SECTION 04 2200

CONCRETE UNIT MASONRY (CMU) (Revised AD-2)

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Concrete Masonry (CMU), as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 REFERENCES

A. Reference Standards:

1. ASTM A36 - Standard Specification for Carbon Structural Steel
2. ASTM C33 - Standard Specification for Concrete Aggregates
3. ASTM C90 - Standard Specification for Loadbearing Concrete Masonry Units
4. ASTM C140 - Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units
5. ASTM C780 Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
6. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials
7. ACI 216.1/TMS 0216 - Code Requirements for. Determining Fire Resistance of Concrete and Masonry. Construction Assemblies
8. ACI 530/530.1 – Building Code Requirements and Specification for Masonry Structures.
9. NMCA TEK 7-1B - Fire Resistance Ratings of Concrete Masonry Assemblies

1.3 SUBMITTALS

A. Product Data:

1. Manufacturer’s data sheet describing properties of concrete masonry units and demonstrating conformance with specified standards.
2. Certification of level of fire resistance provided by units used in fire rated walls.
3. Reinforcing.

1.4 QUALITY ASSURANCE

A. Installer Qualifications:

1. More than five (5) years successful experience in installation of concrete masonry unit systems similar to system required.
2. Include five (5) references with bid from similar size projects.

B. Test results performed to qualify materials and establish mix designs.

C. Mock-up:

1. Use materials and procedures accepted for the work.
2. Minimum sample panel size is 4 feet 1.2 m square.
3. Acceptable standard for the work is established by accepted sample panel.
4. Retain sample panel at site until Work has been completed.
5. Include a grouting demonstration panel if grouting operations planned exceed or vary from limitations set forth in ACI 530.1-05 - Section 3.5

D. Preinstallation Conference:

1. See Section 01 3100.

PART 2 - PRODUCTS

2.1 GENERAL

A. Units to be used in fire resistive wall assemblies:

1. Where units are used in assemblies with fire resistive rating:
   a. Provide units with aggregate type, and equivalent thickness that yield fire-resistances indicated for each wall assemblies.
   b. Acceptable calculation methodologies for determining equivalent thickness:
      1) ASTM C140.
      2) NCMA TEK 7-1B.
      3) ACI 216.1 / TMS 0216.
   c. Units tested per ASTM E119 are also acceptable.
2. Provide solid units, or grouted hollow units, under lintels.
3. Provide matching concrete bricks as required.
4. Do not use chipped, cracked, spalled units exposed in finish work.
5. Provide reinforced concrete masonry lintels fabricated from precast or site cast load bearing masonry units, filled and reinforced as indicated.

2.2 CONCRETE MASONRY UNITS - GENERAL PURPOSE

A. Concrete Masonry Units (CMU):

1. Modular units complying with ASTM C90.
2. Aggregate:
   a. Normal Weight: In accordance with ASTM C33.
3. Sizes and shapes as indicated or required for conditions.
4. Face shell and web thickness: Table 1, ASTM C90.

B. Corner Units:

1. Exposed to view: Use bullnose units at external corners and jambs of openings.
2. Not Exposed to view: Square-nosed units may be used where corners will not be visible in completed wall.

AD-2: Section 04 2200; 09/25/2024: Add Paragraphs 2.2, C.

C. Glazed Concrete Masonry Units:

1. Modular units complying with ASTM C90.

2. Pre-faced CMU with manufacturer's standard smooth resinous facing complying with ASTM C 744.

3. Aggregate:

a. Normal Weight: In accordance with ASTM C33.

4. Sizes and shapes as indicated or required for conditions.

a. Manufactured to dimensions specified in "CMUs" Paragraph and drawings with pre-faced surfaces having 1/16-inch wide returns of facing to create 1/4-inch wide mortar joints with modular coursing.

b. Face shell and web thickness: Table 1, ASTM C90.

5. **Basis-of-Design Product: Subject to compliance with requirements, provide Echelon Trenwyth Astra-Glaze SW+ Glazed Masonry Units, in Snow White, or comparable product by one of the following:**
6. **Manufacturers:**
   a. **Spectra Glaze; "Spectra Glaze Block"**
   b. **Premier "Premier Glazed"**
   c. **Or Equal**

2.3 CONCRETE LINTELS AND SILLS

A. General:
   1. Fabricate concrete lintels and sills in plant or site cast.
   2. Use concrete having minimum 28 day compressive strength of 3000 psi 21 MPa.
   3. Exposed surfaces to have surface texture and color to match adjacent concrete masonry units.
   4. Fabricate lintels to modular sizes to match coursing.
   5. Mark tops of lintels with lintel schedule number.

B. Fabricate lintels by one of following methods:
   1. Use masonry lintel units and reinforced concrete fill.
   2. Cast lintels monolithically with reinforcement.
   3. Provide vertical dummy joints matching pattern of vertical joints and scoring in concrete masonry walls in which installed.

2.4 REINFORCING

A. Horizontal Reinforcing products including wire ladder truss: Specified in Section 04 0523.

B. Reinforcing Bars (vertical and horizontal): Specified in Section 03 2000.

2.5 ACCESSORY ITEMS

A. Masonry Accessories: See Section 04 0523.

B. Mortar and Grout: See Section 04 0516.

C. Firestopping: See Section 07 8413 for rated wall penetrations.

D. Sealants: See Section 07 9200 for non-rated wall penetrations.

E. Grout Fill: See Section 04 0516.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify suitability of substrate to accept work.

B. Verify that anchors and flashings are correct.

C. Installation constitutes acceptance of substrate and responsibility for performance.

3.2 INSTALLATION

A. General:
   1. Comply with provisions of ACI 530 and ACI 530.1, except where exceeded by requirements of Contract Documents.
   2. Perform cutting with masonry saws.
   3. Cut as required to provide pattern indicated.

4. Use solid units where cutting or laying would expose holes.
5. Do not install damaged units.
6. Do not wet concrete masonry units.
7. Avoid use of less than half size units.
8. Build chases and recesses as indicated and required for work of other trades.

B. Install in running bond unless otherwise indicated.

3.3 FIRE AND SMOKE WALL IDENTIFICATION

A. Identify walls indicated on Drawings as having a required fire or smoke rating.

1. Follow guidelines set in Chapter 7 of International Building Code.
2. Permanently identify rating and type of barrier with stencil and paint in contrasting, 3 inches high letters in a manner acceptable to authority having jurisdiction.
3. Text for fire and smoke barriers: "X HOUR FIRE AND/OR SMOKE BARRIER—PROTECT ALL OPENINGS."

3.4 LAYING AND TOOLING

A. Lay out walls in advance for uniform and accurate spacing of bond patterns and joints.

B. Properly locate openings, movement joints and offsets.

C. Lay masonry units with face shells of bed joints fully mortared.

1. Mortar webs in courses of piers, columns, and pilasters, in starting course on foundations and when necessary to confine grout or loose filled insulation.
2. Mortar head joints a minimum distance from each face equal to face shell thickness.
3. Align vertical cells and maintain openings unobstructed to be grouted.

D. Maintain nominal 3/8 inches 9.5 mm joint widths.

1. Cut joints flush where concealed.
2. Tool exposed joints.
3. Compress mortar in below ground joints.

E. Enlarge voids or holes, except weep holes, and fill with mortar during tooling.

F. Point up joints at corners, openings, and adjacent work to provide neat, uniform appearance.

G. Remove masonry disturbed after laying.

1. Clean and relay in fresh mortar.
2. Do not pound units to fit.
3. If adjustments are required, remove units, clean, and reset in fresh mortar.

H. Where work is stopped and later resumed, rake back 1/2 masonry unit length in each course; do not tooth.

1. Remove loose units and mortar prior to laying fresh masonry.

I. Protect against weather when work is not in progress.

1. Cover top of walls with waterproof sheeting, extend at least 4 feet 1.2 m down both sides of walls; anchor in place.
   a. Do not use adhesives on surface of brick.
   b. Do not set sheeting in joint.
2. Provide cold weather protection; Section 04 0505.

J. Build in items indicated and specified.

1. Fill with mortar around built-in items.
2. Grout fill space between metal frames and masonry.
3. Where built-in items are to be embedded in cores of hollow masonry units, place layer of metal lath in joint below and fill core with grout.

K. Remove masonry protrusions extending 1/2 inches 13 mm or more into cells or cavities to be grouted.

3.5 REINFORCING

A. General:

1. In addition to the following general requirements, provide reinforcing size type and spacing as indicated on Drawings and Details.

B. General Reinforcing Requirements:

1. Reinforce masonry openings over 12 inches 300 mm wide, where control and expansion joints are not provided, with horizontal joint reinforcing placed in 2 horizontal joints above lintel and below sill.
   a. Extend reinforcing minimum of 24 inches 300 mm beyond jambs of opening.
2. Embed horizontal reinforcing in bed joint mortar for entire length with minimum cover of 5/8 inches 16 mm on exterior side of walls and 1/2 inches 13 mm at other locations.
   a. Provide same minimum cover for other embedded items.
3. Minimum laps for horizontal reinforcing: 6 inches 150 mm.
4. Do not bridge Control Joints or Expansion Joints with horizontal reinforcing.
   a. Install smooth dowels or other approved device across Control Joints which resist shear loads but allow in-plane expansion, contraction, and linear shrinkage movements.

C. Horizontal Reinforcing (wire ladders/trusses):

1. Provide continuous horizontal joint reinforcing concrete masonry walls.
   a. See elsewhere for reinforcing requirements for anchored veneers.
2. Unless otherwise indicated:
   a. Install horizontal reinforcing within 8 inches 200 mm of first bed joint.
   b. Running Bonds: Install horizontal reinforcing at 16 inches 400 mm OC vertically thereafter.
   c. Stacked Bonds: Install reinforcing 8 inches 200 mm OC vertically thereafter where stack bond masonry is indicated.
3. Make corners and wall intersections by use of prefabricated L and T sections.
   a. Cut and bend as required.
4. At intersecting load bearing walls install rigid steel anchors not over 24 inches 600 mm OC vertically.
   a. Embed ends in grout filled cores.

D. Horizontal Reinforcing Bars:

1. Install where indicated.
2. Sizes as indicated.

E. Vertical Reinforcing Bars at CMU Walls other than Anchored Veneers:

1. Install vertical reinforcing bars as indicated.
2. When not indicated, provide the following minimum vertical reinforcing:
   a. Provide one No.5 continuous at 48 inches 1200 mm on center.

b. Provide one No.5 continuous at each corner, at each side of each opening, at each side of each control joint, and at the ends of walls.

3.6 GROUT FILL

A. Do not place grout until entire portion of wall to be grouted has attained strength to resist grout pressure.

B. Use mechanical vibrator to remove voids and to consolidate fill.

C. Grout walls incrementally as CMU is placed.

D. Minimize lift heights to ensure walls remain safe and stable until grout has attained strength to resist overturning or collapse.

1. Consider detrimental lateral loads which could be anticipated including storms, winds, seismic and soil conditions.
2. Adequately brace.

E. Where vertical or horizontal reinforcing bars are required, place and inspect prior to filling operation.

F. Fill cores containing vertical reinforcing.

G. Place in maximum 4 feet 1200 mm lifts.

H. Leave lifts minimum 1-1/2 inches 38 mm below top of course to form key with next lift.

3.7 CONTROL JOINTS (CJ)

A. Provide control joints and other movement joints as indicated.

B. Where not indicated:

1. Locate control joints at natural planes of weakness in masonry wall such as:
   a. Changes in wall height.
   b. Changes in wall thickness, such as at pipe and duct chases and pilasters.
   c. At (above) movement joints in foundations and floors on which wall is bearing.
   d. At (above) movement joints in roofs and floors that bear on wall.
   e. Within 8 inches 200 mm of one or both jambs of door, window, louver, and similar openings:
      1) Place CJ at one side of openings less than 6 feet 1800 mm wide.
      2) Place CJ at both sides of openings greater than 6 feet 1800 mm wide.
   f. Within 4 feet 1200 mm of corners on one leg, minimum.
      1) Opposing leg: No more than 20 feet 600 mm from corner.
   g. Intersections: Within 12 feet 3600 mm of wall intersections.
2. In addition to the above, locate control joints at no more than the following maximum (horizontal) distances:
   a. Walls greater than 16 feet - 8 inches 5.1 m tall: No more than 25 feet 7.6 m O.C.
   b. Walls between 8 feet 2.4 m and 16 feet - 8 inches 5.1 m tall: Not more than 1-1/2 times wall height.
   c. Walls less than 8 feet 2.4 m tall: 12 feet 3.6 m.

C. Installation/construction of control joints:

1. Utilize sash blocks or similar shapes which have slotted end to accept gaskets.
   a. Pre-molded Control Joint Strips: Specified in Section 04 0523.
2. Cut ladder/truss type horizontal reinforcing as it crosses control joints.
3. While mortar is still fresh, rake out mortar from joint, leaving a completely clean joint.

4. After wall has cured, install backer rod and sealant on both wall faces.
    a. Sealant and Backer Rod: Specified in Section 07 9200.

3.8 LINTELS, FLASHING AND SEALANTS

A. Installation of flashing, weeps, and similar masonry accessories: Specified in Section 04 0523.

B. Sealant installation requirements:

1. Sealant and Backer Rod: Specified in Section 07 9200.
2. Remove mortar in joint under relieving lintel and at ends.
3. Seal joints between CMU's and relieving lintels.
4. Seal Expansion and Control Joints.

C. Provide precast masonry lintels wherever openings more than 12 inches 300 mm wide are indicated without other structural support or other supporting lintels.

1. Thoroughly cure lintels before handling and installation.
2. See lintel schedule for size and type required.

3.9 INSTALLATION TOLERANCES

A. Maximum variation from plumb in vertical lines and surfaces of columns, walls and arises:

1. 1/4 inches 6 mm in 10 feet 3 m.
2. 3/8 inches 9 mm in a story height not over 20 feet 6 m.
3. 1/2 inches 12 mm in 40 feet 12 m or more.

B. Maximum variation from plumb for external corners, control joints, expansion joints and other conspicuous lines:

1. 1/4 inches 6 mm in any story or 20 feet 6 m maximum.
2. 1/2 inches 12 mm in 40 feet 12 m or more.

C. Maximum variation from level of grades for exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines:

1. 1/4 inches 6 mm in any bay or 20 feet 6 m.
2. 1/2 inches 12 mm in 40 feet 12 m or more.

D. Maximum variation from plan location of related portions of columns, walls, and partitions:

1. 1/2 inches 12 mm in any bay or 20 feet 6 m.
2. 3/4 inches 18 mm in 40 feet 12 m or more.

E. Maximum variation in cross section of columns and thicknesses of walls from dimensions indicated:

1. Minus 1/4 inches 6 mm.
2. Plus 1/2 inches 12 mm.

3.10 REPAIR, POINTING AND CLEANING

A. Remove and replace loose, stained, or damaged units.

1. Provide new units to match.
2. Install in fresh mortar.
3. Point to eliminate evidence of replacement.

B. Clean in accordance with Section 04 0510.

3.11 INSPECTION AND TESTING

A. Comply with the requirements of ACI 530.1 Section 1.6C and facilitate the testing and inspection agency's needs.

B. The Owner will provide testing and inspection services. This does not relieve the contractor of the responsibility to furnish materials and construction in full compliance of contract documents.

END OF SECTION

SECTION 08 5113 – ALUMINUM WINDOWS

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, but not limited to, the following:

1. W-03 Aluminum Windows

2. Aluminum window accessories and components as indicated on the drawings, schedules, and as described within these specifications.

B. Related Requirements:

1. Section 072100, Thermal Insulation.

2. Section 076200, Sheet Metal Flashing and Trim.

3. Section 079200, Joint Sealants.

4. Section 084113, Entrances and Storefronts.

5. Section 088000, Glazing.

1.3 REFERENCES

1. Aluminum Association (AA)

a. AA ASD-1 "Aluminum Standards and Data."

b. AA ADM "Aluminum Design Manual."

c. AA DAF45 "Designation System for Aluminum Finishes."

2. American National Standards Institute (ANSI)

a. ANSI H35.2 "Aluminum National Standard Dimensional Tolerances for Aluminum Mill Products."

b. ANSI Z97.1 2015 "American National Standard for Safety Glazing Materials Used In Buildings - Safety Performance Specifications and Methods of Test."

3. American Society of Civil Engineers (ASCE)

a. ASCE 7, "Minimum Design Loads for Buildings and Other Structures."

4. American Society for Heating, Refrigeration and Air-conditioning Engineers (ASHRAE)

    a. ANSI/ASHRAE/IES Standard 90.1, "Energy Standard for Buildings Except Low-Rise Residential Buildings."

5. American Welding Society (AWS)

    a. AWS D1.1 "Structural Welding Code, Steel."

    b. AWS D1.2 "Structural Welding Code, Aluminum."

    c. AWS D1.3 "Structural Welding Code, Sheet Steel."

6. Fenestration and Glazing Industry Alliance (FGIA)

    a. AAMA/WDMA/CSA A440 S1 "NAFS - North American Fenestration Standard/ Specification for Windows, Doors, and Skylights."

    b. AAMA 611, "Voluntary Specification for Anodized Architectural Aluminum."

    c. AAMA 701/ 702, "Voluntary Specification for Pile Weatherstripping and Replaceable Fenestration Weatherseals."

    d. AAMA 910 "Voluntary Life Cycle Specifications and Test Methods for Architectural Grade Windows and Sliding Glass Doors."

    e. AAMA 2603, "Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels."

    f. AAMA 2605, "Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels."

7. International Standards Organization (ISO)

    a. ISO 14025, "Environmental Labels and Declarations: Type III Environmental Declarations – Principles and Procedures."

    b. ISO 21930, "Sustainability in Buildings and Civil Engineering Works - Core Rules for Environmental Product Declarations of Construction Products and Services."

8. National Association of Architectural Metal Manufacturers (NAAMM)

    a. NAAMM AMP-500 "Metal Finishes Manual for Architectural and Metal Products."

9. National Fenestration Rating Council (NFRC)

    a. NFRC 100 "Procedure for Determining Fenestration Product U-Factors.

    b. NFRC 200 "Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence."

c. NFRC 300 "Test Method for determining the Solar Optical properties of Glazing Materials and Systems."

d. NFRC 500 "Procedure for Determining Fenestration Product Condensation Resistance Values."

1.4 SUBMITTALS

A. Product Data:.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Sustainable Design Submittals:
1. Product Data: For sealants, indicating VOC content.
2. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
3. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.

C. Glazing Schedule: Submit for Architect's information, a glazing schedule utilizing the same designations shown on Drawings for glazed windows listing glass types and thicknesses for each size opening and location

D. Shop Drawings: For aluminum windows. Include plans, elevations, sections, full-size details, and attachments to other work.
1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
2. Include details of each type of vertical-to-horizontal intersection of aluminum windows, showing the following:
a. Joinery, including concealed welds.
b. Anchorage.
c. Expansion provisions.
d. Glazing.
e. Flashing and drainage
3. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.

E. Samples for Initial Selection: For units with factory-applied color finishes.

1. Submit 3 samples for each metal type, metal finish and color required. Submit sample finishes on 12-in. lengths of metal having the specified alloy, temper, pretreatment and thickness of metal required for the work, showing the maximum range or variation in color and shade.

2. Submit one sample corner of window unit, representative of fabrication techniques and workmanship of the final products.

3. Submit one sample of each type of window hardware specified.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For aluminum windows for tests performed by manufacturer and witnessed by a qualified testing agency within the last 5 years

C. Source quality-control reports.

D. Field quality-control reports.

E. Sample Warranties: For special warranties.

1.6 MOCKUP

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

B. Visual Mockup: Build mockup of aluminum windows as indicated on Drawings.

1. Provide, at Project site, where directed, in coordination with exterior enclosure work, a mock-up of the aluminum window(s) for visual review by the Architect, extent as shown, and representative of the finished Work. Provide joint conditions, anchorage, specified glass, panels, paint finish and other features as will be used in the final Work.
2. Visual mock-up(s) shall be erected to sizes as noted, containing materials required for proposed finished aluminum windows containing at least 1 entrance door complete with finish hardware.
3. Clean mock-up(s) with materials and techniques intended for use on the Project.
4. Replace unsatisfactory Work as required to obtain approval of the Architect.
5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
6. Subject to compliance with requirements, approved mockups may become part of the completed Work.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For aluminum windows to include in maintenance manuals.

B. Maintenance Data for Structural Sealant: For structural-sealant-glazed storefront to include in maintenance manuals. Include ASTM C1401 recommendations for post-installation-phase quality-control program.

1.8 QUALITY ASSURANCE

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

B. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.

1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

C. Structural-Sealant Glazing: Comply with ASTM C1401 for design and installation of AL windows.

1.9 WARRANTY

A. Special Warranty: Installer agrees to repair or replace components of aluminum-framed entrances and storefronts that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures, including, but not limited to, excessive deflection.
      b. Noise or vibration created by wind and thermal and structural movements.
      c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
      d. Water penetration through fixed glazing and framing areas.
      e. Failure of operating components.
   2. Warranty Period: Two years from date of Substantial Completion.

B. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.

   1. Deterioration includes, but is not limited to, the following:

      a. Color fading more than 5 Hunter units when tested according to ASTM D2244.
      b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
      c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

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

1.10 DELIVERY, STORAGE, AND HANDLING

A. Store aluminum window components in accordance with manufacturer's instructions, above grade on dunnage, properly protected from the weather and construction activities.

B. Delivery of Fabricated Units: Deliver fabricated window units and component parts to project site completely identified in accordance with erection diagrams. Store in accordance with manufacturer's instructions, above grade on dunnage, properly protected from the weather and construction activities.

C. Protective Coatings or Coverings: Temporary coating and coverings may be furnished at manufacturer’s or Contractor’s option to protect the Work during shipment and construction. Such protection shall avoid development of non-uniformity in finishes, shall not impart a residue which would adversely affect the adhesion of sealants, nor cause other deleterious effects in the Work. Temporarily remove protection when requested by Architect for inspection of finishes, and completely remove protection when no longer required.

D. Material Delivery: Deliver materials to Project site in manufacturers' unopened containers, fully identified with trade name, color, size, hardness, type, class, and grade. Store each item in accordance with manufacturer's instructions. Deliver, store and handle glass in accordance with manufacturer's recommendations; protected from weather, staining and damage. During

storage and handling of glass provide cushions at edges to prevent impact damage. Protect glass from scratches and abrasion.

E. Storage: Store in accordance with manufacturer's instructions, above grade on dunnage, properly protected from the weather and construction activities.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General: Comply with the applicable provisions of the referenced standards except as modified by governing codes and the Contract Documents. Where a recommendation or suggestion occurs in the referenced standards, such recommendation or suggestion shall be considered mandatory. In the event of conflict between referenced standards, this specification or within themselves, the more stringent standard or requirement shall govern.

