATER TO 1 1/2" COLD WATER AND 1/2" V, 1/2" CW, 1/2" HW.
2. ALL PLUMBING CONSTRUCTIONS TO BE BUILT OUT IF ALTERNATE BID IS PUBLIC RESTROOMS 3/4" HOT WATER TO 1 1/2" COLD WATER AND 1/2" V, 1/2" CW, 1/2" HW.
3. ALL LINELINE BALL VALVE.
4. 1 THERMOSTATIC MIXING VALVE, MOUNT BOTTOM OF 1 DOMESTIC WATER HEATER, 50 GALLON ELECTRIC.
5. 1 BACKFLOW PREVENTER, REFERENCE DETAIL 3/501.
6. 1 HOSE BIBB, 1/2" CW, MOUNT 12" AFF. PROVIDE LINE SIZE FOR MAINTENANCE. REFERENCE DETAIL 5/501.
7. 1 WALL HYDRANT, 3/4" CW, MOUNT 18" AFG.
8. 1 1/2" CW
9. 1 1/4" CW.
10. 1 EXPANSION TANK, REFERENCE DETAIL 5/501.
11. 1 BACKFLOW PREVENTER, REFERENCE DETAIL 3/501.
12. 1 THERMOSTATIC MIXING VALVE, MOUNT BOTTOM OF 1 DOMESTIC WATER HEATER, 50 GALLON ELECTRIC.
13. 1 PROMANADE DECK DRAIN WITH 4" STORM PIPE DOWN 15.
14. 1 1/2" CW.
15. 1 1/4" CW.
16. 1 1/2" CW.
17. 1 1/4" CW.
18. 1 1/2" CW.
19. 1 1/4" CW.
20. 1 1/2" CW.
21. 1 1/4" CW.
22. 1 1/2" CW.
23. 1 1/4" CW.
24. 1 1/2" CW.
25. 1 1/4" CW.
26. 1 1/2" CW.
27. 1 1/4" CW.
28. 1 1/2" CW.
29. 1 1/4" CW.
30. 1 1/2" CW.
31. 1 1/4" CW.
32. 1 1/2" CW.
33. 1 1/4" CW.
34. 1 1/2" CW.
35. 1 1/4" CW.
1. SEE GENERAL NOTES ON SHEET M-001.

GENERAL NOTES:

1. EXHAUST FAN ON ROOF CURB LOCATED AS SHOWN. SEE SHEET M-101 FOR CONTINUATION INTO BUILDING. SEE DETAIL 'E' ON SHEET M-501.

2. AIR COOLED CONDENSING UNIT LOCATED ON ROOF AT LOCATION SHOWN. MOUNT UNIT ON ROOF RAILS AND VIBRATION ISOLATORS. SEE DETAILS 'A' & 'D' ON SHEET M-501.

3. REFRIGERANT PIPING FROM LOWER LEVEL THROUGH ROOF CURB. SEE DETAIL 'B' ON SHEET M-501.


5. SPLIT SYSTEM HEAT PUMP LOCATED ON ROOF AT LOCATION SHOWN. MOUNT UNIT ON ROOF RAILS AND VIBRATION ISOLATORS. SEE DETAILS 'A' & 'D' ON SHEET M-501.
**Exhaust Fan Schedule**

<table>
<thead>
<tr>
<th>UNIT TAG</th>
<th>LOCATION</th>
<th>TYPE</th>
<th>MBH</th>
<th>CFM</th>
<th>ELECTRIC</th>
<th>WALL</th>
<th>ELECTRIC</th>
<th>CEILING</th>
<th>ELECTRIC</th>
<th>NO.</th>
<th>VOLTS</th>
<th>PHASES</th>
<th>Hz</th>
<th>MCA</th>
<th>MOCP</th>
<th>DISC. SW.</th>
<th>Starter</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>RR103</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RR105</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Ductless Mini-Split System Schedule**

<table>
<thead>
<tr>
<th>UNIT NO.</th>
<th>TYPE</th>
<th>CFM</th>
<th>ELECTRIC</th>
<th>WALL</th>
<th>ELECTRIC</th>
<th>CEILING</th>
<th>ELECTRIC</th>
<th>NO.</th>
<th>VOLTS</th>
<th>PHASES</th>
<th>Hz</th>
<th>MCA</th>
<th>MOCP</th>
<th>DISC. SW.</th>
<th>Starter</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Fan Coil Unit Schedule**