B. Aluminum-framed window system shall withstand the effects of the following performance requirements without failure due to defective manufacture, fabrication, installation, or other defects in construction.

C. Unacceptable Conditions: Noise or vibration created by thermal movement, structural movement, or wind; thermal movement transferred to building structure; loosening, weakening or failure of fasteners, attachments or other components.

D. Design Modifications: Make design modifications of work shown only as may be necessary to meet performance requirements and coordinate the work. Variations in details and materials which do not adversely affect appearance, durability or strength shall be submitted to the Architect for review. Maintain the general exterior design concept without altering profiles and alignments shown.

E. Structural Loads:
1. Wind Loads: As indicated on Structural Drawings.
2. Other Design Loads: As indicated on Structural Drawings.

F. Deflection of Framing Members: At design wind pressure, as follows:

1. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans of up to 13 feet 6 inches (4.1 m) and to 1/240 of clear span plus 1/4 inch (6.35 mm) for spans greater than 13 feet 6 inches (4.1 m) or an amount that restricts edge deflection of individual glazing lites to 3/4 inch (19.1 mm), whichever is less.
   a. Operable Units: Provide a minimum 1/16-inch (1.6-mm) clearance between framing members and operable units.
2. Cantilever Deflection: Where framing members overhang an anchor point, as follows:
   a. Perpendicular to Plane of Wall: No greater than 1/240 of clear span plus 1/4 inch (6.35 mm) for spans greater than 11 feet 8-1/4 inches (3.6 m) or 1/175 times span, for spans of less than 11 feet 8-1/4 inches (3.6 m).

G. Structural: Test according to ASTM E330/E330M as follows:
1. When tested at 150 percent of positive and negative wind-load design pressures, storefront assemblies, including entrance doors and anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceed 0.2 percent of span.
2. Test Durations: As required by design wind velocity, but not less than 10 seconds.

H. Seismic Performance: Aluminum windows shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. Seismic Drift Causing Glass Fallout: Complying with criteria for passing based on building occupancy type when tested according to AAMA 501.6 at design displacement and 1.5 times the design displacement.

I. Energy Performance: Certified and labeled by manufacturer for energy performance as follows:
   1. Thermal Transmittance (U-factor):
      a. Fixed Glazing and Framing Areas: U-factor for the system of not more than 0.41 Btu/sq. ft. x h x deg F (2.33 W/sq. m x K) as determined in accordance with NFRC 100.
   2. Solar Heat-Gain Coefficient (SHGC):
      a. a. Fixed Glazing and Framing Areas: SHGC for the system of not more than 0.26 as determined in accordance with NFRC 200.

J. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes.
   1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

K. Windborne-Debris-Impact Resistance Performance: Shall be tested in accordance with ASTM E1886, information in ASTM E1996, and TAS 201/203.

L. Large-Missile (D) Impact: For aluminum-framed systems located within 30 feet (9.1m) of grade

2.2 WINDOW TYPE W-03

A. Basis of Design Manufacturer: Kawneer –
   1. Series 8225TL Thermal Windows – Casement
   2. Impact resistant frame and glazing – Large Missile D Rated
   3. Finish: 2, Kawneer Permanodic® AA-M10C21A41, AAMA 611, Architectural Class I Clear Anodic Coating (Color #14 Clear)
   4. Window Frame Joinery: Screw-Spline, Factory sealed frame and vent corner Joints Thermally Broken
   5. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
   6. Steel Reinforcement: As required by manufacturer.
   7. Sill Flashing: Manufacturers integrated flashing.

2.3 METAL MATERIALS

A. Aluminum

   1. General: Utilize aluminum members used for aluminum window frames meeting parameters documented in industry-wide environmental product declaration (EPD) published by the Aluminum Association.

   2. Aluminum Extrusions: Shapes as shown and as required to fulfill performance requirements, but not less than 1/8-in. thick, unless otherwise shown. Suitable alloy and proper temper for extruding and fabricating with adequate structural characteristics, and suitable for finishing as specified.

   3. Aluminum Sheets and Plates: Sizes and minimum gauges as shown and as required to fulfill performance requirements. Suitable alloy and proper temper for forming and fabricate with adequate structural characteristics and suitable for finishing as specified.

2.4 FASTENERS, ANCHORAGE AND REINFORCING

A. Anchor Assemblies: 3-way adjustable anchors that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer/fabricator.

1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A123 or ASTM A153 requirements. Provide bolts, washers and shims as required, hot dip galvanized, ASTM A153 , Class A.

2. Steel Anchorage: Anchor assemblies secured to structural steel framing shall be fabricated in accordance with the criteria governing structural steel and where exposed, architecturally exposed structural steel.

B. Fasteners: Stainless steel type 300 series, selected to prevent galvanic action with the components fastened. Where exposed in finished surfaces, use oval-head countersunk Phillips heads and color to match adjacent surfaces. Where fasteners screw-anchor into aluminum less than 1/8 in. thick. reinforce the interior surface with aluminum or non-magnetic type stainless steel to receive screw threw threads or provide manufacturer's standard non-corrosive pressed-in splined grommet nuts. Screwed connections shall be drilled. Unless otherwise indicated, bolts and other fastening devices, including their accessory items (washers, nuts, etc.), shall incorporate self-locking devices and be torques tightened as required to achieve maximum torque tension relationship required by fasteners.

C. Structural Support Steel: ASTM A36 .

D. Steel Angles, Plates, Anchors, Clips, Bars, Rods and other Steel Accessories Required to Join or Reinforce Assembly of Aluminum Components: ASTM A36 and ASTM A283 , galvanized or, if galvanized is not compatible with alloy of component parts, shop painted with primer specified herein after cutting to size. Galvanize ferrous metals embedded in concrete or masonry unless otherwise shown or specified.

E. Aluminum Angles, Plates, Bars, and other Aluminum Members Required to Join or Reinforce Assembly of Aluminum Components: Alloys recommended by manufacturer or fabricator to develop required strength of assembly.

F. Fasteners and Accessories: Manufacturer's standard non-corrosive fasteners and accessories that are compatible with materials used in the window framing system and with exposed portions that match finish of the windows. Where movement should be expected, provide 3-way adjustable anchors that accommodate fabrication and installation tolerances and slip-joint linings of sheets, pads, shims, or washers of fluorocarbon resin or a similar material recommended by the manufacturer.

1. Items for Bolting Aluminum Extrusions and Connecting Members: Stainless steel complying with ASTM A193 , Series 300; unless otherwise recommended by the window manufacturer.

2. Items for Anchoring Window to Supporting Structure: Zinc- coated steel fasteners complying with ASTM A307.

3. Items for Securing Exterior Aluminum Cap Retainers: AISI Series 300 stainless steel screws complying with ASTM A193 .

4. Where fasteners anchor into aluminum less than 1/8-in. thick, provide non-corrosive pressed-in splined grommet nuts or other type reinforcement to receive fastener threads.

A. Glass and Glazing: As specified in Section 088000 Glazing.

B. Sealants: As specified in Section 079200 Joint Sealants.

C. Thermal Separators: Provide thermal break by a continuously extruded, multi-directional 25% glass fiber reinforced 6/6 polyamide nylon strip. Aluminum window framing members separated up to a maximum of 3-in. with a locking mechanical connection to the thermal strip(s) by knurling the aluminum cavity and crimping the strip(s) into place to create a composite thermal barrier assembly. Structural performance values of the Thermal Barrier assembly to meet specific product/project design criteria or at a minimum certified testing criteria and procedures as described by the AAMA TIR-A8 performance standards.

D. Weatherstripping: AAMA 701 and AAMA 702 "Voluntary Specifications for Pile Weatherstripping and Replaceable Fenestration Weatherseals." Provide compressible, removable and replaceable type weatherstripping formed from neoprene or EPDM complying with ASTM D2000 or molded expanded EPDM or neoprene complying with ASTM C509, grade as selected by the manufacturer.

2.5 OPERABLE WINDOW HARDWARE

A. Hardware for Operable Windows: AAMA Series 900 for hardware appropriate to each specified type window. Provide ADA compliant manufacturer's standard or custom design for operation specified; fabricated of stainless steel complying with ASTM A167 or ASTM A666 and finished to match frame of window.

2.6 FABRICATION

A. General: Provide manufacturer's standard fabrication, accessories and finish complying with paragraphs "References" and "Performance Requirements." Units shall be reglazable without dismantling of sash framing. Provide a complete system of anchorage for glazed aluminum window units. Allow for erection tolerances and provide for movements of window units and enframement due to thermal expansion. Fabricate aluminum windows at the manufacturer's shop to the fullest extent possible and before applying finishes.

B. Welding, Cutting, Drilling, Mitering and Fitting of Joints: Complete the welding, cutting, drilling, mitering and fitting of joints prior to finishing. Weld with electrodes and by methods recommended by the metals manufacturer in accordance with applicable recommendations of the AWS. Use only methods which will avoid distortion or discoloration of exposed faces. Grind weld areas smooth before proceeding with other treatment.

C. Fastenings: Conceal fastenings unless otherwise shown or specified. Fit and assemble work in the shop insofar as practicable. Carefully fit and match work with continuity of line and design, using rigidly secured joints with hairline contact, mitered corners, unless otherwise shown. Reinforce members and joints with steel or aluminum plates, bars, rods or angles for rigidity and strength as needed to fulfill performance requirements. Use concealed stainless steel fasteners for jointing which cannot be welded.

D. Panels and Sills: Fabricate aluminum panels and sills utilizing 3/16-in. (min. thickness) aluminum plate. Finish sills and panels to match finish of aluminum frames. Reinforce

panels in concealed locations as required to meet specified performance criteria and to resist anchorage stresses. Fasteners or anchorage shall not be exposed to view on finished face of panel or sill.

E. Weepholes: Provide weepholes and internal water passages in the glazing recess as recommended by the glass manufacturer to conduct infiltrating water to the exterior. Provide weep baffles secured to inside of frame behind weepholes to prevent water migration.

F. Thermal Separator: Fabricate aluminum window units with an integrally concealed low conductance thermal separator, located between exterior metal material and metal material exposed on the interior in a manner that eliminates direct metal-to-metal contact.

G. Subframes: Provide subframes with anchors for window units where shown of profile and dimensions indicated fabricated from not less than 1/8-in. thick extruded aluminum. Miter or cope corners and weld and dress joint smooth with concealed mechanical joint fasteners. Finish to match finish specified for frames.

H. Mullion and Cover Plates: Provide mullion and cover plates where shown matching window units complete with anchors for support to the structure and for the installation of the window units. Allow for erection tolerances and provide for movement of window units due to thermal expansion and building deflections. Comply with specified performance criteria.

I. Mullion Covers: Aluminum windows utilizing exposed exterior mullion covers of the snap-on type design, provide a minimum of two (2) concealed fasteners per 5-ft. length to prevent displacement or accidental removal of trim.

PART 3 - EXECUTION

3.1 GENERAL

A. Manufacturer's Instructions: Prepare substrates, [apply primers,] and install the Work of this Section; including components, accessories in accordance with the manufacturer's instructions, except where more stringent requirements are shown or specified, and where project conditions, require extra precautions or provisions to ensure satisfactory performance of the Work.

3.2 EXAMINATION

A. Verification of Conditions: Examine the areas to receive the Work and the conditions under which the Work would be performed. Check carefully the provisions for anchorage and adjustment, allowances for expansion and contraction, and conditions of preset flashings and flashing connections. Contractor shall remedy conditions detrimental to the proper and timely completion of the Work. Do not proceed until unsatisfactory conditions have been corrected.

B. Verify dimensions of openings by field measurements so that aluminum windows and related items will be accurately designed, fabricated and fitted to the structure. Tolerances for supporting structure are specified in other Sections. Furnish anchor bolts and inserts for setting in concrete formwork or masonry indicated to support aluminum windows.

3.3 COORDINATION AND SCHEDULING

A. Sequence of Installation: Schedule installation of the aluminum windows in sequence with related elements of the Work specified in other Sections to ensure that window assemblies, including flashing, trim, and joint sealers, are protected against damage from effects of weather, age, corrosion, and other causes.

B. Coordination: Coordinate aluminum windows and related metal work with the work of other Sections and provide items to be placed during the installation of other work. Place such items, including connectors and anchors, accurately in relation to the final location of windows

3.4 PREPARATION

A. Substrate Acceptability: Commencement of installation shall constitute acceptance of substrate conditions by the Installer.

3.5 INSTALLATION

A. General: Install aluminum windows supported on shims and secured in place by bolting to clip angles and similar supports anchored to supporting structure. Use only the types of equipment, wedges, spacers, shims and other items during installation which will not corrode nor stain or mar the finish surfaces.

B. Assumed Design Temperature: Dimensions shown on Drawings are based on an assumed design temperature of 70 deg. F Fabrication and erection procedures shall take into account the ambient temperature range at the time of the respective operations.

C. Installation: Install aluminum windows plumb and true in alignment with established lines and grades without warp or rack of framing members. Anchor securely in place. Install components to drain water passing joints and condensation and moisture occurring or migrating within the assembly to the exterior. Lubricate operating hardware and other moving parts. Do not erect members which are warped, bowed, deformed or otherwise damaged to such extent as to impair strength or appearance. Remove and replace members damaged in the process of erection. Provide separators and isolators to prevent corrosion, electrolytic deterioration, and freeze-up of moving joints. Separate dissimilar metals with two coats of dielectric separator. Do not extend coating onto exposed or finished surfaces. Prime paint concealed ferrous metal with specified metal primer. Seal joints in a concealed manner, unless exposed sealant is shown. Comply with requirements of Section 079200 Joint Sealants. Install and demonstrate that the completed operable units are installed in a condition acceptable to the Owner and Architect.

D. Cutting and Trimming: Cut and trim component parts during erection only with the approval of the manufacturer or fabricator and in accordance with his recommendations. Do not cut through reinforcing members. Restore finish completely to protect material and remove evidence of cutting and trimming. Remove and replace members where cutting and trimming has impaired strength or appearance.

E. Welding and Soldering: Weld with electrodes and by methods recommended and in accordance with appropriate recommendations of the AWS. Use only methods which will avoid distortion or discoloration of exposed faces. Grind exposed welds smooth, using only clean wheels and compounds which are free of iron or iron compounds. Restore finish of component parts after welding and grinding. Solder only to fill or seal joints (not to form structural joints). Grind smooth and restore finish. Paint clip angles and other ferrous metal parts not exposed to view with specified rust inhibitive paint. Seal joints in a concealed manner.

F. Erection Tolerances: Erect aluminum windows within the following tolerances:

1. Variation from Plumb or Angle Shown: 1/8-in. maximum variation in 10-ft. height or 10-ft. run, non-cumulative.

2. Variation from Level or Slopes Shown: 1/8-in. maximum variation in 10-ft. height or 10-ft. run, non-cumulative.

3. Variations from Theoretical Calculated Position: Variations from theoretical calculated position as located in plan or elevation in relation to established floor lines, column lines and other fixed elements of the structure, including variations from plumb and level:

   a. 1/8-in. maximum variation in any column-to-column space, floor-to-floor height or 20-ft. run.

4. Offsets: Offsets in end-to-end or edge-to-edge alignment of consecutive members:

   a. 1/16-in. maximum offset in any alignment.

3.6 FIELD QUALITY CONTROL FOR EXTERIOR WINDOWS

A. Contractor's Quality Control Responsibilities: Contractor is solely responsible for quality control of the Work.

B. Water Penetration Test: After completion of the installation and nominal curing of sealants, and glazing compounds, and before installation of interior trim members, finishes and heating unit covers, test exterior windows for water leaks in accordance with AAMA Standard 501.2 "Specifications for Field Check of Metal Curtain Walls for Water Leakage." Provide powered scaffold, hose, radios, water supply and manpower to perform scheduled tests. Conduct tests in the presence of the Architect. Correct deficiencies observed as a result of this test.

C. Pressure Chamber Field Tests: Furnish portable test apparatus in accordance with AAMA 502, "Voluntary Specification for Field Testing of Windows and Sliding Glass Doors" consisting of a pressurized enclosure sealed against the aluminum window on the indoor side, and a spray rack of pipe grid with nozzles to spray water onto the exterior of the window. Provide test apparatus equivalent in size to mock-up, unless directed otherwise.

1. Air Infiltration: Test for resistance to air infiltration using static air pressure difference in accordance with AAMA 502 and ASTM E783 "Field Measurement of Air Leakage Through Installed Exterior Windows and Doors." Test at 6.24 psf test pressure.

2. Water Penetration: Test for water penetration in accordance with AAMA 502 and ASTM E1105 requirements. Test at pressure at 20% of design pressure or 12 psf whichever is greater.

3. Test Locations: Test areas shall be at location(s) indicated by Architect. Perform tests after completion of the installation and nominal curing of sealants,

   and before installation of interior trim members and heating unit covers. Conduct one successful test for each location.

3.7 ADJUSTING

A. Adjustment: Adjust operating sash of operable aluminum windows to provide an even, tight fit at contact points and weather stripping for smooth operation and weather tight closure. Adjust operable aluminum windows to operate smoothly with hardware and operators functioning properly. Lubricate hardware and other moving parts. Remove and replace any defective parts.

B. Touch-Up to Powder Coated Paint System: Touch up all damaged, scratched, marred or abraded exposed baked organic coatings utilizing manufacturer/fabricator approved air dried fluoropolymer resinous, or other paint system in matching colors and sheen using means and methods as recommended by the manufacturer. Obtain Architect's approval of finished touch-up.

3.8 CLEANING

A. Maintenance of Installation: Maintain the aluminum windows throughout the construction period in a clean and properly protected condition so that it will not be damaged at the time of acceptance by the Owner. Cleaning and protective methods shall be carefully selected, applied and maintained so that finishes will not become uneven or otherwise impaired as a result of unequal exposure to light and weathering. Remove deleterious materials from surfaces of aluminum and glass immediately. Protect glass from breakage immediately upon installation. Use streamers or ribbons suitably attached to framing and held free of the glass. Do not apply warning markings directly to the glass.

B. Cleaning: Upon completion of installation, wash exposed surfaces to leave clean and free from blemishes. Clean excess sealant or compound from glass and framing members immediately after application using solvents or cleaners recommended by manufacturers.

3.9 PROTECTION

A. Protection: Protect the Work during erection and construction to avoid non-uniformity of appearance or other defects in the Work. When requested for inspection of finishes, remove and replace temporary protection. Remove protection when no longer required.

END OF SECTION 08 5113

SECTION 11 6723 - RANGE EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes the Following:
1. RNG-01: Indoor Rubber Berm Trap
2. RNG-02: Running Man Targets
3. RNG-03: Lateral Target Turners
4. RNG-04: Range Control System
5. BSC-01: Ballistic Ceiling Baffles
6. NBC-01: Non Ballistic Acoustic Ceiling
7. ARB-01: Ballistic Rubber Wall
8. AWP-01: Acoustic Wall Panels

B. Related Sections

1. Section 055000 "Metal Fabrications" for miscellaneous steel fabrication parts

2. Section 061000 "Rough Carpentry" for wood furring, blocking, shims, and hanging strips required

3. Section 092216 "Non-Structural Metal Framing" for standard, interior non-load-bearing, metal-stud framing, with height limitations and ceiling-suspension assemblies.

4. Related sections in Division 27 "Communications"

~~4.~~ **5. Section 09 5113 Acoustical Panel Ceiling for Acoustical Ceiling assemblies.**

1.2 REFERENCES

A. General: Comply with the applicable provisions of the referenced standards except as modified by governing codes and the Contract Documents. Where a recommendation or suggestion occurs in the referenced standards, such recommendation or suggestion shall be considered mandatory. In the event of a conflict between referenced standards, this specification or within themselves, the more stringent standard or requirement shall govern:

B. Reference Standards:
1. National Institute of Occupational Safety and Health (NIOSH):
a. NIOSH 76-130 - Lead Exposure and Design Considerations for Indoor Firing Ranges.
2. Underwriters Laboratories (UL):
a. UL 94 HB - Horizontal Burning.
b. UL 94 - Standard for Safety of Flammability of Plastic Materials for Parts in Devices and Appliances.
c. UL 752 - Standard for Bullet-Resisting Equipment.
3. ASTM International (ASTM):
a. ASTM C423 - Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
b. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Materials.

4. International Organization for Standardization (ISO):
   a. ISO 9001 - Quality Management.
   b. ISO 14001 - Environmental Management.
5. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).
6. U.S. Environmental Protection Agency (EPA):
   a. EPA 40 CFR 50.12 - National Primary and Secondary Ambient Air Quality Standards for Lead.
7. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).
8. Society for Protective Coatings (SSPC):
   a. SSPC-SP6 - Commercial Blast Cleaning.
9. Conveyor Equipment Manufacturers Association (CEMA).
10. Unified Facility Criteria (UFC)
    a. UFC 4-179-02 Small Arms Ranges
11. OSHA
    a. OSHA CFR 29 1910.95 – Occupational Noise exposure
    b. OSHA CFR 29 1910.1025 - Lead

1.3 PERFORMANCE REQUIREMENTS

A. This is a performance-based specification. Architectural drawings indicated the design intent and establish the required geometry of visible components.

B. As performance-based documents, the drawings and specifications do not provide complete details of the proposed systems. It is the Contractor's responsibility to become fully informed of the extent and detailing of the Works and make all necessary monetary and time allowances.

C. The Contractor must engineer, test, fabricated, deliver, install, and guarantee all construction necessary to provide the Work that meets the specified performance.

D. Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects and Performance is indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines to one another and to adjoining construction.

E. Do not change intended aesthetic effects, as judged solely by the AOR, except with AORs approval. If changes are proposed, submit comprehensive explanatory data to AOR for review.

F. Any necessary part not specifically shown on the drawings or specified herein shall be furnished and installed if the omission is regularly and clearly a part of the equipment.

G. Detailed performance characteristics can be found in Part 2 Product details.

1.4 COORDINATION

A. Coordinate requirements for wall and overhead supports/attachment to structure, electrical items (conduit and power needs to equipment), mechanical ducts, lighting, fire protection and AV equipment.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include selected products and material descriptions, dimensions of all components and finishes for each product specified. **Show Options selected to clearly designate specific product for the project.**

2. Preparation instructions and recommendations.

3. Storage and handling requirements and recommendations.

4. Typical installation methods.

5. Laboratory Test Reports indicating Acoustic Sound Absorption Coefficients per ASTM C423 compliance to the performance specification for any assembly with Acoustic Requirements.

B. Shop Drawings: Show fabrication and installation details of each product.

1. Include plans, elevations, sections, details, and attachments to other Work.

a. Provide detailed drawings for Baffles and Closure panels for Coordination with elements mounted to Closure plates.

2. Provide loading information for all assemblies.

3. Include details of installation and diagrams for power, low voltage and control wiring. Include all electrical data and connection details. Coordinate all details on drawings of the exact locations.