<table>
<thead>
<tr>
<th>UNIT NO.</th>
<th>LOCATION</th>
<th>CFM</th>
<th>ELECTRIC</th>
<th>WALL</th>
<th>ELECTRIC</th>
<th>CEILING</th>
<th>ELECTRIC</th>
<th>NO.</th>
<th>VOLTS</th>
<th>PHASES</th>
<th>Hz</th>
<th>MCA</th>
<th>MOCP</th>
<th>DISC. SW.</th>
<th>Starter</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Supply Diffuser Schedule**

<table>
<thead>
<tr>
<th>UNIT NO.</th>
<th>LOCATION</th>
<th>CFM</th>
<th>ELECTRIC</th>
<th>WALL</th>
<th>ELECTRIC</th>
<th>CEILING</th>
<th>ELECTRIC</th>
<th>NO.</th>
<th>VOLTS</th>
<th>PHASES</th>
<th>Hz</th>
<th>MCA</th>
<th>MOCP</th>
<th>DISC. SW.</th>
<th>Starter</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Return and Exhaust Grille Schedule**

<table>
<thead>
<tr>
<th>UNIT NO.</th>
<th>LOCATION</th>
<th>CFM</th>
<th>ELECTRIC</th>
<th>WALL</th>
<th>ELECTRIC</th>
<th>CEILING</th>
<th>ELECTRIC</th>
<th>NO.</th>
<th>VOLTS</th>
<th>PHASES</th>
<th>Hz</th>
<th>MCA</th>
<th>MOCP</th>
<th>DISC. SW.</th>
<th>Starter</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Air Cooled Condensing Unit Schedule**

<table>
<thead>
<tr>
<th>UNIT NO.</th>
<th>LOCATION</th>
<th>CFM</th>
<th>ELECTRIC</th>
<th>WALL</th>
<th>ELECTRIC</th>
<th>CEILING</th>
<th>ELECTRIC</th>
<th>NO.</th>
<th>VOLTS</th>
<th>PHASES</th>
<th>Hz</th>
<th>MCA</th>
<th>MOCP</th>
<th>DISC. SW.</th>
<th>Starter</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
THE UNIT SHALL BE CONTROLLED BY PACKAGED CONTROLS PROVIDED BY THE MANUFACTURER.

THE UNIT SHALL RUN CONTINUOUSLY.

NORMAL MODE:

A. SUPPLY FAN:
1. THE SUPPLY FAN SHALL RUN CONTINUOUSLY, UNLESS SHUT DOWN ON MANUFACTURER PROVIDED SAFETIES.

B. REFRIGERANT COOLING:
1. THE CONTROLLER SHALL MODULATE THE COOLING VALVE TO MAINTAIN SPACE SETPOINT AT 72°F (ADJ.)
2. THE COOLING COIL SHALL BE ENABLED WHENEVER:
   2.1. TEMPERATURE AT THE THERMOSTAT READS GREATER THAN 75°F (ADJ.).
   2.2. AND THE SUPPLY FAN STATUS IS ON.

C. ELECTRIC HEATING:
1. THE CONTROLLER SHALL TOGGLE THE ELECTRIC HEATING COIL TO MAINTAIN SPACE SETPOINT AT 72°F (ADJ.)
2. THE HEATING COIL SHALL BE ENABLED WHENEVER:
   2.1. TEMPERATURE THE THERMOSTAT READS LESS THAN 69°F (ADJ.).
   2.2. AND THE SUPPLY FAN STATUS IS ON.