4. Shop Drawings and Calculations for Rubber Berm Trap. Stamped by Professional engineer in the state of Nebraska.

C. Samples for design reference samples for initial verification of design intent, for each type of finish listed below in sets of three, representative of finish, color, and texture variations expected; approximately 12 by 12 by 2 inches

1. Initial Samples for Verification: Provide samples of all wall and ceiling surface finish of at least 12" x 12" size.:

a. Ballistic Rubber Wall
b. Acoustic Panel finish (Wall and Ceiling)

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: Maintenance Data: Submit the following:

1. Maintenance schedule for all operable equipment

2. Maintenance Manuals: Two (2) copies of bound maintenance manuals, describing the materials, and procedures for cleaning and maintaining each piece of equipment. Include manufacturer's data describing the materials and finishes used in the work including parts lists. Assemble manuals for component parts into single binders identified for each system.

B. Warranties: Special warranties as specified.

C. Live Fire Noise Level Testing Results

1.7 QUALITY ASSURANCE

A. Contractor's Quality Control Responsibilities: Contractor is solely responsible for quality control of the Work.

B. Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances and regulations of authorities having jurisdiction. Obtain necessary approvals from all such authorities.

C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with a minimum ten years documented experience.

D. Equipment Installer Qualifications: Company specializing in performing Work of this section. Minimum five years documented experience with projects of similar scope and complexity.

1. Installation shall be under the direct supervision of the Manufacturer.

E. Source Limitations: Provide each product type from single manufacturer ensuring uniformity.

F. Basis of Design: When particular manufacturers' materials, products or processes are specified for an item of Work, any one thereof is acceptable for the Contractor to choose. An alternative material, product or process will be considered if the Contractor submits a written substitution request per the requirements for substitutions in this section to the Architect to assist in determining whether the proposed substitution is acceptable; the burden of proof rests solely upon the Contractor.

G. Substitutions:

1. Contractor is solely responsible to fully meet the quality and full functional and performance requirements outlined in the specifications. Minor variations are acceptable with Owner and Architect written approval prior to bidding. No variations are permissible in quality, performance capabilities or material specified. Quality and performance are the criterium used by the Architect in determining if a substitution is acceptable not cost.

2. No unapproved prototypes will be allowed. A prototype is defined as a product that has not been in service for at least 3 years.

3. Variations in design or operation of equipment require the submittal of a list of substitutions to the Owner and Architect. The submittal shall include a detailed explanation of any and all deviations and individual line-item compliance certifications for each deviation and substitution. This information must be submitted and received by the Owner and Architect for review and approval at least 10 Days prior to the bid date.

4. Substitution proposal must include samples of all proposed product supplied to the Owner and Architect. Samples shall be working models of the exact dimensions proposed.

5. All substitution proposals shall list all proposed equipment and services, item by item, with detailed explanations stating why the items are equal to the specified item. Proposals with substitutions shall include the manufacturer’s specifications, cut sheets, and other data needed to demonstrate complete compliance with the specified requirements.

6. Substitution proposal shall list no less than five clients who have the same equipment that is being proposed. List must have full project name, address, POC with Phone & Email, completion date and project value.

1.8 DELIVERY, STORAGE, AND HANDLING

A. General: Deliver and store materials in manufacturer's original packaging, labeled to show name, brand, type, and grade. Store and handle in strict compliance with manufacturer's written instructions and recommendations.

B. Deliver all equipment boxed or crated to provide protection during transit and job storage.

C. Inspect equipment upon delivery for damage. Minor damages may be repaired, provided the finish items are equal in all respects to new work and acceptable to the Owner and Architect; otherwise, remove and replace damaged items immediately.

D. Store equipment at the site under cover in a secured place. Store equipment off the floor and in a manner to promote air circulation. Avoid the use of non-vented plastic or canvas shelters that could create a humidity chamber.

E. Project Conditions: Projects Prime Contractor to maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's recommended limits.

1.9 SEQUENCING

A. Supply products to affected trades in time to prevent interruption of construction progress.

1.10 WARRANTY

A. Manufacturer's Warranty: Provide manufacturer's standard limited warranty for defects in workmanship and materials for a period of one (1) year from the date of substantial completion.

B. The manufacturer shall instruct the Owner as to the proper operation and maintenance of the equipment a the time of acceptance of the work.

1. Maintenance Manuals:

2. Maintenance Data: Submit the following:

a. Maintenance schedule for all operable equipment

1. Maintenance Manuals: Two (2) copies of bound maintenance manuals, describing the materials, and procedures for cleaning and maintaining each piece of equipment. Include manufacturer's data describing the materials and finishes used in the work including parts lists. Assemble manuals for component parts into single binders identified for each system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, products by one of the following, or approved equal:
1. Action Target Inc., 3411 Mountain Vista Pkwy., Provo, UT 84606.
2. Inveris Training Solutions, 296 Brogdon Road, Suwanee, GA 30024.
3. Range Systems 5121 Winnetka Ave N New Hope, MN 55428

B. Products of other manufacturers will be considered only if evidence is furnished showing compliance with the minimum design and performance requirements specified.

C. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00 - Product Requirements.

2.2 RNG-01 RUBBER BERM TRAP

A. Description: Designed for all small arms including handguns, shotguns, and rifles. Utilizes specialty treated rubber granulate made from recycled materials, that safely stops bullets and maintains their basic original shape, thus minimizing broken up lead particles released into the atmosphere. Allows recovery of largely intact spent rounds.

B. Performance Criteria

1. Ballistic Rating: Designed for all small arms including handguns, shotguns using 00 buck shot or higher, and rifles with a maximum velocity of 3600 FPS and maximum energy of 3600 ft. lbs.

a. Independently tested to validate ballistic standards.

2. Comply with structural requirements. Structural stamp provided by licensed professional engineer in Nebraska

a. Deck Plate: Secure to framework with Grade 5 nuts and bolts in horizontal and vertical directions.

b. Toe of Deck Plate: Anchors to concrete floor creating a structural diaphragm.

c. Structural strap.

3. Construction:
a. Free standing.
b. Self-supporting.
c. Frame: Galvanized steel with interlocking and bolted connections.

4. Height: ~~As required to protect range with Bottom of Range Baffles~~ **10ft Tall**

5. Capacity: 80,000 rounds per lane minimum

6. Contains no EPA regulated materials or water-absorbing material.

7. No exposed metal surfaces in the target shooting zone.

8. Provide corner trap wall protection with 3/8” AR500 Ballistic plate covering Vertical drops at downspouts piping locations in the two corners of the trap area. Coordinate final size with the other trades.

9. Rubber Granules

    a. Chopped rubber, free of metal parts.

    b. Media: Chopped or granulated rubber, 1.25 in (32 mm) average size, pure SBR, and 99.9 percent free of loose wire and exposed steel.

    c. Minimum Depth: Perpendicular deck plane, 24 inches (610 mm); horizontal shooting depth, 48 inches (1219 mm).

    d. Captures fired rounds with little or no fragmentation or back-splatter.

    e. Fire retardant treated with treatment that meets ASTM E108 Class A standards.

    f. Meets ASTM E84 Class A requirements for flame spread and smoke development.

    g. Allows for use of oblique angles for shooting.

    h. Shall work with the Range layout or configuration shown in the drawings.

10. Deck Plate and Back Plate: 1/4 inch AR-500 armor deck plate and back plate.

11. Sidewalls: 3/8 inch AR-500 armor plate and back plate or minimum required to meet ballistic rating.

    a. Plates shall cover both trap area sidewalls in the bullet trap.

    b. Plates must only have vertical seams and no horizontal seams.

12. Eyebrow Protection: 3/8 inch AR-500 armor plate and back plate or minimum required to meet ballistic rating.

13. AR-500 armor plate shall:

    a. Have a factory applied coat of primer / paint.

    b. Complies with UL 752 standards for Level 8 protection.

    c. Independently tested to validate ballistic standards.

14. Maximum 15 degrees from horizontal as shown on drawings.

15. Back Plate Fascia: Replaceable 1-1/2 inch (38 mm) thick SBR panel.

16. Fire Protection: ASTM E108, Class A.

17. The bullet trap shall allow the recovery of largely intact spent rounds.

18. All metal parts not otherwise finished or plated shall be primed and painted.

2.3 RNG-02 RUNNING MAN TARGETS

A. Description: Running Man Target system with parallel tracks

B. Performance Requirements:

1. Runner: Computerized programmable control system

a. Mounting: Ceiling Mounted

b. Downrange Control Panel: UL listed

2. Wireless Control

a. Proximity Sensors: Reset trolley position and compensate for any drift.

b. Electrical Requirements: Operate on 208-240 volt single phase 20 A service.

c. Two lateral, parallel carriers, independent from one another.

3. Performance Requirements:

1) Automatic track length detection.

2) Automatic trolley drift compensation.

3) Change trolley direction and speed while moving.

4) Intelligent error reporting:
a) Cable slip detection.
b) Drive errors.
c) Proximity sensor errors.
d) Wiring errors.

5) Status monitoring.

6) Calibration.

7) Data logging.

8) Speed up to 20fps without knobs or switches

9) Accelerating up to 0.5 g

4. Trolleys:

1) Adjustable for target widths from 12 to 24 inches (305 x 610 mm).

2) Accept wooden 1 x 2 inch (25 x 51 mm) target holders.

~~7.~~**3) Powder coated and zinc plated components**

~~4.~~**5.** AR-500 armor plate shall:

a. Have a factory applied coat of primer / paint.

b. Complies with UL 752 standards for Level 8 protection.

c. Independently tested to validate ballistic standards.

2.4 RNG-03 TARGET TURNERS

A. Description: Allows targets to be repositioned laterally along a fixed rail without the use of tools. It will slide left and right for positioning in groups or creating open spaces on the range. Used in conjunction with the running man target system, these targets can represent bystanders or perpetrators to simulate real-world scenarios.

B. Performance Requirements:

1. 360 Turning

2. Ceiling Rail Mounted

3. AR 500 Ballistically rated armor plate.

4. Targets may be controlled individually or simultaneously.

5. Targets are easy to reposition in groups or divide laterally as needed.

6. Integrates with range control software for advanced features and functionality.

7. AR-500 armor plate shall:

a. Have a factory applied coat of primer / paint.

b. Complies with UL 752 standards for Level 8 protection.

c. Up to 3,888 fps and energy level up to 3,600 ft/lbs.

d. Independently tested to validate ballistic standards.

2.5 RNG-04 RANGE CONTROLS

A. Description: Control for Targetry

1. Advanced scenario building for writing and executing complex courses of fire.

2. Save unlimited courses of fire programs in local pc storage.

3. Integrated Target Timers: To control specified target presentation times for accurate qualification metrics.

4. Organize targets into groups for individual or simultaneous operations.

5. Integrated range layout configurator for dynamic modification of course layouts.

6. Integrates both target systems- running man targets and 360 target turners

7. Provides Input/Output command control for external devices.

8. Control Systems: Two Wireless Tablets and Control Room Desktop Touch Screen Controls.

9. Range Server to be located in the back of the Control Room, wall mounted.

2.6 **BSC-01:** ~~RNG-05~~ INDOOR RANGE **BALLISTIC** CEILING BAFFLES

A. Description: Range Ceiling protection Designed to enclose the Range Ceiling for ballistic and acoustical purposes. Shelters the ceiling area and redirects rounds toward the bullet trap and minimizes bullet splatter from exiting the panel or returning to the open range area.

B. Performance Requirements:

1. 3/8 inch AR-500 armor plate panels required to meet UL 752 Level 8 – Up to 3,888 fps and energy level up to 3,600 ft/lbs.

2. Configuration: Tactical Baffles with overlapping plates set at 15 degrees.

3. Acoustic Material

a. Acoustic Performance of Assembly to meet: NRC .85 or higher meeting the below testing criteria.

b. Compliant with ASTM E-84 Class 1 flammability requirements and UL 1715 corner burn test

c. Passes ASTM G 21 for fungus resistance and UL 121 for microbial growth.

d. Sound Absorption Coefficients per ASTM C423.

e. Acoustic Material must meet the Following minimum octave band absorption requirements:

125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz
0.15	0.39	0.61	0.75	0.85	0.99

4. No protrusions not complying with design drawings

5. Provide an enclosure plate between baffles. Provide shop drawings detailing this for coordination with lights and sprinklers.

6. Provide closure plate and overlap over **range,** target area and trap to prevent bullets from escaping range in this area. Coordinate with mechanical exhaust and lighting.

7. Connection type: Structural flexible cable hangers per International Building Code (IBC) for areas that require a structural stamp for baffling.

8. Wall Attachment: ~~12" Concrete Walls –~~ **CMU Walls –** see drawings.

9. Splatter protection with Air Gap; Fire Treated 1" minimum thickness. Splatter protection thickness can double as acoustical material.

10. Coverage: Full Length of the Range, see drawings.

11. No gaps are allowed through which bullet fragments may pass.

12. AR-500 armor plate shall:

    a. Have a factory applied coat of primer / paint.

    b. Complies with UL 752 standards for Level 8 protection.

    c. Up to 3,888 fps and energy level up to 3,600 ft/lbs.

    d. Independently tested to validate ballistic standards.

13. Drawings depict conceptual baffle layouts. **Coverage shown must be met at a minimum. Bottom of baffle height must stay above 9ft at target area.** Final Baffle layouts, arrangement, finish and details by Vendor to meet performance criteria in specifications.

14. Color: Gray, factory finish.

2.7 NBC-01: INDOOR RANGE NON-BALLISTIC CEILING BAFFLES

A. Description: Range Acoustic Ceiling for acoustical purposes. Shelters the ceiling area. Non Ballistic

B. Performance Requirements:

1. Configuration: As shown on drawings.

2. Acoustic Material

a. Acoustic Performance of Assembly to meet: NRC .85 or higher meeting the below testing criteria.

b. Compliant with ASTM E-84 Class 1 flammability requirements and UL 1715 corner burn test

c. Passes ASTM G 21 for fungus resistance and UL 121 for microbial growth.

d. Sound Absorption Coefficients per ASTM C423.

e. Acoustic Material must meet the Following minimum octave band absorption requirements:

125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz
0.15	0.39	0.61	0.75	0.85	0.99

3. **Connection type: Structural flexible cable hangers per International Building Code (IBC) for areas that require a structural stamp for baffling.**

4. **Wall Attachment: CMU Walls – see drawings.**

5. **Coverage: see drawings.**

6. **Drawings depict layouts., arrangement, finish and details by Vendor to meet performance criteria in specifications.**

7. **Color: Gray, matching BSC-01**

2.7**2.8** ~~RNG-06~~ **ARB-01** BALLISTIC RUBBER PANELS

1. Description: Composite recycled vulcanized rubber with a urethane binder and ballistic steel armor plate. Steel panel system to allow 180 degree multi-direction firing within the range towards the bullet trap.

2. Use in conjunction with AR 500 armor plate, see drawings for substrate Provides ballistic barrier that contains bullet splatter and lead dust.

3. Coverage: See drawings. **Must go to underside of baffles.**

4. Size: 24 x 24 x 2 inches (610 x 610 x 51 mm).

5. Durometer: 60 Shore A. Plus or minus 5.

6. Intumescent UL E-84 fire retardant.

7. Splatter protection with Air Gap; Fire Treated

8. Ballistically safe as certified by the Contractor and Manufacturer.

   a. Independently tested to validate ballistic standards

9. Acoustical sound absorption surface meeting NRC. 65

   a. Independently tested to validate acoustic standards

10. Acoustic Material:

    a. Compliant with ASTM E-84 Class 1 flammability requirements and UL 1715 corner burn test

    b. Passes ASTM G 21 for fungus resistance and UL 121 for microbial growth.

    c. Sound Absorption Coefficients per ASTM C423.

11. No gaps are allowed through which bullet fragments may pass.

12. AR-500 armor plate shall:

    a. Have a factory applied coat of primer / paint.

b. Complies with UL 752 standards for Level 8 protection.

c. Up to 3,888 fps and energy level up to 3,600 ft/lbs.

d. Independently tested to validate ballistic standards.

13. Color: Black

~~2.8~~**2.9** ~~RNG-07~~ **AWP-01** ACOUSTIC WALL PANELS

1. Wall Attachment: See Drawings

~~2. Splatter protection with Air Gap; Fire Treated~~

~~3.~~**2.** Coverage: See drawings

1. Acoustic Material

a. Acoustic Performance of Assembly to meet: NRC .85 or higher.

b. Compliant with ASTM E-84 Class 1 flammability requirements and UL 1715 corner burn test

c. Passes UL 94.

d. Passes ASTM G 21 for fungus resistance and UL 121 for microbial growth.

e. Sound Absorption Coefficients per ASTM C423.

f. Acoustic Material must meet the Following minimum octave band absorption requirements:

125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz
0.15	0.39	0.61	0.75	0.85	0.99

2. Color: Gray – factory finished. **Matching NBC-01 and ARB-01 panels.**

PART 3 - EXECUTION

3.1 GENERAL

A. Manufacturer's Instructions: Prepare substrates and install the Work of this Section; including components, accessories in accordance with the manufacturer's instructions, except where more stringent requirements are shown or specified, and where project conditions, require extra precautions or provisions to ensure satisfactory performance of the Work.

3.2 EXAMINATION

A. Verification of Conditions: Examine the areas to receive the Work and the conditions under which the Work would be performed. Remedy conditions detrimental to the proper and

timely completion of the Work. Do not proceed until unsatisfactory conditions have been corrected.

3.3 PREPARATION

A. Substrate Acceptability: Commencement of installation shall constitute acceptance of substrate conditions by the Installer.

3.4 INSTALLATION

A. Install in accordance with manufacturer's instructions, approved submittals and in proper relationship with adjacent construction.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Services: Manufacturer provides field quality control with onsite personnel for instruction or supervision of product installation, application, erection or construction.

3.6 ADJUSTING

A. Test the functionality of all systems, safety systems, target systems and control systems.

B. Correct any deficiencies and replace any equipment not operating as required.

3.7 PROTECTION

A. Clean products in accordance with the manufacturer's recommendations.

B. Touch-up, repair or replace damaged products before Substantial Completion.

3.8 TESTING

A. Ambient and Live Fire Noise Level Testing post installation required

B. Reverberation Time:

The acoustic design must include mitigation methods and construction materials to reduce the measured Reverberation Time 60dB (RT60) to less than 1.3 seconds in the 250 Hz, 500 Hz, 1 kHz, 2 kHz, and 4 kHz octave bands in accordance with ASTM E2235. Testing must be performed, post installation, in accordance with ASTM E2235 with noise generating devices placed at the firing line meeting testing requirements listed in this document.

1. Aim device parallel with the line of fire when not using omni-directional devices. The contractor must provide certified test results showing that the reverberation time and noise exposure limit requirements are met.

2. The contractor must provide certified test results showing that the reverberation time requirements are met after installation per UFC 4-179-02: 4-20.5.1 Sound Decay Rate Testing.

   Per UFC 4-179-02, All Ambient and peak noise level measurements must be taken with all range equipment on, including the air handling and dust collection systems, and no gun fire.

All live fire noise levels must be taken with all range equipment on and with continuous gunfire from four Owner provided shooters firing the maximum caliber design weapon, at full automatic if applicable, and using ball ammunition. Firing must be from the most up range firing line without using suppressors.

C. Exposure Limits:

The contractor must provide certified test results for the ambient and live fire noise levels within the range and areas designated in the UFC do not exceed levels shown in Table 4-3 below and OSHA guidelines for exposure limits.

Table 4-3 Maximum Noise Levels

	Maximum Ambient Noise Levels (dBA)	Maximum Live Fire Noise Levels (dBA)
Inside the Firing Range	75	Sound Decay Rate Test
Inside the Range Control Booth	60	85
Offices	45	55
Classrooms	45	55

3.9 INSTRUCTION

A. The manufacturer shall include and schedule training time to instruct the Owner's personnel as to the proper operation and maintenance of the equipment at time of acceptance of the work.

END OF SECTION **11 6723**

SECTION 23 0100

RANGE MECHANICAL (Revised AD-2)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Range Ventilation System Contractor (RVC) Definition.
2. RVC Experience Clause.
3. RVC Scope of Work.
4. System Description.
5. General Direct Digital Control Requirements.
6. Radial Diffuser Plenums.
7. Filters.
8. Ductwork.
9. Range Ventilation Air-Handling Units.
10. Acceptance Test/Commissioning.
11. Operation and Maintenance.

1.2 RANGE VENTILATION SYSTEM CONTRACTOR DEFINITION

A. The Project requires a specialized engineer/contractor with experience in indoor firing range ventilation systems to design, construct, balance, and commission the range ventilation systems. The specialized contractor shall be designated as the range ventilation contractor (RVC) for the purpose of this project and shall have the experience required in part 1.3. The range ventilation contractor shall submit any intended deviations to guarantee the performance of the system or shall accept and provide the system as designed and shall be solely responsible for all equipment, controls, ductwork, and any other necessary components not listed or shown to provide a complete working system. The range ventilation contractor shall at no expense to the owner make changes to the system until satisfactory testing results are achieved as approved by the owner.

B. Design of the Range Ventilation System shall be provided by a Licensed Professional Engineer in the State of Nebraska, who shall take all responsibilities of proper design in coordination with the RVC contractor to provide a system that meets all NIOSH, OSHA, IBC, IMC, IECC, State of Nebraska and City of Grand Island codes, as required at this project location.

1.3 RANGE VENTILATION CONTRACTOR EXPERIENCE CLAUSE

A. The range ventilation contractor shall have experience in construction, balancing, and commissioning of ventilation systems meeting the National Institute of Occupational Safety and Health (NIOSH), Occupational Safety and Health (OSHA), and Environment Protection Agency (EPA) criteria requirements similar to those included in this project, specifically, providing ventilation for multi-lane ranges having laminar or even air flow averaging 75FPM (+/- 5%) over the entire cross sectional area of the firing line, with no reading less than 50 FPM and maintaining a negative pressure of 0.05 (+/- 0.02) inches water column, with similar controls to those required for this project.

B. The RVC shall submit with the bid a list of at least ten ranges in operation within the continental United States of which all ten must be government owned and tested by an industrial hygienist, with at least a 40 foot firing line, that meets these requirements and will be accessible to the owner for verification testing. Include range information, including range width, number of lanes, description of control system, and name/address of owner. The owner has the option to verify that the existing ranges meet these requirements. If ranges do not meet requirements the RVC

will be deemed unsuitable. The experience pertains to only that work which the range ventilation contractor has done directly and was responsible for the complete system including design, controls, equipment, and ductwork.

C. The RVC shall show proof of pollution liability insurance. The RVC shall procure and pay for pollution liability insurance with an insurance company currently rated no less than “A VII” by A.M. Best, and acceptable to the owner. The coverage must provide for third-party coverage for bodily injury, property damage, defense, cleanup, and related costs as a result of pollution conditions (sudden/accidental or gradual) arising from contracting operations performed by or on behalf of the range ventilation contractor. The limit of the policy shall not be less than $3,000,000 and not subject to a retention greater than $15,000.

D. The RVC shall show proof of errors and omissions insurance for not less than $1,000,000.00.

E. The RVC shall provide specialized supply air radial distribution devices that have proven to provide ‘laminar’ or even airflow at the firing line. The radial distribution devices shall be a standard manufacturer product that has been used on at least 10 law enforcement or government projects that have been tested by an industrial hygienist and have been provided to provide ‘laminar’ or even airflow and meet the exposure requirements per OSHA 29 CFR 1910,1025 and 1926.62.

F. Range Ventilation Contractor (RVC) Basis of Design: Carey’s Small Arms Range Ventilation. Contact: Brian Wright 708-532-2449.

G. Other RVC contractors shall submit preliminary information as defined above to achieve approval for bidding. Other RVC contractors desiring approval shall comply with Section 01 6000, submitted 10 days prior to bid date.

1.4 RVC SCOPE OF WORK

A. The RVC shall build the ventilation system for the live fire indoor range and oversee all HVAC work for the live fire indoor range project including but not limited to the range ventilation system, and all related controls and safeties. The RVC shall provide all wiring required for the range ventilation low voltage controls and safeties, including all DDC controls. All control cabling and tubing shall be run continuously in conduit. RVC shall furnish equipment with factory installed variable frequency drives (VFDs) for the range ventilation system fans. All low voltage control connections to the VFDs shall be provided by the RVC, along with setup, programming, and commissioning of the VFDs. The RVC shall provide all testing and balancing and commissioning of the range ventilation system as outlined in 3.1.

B. Range Ventilation System Control Maintenance and Performance Monitoring.

1. The range ventilation contractor shall provide 1 year's remote control maintenance and warranty along with monthly performance check for the range ventilation system and 24/7 technical support as part of this construction contract. The ventilation systems performance shall be remotely checked at least once a month to perform routine control component maintenance and check controls on all ventilation equipment. Remote communication shall be capable of sending information on all control points for the DDC system.

C. Controls and Instrumentation (DDC/BAS)

1. The range ventilation contractor shall install a standalone independent direct digital control (DDC) system to control the range ventilation system. The RVC shall provide a range DDC control panel. The range ventilation contractor shall provide a complete system of controls to operate all range ventilation systems and equipment in full accordance with the specifications and system descriptions provided, including controllers, sensors, actuators, wiring, conduit, tubing, and all other types of materials, equipment, and services whether or not specifically indicated or called for.
2. The Range control system shall have a BACnet connection to the owner’s Trane Synchrony campus control system, such that the owner’s maintenance staff will be able to view all graphics of the RVC DDC control system.

3. Provide 16 hours of training for the Owner's staff during system start up and provide follow-up training and maintenance services to the Owner for the first year of warranty.
4. RVC control contractor shall commission their own controls and shall coordinate with the Cx agent where there are any interactions between the new RVC DDC system and the new BMS DDC system. In general, the two systems are not to be integrated together.

1.5 SYSTEM DESCRIPTION

A. The range ventilation system serves the firing range portion of the building to include the bullet trap area. The system will be a recirculation system with 25% outside air. The system shall be designed for approximately 10% more return air than the supply air to the range and shall modulate to maintain a negative pressure in the range as referenced to the base building area. The system shall have modulating gas heat and DX cooling with modulating hot gas reheat for dehumidification control. All new refrigeration systems in the RTU's will need to have acceptable government approved next generation refrigerants.

B. The Range Space Design Air conditions:

1. Summer: 71°F 52%RH
2. Winter: 71°F dry bulb.

C. Outside Air conditions:

1. Summer: 94°F dry bulb / 75°F wet bulb
2. Winter: -6.1°F dry bulb

D. Supply System: The supply air distribution system has been designed in accordance with the National Institute of Occupational Safety and Health (NIOSH) suggested design criteria. These requirements have proven to provide exposures under the Occupational Safety and Health Association (OSHA) allowable limits for lead exposure found in OSHA 29 CFR. The system shall be constructed to provide an even air flow (75 fpm +/- 5 percent with no single reading less than 50 fpm) in each firing lane and at each firing position (standing, kneeling, and prone) across the width of the range that meets the acceptance criteria provided herein. Supply air from the supply fan(s) shall be delivered through a continuous graduated plenum, and then through ductwork into radial diffuser system. The branch ductwork into the diffuser system shall have dampers to allow for adjustment of air into the individual diffuser sections. The diffuser system shall consist of a series of adjacent sections from which air enters the range through the radial diffuser. The supply diffuser shall not restrict view into the range from the range control booth.

1. Provide a supply air flow measuring station to measure supply air from each MAU air handler.

E. Supply filters: Provide single stage MERV8 filters to filter outside air.

F. Return system: The return air distribution system has been designed to evenly pull air across the range space at the trap end of the range. The return/exhaust fan and filter system shall be designed to allow for 350 to 500 fpm velocities across the filter media. Provide a minimum two stage filter system including a MERV15 stiff pocket bag filter, and a high-efficiency particulate arrestor (HEPA) filter for the final filter. The pocket filters shall have an empty 2" pre-filter track for optional future use. The final filter media shall be at least 99.97% (HEPA) @ 0.03 micron. The return fan(s) shall be sized to allow for an operational static pressure of at least 7.0 inches water gauge at the desired volume of air flow, with a "clean" HEPA filter loss of 1.25" water gauge and a minimum of 5.25" across the "dirty" HEPA filters to allow extended time between filter changes. The return/exhaust fan shall modulate through a variable frequency drive to maintain a negative air pressure in the firing range and bullet trap area of -0.05 inches of water column relative to the base building area. The negative pressurization requires tight seals on all wall and roof joints at the perimeter of the firing range and bullet trap area.

1. On the inlet to each exhaust air unit, provide an air flow measuring station to measure system air flow.

G. Filter access: provide HEPA filter rated filter housing for the HEPA filters. Provide easy access, removal, and replacement of supply and return/exhaust filters. Access doors shall be located with no adjacent equipment, pipes, or other features blocking or hindering access, and shall be easily opened without any special tools or equipment. Access door shall close tightly and evenly around the perimeter. Filters shall be capable of being removed and replaced without any special tools or equipment.

1.6 GENERAL DIRECT DIGITAL CONTROL (DDC) REQUIREMENTS

A. The range ventilation DDC system will include range "do not shoot", "safe to shoot" and “warning" status lights located on remote start/stop station. The system shall provide status of mechanical systems according to the following:

1. "Safe to shoot" light will be on only when all systems are within operating parameters. Otherwise, "do not shoot" light will be on.
2. Conditions to turn on "do not shoot" light (if any of these conditions occur, controls shall activate light, sound alarm, and shut down of range ventilation system):
    a. Do not shoot light shall remain on during system start-up (no alarm).
    b. Either MAU or FAU VFD is offline or offnet or in hand.
    c. Range supply pressure is less than the design rate - set at commissioning.
    d. Range to base building differential pressure is outside the upper limit (0 inches of water, non-negotiable) for a given time (2 minutes typical, but adjustable).
    e. Total return filter pressure is higher than manufacturer allowable unit pressure rating.
    f. Fire alarm input is activated.
    g. Emergency kill switch is activated.
3. Controls to turn on "warning" light (if any of these conditions occur, controls shall activate light):
    a. Return filters differential pressure is past limit.
    b. System runtime hours are past maintenance set points.
        1) RVC shall program digital runtime maintenance clocks into graphics screen with digital reset buttons for 200hrs, 600hrs, 2400hrs.
4. Controls to turn on "warning" light and sound alarm (if any of these conditions occur, controls shall activate light and sound alarm):
    a. Any range door is open for longer than 15 seconds (adjustable) during system start-up.
    b. Any range door is open for longer than 1 minutes (adjustable) during normal operation.
5. Provide DDC with all points necessary to meet all range ventilation system requirements and including but not limited to:
    a. Outside air temperature.
    b. Range ventilation status.
    c. Discharge temperature.
    d. Discharge humidity.
    e. Supply air static pressure.
    f. FAU exhaust fan start/stop with VFD.
    g. FAU exhaust fan run status.
    h. FAU exhaust fan fault status.
    i. Return air combination stage 1 & 2 filter status.
    j. Return air HEPA filter status.
    k. Exhaust damper position.
    l. Outside air damper position.
    m. Cooling command.

n. Cooling coil leaving temperature.
o. Heating command.
p. Reheat command.
q. MAU return air temperature.
r. Range to base building air pressure differential.
s. All points from FAU variable frequency drive.
t. All points from MAU package unit controller.

6. Range ventilation system startup and operation:
   a. The operator will push start/stop button.
   b. The “Starting-up / Do Not Shoot” light shall turn on.
   c. Dampers shall open to setpoints determined at commissioning.
   d. MAU and FAU fans shall start when dampers end switches make. FAU fan shall start slightly ahead of MAU fan.
   e. The FAU variable frequency drives shall modulate the FAU fan throughout the occupied cycle to maintain range pressure of negative 0.05” wc as referenced to the base-building.
   f. MAU fan shall slowly ramp up to setpoint speed determined at commissioning. FAU fan shall modulate to maintain negative pressure throughout the ramp.
   g. Two minutes after MAU has reached setpoint speed and system has stabilized, the system shall turn off the “start-up / do not shoot” light and shall turn on the “safe to shoot” light.
   h. If outside air is less than setpoint (adjustable) MAU shall enable heating mode and modulate to maintain supply air temperature setpoint (adjustable).
   i. If outside air is greater than setpoint (adjustable) MAU shall enable cooling mode, stage on compressors, and modulate hot gas reheat to maintain range supply temperature setpoint (adjustable).
   j. The range shall be shut off with the push button switch. There shall be a lockout period of 5 minutes after shutdown where the system cannot be restarted.
   k. System will remain off during unoccupied conditions. Cycle system on as needed to heat range during unoccupied conditions.
   l. It is recommended that the user runs the ventilation system for 15 minutes after range use before shutting down.
7. DDC system shall provide the following minimum data trending points:
   a. Differential static pressure.
   b. Filter differential for pre filters.
   c. Filter differential for HEPA filters.
   d. Supply static pressure.
   e. MAU discharge temperature.
   f. Cooling coil leaving temperature.
   g. Cooling command.
   h. Reheat command.
   i. Heating command.
   j. Outside air temperature.
   k. MAU return air temperature.
   l. Range supply temperature.
   m. Range supply humidity.
   n. FAU fan command.

o. Space temperature.
p. Space humidity.
q. Supply air CFM.
r. Exhaust air CFM.

PART 2 - PRODUCTS

2.1 RADIAL DIFFUSER PLENUMS

A. Requirements

1. The RVC shall supply specialized supply air radial distribution devices that have proven to provide "laminar' or even air flow at the firing line. The radial distribution devices shall be a standard manufacturer product that have been in use for over 5 years and have been used on at least 10 United States military projects that have been tested by an industrial hygienist and have been proven to provide "laminar" or even airflow and meet all exposure requirements per OSHA 29 CFD. 1910.1025 and 1926.62. Basis of design: Carey's Small Arms Range Ventilation ABS radial diffusers, or an approved equal.

B. Construction

1. Type: Perforated radial diffuser and associated sheet metal plenum.
2. Plenum shall be constructed with a header for attaching grid ceiling.
3. Diffusers shall be fabricated to meet size and capacities shown on the design drawings.
4. Plenums shall be provided with round holes in the top for connecting spiral sheet metal crossovers.
5. Radial diffuser plenums shall be supplied with equivalent size round manual volume balancing dampers shipped loose for field installation. Damper shall be constructed of 24 ga. sleeve with an 18 ga. blade approximately 1 inch smaller than the round duct size. The damper shall have a 1/2" manual quad and 2 piece 1/2" rod welded and strapped to blade with bearing sleeves.
6. Turning vanes shall be factory-fabricated and factory installed inside the sheet metal plenum.
7. Radial diffuser plenums shall be constructed with perforated ABS plastic face and galvanized sheet metal edges exposed to view rolled or otherwise stiffened and painted to match plastic.
8. Where diffuser length necessitates sectional installation, joints between diffuser sections shall appear as hairline cracks.

2.2 FILTERS

A. Supply Air Filters

1. Flat-panel filter units design and fabricated for disposal when dust-load limit is reached.
2. Dry or adhesive-coated filter media, as standard with manufacturer.
3. Filters shall be rated for minimum 2000 cubic feet per minute airflow.
4. Maximum air flow through filters: Not exceeding manufacturer's published rated capacity but not exceeding 500 feet per minute at 0.10-inch w.g.
5. Filters shall be UL900 Class I listed.
6. Filters shall have a minimum rating of MERV-8.

B. Return Pocket-filters:

1. Pocket filter units design and fabricated for disposal when dust-load limit is reached.
2. Filters shall be rated for minimum 2000 cubic feet per minute airflow.

3. Maximum air flow through filters: Not exceeding manufacturer's published rated capacity but not exceeding 500 feet per minute at 0.50-inch w.g.
4. Filters shall be UL900 Class I listed.
5. Filters shall have a minimum rating of MERV-14.

C. Return High Efficiency Particulate Arrestor (HEPA) Filters:

1. Media shall be spaced with corrugated aluminum separators.
2. HEPA filters shall be constructed of 16 gauge galvanized steel. The cell side provides for a very rigid filter and all interior surfaces of the air filter media are sealed to the enclosing frame.
3. HEPA filters are manufactured to provide a leak-free seal between the media pack and cell side. All sides of the media pack are to be sealed with an adhesive to ensure filter integrity.
4. HEPA filters shall be supplied with a standard downstream sealing gasket. The gasket shall be an interlocking dove tail design constructed of neoprene and attached to the HEPA cell side.
5. HEPA filters shall be tested and labeled for minimum DOP efficiency on 0.3 micron particles.
6. HEPA filters shall be 12" deep and conform to industry standards for fit and performance.
7. Capacity based on air-handling capacity of unit to which it is applied with velocity limited to maximum of 500 feet per minute through filter based on net filter area.

2.3 DUCTWORK

A. Construction:

1. All range ventilation ductwork shall be 2" water column pressure rated and installed per SMACNA Standards.
2. Use a flanged type of transverse duct connector or DUCTMATE type connection on all range ventilation ductwork.
3. Seal all range ventilation ductwork with united or equivalent sealant. Seal all transverse joints, longitudinal seams, connections, and duct-wall penetrations. All range ventilation ductwork shall meet the requirements of seal class A.
4. Follow SMACNA standards for duct construction and duct reinforcement details.
5. All ductwork, return openings, supply openings, and equipment shall be protected from construction dust throughout the duration of the project. To prevent the accumulation of dust, debris, and foreign material during construction, perform temporary dust control protection. Protect the distribution system (supply and return) with temporary seal-offs at all inlets and outlets at the end of each day’s work. Keep temporary protection in place until system is ready for start-up.

AD-2: Section 23 0100; 09/25/2024: Delete Paragraph 2.4.

~~**2.4 RANGE VENTILATION AIR-HANDLING UNITS**~~

~~A. FAU / MAU units shall be selected as needed to meet range air flow requirements. Refer to sections 23 73 13 and 23 74 14 for roof mounted air handlers and packaged roof top equipment minimum construction requirements. Units selected shall comply with the approved manufacturer’s listed in those sections.~~

AD-2: Section 23 0100; 09/25/2024: Add Paragraphs 2.5-2.7.

2.5 RANGE VENTILATION PACKAGE FILTRATION AIR-HANDLING UNITS

A. FAU Unit Casing

1. The unit shall be constructed of a complete frame and removable double wall panels. Panels and access doors shall be 2-inch nominal thickness, thermally broke double wall, injected with foam insulation for an R-value of not less than R-13. Removal of side panels must not affect the structural integrity of each module. The casing must be able to with stand up to 9 inches of negative static pressure and up to five inches of positive static pressure. All exterior wall panels shall be pre-painted G60 galvanized steel. The inner liner shall be G90 galvanized steel. The panel deflection shall not exceed L/240 at 125% of design static pressure. The casing leakage shall not exceed 0.5 CFM per square foot of cabinet area at up to six inches of negative static pressure and up to five inches of positive static pressure. The unit may be delivered in modules. Modules to module assembly shall be accomplished with an overlapping, full perimeter, insulated, internal splice joint sealed with bulb type gasketing on both mating modules.
2. Access doors shall be flush mounted to cabinetry, with a minimum of two six inch long stainless steel piano-type hinges, latch and full size (4.5" minimum) handle assembly and full perimeter gasket.
3. Units shall be factory assembled (within freight limitations) to a galvanized steel base rail.
4. Outdoor installed units shall be specifically designed for outdoor installation which shall include the following features:

    a. Cross-broken roof caps to eliminate standing water.
    b. C-Shape cap over roof seam. Caps are extended over piping vestibules when provided.
    c. Drip shield are provided on all sides of unit and over all doors.

B. FAU Fan

1. FAU fan shall be centrifugal airfoil belt drive type.
2. Fans shall be certified as complying with ARI standard 430. Centrifugal fans shall be dynamically and statically balanced at the factory as a complete fan assembly (fan wheel, motor, drive, and belts). Fan shafts shall not pass through their first critical speed at any cataloged rpm.
3. Fans shall be equipped with self-aligning, antifriction pillow block grease lubricated bearings with a minimum L-50 life of 200,000 hours.
4. Fan and motor assembly shall be isolated from the unit casing by spring isolators, furnished and installed at the factory.

C. FAU Motor

1. Motors shall be mounted integral to an isolated fan assembly furnished by the manufacturer. Motors shall be mounted inside the unit casing. Motor mounts shall be direct drive and sized to allow room for filter loading.
2. Drives shall be fixed pitch and shall be selected at a minimum 1.3 service factor.
3. Motors shall be premium efficiency and suitable for operation on a variable frequency drive.

D. FAU Filters

1. Provide a three stage filter section with 3 filter racks and guides with hinged and latching access doors for filter removal on the drive side of the unit.
2. Return Air Filters shall consist of:

    a. Empty 2" pre-filter track
    b. Min 21" deep, MERV 15 stiff pocket-filters
    c. 12" deep, High Efficiency Particulate Arrestor Filters (HEPA) 99.97% efficient

E. FAU Curb

1. Equipment curb shall be fabricated from G90 Galvanized Sheet metal with standard manufacturer finish. The curb manufacturer shall be fabricated with a pitch to match the structural slope of the roof.

F. Basis of Design:

1. Daikin Skyline OAH or equal

2.6 RANGE EXHAUST FANS AND SEPARATE HEPA RACKS

A. Range Exhaust fans

1. Fans must be tested in accordance with AMCA Publications 211 and 311 in an AMCA accredited laboratory and certified for air and sound performance. Fan shall be licensed to bear the AMCA ratings seal for fan energy index, air performance (AMCA 210) and sound performance (AMCA 300). Fan housing to be aerodynamically designed with high-efficiency inlet, engineered to reduce incoming air turbulence. Tubular housing shall be completely welded and coated with a minimum of 2-4 mils Permatector (Polyester Urethane), electrostatically applied and baked. Housing and bearing support shall be constructed of welded structural steel members to prevent vibration and rigidly support the shaft and bearings. An access door shall be supplied for impeller inspection and service. OSHA compliant motor cover to be installed to completely cover the motor pulley and belt(s). Fan impleller shall be electronically balanced both statically and dynamically to balance grade G6.3 per ANSI S2.19. Impellers constructed of steel shall be coated with a minimum of 2-4 mills of Permatector (Polyester Urethane), electrostatically applied and baked. Motors shall meet or exceed EISA efficiencies. Motors to be NEMA T-frame 1800 or 3600RPM, ODP with a 1.0 service factor and VFD rated. Motors shall have shaft grounding and be premium efficiency. Bearings shall be selected for a minimum basic rating fatigue life (L-10) of 200,000 hours. Bearings shall have extended lube lines with Zerk fittings to allow for lubrication from the exterior of the fan.
2. Fans shall be isolated from ductwork with heavy duty canvas connections and thrust restraints. Fans shall sit on restrained, 2-inch direct mount isolator springs rated for outdoor use.
3. Basis of Design: Greenheck QEI Mixed Flow Belt Drive or equal
4. Equipment curb shall be fabricated from G90 Galvanized Sheet metal with standard manufacturer finish. The curbs shall be fabricated with a pitch to match the structural slope of the roof.

B. Range HEPA Racks

1. Range HEPA racks shall be constructed from 14ga galvanized steel to withstand a static pressure of +/- 10”wc. Rack housing shall be double wall insulated with 1.5# insulation and rated for exterior use with a weatherproof cap. Rack shall have factory installed pressure ports. Filter tracking shall be extruded aluminum with woven nylon pile seals. Filter access doors shall be sealed with closed cell neoprene gasket. HEPA racks shall consist of 3 stages: empty 2” pre-filter track for optional future use, 1” track for MERV15 stiff pocket filter up to 30” deep, final HEPA filter slots with gasket seals.
2. First set of stiff pocket bag filters and HEPA filters shall be provided with rack.
3. Basis of design: AFI SA3S Aire-loc
4. Equipment curb shall be fabricated from G90 Galvanized Sheet metal with standard manufacturer finish. The curb shall be fabricated with a pitch to match the structural slope of the roof.

2.7 RANGE VENTILATION MAKE-UP AIR UNITS

A. MAU General Description

1. Confirguration: Fabricate unit with
    a. Return air / Economizer section
    b. Filter section
    c. Cooling Coil section with modulating hot gas reheat
    d. Draw-through supply fan section
    e. gas heat section
    f. Discharge plenum section
    g. Condensing unit section
2. The complete unit shall be ETL/MEA listed.
3. The unit shall be specifically designed for outdoor rooftop application and include weatherproof cabinet. Each unit shall be completely factory assembled and shipped in once piece. Packaged unit shall be shipped fully charged with Refrigerant R410A.
4. The unit shall undergo a complete factory run test prior to shipment. The factory test shall include final balancing of the supply fan assemblies, a refrigeration circuit run test, a unit control system operations checkout, test and adjustment of the gas furnace, a unit refrigerant leak test and a final unit inspection.
5. All units shall have decals and tags to indicate caution areas and aid unit service. Unit nameplates shall be fixed to the main control panel door. Electrical wiring diagrams shall be attached to the control panels. Installation, operating and maintenance bulletins and start-up forms shall be supplied with each unit.
6. The Rooftop unit shall be designed, manufactured, and independently tested, rated, and certified to meet the seismic standards of the 2009 International Building Code and ASCE 7-06. Certificates of Compliance shall be provided with the quotation and include the manufacturer's identification, designation of certified characteristics, and the Independent Certifying Agency's name and report identification. Clear installation instructions shall be provided including all accessory components
7. Warranty: The manufacturer shall provide 12-month parts only warranty. Defective parts will be repaired or replaced during the warranty period at no charge. The warranty period shall commence at startup or six months after shipment, whichever occurs first.