FCU-1 SEQUENCE OF OPERATIONS

TEMPERATURE CONTROL EXHAUST FAN SEQUENCE OF OPERATIONS

1. NORMAL OPERATION
   A. THE TEMPERATURE SENSOR IN THE ROOM SHALL SEND A SIGNAL TO THE FAN MOTOR STARTER FOR THE FAN TO START. START-UP SIGNAL SHALL BE SENT AT SETPOINT OF 80°F (ADJ.).
   B. THE FAN SHALL DE-ENERGIZE UPON FALLING BELOW TEMPERATURE OF 80°F (ADJ.).
GENERAL NOTES:
1. PROVIDE PHOTOCELL FOR LIGHTING CONTACTOR LC-1 ON PARAPET. SEE LIGHTING CONTROL DIAGRAM ON SHEET E501.
2. MECHANICAL EQUIPMENT PROVIDED WITH INTEGRAL DISCONNECT SWITCH.
3. RECEPTACLE MOUNTED TO INSIDE OF ROOF PARAPET.
4. PROVIDE 30A/2P FUSED DISCONNECT SWITCH IN NEMA 3R ENCLOSURE WITH 25A FUSES. MOUNT ON UNISTRUT FRAME. MAKE FINAL CONNECTION TO MECHANICAL EQUIPMENT.
5. WIRE BRANCH CIRCUIT THROUGH COMBINATION STARTER LOCATED IN MECHANICAL ROOM BELOW TO PANEL INDICATED.
6. PROVIDE 30A/2P FUSED DISCONNECT SWITCH IN NEMA 3R ENCLOSURE WITH 15A FUSES. MOUNT ON UNISTRUT FRAME. MAKE FINAL CONNECTION TO MECHANICAL EQUIPMENT.
7. PROVIDE PHOTOCELL FOR STAGE LIGHTING CONTROLS ON PARAPET. SEE STAGE LIGHTING CONTROL DIAGRAM ON SHEET E001.

PLAN NOTES:
# 1 PROVIDE PHOTOCELL FOR LIGHTING CONTACTOR LC-1 ON PARAPET. SEE LIGHTING CONTROL DIAGRAM ON SHEET E501.
# 2 PROVIDE 30A/2P FUSED DISCONNECT SWITCH IN NEMA 3R ENCLOSURE WITH 25A FUSES. MOUNT ON UNISTRUT FRAME. MAKE FINAL CONNECTION TO MECHANICAL EQUIPMENT.
# 3 PROVIDE 30A/2P FUSED DISCONNECT SWITCH IN NEMA 3R ENCLOSURE WITH 15A FUSES. MOUNT ON UNISTRUT FRAME. MAKE FINAL CONNECTION TO MECHANICAL EQUIPMENT.
# 4 PROVIDE PHOTOCELL FOR STAGE LIGHTING CONTROLS ON PARAPET. SEE STAGE LIGHTING CONTROL DIAGRAM ON SHEET E001.
### AV Back Box and Conduit Schedule

<table>
<thead>
<tr>
<th>Number</th>
<th>Box Code</th>
<th>A01</th>
<th>A02</th>
<th>A03</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>101</td>
<td>CS-EF-1</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>208 V 15 A 15 A 0 TYPE 1</td>
</tr>
<tr>
<td>102</td>
<td>CS-EF-2</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>208 V 15 A 15 A 0 TYPE 1</td>
</tr>
</tbody>
</table>

### Conduit Routing Notes

*AV Back Box and Conduit Schedule

### Motor Controller Schedule

<table>
<thead>
<tr>
<th>Number</th>
<th>Controller Code</th>
<th>Description</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Low Voltage Transformer Schedule

<table>
<thead>
<tr>
<th>Number</th>
<th>Description</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### High Voltage Transformer Schedule

<table>
<thead>
<tr>
<th>Number</th>
<th>Description</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Notes

1. AV Back Box and Conduit Schedule: See Conduit Routing and Conduit Notes on Sheet AV-601.
2. All Conduit Runs to Raceway Are Listed in this Schedule.
### Switchboard Schedule

<table>
<thead>
<tr>
<th>Ckt</th>
<th>Load Name</th>
<th>Pole</th>
<th>Rating</th>
<th>Type</th>
<th>Peak Load</th>
<th>Demand</th>
<th>KVA</th>
<th>Demand Factor</th>
<th>Trip Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Panelboard Schedules

**PANELBOARD SCHEDULE**

<table>
<thead>
<tr>
<th>Ckt</th>
<th>Load Name</th>
<th>Pole</th>
<th>Rating</th>
<th>Type</th>
<th>Peak Load</th>
<th>Demand</th>
<th>KVA</th>
<th>Demand Factor</th>
<th>Trip Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**FEEDER**

<table>
<thead>
<tr>
<th>Ckt</th>
<th>Load Name</th>
<th>Pole</th>
<th>Rating</th>
<th>Type</th>
<th>Peak Load</th>
<th>Demand</th>
<th>KVA</th>
<th>Demand Factor</th>
<th>Trip Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Location:**

- Surface

**Mounting:**

- Panel RP-3
- Panel RP-2
- XFMR-AV1 (Panel AV1)
- MCB

**Amp:**

- Main: 200 A
- MLO: NEW
- LSI: 19.21

**Location:**

- Project No.: 20032.000
- Project Name: BSU Brown Family Amphitheater

**Date:**

- 20032.000

**Applied Engineering Services (317) 810-4141**