B. MAU Cabinet, Casing and Frame

1. Standard double-wall construction for all side wall access doors and floor areas shall be provided with 22-gauge, solid galvanized steel inner liners to protect insulation during service and maintenance. Insulation shall be a minimum of 1" thick, 3/4-lb. density neoprene-coated glass fiber. Insulation on ceiling and end panels shall be secured with adhesive and mechanical fasteners. Heavy gauge solid galvanized steel liners shall be provided throughout, allowing no exposed insulation within the air stream. All cabinet insulation, except floor panels, shall be a nominal 2" thick, 1½-lb. density, R6.5, glass fiber. All floor panels shall include double wall construction and include a nominal 2" thick, 1½ lb. density, R6.5 glass fiber insulation.
2. Exterior surfaces shall be constructed of pre-painted galvanized steel for aesthetics and long term durability. Paint finish to include a base primer with a high quality, polyester resin topcoat of a neutral beige color. Finished surface to withstand a minimum 750-hour salt spray test in accordance with ASTM B117 standard for salt spray resistance. Service doors shall be provided on both sides of each section in order to provide user access to all unit components. Service doors shall be constructed of heavy gauge galvanized steel with a gauge, galvanized steel interior liner. All service doors shall be mounted on multiple, stainless steel hinges and shall be secured by a latch system that is operated by a single, flush-mounted handle. The latch system shall feature a staggered engagement for ease of operation. Removable panels, or doors secured by multiple, mechanical fasteners are not acceptable.

3. The unit base frame shall be constructed of 13-gauge (045D–140D) pre-painted galvanized steel. The unit base shall overhang the roof curb for positive water runoff and shall have a formed recess that seats on the roof curb gasket to provide a positive, weather tight seal. Lifting brackets shall be provided on the unit base with lifting holes to accept cable or chain hooks.

C. MAU Supply Fan

1. All fan assemblies shall be statically and dynamically balanced at the factory, including a final trim balance, prior to shipment. All fan assemblies shall employ solid steel fan shafts. Heavy-duty pillow block type, self-aligning, grease-lubricated ball bearings shall be used. Bearings shall be sized to provide an L-50 life at 200,000 hours. The entire fan assembly shall be isolated from the fan bulkhead and mounted on spring isolators. Fixed pitch V-belt drives with matching belts shall be provided. V-belt drives shall be selected at the manufacturer's standard service factor.
2. Fan motors shall be heavy-duty 1800 rpm open drip-proof (ODP) type with grease-lubricated ball bearings. Motors shall be premium efficiency. Motors shall be mounted on an adjustable base that provides for proper alignment and belt tension adjustment.
3. All fans shall be mounted using shafts and hubs with mating keyways. Fans shall be Class II type and fabricated from heavy-gauge aluminum. Fan blades shall be continuously welded to the back plate and end rim. Fans shall be mounted using shafts and hubs with mating keyways.

D. MAU Electrical

1. Unit wiring shall comply with NEC requirements and with all applicable UL standards. All electrical components shall be UL recognized where applicable. All wiring and electrical components provided with unit shall be numbered and color-coded and labeled according to the electrical diagram provided for easy identification. The unit shall be provided with a factory wired weatherproof control panel. Unit shall have a single point power terminal block for main power connection. A terminal board shall be provided for low voltage control wiring. Branch short circuit protection, 115- volt control circuit transformer and fuse, system switches, high temperature sensor, and a 115-volt receptacle with a separate electrical connection shall also be provided with unit.
2. Each compressor and condenser fan motor shall be furnished with contactors, current sensing manual motor and short circuit protection, and inherent thermal overload protection. Supply fan motors shall have circuit breakers and built in overload protection with VFDs. Knockouts shall be provided in the bottom of the main control panels for field wiring entrance. All 115–600 voltage wire shall be protected from damage by raceways or conduit.
3. Phase failure and under voltage protection on three-phase motors shall be provided to prevent damage from single phasing, phase reversal, and low voltage conditions.
4. Ground fault protection shall be provided to protect against arcing ground faults.

E. MAU Cooling Section

1. The cooling coil section shall be installed in a draw through configuration, upstream of the supply air fan. The coil section shall be complete with factory piped cooling coil and sloped drain pan. Hinged access doors on both sides of the section shall provide convenient access to the cooling coil and drain pan for inspection and cleaning.
2. Direct expansion (DX) cooling coils shall be fabricated of seamless 1/2" diameter high efficiency copper tubing that is mechanically expanded into high efficiency aluminum plate fins. Coils shall be a multi-row, staggered tube design with a minimum of 5 rows and a maximum of 10 fins per inch. All units shall have two independent refrigerant circuits and shall use an interlaced coil circuiting that keeps the full coil face active at all load conditions.
3. All coils shall be factory leak tested with high pressure air under water.

4. A stainless steel, positively sloped drain pan shall be provided with the cooling coil. The drain pan shall extend beyond the leaving side of the coil and underneath the cooling coil connections. The drain pan shall have a minimum slope of 1/8" per foot to provide positive draining. The drain pan shall be connected to a threaded drain connection extending through the unit base. Units with stacked cooling coils shall be provided with a secondary drain pan piped to the primary drain pan.

F. MAU Heating Section

1. A natural gas fired furnace shall be installed in the unit heat section. The heat exchanger shall include a type 321 stainless steel cylindrical primary combustion chamber, a type 321 stainless steel header, type 321 stainless steel secondary tubes and type 321stainless steel turbulators. Carbon and aluminized steel heat exchanger surfaces are not acceptable. The heat exchanger shall have a condensate drain. Clean out of the primary heat exchanger and secondary tubes shall be accomplished without removing casing panels or passing soot through the supply air passages. The furnace section shall be positioned downstream of the supply air fan.
2. The furnace will be supplied with a modulating forced draft burner. The burner shall be controlled for low fire start. The burner shall be capable of continuous modulation between 33% and100% of rated capacity and shall operate efficiently at all firing rates.
3. The burner shall be specifically designed to burn natural gas and shall include a microprocessor based flame safeguard control, combustion air proving switch, pre-purge timer and spark ignition. The gas train shall include redundant gas valves, maximum 0.5psi pressure regulator, shutoff cock, pilot gas valve, pilot pressure regulator, and pilot cock. The burner shall be rated for operation and full modulation capability at inlet gas pressures down to 7.0. W.C..
4. The gas burner shall be controlled by the factory installed main unit control system.
5. The burner shall be fired, tested and adjusted at the factory. Final adjustments shall be made in the field at initial start-up by a qualified service technician to verify that installation and operation of the burner is according to specifications.

G. MAU Filters

1. Unit shall be provided with a draw-through filter section. The filter section shall be supplied complete with the filter rack as an integral part of the unit. The draw-through filter section shall be provided with panel filters.
2. 2" thick MERV 8, 30% efficient pleated panel filters shall be provided. Filters shall be frame mounted and shall slide into galvanized steel racks contained within the unit. Filters shall be installed in an angular arrangement to maximize filter area and minimize filter face velocity. Filters shall be accessible from both sides of the filter section.

H. MAU Outdoor / Return Air Section

1. A return air plenum shall be provided with a outdoor air hood and damper. The hood shall allow outdoor air to enter at the back of the return air plenum. The outdoor air hood shall be factory installed and constructed from galvanized steel finished with the same durable paint finish as the main unit. The hood shall include a bird screen to prevent infiltration of foreign materials and a rain lip to drain water away from the entering air stream. The return air plenum shall allow return air to enter from the bottom of the unit.
2. Daikin UltraSeal low leak dampers shall be provided. Damper blades shall be fully gasketed and side sealed and arranged horizontally in the hood. Damper leakage shall be less than 0.2% at 1.5 inches static pressure differential. Leakage rate to be tested in accordance with AMCA Standard 500. Damper blades shall be operated from multiple sets of linkages mounted on the leaving face of the dampers. Control of the dampers shall be from a factory installed actuator wired to unit’s package controller.

I. MAU Condensing Unit

1. The condensing section shall be open on the sides and bottom to provide access and to allow airflow through the coils. Condenser coils shall be multi-row and fabricated from cast aluminum micro-channel coils. Each condenser coil shall be factory leak tested with high-pressure air under water. Coils are to be recessed so that the cabinet provides built in hail protection.
2. Condenser fans shall be direct drive, propeller type designed for low tip speed and vertical air discharge. Condenser fan rpm shall be 1140 rpm maximum. Fan blades shall be constructed of steel and riveted to a steel center hub. Condenser fan motors shall be heavy-duty, inherently protected, three-phase, non-reversing type with permanently lubricated ball bearing and integral rain shield.
3. Each circuit shall have fan cycling of at least one condenser fan to maintain positive head pressure. An ambient thermostat shall prevent the refrigeration system from operating below 45º F.
4. Liquid tight conduit shall be provided on exposed condensing section wiring.
5. Each unit shall have two independent refrigeration circuits. Each circuit shall be complete with low pressure control, filter-drier, liquid moisture indicator/ sight-glass, solenoid, thermal expansion valve, liquid line shutoff valve with charging port, discharge line shutoff valve, a manual reset high pressure safety switch and high pressure relief device. The thermal expansion valve shall be capable of modulation from 100% to 25% of its rated capacity. Sight-glasses shall be accessible for viewing without disrupting unit operation. Each circuit shall be dehydrated and leak tested.
6. Refrigeration capacity control shall be accomplished by staging of the unit's multiple compressors. To maintain desired temperature control, the unit shall have a minimum of four steps of capacity control.
7. All compressor capacity control staging shall be controlled by the factory installed main unit control system.
8. Modulating hot gas reheat shall be provided complete with modulating valves, micro-channel refrigerant reheat coil, and dehumidification control. Controls shall maintain ± 0.5ºF control of the reheat coil leaving air temperature.

J. MAU Curb

1. Equipment curb shall be fabricated from G90 Galvanized Sheet metal with standard manufacturer finish. The curb shall be fabricated with a pitch to match the structural slope of the roof.

K. MAU Controls

1. Each unit shall be equipped with a complete MicroTech III microprocessor based control system. The unit control system shall include all required temperature and pressure sensors, input/output boards, main microprocessor and operator interface. The unit control system shall perform all unit control functions including unit diagnostics and safeties. All boards shall be individually replaceable for ease of service. All microprocessors, boards, and sensors shall be factory mounted, wired and tested.
2. A BACnet MS/TP communication module shall be provided for direct interface to the range ventilation control system.
3. All digital inputs and outputs shall be protected against damage from transients or wrong voltages. The status of each input and output can be read on the display. All field wiring shall be terminated at a separate, clearly marked terminal strip.
4. The microprocessor memory shall be protected from all voltage fluctuations as well as any extended power failures. The microprocessor shall maintain existing set points and operate standalone if the rooftop loses either direct connect or network communications.

5. The display character format shall be 22 characters × 5 lines. The character font shall be a 5 × 8 dot matrix. The display shall be a supertwist liquid crystal display (LCD) with black characters on yellow background providing high visibility. The display form shall be in plain English coded formats. Lookup tables are not acceptable.
6. Adjustments and readings shall be made through a push/pull navigational wheel. All control settings shall be password protected from changes by unauthorized personnel.
7. The display shall provide the following information as required by selected unit options:
    a. Unit status showing number of stages or percent capacity for heating, cooling, and economizer
    b. Supply, return, outdoor, and space air temperature
    c. Duct and building static pressure; the control contractor is responsible for providing and installing sensing tubes
    d. Supply fan and return fan status and airflow verification
    e. Supply VFD speed
    f. Outside air damper position
    g. Cooling and heating changeover status
    h. Occupied, unoccupied, and dirty filter status
    i. Date and time schedules
    j. Up to ten current alarms and 25 previous alarms with time and date
8. The push/pull navigation wheel shall allow the following set points as a minimum as required by selected unit options:
    a. Six control modes including off manual, auto, heat/cool, cool only, heat only, and fan only
    b. Four occupancy modes including auto, occupied, unoccupied and bypass
    c. Control changeover based on return air temperature, outdoor air temperature, or space temperature
    d. Primary cooling and heating set point temperature based on supply or space temperature
    e. Setup space temperature
    f. Cooling and heating control differential (or dead band)
    g. Cooling and heating supply temperature reset options based on one of the following: Return air temperature, outdoor air temperature, space temperature, airflow, or external (1–5 VDC) signal
    h. High supply, low supply, and high return air temperature alarm limits
    i. Ambient compressor and heat lockout temperatures
    j. Compressor interstage timers duration
    k. Duct and building static pressure
    l. Current time and date

L. Basis of Design

1. Daikin Rebel DPSA

PART 3 - EXECUTION

3.1 ACCEPTANCE TEST/COMMISSIONING

A. Preliminary Test / Commissioning.

1. Contractor to conduct testing and commissioning well in advance of final acceptance test.

2. System shall be fully completed prior to preliminary test and commissioning.
3. Test & balance work shall be fully completed prior to preliminary test and commissioning.
4. Perform all tests required for final acceptance test.
5. Balance, adjust, retest, and repeat as necessary until all tests meet or exceed criteria.
6. Operate system in all modes and run through all control sequences.
7. Verify each safety for proper operation under all conditions of operation.
8. Notify owner that the preliminary test has been successfully completed.

B. Final Acceptance Test

1. The final acceptance tests may be witnessed by the owner and the owner's commissioning agent utilized on all other HVAC systems. Schedule in advance. The contractor is responsible for assuring the system is working properly before scheduling the final acceptance tests.

C. Range Pressure Test

1. Check and verify differential air pressure between indoor range and the range office. Indoor range air pressure shall be between -0.02 and -0.06 inches water column (negative with respect to the range office air pressure). Read from DDC instrumentation (differential pressure transducer) and validate in field.

D. Smoke Tests

1. Provide prior to airflow tests to identify potential problem areas. Provide either a fog machine or "smoke bombs" in sufficient supply (not less than ten) to complete testing with all tests demonstrating compliance with system requirements. Release smoke in each lane along the entire height from floor to ballistic ceiling at the firing line most distant from the target line. All smoke must move downrange. Smoke going backwards will constitute failure of acceptance.

E. Airflow Measurements

1. Take measurements with the system on and running, with the get-ready area empty. Note the time of day, outside air temperature, and space temperature. Calibrate these air flow tests with the air flow measuring stations.
2. Take measurements at the firing line at three heights in the center of each lane (1ft, 3ft, 5ft)
    a. Acceptable readings are as follows:
        1) Individual readings: no single reading under 50 fpm or over 120 fpm.
        2) Lane average: each lane between 60 fpm and 90 fpm.
        3) Range average: between 71 fpm and 79 fpm.

F. Control Inspection and Commissioning

1. Verify the control sequence, warning conditions, and alarm conditions.
2. Verify the control points are responding and record readings.
3. Range Ventilation Contractor to Provide:
    a. Test and Balance Report.
    b. Written confirmation on commissioning results.
    c. Training on operation and maintenance.
    d. Training on DDC control system.
    e. O&M manuals.
    f. Smoke bombs (10 minimum) or fogging machine.
    g. Written test results. Include meter readings.

3.2 OPERATION AND MAINTENANCE

A. Operation and Maintenance Manuals

1. Submit a minimum of two hard copy manuals and 1 digital manual at least 2 weeks prior to field training.

B. Operation And Maintenance Training:

1. Conduct a training course for the members of the operating staff as designated by the government. Make the training period consist of 6-8 hours of normal working time and start it after all work specified herein is functionally completed and the Performance Tests have been approved. Conduct field instruction that covers all of the items contained in the Operation and Maintenance Manuals as well as demonstrations of routine maintenance operations. Submit the proposed On-site training schedule concurrently with the Operation and Maintenance Manuals and at least 14 days prior to conducting the training course.
   a. Provide Training for:
      1) Operation of the system.
      2) Troubleshooting.
      3) Preventative maintenance.
      4) Control System.
      5) Control Panel readings and what they mean.
      6) Filter removal and replacement.

END OF SECTION

SECTION 23 7200

TOTAL AIR-TO-AIR HEAT RECOVERY EQUIPMENT (Revised AD-2)

PART 1 - GENERAL

1.1 SUMMARY

A. Total Heat Recovery air to air plate heat exchanger is provided as part of the Rooftop Air Handler serving the Gun Cleaning Room.

B. Furnish labor, materials, tools, equipment, and services for Total Air-to-Air Heat Recovery Equipment, as indicated, in accordance with provisions of Contract Documents.

C. Description of systems:

1. Air-to-air plate heat exchanger.

D. Abbreviations:

1. ASHRAE: American Society of Heating, Refrigeration, and Air Conditioning Engineers.
2. NFPA: National Fire Protection Association.
3. U.L.: Underwriters Laboratories.

E. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Standards:

1. ASHRAE 15 Safety Standards for Refrigeration Systems.
2. ASHRAE 84 Methods for Testing Air-To-Air Heat Exchangers.
3. NFPA 70 National Electrical Code.
4. NFPA 90A Installation of Air Conditioning and Ventilation Systems.
5. NFPA 90B Installation of Warm Air Heating and Air Conditioning Equipment.
6. U.L. 723 Test of Surface Burning Characteristics of Building Materials.

1.3 SUBMITTALS

A. Project Information:

1. Air to air energy core heat exchanger:
   a. Summer and winter psychrometric charts.
   b. Summer and winter static core performance data.
   c. Unit drawings.
   d. AHRI Certified Ratings

B. Contract Closeout Information:

1. Operation and Maintenance Data and Owners instruction report.
   a. See Section 01 7823.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Air to Air Plate Heat Exchanger:

1. Base: Valent.
2. Optional:
   a. AEX Corp.

b. Daikin.
c. Semco.
d. Xetex Corp.

AD-2: Section 23 7200; 09/25/2024: Add Paragraphs 2.1, A, 2, e and f.

e. Annexair
f. Trane

B. Other manufacturers desiring approval comply with Section 01 6000.

2.2 MATERIALS

A. Air to Air Energy Core Heat Exchanger:

1. Cabinet:
   a. The cabinets will be factory built and field convertible in a flow configuration that corresponds with the positioning of the unit.
   b. Multi-positional: The unit shall be multi-positional; therefore, it can be placed in a horizontal, vertical, or side position.
   c. Access Doors: Will be provided for top access and controls.
   d. Door Panels: Shall be removable with spring loaded hinges and latches to provide for easy access.
   e. Exterior panels: 20 gauge, painted steel with 500 hour salt spray certification.
   f. Internal assemblies: Single wall door panels consist of 20 gauge, galvanized (G90) steel with an internal core coating of standard ¼ inch rubberized foam insulation.
   g. External assemblies: Shall contain four hanging brackets/floor mounts for ease of installation.
2. Features (Standard):
   a. Static Core: Static Core shall be equal to the dPoint Technologies ERV Core with a polymer membrane. Shall operate at lower temperatures without defrost (23 degrees F). The exhaust air pre-conditions the outside air by transferring heat and humidity from one air stream to another. Allows for latent and sensible energy recovery with no cross contamination or moving parts. Shall withstand pressure differentials up to 10 inch w.c. Slide out core assembly will provide ease for external cleaning or replacement.
   b. Filters: Shall be 2 inch MERV 8, medium efficiency, pleated filters before the static core in both the intake and exhaust sides.
   c. Insulation: Consists of ¼ inch rubberized foam insulation with peel and stick backing.

B. Module Construction:

1. Module casing:
   a. Provide complete protection for all components and controls.
   b. Material: G90 galvanized steel for corrosion protection.
   c. Panel construction: 2 inches , double wall, insulated to R-12.5, and all internal seams shall be watertight.
      1) Exterior walls and roof panel material thickness: 18 gauge .
      2) Interior walls material thickness: 16 gauge .
      3) One-piece or standing seam construction for maximum protection from water intrusion.
2. Module base:
   a. Structural “C” channel added as required to support optional components specified.
   b. The module’s base shall be formed from a minimum of 16 gauge steel for rigidity and strength.

3. Access panels:
   a. Insulated double wall construction, same thickness, and R-value as casing.
   b. Gasketed.
4. Unit insulation shall meet the following standards and or approvals:
5. NFPA: 90A and 90B.
6. UL 723: Flame spread not exceeding 25 and smoke development rating not exceeding 50.
7. Equipped with lifting lugs.

C. Winter Operation:

1. Preheat Electric Coil (Provided as part of the Rooftop Unit System)
   a. Heat Exchanger Defrost System:
      1) The heat exchanger shall have the leaving air temperature (LAT) as shown on the schedule while operating at the specified conditions and while operating on its defrost system.
      2) The defrost system shall provide continuous output temperatures.
      3) The defrost system shall have no moving parts.

PART 3 - EXECUTION

3.1 GENERAL

A. Install equipment as indicated and in accordance with manufacturer's instructions.

B. Provide clearance for inspection, repair, replacement, and service.

3.2 FIELD QUALITY CONTROL

A. Schedule and administer specified tests.

1. Provide required personnel.
2. Provide required instruments and equipment to perform such test.
3. Give Owner's Representative ample notice of dates and times scheduled for test and trials.
4. Conduct test in presence of Owner's Representative.

B. Inspections

1. Prior to initial operation, inspect equipment installation for conformance with contract documents and specifications.

3.3 FIELD TRAINING

A. Conduct a training course for operation and maintenance personnel as designated by the Owner's Representative. Training shall be provided for a period of 4 hours of normal working time and shall start after the system is functionally complete but prior to the performance of tests. The field instruction shall cover all items contained in the Approved Operations & Maintenance instructions.

3.4 OPERATING TEST

A. After systems are balanced, conduct operating test of not less than 8 hours duration to demonstrate to satisfaction of Architect that system(s) comply with requirements of plans and specifications, and that equipment and controls are functioning properly.

END OF SECTION

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SECTION 23 7414

DIRECT EXPANSION PACKAGED ROOFTOP AIR HANDLING UNITS (Revised AD-2)

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Packaged Rooftop Air Handling Units, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. ARI standard 210-66.

B. Factory test coils.

1.3 SUBMITTALS

A. Shop Drawings:

1. Wiring diagrams.
2. Control diagrams.

B. Product Data:

1. Packaged rooftop air handling units.
   a. Certified performance data.

C. Contract Closeout Information:

1. Operation and Maintenance Data.
2. Owner instruction report.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Direct Expansion Packaged Rooftop Units:

1. Base:
   a. Valent
2. Optional:
   a. Carrier
   b. Daikin
   c. Innovent
   d. JCI/York
   e. Trane

AD-2: Section 23 7414; 09/25/2024: Add Paragraphs 2.1, A, 2, f.

f. Annexair

B. Other manufacturers desiring approval comply with Section 01 6000.

2.2 MATERIALS

A. Roof top Air Handling Units:

1. General:
   a. Factory assembled, piped and internally wired.

b. Fully charged with new generation currently approved refrigerant.
c. Design to operate at outdoor ambient temperatures as high as 120 deg F.
d. Designed for outdoor rooftop installation.
e. Cooling and heating capacities rated in accordance with ARI standards.
f. Design certified by American Gas Association (AGA) for outdoor applications using natural gas.
   1) Cooling units UL listed.
g. Exterior surfaces of units phosphatized galvanized steel with epoxy resin primer and baked enamel finish.
h. Capacity: As scheduled.

2. Casings:
   a. 20 GA steel, gasketed and insulated.
   b. 1 inch, 1 pound density foil faced glass fiber insulation on heat exchanger section.
   c. Same composition mat faced insulation in evaporator section.
   d. Base pan and mounting rails: 18 GA.
3. Refrigeration controls:
   a. Single or dual circuited as required for capacity.
   b. Include condenser fan, evaporator fan and compressor contactors, and 24-volt transformer.
   c. Each circuit separate set of refrigerant controls.
   d. Safety controls include high- and low-pressure controls and compressor overloads.
4. Compressors:
   a. 3,600 rpm hermetic resealed compressors.
   b. Equipped with over temperature, over current and high-pressure controls.
   c. Furnish Crankcase heaters.
5. Evaporator coil:
   a. 1 or 2 independent circuits as required.
   b. 3/8 inches, OD seamless copper tubing mechanically bonded to aluminum fins (spiral fins are not acceptable).
   c. Factory pressure and leak tested at 225 psig.
   d. Split or spline aluminum fins not acceptable.
6. Drain pans:
   a. For both evaporator and condenser coil.
   b. Evaporator pan internally sealed and insulated.
   c. Threaded drain connection in evaporator section, drain opening in condensing section.
7. Condenser coil:
   a. Single or dual circuited as required.
   b. 3/8 inches, OD seamless copper tubing mechanically bonded to aluminum fins.
   c. Factory pressure and leak tested at 425 psig.
8. Indoor air fan:
   a. Direct drive or belt driven, forward curved, centrifugal type fans equipped with adjustable motor sheaves.
   b. Motor thermally overload protected with permanently lubricated fan and motor bearings.
   c. Fan drive components mounted on rubber-in-shear isolators.
   d. Belt Guards: As specified in Section 23 0500.
9. Condenser fans:

a. Direct drive, statically and dynamically balanced propeller fans.
b. Weatherproofed PSC fan motors UL listed for outdoor use.
1) Built-in thermal overload protection.

10. Gas fired heating section:
a. Completely assembled, wired and piped, gas fired heating systems within unit
b. Threaded gas connection on unit
11. Heat exchanger:
a. Embossed, formed, and seamed, 18 GA aluminized steel.
b. Factory tested for gas leaks.
c. Stress relieved, free floating design.
d. Located upstream of cooling coil.
12. Burners:
a. Stamped and seamed welded.
b. 20 GA aluminized steel.
13. Force combustion blower:
a. Ensure flame stability under varying wind conditions.
b. Combustion blower motor out of hot air stream.
14. Electronic ignition system:
a. Pilot to light each time thermostat calls for heat.
b. Flame sensor to prove pilot flame and turn on main burners.
1) Should a loss of pilot flame occur, main valve closes and a spark re-occurs within 0.8 seconds.
c. When thermostat is satisfied both pilot and main burner are extinguished.
15. Gas valves:
a. 2 stage gas valves on units selected for high heat.
b. 50% heating input on first stage and 100% on second stage.
16. Anti-short cycle:
a. Lockout timer to provide minimum OFF time of 5 minutes between compressor cycling.
17. Hot Water Heating coil. This coil is provided only for the Gun Cleaning RTU. Coil shall be ARI certified. See schedule on drawings for performance.
18. Economizer:
a. Factory installed dry-bulb controlled economizer.
b. Automatically use outdoor air for free cooling when outdoor air temperature and humidity are at acceptable levels.
c. Automatically modulate outdoor and return air dampers to maintain proper discharge air temperature into conditioned space.
d. Provide with adjustable minimum position control.
e. Spring return motor.
1) Upon loss of power, dampers close shut.
f. Ultra-low leak dampers.
g. Relief fan and relief damper and hood.
19. Filters: See schedule on drawings.
20. Supply and return casing:
a. Constructed and insulated with same materials as rooftop unit.
b. Furnish for horizontal units to provide a complete, watertight down flow configuration.
c. Include base pan and attachments for concentric ductwork where required.

21. Roof mounting:
    a. Roof curb designed to mate with unit and provide complete support and watertight installation.
    b. 16 GA galvanized steel with a wood nailer.
    c. Provide curbs as required for a level installation, regardless of roof slope.
    d. Curbs minimum 12 inches high.
22. Temperature controls:
    a. Furnish controls, factory mounted, as required for complete operation, as follows:
    b. Provide heating or cooling upon demand to satisfy discharge setpoint temperature.
    c. Furnish a packaged combined status panel (installed and wired under Section 25 1000 work).
    d. BacNet control system. See Section 25 9000 for requirements.
    e. Status panel with following signal lights:
        1) Four signal lights to indicate power, pilot outage, clogged filters, and reset relay.
        2) Power signal shows green indicating power available to unit.
        3) Power signal shows red when gas service is interrupted or there is an electrical ignition malfunction.
        4) Filter signal shows red when filters clog and need replacement.
        5) Reset signals show red if system is out on cooling safety controls.
23. Power Exhaust/Relief Fan:
    a. Provide power exhaust/relief fan with integral speed control.
24. Hot Gas Reheat coil and controls. Provide Humidistat, see plans for location.
25. Gun Cleaning RTU shall have a Heat Recovery Core. See specification section 23 7200. As part of this heat recovery system, provide an electric pre-heat coil and packaged defrost control system as part of the RTU controls.

B. Gas Piping:
    1. See Section 23 1123.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accord with manufacturer's instructions and recommendations.

B. Provide (3) layers of ¾” drywall and 2” rigid fiberglass insulation in base of curb.

C. Vibration isolation: section 23 0550.

END OF SECTION

SECTION 25 1000

BUILDING MANAGEMENT SYSTEM (BMS) (Revised AD-2)

PART 1 - GENERAL

1.1 APPLICATION OF THIS SECTION

A. This Section applies to all heating, ventilating, and air conditioning work. Coordinate with applicable Sections as required.

B. Refer to other Sections in Division 22, 23, 26, 27 and 28 for general requirements pertaining to plumbing, mechanical, electrical, telecom, and fire alarm work.

C. Undivided Responsibility: Work of this section shall be included with the work specified in the following Sections:

1. Section 25 3000 – Building Management System (BMS) – Field Equipment.
2. Section 25 9000 – Building Management System (BMS) – Sequence of Operation.

D. The new DDC BMS control system shall have a BACnet connection to the owner's Trane Synchrony campus control system, such that the owner's maintenance staff will be able to view all graphics of the new DDC BMS control system.

1.2 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Building Management System (BMS), as indicated, in accordance with provisions of Contract Documents.

B. Section Includes:

1. Building Management System (BMS) hardware and software.

C. Related Sections:

1. Section 01 7700 - Closeout Procedures.
2. Section 01 8133 - Cyber Security Requirements.
3. Division 22 Sections.
4. Division 23 Sections.
5. Division 26 Sections.
6. Division 27 Sections.
7. Division 28 Sections.

D. Completely coordinate with work of other trades.

1.3 GENERAL REQUIREMENTS

A. Furnish and install a complete state of the art direct digital control (DDC) Building Management System (BMS) system. The system shall be fully functional and complete in all respects including all labor, materials, equipment, and services necessary, and shall be installed by personnel regularly employed, trained, and certified by system manufacturer.

B. The Building Management System (BMS) shall be an open complete system suitable for the control of the heating, ventilating and air conditioning (HVAC) and other building-level systems as specified and shown.

C. The BMS shall meet the functional requirements of this specification, the construction documents, and shall be capable of executing all control algorithms defined in Section 25 9000 – BMS Sequence of Operation.

D. The Building Management System (BMS) contractor shall furnish, install, and wire a fully integrated Facility automation system, incorporating direct digital control (DDC) for energy

management, equipment monitoring and control, and subsystems with proprietary communications capabilities as herein specified.

E. The system shall be scalable in nature and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers, and operator workstations.

F. Devices of the same type shall be products of a single manufacturer. Each major component within the system shall have the manufacturer's name and address, and the model and serial number in a conspicuous place. Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of these and similar products. The standard products shall have been in a satisfactory commercial or industrial use for five years prior to use on this project. The five-year use shall include applications of equipment and materials under similar circumstances and of similar size to this project. The equipment items shall be supported by a service organization. Items of the same type and purpose shall be identical, including equipment, assemblies, parts, and components.

G. Provide dedicated labor to set up or modify trends and assist the Owner with developing existing or new trends.

H. Provide dedicated labor to develop customized reports and assist the Owner with developing customized reports. This time is in addition to the time required to perform the functions specified herein.

I. Provide dedicated labor to support the third-party commissioning agent's commissioning of the BMS.

J. Provide a BMS in accordance with UL 916 and with the following characteristics:

1. The system shall perform supervisory monitoring and control functions including but not limited to Scheduling, Alarm Handling, Trending, and Report Generation as specified.
2. The system shall include monitoring and control (M&C) software which shall allow for graphical navigation between systems, 2-Dimensional (2D) and 3-Dimensional (3D) graphical representations of systems, access to real-time data for systems, ability to override points in a system, access to all supervisory monitoring and control functions.

K. Provide the necessary documentation (including rights to documentation and data), configuration information, configuration tools, application programs (with comments explaining program logic), application source code for programmable controllers, drivers, and other software shall be licensed to and remain with the Owner such that the Owner or its agents are able to perform repair, replacement, upgrades, and expansions of the system without subsequent or future dependence on the BMS contractor.

L. After becoming familiar with all details of the work, verify all dimensions in the field, and shall advise the Mechanical Contractor of any discrepancy before performing any work.

M. The contract drawings will not indicate all offsets, fittings, and accessories that may be required. Investigate the mechanical, electrical, and finish conditions that could affect the work to be performed, shall arrange such work accordingly, and shall provide all work necessary to meet such conditions.

N. Provide all control wiring for fan and pump VFDs and motor starters. Verify all control wiring prior to start-up to ensure no damage to equipment or personnel. Ensure all BMS safeties and interlocks are wired correctly. Add and remove jumpers across BMS terminals, as needed, when various options are not being utilized.

O. The BMS shall be connected to the Owner’s IT network, whereby the BMS shall transmit e-mail alarm messages to the Owner’s employees. The BMS contractor shall provide all equipment and labor necessary to ensure a fully functional remote notification system, including but not limited to the following: coordinate the content of the alarm messages, which alarms require messaging, which employees require the e-mails, and all technical aspects.

P. Provide actuators for all control dampers provided by Division 23. All smoke and combination fire/smoke dampers provided by Division 23 shall include integral UL-listed damper actuators.

Q. Provide damper position switches for all control, smoke and combination fire/smoke dampers as indicated on the contract drawings.

R. Division 26 contractor to provide 120VAC power to junction boxes local to BMS equipment as indicated on Electrical power drawings. Division 25 contractor shall extend power to all BMS control equipment and devices from the junction boxes.

S. Division 25 contractor to provide 24VAC step-down transformers and power trunk wiring for all BMS Controllers.

T. Provide a letter of substantial completion indicating that all performance and verification tests (PVTs) have been completed and the BMS is ready for third-party commissioning.

U. The BMS contractor programming shall be completed offsite and tested offline prior to implementing into the BMS controllers and fine tune programming during the point-to-point checkout process.

V. All writable object properties and other programming parameters needed to comply with the project specification shall be adjustable for devices at any network level, including those accessible with web-browser communication, and regardless of programming methods used to create the applications.

1.4 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Furnish control valves, sensor wells, flow meters, and gauge taps to Section 23 2113.

B. Furnish flow meters to Section 23 2113.

C. Furnish duct-mounted airflow stations to Section 23 3113 for installation.

D. Furnish fan-mounted airflow stations to Section 23 7313 for installation.

1.5 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

A. Provide control wiring in conduit to equipment furnished under the following sections:

1. Section 25 2300 – Variable Frequency Drives and Controls.

B. Provide all control wiring between A/C units and the remote condensing units.

C. Install room temperature sensors and provide control wiring for all air conditioning units.

D. Install room temperature sensors and provide control wiring for all air curtains.

E. Provide wiring between the chiller control panel and the associated differential pressure switches.

F. Provide all wiring for boiler sensors and equipment shipped loose, e.g. Flow switches, boiler control sensors, pump control wiring, etc.

G. Coordinate damper actuator requirements for any control dampers furnished and installed by others, to ensure compatibility with BMS controllers. Provide damper actuators for all control dampers in cases where dampers are furnished and installed by others without actuators.

1.6 BMS INTEGRATION

A. Integrate to the equipment and systems listed in this section. Provide all hardware, wiring, conduit, software configuration, and labor to successfully integrate the listed equipment and systems. Provide 2D and/or 3D graphic screens, as needed, for all the equipment and systems integrated to the BMS. The graphic screens shall depict the equipment, systems and all the software points available. The operator shall be able to view and control all aspects of the systems from any BMS operator workstation. All listed equipment and systems shall be provided with network interface capable of communication via Ethernet or RS-485 Serial

Communication. Communication protocols shall include BACnet and Modbus. All software points in the equipment/system shall be visible to the BMS for monitoring and/or control.

1. The following plumbing equipment shall be integrated in the BMS, coordinate requirements with Division 22:
   a. Digital Mixing Valves
2. The following mechanical equipment shall be integrated into the BMS, coordinate requirements with Division 23:
   a. Variable Frequency Drives (VFD).
   b. Boilers.
   c. BTU/Hydronic Flow Meters.
   d. Packaged Roof Top (RTU) Units.
   e. Air Source Heat Pump (ASHP) Units.
3. The following electrical equipment shall be integrated in the BMS, coordinate requirements with Division 26:
   a. Automatic Transfer Switches (ATS)
   b. Emergency Generator
   c. Electric Energy Meters
4. The following third-party controls systems shall be integrated into the BMS:
   a. Lighting Control System

B. Integrate all new Programmable System Controllers (PSC), Supervisory Controllers (SC), Application Specific Controller (ASC) and third-party equipment and systems into the existing BACnet system. The incumbent BMS contractor shall coordinate with the BMS contractor to provide a completely functional system.

1. Incumbent BMS contractor's responsibilities:
   a. Provide the following to the BMS contractor:
      1) A copy of the as-built drawings for the primary level network riser.
      2) An AutoCAD compatible version of the system architecture diagram for the primary level network riser.
      3) Product specification sheets for all network equipment.
      4) As-built wiring specifications for the existing network.
      5) All BIBBS and PICs for the existing BACnet equipment.
      6) Any additional information requested by the BMS contractor.
   b. Follow the steps outlined in the "Controller Integration to Existing BMS Network" paragraph in this section for the integration process.
   c. During the integration process, coordinate with the BMS contractor to resolve all issues prior to turnover.
   d. Submit a migration strategy, as specified herein, to the A/E and Owner prior to implementation.
2. Section 25 1000 - Building Management System (BMS) responsibilities:
   a. Provide the following to the incumbent BMS contractor:
      1) Approved submittal package, submittal package contents are specified in this section.
      2) All BIBBS and PICs for the new BACnet equipment.
      3) Any additional information requested by the incumbent BMS contractor.
   b. Develop a system architecture diagram showing all of the new controllers, all of the existing controllers, all new and existing network equipment, all node addresses, and controller types. Submit the system architecture diagram in the as-built shop drawings.

c. Provide the new controllers as specified herein.
d. Provide all wiring and power to all new controllers and network equipment as specified herein.
e. Provide all new routers and repeaters as required for a fully functional system.
f. Start-up and execute the static and dynamic control system tests, as specified in this section.
g. During the integration process, coordinate with the incumbent BMS contractor to resolve all issues prior to turnover.

C. The incumbent BMS contractor shall integrate all existing Programmable System Controllers (PSC), Supervisory Controllers (SC), Application Specific Controllers (ASC) and third party equipment/systems into the new BACnet system. Coordinate with the incumbent BMS contractor to provide a completely functional system.

1. Incumbent BMS contractor's responsibilities:
   a. Provide the following to the BMS contractor:
      1) A copy of the as-built drawings for the primary level network.
      2) An AutoCAD compatible version of the system architecture diagram for the primary level network.
      3) Product specification sheets for all network equipment.
      4) As-built wiring specifications for the existing network.
      5) All BIBBS and PICs for the existing BACnet equipment.
      6) Any additional information requested by the BMS contractor.
   b. Support the BMS contractor during the integration process to resolve all hardware and wiring issues related to the existing system.
   c. Provide all labor necessary to correct all existing wiring and hardware problems.
2. Section 25 1000 - Building Management System (BMS) responsibilities:
   a. Develop a system architecture diagram showing all of the new controllers, all of the existing controllers, all new and existing network equipment, all node addresses, and controller types. Submit the system architecture diagram in the as-built shop drawings.
   b. Provide the new controllers as specified herein.
   c. Provide all wiring and power to all new controllers and network equipment as specified herein.
   d. Provide all new routers and repeaters as required for a fully functional system.
   e. Start-up and execute the static and dynamic control system tests, as specified in this section.
   f. Follow the steps outlined in the "Controller Integration to Existing BMS Network" paragraph in this section for the integration process.
   g. Submit a migration strategy, as specified herein, to the A/E and Owner prior to implementation.

1.7 QUALIFICATIONS

A. The BMS system shall be designed, installed, commissioned, and serviced by manufacturer-employed, factory-trained personnel and qualified sub-contractors. Manufacturer representative shall have an in-place support facility within 100 miles of the job site with technical staff, spare parts inventory, and necessary test and diagnostic equipment. Provide toll-free phone number access to 24-hour support center, staffed with factory-trained personnel to assist in troubleshooting and problem resolution. Distributors or licensed installing contractors are not acceptable. Provide out-sourced products as specified.

B. Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of building management systems for this type of facility and shall be manufacturer's latest standard design that complies with the specification requirements.

C. BMS shall comply with UL 916 PAZX and other subsystem listings as applicable, and herein specified, and be so listed at the time of bid. All control systems used for smoke control shall be listed in accordance with UL 864, category UUKL for their intended purpose, and installed in accordance with the applicable building codes for the project.

D. All electronic equipment shall conform to the requirements of FCC Part 15, Section 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.

E. The BMS contractor shall be regularly engaged in the manufacturing, installing, and maintaining of BMS systems with similar size and complexity to this project.

F. The BMS contractor shall have a minimum of 10 years of demonstrated technical expertise with projects in the industry.

G. The Building Management System manufacturer shall provide documentation supporting compliance with ISO 9002 (Model for Quality Assurance in Production, Installation, and Servicing). The intent of this requirement is to ensure that products from the manufacturer are delivered through a Quality System and Framework that will assure consistency in the products delivered for this project.

H. The following are the minimum personnel qualifications for the specific individuals assigned to this project.

1. The project manager shall have at least 10 years of experience in the role of project management.
2. Application Engineers shall have at least 10 years of experience engineering building automation systems in critical environments.
3. Programmers shall have at least 10 years of experience writing and troubleshooting programming code.

1.8 SUBMITTALS

A. The following shall be submitted in accordance with Section 01 3300.

B. Refer to Section 01 8133 - Cyber Security Requirements for required cyber security related submittals.

C. Shop Drawings: Design drawings shall be submitted electronically in portable document format (PDF)

1. Resubmitted Shop Drawings: Provide typed responses to all comments. All changes shall be clearly identified with revision clouds and revision numbers. The resubmittal package will be rejected without review if all comments are not addressed, and all changes are not clearly identified.

D. Submit shop drawings and product data as single complete submission. Partial submissions will be rejected. Control valve, flow meter, and air flow measuring station schedules with product data may be submitted separately. Submit electronic copies of the following:

1. System Architecture: Show location of the server, workstations, Programmable System Controller (PSC), Supervisory Controller (SC), Application Specific Controller (ASC), Network Controllers (NC), routers, repeaters auxiliary equipment, I/O device, panel, and other major system component. Indicate all network interface devices (gateways, drivers, open communication modules).
2. Instrument Index (Bill of Material): For all systems, provide a complete list of all instruments and final control elements (valves/dampers) furnished. Provide instrument description, manufacturer, model number.
    a. Instrument List shall have (as a minimum) the following categories:

1) Vendor Tag Number: Provide a unique tag number to identify each device. Owner will use this number as reference to generate Owner tag numbers, and to account for each device.
    a) The tag number shall conform to the following format: AAA-XXXXX-AAA-N. "A" designates an alpha identifier. "X" designates an alphanumeric identifier. "N" designates a numeric identifier. The first field shall be associated with equipment. The second field will identify the unique equipment and shall be consistent with the contract documents. The third field of alpha codes is for the device type, followed by a sequential number.
        (1) Example: AHU-1234-PSL-1.
    b) The tagging shall follow the existing site standard utilized by the NLETC campus.
2) Description of Instrument: Define device's function (e.g. differential pressure transmitter, room temperature sensor, photocell etc.).
3) Instrument Manufacturer/Model Number.
4) Equipment Cross Reference: Where applicable, list equipment the instrument is associated with (e.g. freezer, incubator, room number etc.).
5) Instrument accuracy.
6) Instrument range.
7) Instrument display (engineering units).

3. System Flow Diagrams: Show location of devices, interconnections, wire numbers, pneumatic tubing, junction boxes, computer I/O connections, bulkheads, grounding, and terminals.
    a. Include indication of control algorithms or logic used for each system in the sequence of operation. Provide logic tables wherever possible to easily communicate interlock or failure logic.
    b. Provide a unique flow diagram for each HVAC and mechanical system. Typical drawings are not acceptable. Each drawing shall identify each instrument with a unique tag number.
    c. Provided typical drawings for terminal equipment accompanied by a schedule listing the unique equipment information.
4. Electrical Diagrams: Show all wires and terminations. All terminals shall be identified in the as-built drawings. Include starter and Variable Frequency Drive wiring diagrams depicting safeties and automated start/stop contacts. Indicate hardwired interlocks.
5. System Sequence of Operation: Provide for all equipment controlled or monitored by the BMS. Submit unique sequences for each system, typical sequences are not acceptable. The sequence shall include the unique point identifier for each point referenced in the system. The identifier shall be in the body of the sequence and listed whenever the instrument or device is mentioned. E.g., "The reheat valve (TCV-RMSH1234-1) shall modulate to maintain the room temperature (TT-RMSH1234-1) at setpoint".
    a. Refer to Section 25 9000 for the sequence of operations.
    b. Contractor shall thoroughly review and vet all sequences provided in Section 25 9000 prior to programming, startup, and commissioning. Submittal to clearly identify any changes or exceptions to the project sequence of operations. Submit Request for Information (RFI) forms when clarification is required.
        1) Copying sequences from contract documents does not absolve the Division 25 contractor of the responsibility stated above, and submittals with copied sequences may be rejected.
6. Control Valve Schedules: Include valve curves (flow versus percent open), service (e.g., hot/chilled/condenser water or steam), quantity, actuator type and model number, spring range (where applicable), sizes, capacity in GPM for water (LB/hour for steam), CV of

valve, actual pressure drop across valve in psi, failed position, shutoff ratings, and valve characteristics (equal percent or linear).

7. Hydronic Flow Meter Schedules (water & steam): Include hydronic flow meter size, maximum flow, calibrated flow, minimum allowable flow for accuracy, and minimum upstream and downstream straight pipe requirements. Coordinate locations, sizes, and straight pipe requirements with Section 23 2113 prior to procurement.
8. Air Flow Measuring Station Schedules: Include air flow measuring station width, height, depth, velocity pressure at setpoint, minimum upstream and downstream duct requirements, minimum allowable velocity pressure to accurately read flow, and maximum allowable velocity pressure. Coordinate locations, sizes, and straight duct requirements with Section 23 3113 prior to procurement.
9. Instrument Mounting/Field Connection Diagrams: Include pipe, tank and duct mounting details of sensor types to be used.
10. Panel Layout/Diagrams: Panel Layout/Diagrams including bill of material and mounting details for recessed, semi-recessed, surface mounted and free-standing panels. Provide installation details and mounting requirements. For panels installed in finished areas, provide a detail showing how the panels are arranged on the finished wall. Panel design shall be approved prior to fabrication and installation.
11. Include the following paragraph if Owner is requiring a mockup panel for approval.
12. Points Schedules: Provide schedule which lists every physical and virtual point in the BMS as indicated on contract drawings and required to meet the sequence of operation in a tabular format. At a minimum, the list shall include the following fields: unique point identifier, point type, software address, associated PSC or SC, associated room number (where applicable), associated equipment/device tag (where applicable), signal range, measurement range, point is alarmable, alarm threshold, alarm delay, point is trended, trend interval.
13. Include the following paragraph if a dedicated Instrument Compressed Air system is included in the project.
14. User Interface Graphics: Provide custom graphics for each individual piece of mechanical equipment being controlled. Include graphics for lighting, when integrated with the BMS.
15. Symbols, Definition and Abbreviations: Symbols, definitions, and engineering unit abbreviations used in information displays, submittals and reports shall be as shown in the contract drawings. Symbols, definitions, and abbreviations not in the contract drawings shall conform at a minimum to IEEE Std 100 and the ASHRAE FUNDAMENTALS I-P, as applicable.
16. System Units and Accuracy: System displays, printouts, and calculations shall be performed in English (inch-pound) units. Calculations shall have accuracy equal to or exceeding sensor accuracy as specified in this Section. Displays and printouts shall have precision and resolution equal to or exceeding the worst-case sensor accuracy as specified in this Section.
17. Special Warranties: Provide warranties for all third-party equipment purchased by the contractor. Including but not limited to air compressors, lighting control systems, and gas detection systems. The duration of all third-party warranties shall meet or exceed the warranty period specified in this section.
18. If any portion of the BMS is utilizing BACnet as a communication protocol, provide all Protocol Implementation Conformance Statements (PICS) and BACnet Interoperability Building Blocks (BIBBS) for all BMS equipment utilizing BACnet as specified herein.

E. Product Data: Include technical bulletins and catalog data for each control system component. Clearly identify, by use of symbol or tag number, service of each item. Clearly identify model number of the device including any device options. Each product data sheet shall clearly reference page and paragraph number of specification section to which it applies. Failure to comply with this requirement will result in automatic rejection without review.

1. Submit complete data on controllers, instrumentation, and software. Include signal type, signal characteristics and ranges, installation instructions, calibration data, typical alarm printouts, advisory messages, logging formats, and other pertinent data archive information available on the proposed system. Include all commercial software required for servers, bridges, workstations, and controllers including latest version numbers.
2. All products, material, and equipment shall be listed, labeled, or certified by Underwriters' Laboratory.

F. Verification Reports: Submit sample forms to be used for installation and operational verification reports. Submit the proposed performance verification tests to the Owner for review and approval prior to the start of testing. Submit the final completed reports to the A/E and Owner. The testing reports include:

1. Static System Checkout Sheets, as specified herein.
2. Dynamic Performance Test Sheets, as specified herein.
3. NIST traceable instrument calibration reports for test instrumentation used by the contractor to execute the Static System Checkout.

G. Programming Software: At the end of the project submit the most recent version of the programming software for each type (manufacturer and model) of Programmable System Controller (PSC) shall be submitted and shall be licensed to the project site. The software user's manual shall be submitted for each piece of software provided.

H. Operation and Maintenance Manuals (O&M): At the end of the project submit two copies of the Operation and Maintenance Manuals, indexed and in booklet form shall be submitted. The requirements are specified in this section.

I. Training Documentation: At the conclusion of the training sessions, training manuals shall be delivered for each trainee on the course attendee list with two additional copies delivered for archival at the project site. Two copies of the course attendee list shall be delivered with the archival copies. The Training Documentation may be submitted as a Technical Data Package.

J. Migration Strategy: Prior to integrating the existing DDC controllers into the new Building Management System, outline the migration process, timelines, potential migration problems and the actions the contractor intends to take to mitigate potential problems. The migration strategy shall be approved by the A/E and Owner prior to implementation.

K. Migration Strategy: Prior to integrating the new DDC controllers into the existing Building Management System, outline the migration process, timelines, potential migration problems and the actions the contractor intends to take to mitigate potential problems. The migration strategy shall be approved by the A/E and Owner prior to implementation.

L. Alarm Matrix: Coordinate with Owner to determine which point types shall be alarmed and the alarm parameters for each type. Provide a comprehensive matrix of all points within the scope of this project which shall be alarmed. The matrix shall include point name, node address, point description, associated room number, range of sensor, high alarm limit, low alarm limit, set point, time delays, and whether or not the point alarms remain active when the associated HVAC equipment is de-energized. The matrix shall be reviewed and approved by the Owner prior to implementation.

M. Commissioning Plan: Submit a commissioning plan. The specified commissioning procedures outlined in this specification section shall be used as a guide for developing a detailed commissioning plan. At a minimum the following test procedures shall be addressed:

1. Hardware identification and assembly verification.
2. Wiring installation verification.
3. Binary Inputs (BIs).
4. Binary Outputs (BOs).
5. Analog Inputs (AIs).

6. Analog Outputs (AOs).

1.9 SEQUENCING AND SCHEDULING

A. Sequence work to ensure installation of components is complementary to installation of similar components in other systems.

B. Coordinate work under provisions of Section 01 9113 to ensure system is complete and fully commissioned.

C. Coordinate installation and startup of system components with installation of mechanical systems equipment.

1.10 DELIVERY AND STORAGE

A. Products shall be stored with protection from the weather, humidity, and temperature variations, dirt and dust, and other contaminants, within the storage condition limits published by the equipment manufacturer.

1.11 OPERATION AND MAINTENANCE (O&M) MANUALS

A. The BMS Operation and Maintenance Instructions shall include:

1. As-built Instrument List as specified in the "Shop Drawings" paragraph above for each piece of control equipment.
2. HVAC control system sequences of operation formatted as specified.
3. Procedures for the HVAC system startup, operation, and shutdown including the manufacturer's supplied procedures for each piece of equipment, and procedures for the overall HVAC system.
4. Final As-Built Drawings shall be submitted electronically in PDF and in AutoCAD format. All the same documents listed in "Shop Drawings" paragraph above shall be submitted.
    a. PDF document shall be organized with either bookmarks or hyperlinks to allow navigation from an electronic table of contents directly to individual control drawings, product data, schedules, wiring diagrams, etc.
    b. AutoCAD version shall be determined at project completion.
5. Routine maintenance checklist. The routine maintenance checklist shall be arranged in a columnar format. The first column shall list all installed devices, the second column shall state the maintenance activity or state no maintenance required, the third column shall state the frequency of the maintenance activity, and the fourth column for additional comments or reference.
6. Qualified service organization list.
7. Provide completed verification reports as specified herein.
    a. All Static Performance Test Sheets, refer to the “Verification Tests” paragraph in this section for details.
    b. All Dynamic Performance Test Sheets, refer to the “Verification Tests” paragraph in this section for details.
    c. NIST traceable instrument reports for test instrumentation used by the contractor to execute the Static System Checkout.
8. Provide a recommended spare parts list, accompanied by unit pricing.

1.12 MAINTENANCE AND SERVICE

A. Beginning at the point of beneficial use, provide 12 months' full maintenance service by skilled, competent employees of the system manufacturer. Perform inspection, testing, cleaning, and part or component replacement as specified and as required to maintain the warranty. Work includes providing necessary preventive and unscheduled maintenance and repairs to keep the BMS operating as specified. Work shall comply with manufacturer's recommendations and industry standards. Provide technical support via telephone during regular working hours.

B. Provide field services as specified in section 01 4000 - Quality Requirements.

C. Working Hours:

1. Working hours are from 7:30 A.M. to 4:00 P.M. local time Mondays through Fridays except national holidays, as coordinated with Owner.

D. Preventative Maintenance:

1. Include quarterly (two 8-hour days each) preventive maintenance, repair, or replacement of worn or defective components, lubrication, cleaning, and adjusting as required to maintain specified or normal operation. Use only parts and supplies as used in manufacturer and installation of original equipment.

E. Service Call Reception:

1. An Owner representative will advise the BMS contractor by phone or in person of all maintenance and service requests.
2. The contractor shall have procedures for receiving and responding to service calls 24 hours per day, seven days a week, including weekends and holidays. A single telephone number shall be provided by the contractor for receipt of service calls during regular working hours. Service calls shall be considered received by the contractor at the time and date the telephone call is placed by the authorized Owner representative.
3. The contractor shall separately record each service call request. The completed form shall include the serial number identifying the component involved, its location, date, and time the call was received, nature of trouble, names of the service personnel assigned to the task, instructions describing what has to be done, the amount and nature of the materials to be used, the time and date work started, and the time and date of completion.
4. The contractor shall respond to each service call request within two working hours. The status of any item of work must be provided within four hours of the inquiry during regular working hours, and within 16 hours after regular working hours.

F. Service Call Work Warranty: Provide an unconditional warranty on service call work. The warranty shall include labor and material necessary to restore the equipment involved in the initial service call to a fully operable condition. In the event the contractor's service call work causes damage to additional equipment, the contractor shall be liable for labor and material to restore the system to full operation. The contractor response to service call warranty work shall be the same as required by the initial service call.

G. System Modifications: Provide recommendations for system modification in writing to the Owner. No system modifications shall be made without prior approval of the Owner. Any modifications made to the system shall be incorporated into the Operations and Maintenance Instructions, and other documentation affected. The contractor shall make available to the Owner software updates for all software furnished under this specification during the life of this contract. There shall be at least one scheduled update near the end of the contract period, at which time the contractor shall make available the latest released version of all software provided under this specification and shall install and commissioning it upon approval by the Owner.

H. Continuing Maintenance Service: Provide a continuing maintenance proposal from installer to Owner, in form of a standard yearly (or other period) maintenance agreement, starting on the date the initial warranty period concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

1.13 SYSTEM ACCURACY

A. Input Accuracy: Sensors, transmitters and DDC Hardware shall be selected, installed, and configured such that the maximum end-to-end error (from the sensor to the server) in the point value is less than 150 percent of the maximum allowable error specified for the sensor or instrumentation.

B. Control Stability and Accuracy:

1. Airflow:
   a. For air handling systems: Plus or minus 5 percent.
   b. For mechanical areas and electrical areas: Plus or minus 10 percent.
2. Temperature:
   a. For air handling systems: Plus or minus 2 deg F.
   b. For hydronic systems: Plus or minus 2 deg F.
   c. For mechanical areas and electrical areas: Plus or minus 5 deg F.
3. Humidity:
   a. For air handling systems: Plus or minus 5 percent RH
   b. For mechanical areas and electrical areas: No humidity control.
4. Pressure:
   a. For room pressure monitoring: Plus or minus 0.01 in WC.
   b. For air handling systems: Plus or minus 0.05 in WC.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Honeywell, Inc. (ComfortPoint Open BMS, or newer).

B. Johnson Controls, Inc. (Web-based Metasys).

C. Siemens Industries, Inc. (Desigo CC Automation System).

D. Schneider Electric (EcoStruxure System).

AD-2: Section 25 1000; 09/25/2024: Add Paragraphs 2.1, E.

E. Trane.

2.2 SYSTEM REQUIREMENTS

A. Refer to Section 01 8133 - Cyber Security Requirements for cyber security related product requirements.

B. The communication speeds between ASCs, PSCs, and SCs shall be stable, robust, and sufficient to ensure that no degradation of system response time shall occur under any operating condition of the facility.

C. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each PSC shall operate independently by performing its own specified control, alarm management, operator I/O, and data collection. The failure of any single component or network connection shall not interrupt the execution of any control strategy, reporting, alarming and trending function, or any function at any operator interface device.

D. Provide a sufficient quantity of SCs, PSCs, and ASCs to meet the physical and software I/O point requirements shown on the contract drawings, specified herein, and to meet the sequence of operations in Section 25 9000. Each SC and PSC shall contain all input/output points necessary to provide control and monitoring of the connected system in accordance with the sequence of operation. Provide at least 20 percent spare points in each SC and PSC for future expansion. Spare points shall contain a combination of all point types. Spare points of only one type per panel are not acceptable. List quantity and type of spare points available per controller on the shop drawing submittal. Under no circumstance shall all input/output points in a controller be completely used.

E. System performance shall ensure that any alarm occurring at any ASC, PSC, or SC (provided under the scope of this project) is annunciated at all workstations and all alarm printers within 15 seconds under all operating conditions of the facility.

F. System performance shall ensure that any point commanded from any operator workstation, PSC, or SC (provided under the scope of this project) shall commence within 2 seconds under all operating conditions of the facility, with some form of acknowledgment provided at that time.

G. System performance shall ensure that a change in value, greater than the change of variable (COV) limit, of any point within the system (provided under the scope of this project) is updated on all open graphic screens at all workstations within 5 seconds under all operating conditions of the facility.

H. The SCs shall poll the software points connected to its respective secondary level network for trend data. At least one SC shall be provided for each secondary level network. The trend data shall remain in the RAM of the SC until the server retrieves the data. The time intervals between retrievals shall be governed by two factors. The time interval shall not be so short that the communication speed of the network is hindered in any way but shall not be so long that an interruption in the network for more than 7 days will cause the data in the controller to overwrite trend data which has not been retrieved. Using the server to poll software points directly for trend data is unacceptable.

I. The BMS shall synchronize all DDC hardware, which has a real-time clock, at least once per day. Provide automatic daylight savings time corrections.

J. Provide engineered BMS networks. The network bandwidth usage under a heavily loaded condition shall not exceed 60 percent for either the primary level network or the secondary level networks.

1. A heavily loaded primary level network is characterized as one performing the following activities simultaneously:
    a. Transmitting batches of trend data for every point in the building in response to polling requests at 15-minute intervals.
    b. Transmitting 500 point values to the server in response to polling requests at 5-second intervals.
    c. Transmitting 100 point override commands from the server to every SC or PSC at 10 second intervals.
2. Heavily loaded secondary level networks are characterized as ones performing the following activities simultaneously:
    a. Transmitting trend data for every point on the secondary level network to the supervisory controller in response to polling requests at 5-minute intervals.
    b. Transmitting every point value to the supervisory controller in response to polling requests at 5 second intervals.
    c. Transmitting 100 point override commands from the supervisory controller to the Application Specific Controllers at 10 second intervals.

2.3 NETWORK ARCHITECTURE

A. Refer to Section 01 8133 - Cyber Security Requirements for cyber security related product requirements.

B. The design of the BMS shall network all servers, operator workstations, supervisory controllers (SC), Programmable System Controllers (PSCs), application specific controllers (ASCs), and protocol gateways. The network architecture shall consist of two levels: a primary level network which shall be an Ethernet based network as specified herein and a secondary level network which shall be a twisted-pair type network as specified herein.

C. Primary Level Network.

1. Primary level network is the building's IT network. The BMS primary network shall support communication using a VLAN, which shall be configured by the BMS contractor and coordinated with the Owners IT department.
2. The workstations, server, SCs, PSCs (depending on the manufacturer), and IP Routers shall reside on industry standard Ethernet utilizing standard IP protocols, IEEE Std 802.3.
3. The PSCs and SCs shall be able to communicate global data across the network, including but not limited to outdoor air temperature / humidity / CO2, economizer mode changeover, humidity control in spaces, heat recovery system enable, and restart after power failure.
4. The primary level network shall allow the SCs, and PSCs to access any data from, or send control commands and alarm reports directly to, any other SC or PSC or combination of multiple SCs and PSCs on the network without dependence upon a central or intermediate processing device.
5. SCs and PSCs shall send alarm reports to multiple operator workstations without dependence upon a central or intermediate processing device. The network shall also allow any SC or PSC to access, edit, modify, add, delete, back up, restore all system point database and all programs.
6. The Ethernet network shall provide speeds of at least 100 Mbps on the entire network using the IP protocol. The Bit Error Rate (BER) of the data communications components shall be no greater than one error in 10E9 for the entire network. The Network shall use the following protocols for layers 1 through 7 as defined in the ISO OSI Model (at a minimum):
    a. OSI Layer 1. The physical layer shall be in conformance with IEEE Std 802.3 (Ethernet) and operate at least 100 megabits per second Mbps (100Base-T). Higher speed protocols may be used. If higher speed physical layers are used, bridging hardware shall be provided to ensure compatibility with 100 Mbps devices.
    b. OSI Layer 2. The data-link layer shall be the IEEE Std 802.2 Logical Link Control (LLC), Type 1, Class 1, in combination with the IEEE Std 802.3 Protocol.
    c. OSI Layer 3. The network layer shall be the Internet Protocol (IP; RFC 791), the Internet Control Message Protocol (ICMP; RFC 792), and the Address Resolution Protocol (ARP; RFC 826).
    d. OSI Layers 4 - 7. Network shall support all layer 4 protocols supported by IP (RFC 791) including but not limited to ICMP (RFC 792), IGMP (RFC 1112), TCP (RFC 793), UDP (RFC 768), IGP (RFC 1371, and GRE (RFC 2784).
7. BACnet Communication Protocol:
    a. Provide a BMS which communicates BACnet protocol via the IP Ethernet based primary level network.
    b. The BMS shall be in accordance with ANSI/ASHRAE 135-2008. Minimum system functionality must include monitoring, commanding, and alarming for daily operator functions from any operator workstation.
    c. The system shall be open in that it is designed and installed such that the Owner is able to perform repair, replacement, upgrades, and expansions of the system without further dependence on the original hardware vendor.
    d. All control equipment which communicates on the primary level network shall be BACnet laboratories Tested (BTL) certified.
    e. Minimize the use of proprietary BACnet objects and properties.
    f. Conform to the BACnet Testing Lab's Device Implementation Guidelines.
    g. Provide BACnet objects, properties, and services required to support the application and supervisory monitoring and control functionality including:
        1) System start/stop and overrides.
        2) Scheduling.
        3) Alarming.
        4) Trending.

h. All devices shall have a Protocol Implementation Conformance Statement (PICS) that identifies all of the portions of BACnet that are implemented. The PICS shall be submitted in the shop drawing package.

i. All devices shall have BACnet Interoperability Area and associated BACnet Interoperability Building Blocks (BIBBS). The BIBBS shall be submitted in the shop drawing package.

D. Secondary Level Network:

1. The secondary level network is a lower tier network connected to PSCs, SCs and IP routers. This level of communication shall support a family of ASCs. Provide a fully functional secondary level network. All ASCs shall successfully communicate on the secondary level network.
2. The use of ASCs to control AHUs, HRUs, large pieces of HVAC equipment, and mechanical systems is not acceptable.
3. Operation shall be protected against electrical noise of 5-120 Hz and from keyed radios up to 5 W at 1 meter (3 feet).
4. Each segment of the secondary level network will have a maximum number of nodes which can be accommodated. No more than 90 percent of the nodes on any given segment shall be utilized.
5. All controller sequences and operation shall provide closed loop control of the intended application. Closing control loops over any network is not acceptable.
6. BACnet Communication Protocol:
   a. Provide a BMS which communicates the BACnet MS/TP protocol via the EIA-485 based secondary level network.
   b. All cable characteristics and wiring lengths shall conform to the manufacturer's cable and wiring specifications.
   c. The network shall have no control devices connected to it.
   d. Provide and power all necessary BACnet MS/TP repeaters.

2.4 NETWORK HARDWARE

A. Refer to Section 01 8133 - Cyber Security Requirements for cyber security related product requirements.

B. Ethernet Switch: Switches shall be IEEE Std 802.3 bridges which shall function as the center of a distributed-star architecture and shall be "learning" bridges with spanning tree algorithms per IEEE Std 802.1D. The switch shall support the connected media types and shall have a minimum of 150 percent the required ports and no fewer than 4 ports. One port shall be switch selectable as an uplink port. The switches shall be wall mounted.

C. Fiber Optic Patch Panel: In the event that fiber optic cable is provided as an Ethernet backbone, the cable shall be terminated on both ends at a fiber optic patch panel. A fiber optic patch cable shall be provided to connect the fiber optic patch panel to the Ethernet switch.

1. The fiber Optic Patch Panels shall be wall mountable and designed to provide termination facilities for up to 24 fibers. Unit shall also have capability to be equipped with spliced trays, six packs (for adapters), and blank panels for easy termination of the fiber bundles and tube cables.
2. Fiber-optic terminating equipment shall provide for mounting of ST or SC connectors on an optical patch panel. Fiber-cable management and cable-routing hardware shall be provided by the Contractor to assure conformance to minimum fiber and cable bend radii. Connectors on the patch panel shall be ST or SC feed through.
3. Access to both sides of the panel shall be provided by the Contractor.
4. The patch panel for the connectors shall be mounted to facilitate rearrangement and identification.

5. Each apparatus shall have cabling and connection instructions associated with it.

D. Fiber Optic Media Converter: Fiber Optic media converter shall provide media conversion between layer 1 copper and fiber media to support data rates equal to the greater of the physical layer or 100 Mbps as specified in IEEE Std 802.3.

E. IP Router: Provide IP router network equipment. The routers shall be fully configurable for protocol types, security, and routing selection of sub-networks. The router shall meet all requirements of RFC 1812.

2.5 COMPUTER HARDWARE

A. Refer to Section 01 8133 - Cyber Security Requirements for cyber security related product requirements.

B. Nameplates: Laminated plastic nameplates shall be provided for each server and workstation. Each nameplate shall identify the function, network address and identifier of the server or workstation. Laminated plastic shall be 0.125 inches thick, white with black center core. Nameplates shall be a minimum of 1 by 3 inches with minimum 0.25 inches high engraved block lettering. All nameplates shall be attached to the device in conspicuous location.

C. All computer hardware provided must meet the minimum hardware requirements for all software to be installed on it, as specified by the software manufacturer or the minimum requirements in this section (whichever is stricter). If multiple software packages are to be installed on the same server/desktop/laptop, then contractor must coordinate the increased hardware required to meet the needs of all combined software. In the absence of clear software or customer IT guidance, this section is intended to define the minimum acceptable hardware.

D. Server Hardware (Critical Environments):

1. Computer Server Hardware (server) shall be a standard unmodified digital computer of modular design currently being manufactured. The modular components of the server shall be products of a single manufacturer which advertises service in all 48 contiguous states. Provide (1) server as shown on System Architecture diagrams. Server hardware shall meet the following minimum requirements (when not required by the BMS software):
   a. Processor Speed: Quad-Core Intel® Xeon® (or better), 8MB Cache, 3.3GHz, 1066MHz FSB.
   b. Random Access Memory (RAM): 48GB DDR, 667MHz, 2x512MB Single Ranked DIMMs.
   c. Communications Ports: (4) USB 3.0 ports, multi-port serial port adapter, in addition to any ports required for the keyboard and mouse.
   d. Drives and Controller: Each controller and drive shall provide at least 2.0 TB usable disk space with an average seek time of 7 milliseconds or less using hardware RAID (Redundant Array of Inexpensive Disks) at level 1(RAID-1). Provide SSD solid state drives.
   e. CD/DVD-RW Drive: Combo CD-RW with 32x read, 24x write and 16x rewrite and DVD-RW with 12x read; 4x re-write; 2x write.
   f. Video Output Card: Support at least 24-bit color at a minimum resolution of 1280 by 1024 at a minimum refresh rate of 70 Hz.
   g. Network Interface Card (NIC): Integrated 100Base-T Ethernet NIC with an RJ45 connector.
   h. Monitor: Sized as shown but no less than 17 inches with a minimum resolution of 1280 by 1024 pixels, non-interlaced, a maximum dot pitch of 0.28 mm, and a minimum refresh rate of 70Hz.
   i. Keyboard: 101-key keyboard, having a minimum 64-character standard ASCII character set based on ANSI INCITS 154.
   j. Mouse: 2-button mouse with a minimum resolution of 400 dots per inches.

k. Hot-swappable redundant power supplies.

l. Internal removable disk backup with a minimum of 200GB storage.

m. Provide any additional hardware required to successfully integrate to third-party automation systems, as indicated on contract drawings.

E. Server Hardware (Office Building):

1. Computer Server Hardware (server) shall be a standard unmodified digital computer of modular design currently being manufactured. The modular components of the server shall be products of a single manufacturer which advertises service in all 48 contiguous states. Provide (1) server as shown on System Architecture diagrams. Server hardware shall meet the following minimum requirements (when not required by the BMS software):

a. Processor Speed: Quad-Core Intel® Xeon® (or better), 4MB Cache, 3GHz, 1066MHz FSB.

b. Random Access Memory (RAM): 32GB DDR, 667MHz, 2x512MB Single Ranked DIMMs.

c. Communications Ports: (4) USB 3.0 ports, multi-port serial port adapter, in addition to any ports required for the keyboard and mouse.

d. Drives and Controller: Each controller and drive shall provide at least 1.0 TB usable disk space with an average seek time of 7 milliseconds or less. Provide SSD solid state drives.

e. CD/DVD-RW Drive: Combo CD-RW with 32x read, 24x write and 16x rewrite and DVD-RW with 12x read; 4x re-write; 2x write.

f. Video Output Card: Support at least 24-bit color at a minimum resolution of 1280 by 1024 at a minimum refresh rate of 70 Hz.

g. Network Interface Card (NIC): Integrated 100Base-T Ethernet NIC with an RJ45 connector.

h. Monitor: Sized as shown but no less than 17 inches with a minimum resolution of 1280 by 1024 pixels, non-interlaced, a maximum dot pitch of 0.28 mm, and a minimum refresh rate of 70Hz.

i. Keyboard: 101-key keyboard, having a minimum 64-character standard ASCII character set based on ANSI INCITS 154.

j. Mouse: 2-button mouse with a minimum resolution of 400 dots per inches.

k. Internal removable disk backup with a minimum of 200GB storage.

l. Provide any additional hardware required to successfully integrate to third-party automation systems, as indicated on contract drawings.

F. Operator Workstation Hardware (Desktop):

1. Computer Workstation Hardware (workstation) shall be a standard unmodified digital desktop computer of modular design as shown. The modular components of the desktop shall be products of a single manufacturer which advertises service in all 48 contiguous states. Provide Desktops as shown on System Architecture diagrams. Workstation hardware shall meet the following minimum requirements (when not required by the BMS software):

a. Processor Speed: Intel i5 (or better), 3.0GHz.

b. Random Access Memory (RAM): 8 GB RAM.

c. Communications Ports: One serial port, one enhanced parallel port and two USB 3.0 ports in addition to any ports required for the keyboard and mouse.

d. Drive and controller: 160 GB formatted disk space with an average seek time of 7 milliseconds or less. Provide SSD solid state drives.

e. CD-RW Drive: 24x read; 12x re-write; 24x write.

f. Video Output Card(s): Support at least 32-bit color at a minimum resolution of 1280 by 1024 at a minimum refresh rate of 70 Hz and shall support the quantity of monitors provided for each workstation.

g. Network Interface Card (NIC): Integrated 100Base-TX Ethernet NIC with an RJ45 connector.

h. Monitor: Monitor sized as shown on drawings but no less than 19 inches with a maximum supported resolution of no less of 1280 by 1024 pixels, flat screen, non-interlaced, and a maximum dot pitch of 0.28 mm. The workstation located in work room 1NA102 shall be provided with (5) monitors.

i. Keyboard: 101-key keyboard having a minimum 64-character standard ASCII character set based on ANSI INCITS 154.

j. Mouse: 2-button mouse with a minimum resolution of 400 dots per inches.

k. Coordinate location of desktop with Owner. Provide power and data connections as required. Coordinate with electrical contractor.

G. Laptop Hardware:

1. Laptop Hardware shall be a standard unmodified digital laptop computer. The modular components of the laptop shall be products of a single manufacturer which advertises service in all 48 contiguous states. Provide Laptops as shown on System Architecture diagrams. Laptop hardware shall meet the following minimum requirements (when not required by the BMS software)

a. Processor Speed: Intel i5 (or better), 3.0GHz.

b. Random Access Memory (RAM): 8 GB RAM.

c. Communications Ports: One serial port and two USB 2.0 ports in addition to any ports required for the keyboard and mouse.

d. Drive and Controller: 200 GB formatted disk space with an average seek time of 7 milliseconds or less. Provide SSD solid state drives.

e. CD-RW Drive: 24x read; 12x re-write; 24x write.

f. Network Interface Card (NIC): Integrated 100Base-TX Ethernet NIC with an RJ45 connector, and wireless LAN 802.11n or newer.

2.6 COMPUTER SOFTWARE

A. Refer to Section 01 8133 - Cyber Security Requirements for cyber security related product requirements.

B. Operating System (OS): Provide an operating system for all servers, workstations and laptops provided for the project. The operating system (OS) shall fully support all installed software and peripherals and shall be able to obtain screen capture of the monitor display being viewed.

C. Standard Office Software: Provide standard office software. The office software shall be coordinated with the client prior to installation. The software shall consist of spreadsheet and word processing portions of the project site's standard office software.

D. Document Viewer: Provide a PDF document viewer, along with any other viewer software required to open and display any files stored or accessed as part of the M&C software, including any relevant help files, training files, etc.

E. Login and Passwords:

1. Coordinate login/password management requirements with Owner and Section 01 8133 – Cyber Security Requirements. The Monitoring and Control (M&C) software shall provide user-based access to M&C functionality. The M&C Software shall obtain user information from the Operating System and shall recognize at least 20 separate users and have at least 4 levels of user permissions. User permission levels (from most restrictive to most permissive) shall include:

a. Permission Level 1: View System Graphic Displays.
b. Permission Level 2: Permission Level 1 plus acknowledge alarms and set up (configure) trends and reports.
c. Permission Level 3: Permission Level 2 plus point commanding and set up (configure) alarms, schedules, and demand limiting.
d. Permission Level 4: Permission Level 3 plus create and modify System Graphic Displays, create custom programs, and create software points.

2. Passwords shall not be displayed. The system shall maintain a disk file logging all activity of the system. If the file format is not plain ASCII text, provide a means to export or convert the file to plain ASCII text. This file shall maintain, as a minimum, a record of all operators logged onto the system, alarm acknowledgments, commands issued and all database modifications. Passwords shall not be logged. The activity log shall be maintained at the server hardware. The system shall automatically provide a mechanism for archiving the log files for long term record storage.
3. Setup system permission level templates, so that as users are added to the system the template can be applied to the users.

F. System Graphic Displays:

1. The M&C software shall include graphical displays through which an operator can perform real-time access and manipulation of the M&C functions as specified and shown. The graphical displays shall consist of building-level systems (air handler units, EFs, VAV boxes, AHUs, HRUs, etc.) graphic displays, alarm displays, scheduling displays, and trending displays.
2. Identify all points the Owner wants displayed on the graphic screens. Provide a list of graphical symbols to the Owner for review and approval prior to developing the graphic screens.

G. Navigation Scheme:

1. System graphic displays of building-level systems and points shall be hierarchical displays using a building-to-equipment point-and-click navigation scheme. Each display shall show the building name and number. Each display shall show system wide data such as outside air temperature and humidity in the case of an HVAC system application.
   a. Each Building or Building Sub-Area display shall show the building footprint and basic floor plan and shall clearly show and distinguish between the individual zones and the equipment serving each zone and space. The building display shall also show all space sensor and status readings, as applicable, for the individual zones such as space temperature, humidity, differential pressure, occupancy status, etc. The building display shall show the locations of individual pieces of monitored and controlled equipment.
   b. Each equipment display shall show a 3-dimensional representation of the individual pieces of equipment using the symbols and M&C point data types as specified. Different colors and textures shall be used to indicate various components and real time data. Color and texture meanings shall be consistent across all displays.
   c. Each display shall clearly distinguish between the following point data types and information:
      1) Real-time data.
      2) User-entered data.
      3) Overridden or operator-disabled points.
      4) Devices in alarm (unacknowledged).
      5) Out-of-range, bad, or missing data.

H. Navigation Commands:

1. The system graphic displays shall support English language operator commands via point-and-click mouse or keyboard entry for defining and selecting points, parameters, graphics, report generation, and all other functions associated with operation. The operator commands shall be usable from any operator workstation with individual operator passwords as specified.
    a. Command Input: Operator's commands shall be full words and acronyms selected to allow operators to use the system without extensive training or any data processing backgrounds. The system shall prompt the operator in full words and acronyms for all required information, identifying acceptable command formats. The operator's response shall be a point-and-click selection, word, phrase, or acronym including parameters where required.
    b. Command Input Errors: The system shall supervise operator inputs to ensure they are correct for proper execution. Operator input assistance shall be provided whenever a command cannot be executed because of operator input errors. The system shall explain to the operator why the command cannot be executed. Conditions for which operator error assist messages shall be generated include:
        1) The command used is incorrect or incomplete.
        2) The operator is restricted from using that command.
        3) The command addresses an out-of-range or bad data point.
        4) The command addresses a point that does not exist.
        5) The command would violate constraints.
    c. Operator's Commands: The operator's commands shall provide the means for entry of control and monitoring commands, and for retrieval of information. The operator's commands shall perform tasks, including:
        1) Request a display of any database point or calculated point or any group of related points and calculated points.
        2) Start-up and shutdown selected systems or devices.
        3) Override any point to an operator selected value.
        4) Release the override of a point.
        5) Modify time and event scheduling.
        6) Initiate reports.
        7) Generate and format reports.

I. Display Editor:

1. The display editor shall enable the user to create, modify, and delete displays and graphic symbols. The primary use shall be for adding and modifying one-line diagrams, status displays, system summaries, and system directories, as new controllers, points, data, and other necessary changes are made. The basic functions shall include:
    a. Create and save displays and graphic symbols.
    b. Group and ungroup graphic symbols. The grouped symbol shall be manipulated as a single symbol.
    c. Modify a portion of a graphic symbol.
    d. Save graphic symbols as a library object.
    e. Rotate and mirror a graphic symbol.
    f. Delete a graphic symbol.
    g. Place a graphic symbol on a display.
    h. Cancel the display of a graphic symbol.
    i. Assign conditions which automatically initiate the display.
    j. Overlay alphanumeric and graphics.

k. Save new, modified, or existing graphics as new graphics.
l. Integrate real-time data with the display.
m. Define the background color.
n. Define the foreground color.
o. Locate the symbols.
p. Position and edit alphanumeric descriptors.
q. Establish connecting lines.
r. Establish sources of latest data and location of readouts.
s. Display analog values as specified.
t. Cursor control (up, down, right, left).
u. Create and display alphanumeric displays.
v. Assign graphics a depth such that when there are coincident graphics the one with the lower depth is displayed.
w. Symbols Library: The library of callable display symbols shall include: Pump, Motor, Two- and Three-way Valves, Flow Sensing Element, Point and Averaging Temperature Sensors, Pressure Sensor, Humidity Sensor, Single and Double Deck Air Handling Unit, Fan, Chiller, Boiler, Air Compressor, Chilled Water Piping, Steam Piping, Hot Water Piping, Ductwork, Unit Heater, Pressure Reducing Valve, Damper, Electric Meter, Limit Switch, Flow Switch, High- and Low- Point and Averaging Temperature Switches, High- and Low- Pressure Switches, Coil, Solenoid Valve, Filter, Condensing Unit, Cooling Tower, Variable Frequency Drive (VFD), Heat Exchanger, Current Sensing Relays. Symbols shall at a minimum conform to ASHRAE Fundamentals Handbook where applicable.

J. Scheduling:

1. The M&C software shall be capable of changing the value of any point in the database. A minimum of 200 user-definable schedules shall be supported and the specified scheduling functions shall be operator accessible and adjustable via graphics display. The graphics display shall include the following fields and functions:
   a. Current date and time. The OS and M&C software shall automatically make Daylight Savings Time adjustments. Daylight savings time adjustment shall be capable of being disabled by the operator.
   b. Building name and number.
   c. System identifier and name.
   d. System group. Systems shall be capable of being grouped by the user to perform according to a common schedule.
   e. Weekly schedules. Each system shall have a weekly schedule based on a seven day per week schedule with independent schedules for each day of the week including no less than 6 value changes per day.
   f. Holiday and special event schedules. System scheduling shall support holiday and special event calendar schedules independent of the daily schedule. Special event schedules shall include one-time events and recurring events. Scheduling of one-time events shall include the beginning and ending dates and times of the event. Holiday and special event schedules shall have precedence over device weekly schedules.

K. Alarms: The M&C software shall be capable of generating alarms and handling network alarms from the control network. M&C Software shall be capable of handling and managing no less than 20,000 alarm points daily.

L. Alarm Data:

1. Alarm data to be displayed and stored, as applicable and as specified, shall include:
   a. Identification of alarm including building, system (or sub-system), and device name.

b. Date and time to the nearest second of occurrence.
c. Alarm type:
   1) Unreliable: Indicates that the source device has failed due to the sensing device or alarm parameter being out-of-range or bad data.
   2) High Alarm.
   3) Low Alarm.
d. Alarm set point and dead band (if analog).
e. Engineering units.
f. Current value or status of the alarm point.
g. Alarm priority: There shall be two alarm priority levels; critical and informational. Critical alarms shall remain in alarm until acknowledged by an operator and the alarm condition no longer exists; informational alarms shall remain in alarm until the alarm condition no longer exists or until the alarm is acknowledged.
h. Alarm Message: A unique message with a field of 60 characters shall be provided for each alarm. Assignment of messages to an alarm shall be an operator editable function.
i. Alarm Secondary Message: Secondary messages shall be assignable by the operator for printing to provide further information, such as telephone lists or maintenance functions, and shall be editable by the operator. The system shall provide for 100 secondary messages, each with 25 lines of 60 characters each.
j. Messages shall be sent via either SMS text message or email. Alarm distribution shall be configurable at the BMS operator workstation. Operator shall be capable of selecting specific recipients or groups of recipients for each alarm.
k. Acknowledgement status of the alarm and, where acknowledged, the time and date of acknowledgement.
l. User who acknowledged the alarm.

M. Alarm Notification and Routing:

1. The M&C software shall be capable of performing alarm notification and routing functions. Upon receipt or generation of an alarm the M&C software shall immediately perform alarm notification and routing according to an assigned routing for that alarm. The M&C software shall support at least 100 alarm routes; an alarm route shall be a unique combination of any of the following activities:
   a. Generate a pop-up display on designated workstation monitors. The pop-up display shall include identification of the alarm, date and time of the alarm, alarm message, and current value/status of the alarm point. Alarms shall be capable of being acknowledged from the pop-up display by operators with sufficient permissions. Pop-up displays shall be displayed until acknowledged.
   b. Print alarms to designated alarm printers. The printed message shall be the same as the pop-up message.

N. Alarm Display and Acknowledgement: The M&C software shall include an alarm display. A minimum of the most recent 100 system alarms shall be available for display at each workstation as shown, along with all associated alarm data. Alarms shall be capable of being acknowledged from this display. Multiple alarms shall be capable of being acknowledged using a single command. Operator acknowledgment of one alarm shall not automatically be considered as acknowledgment of any other alarm nor shall it inhibit reporting of subsequent alarms.

O. Alarm Storage and Reports: The M&C software shall store each alarm and its associated alarm data to hard disk. The stored data shall be user-sortable and formatted for printing.

P. Trending:

1. The M&C software shall be capable of performing real-time trending of a minimum of 5,000 points simultaneously with a minimum trending capacity of 100 points per second. The M&C software shall be capable of displaying and printing a graphical representation of each trend, and of multiple trended points on the same graph. The software shall be capable of saving trend logs to a file. If the file format is not plain ASCII text in a Comma-Separated-Value (CSV) format, provide a means to export or convert the file to plain ASCII text in a CSV format. Each trend shall be user-configurable for:
    a. Point to trend.
    b. Sampling interval with a minimum sampling interval no greater than 1 second, and a maximum sampling interval no less than 1 hour.
    c. Start and Stop Time of Trend: Start and stop times shall be determined by one or more of the following methods:
        1) Start Time and Stop Time.
        2) Start Time and Duration.
        3) Start Time and number of samples.
    d. Coordinate the points which require trending, the trend configuration, and the reports with the client. Provide all labor necessary to configure the trends and associated reports.

Q. Report Generation:

1. Software shall be provided with commands to generate and format reports for displaying on current Workstation, printing, and storing on disk. Reports shall be stored by type, date, and time. The destination of each report shall be selectable by the operator.
2. Dynamic operation of the system shall not be interrupted to generate a report.
3. The report generation mode, either automatic or requested, shall be operator assignable.
4. The report shall contain the time and date when the samples were taken, and the time and date when the report was generated.
5. The software shall be capable of saving reports to a file. If the file format is not in a format compatible with the provided Office Automation Software, provide a means to export or convert the file to a compatible format.
6. Software shall be provided to format and store all data, trends, profiles, reports, and logs specified herein in a comma-delimited text format to any media supported by the operating system.
7. The software shall allow for automatic or manual generation of reports.
    a. For automatic reports, the operator shall be able to specify the time the initial report is to be generated, the time interval between reports, end of period, and the output format for the report. The operator shall be able to modify or inhibit a periodic report.
    b. Manual report generation shall allow for the operator to request at any time the output of any report. The software shall have a report generation utility capable of generating the following standard reports:

R. Energy Usage Report:

1. Where energy meters are indicated on the contract documents and monitored by the BMS, the BMS shall provide an energy usage summary, operator selectable, for a unit, building, area, installation, and the entire BMS, as appropriate for the meters installed. The report shall be divided by utility and shall be capable of reporting on at least four separate utilities. The report shall include the following information:
    a. Beginning and ending dates and times.
    b. Total energy usage for each utility for the current and previous day.
    c. Total energy usage for each utility for the current and previous month.
    d. Outside air (OA) temperature and OA relative humidity (RH) or dew point for:

1) Average for current day, and average for previous day.
2) Minimum and maximums of previous day
3) Average values of each for previous month
4) Average values of each for current month

S. Alarm Report: Outstanding alarms by building or unit, including time of occurrence.

T. Override Report: Points overridden, including time overridden, and identification of operator overriding the point.

U. Run Time Reports: A report totalizing the accumulated run time of individual pieces of equipment. The operator shall be able define equipment groupings and shall be able to generate reports based on these groupings.

V. Programming Language:

1. The M&C Software shall incorporate a programming (scripting) language for creating custom applications. Actions that shall be available through the programming language shall include the following functions:
   a. Override points.
   b. Monitor points.
   c. Clock / Timer Functions.
   d. Math Functions: Addition, subtraction, multiplication, division, exponentiation, trigonometric and logarithmic functions.
   e. Loops ("for" and "while").
   f. Conditional Branches ("if-then-else").
   g. Variable Define / Assignment / Use.
   h. Provide data to a graphic display.
   i. Get data from a graphic display.
   j. Initiate alarm conditions.
   k. Initiate Reports.
   l. Logic Functions ("and", "or" and "not").
   m. Bitwise logic functions.
   n. User defined subroutines and functions.

W. Remote Access:

1. The M&C Software shall allow for remote access via a secure Internet connection. M&C Software shall allow for basic Cybersecurity features, such as firewall protection that would be configured by the Owner.
2. Remote access shall allow for viewing all BMS graphics, making commands (such as setpoint changes), viewing reports (such as trend logs), and viewing the alarm history.
3. Remote access shall be configured with access restrictions, such as name and password requirements, to regulate the users that have remote access capabilities.

2.7 CONTROLLERS

A. Supervisory Controller (SC):

1. Provide supervisory controllers (SCs) which comply with the following requirements. The SC shall have two components. The first is a communication interface between the primary level network and secondary level network. The second is supervisory interface which manages the BMS point database. Provide one controller with both components integral if the controller is available from the BMS manufacturer, or two separate components in the same enclosure.

a. Communication Interface: Shall be the primary system point of contact between the secondary level network and the primary level network through which all communication traffic to/from the two networks passes. Communication interface shall communicate at a minimum of 10/100 Mbps on the primary level network.

b. Supervisory Interface: Shall manage alarm and trend data. Trend data shall be stored at the supervisory interface and uploaded to the server when retrieval is desired. Uploads shall occur based upon either user-defined interval, manual command or when the trend buffers are full. Uploading trend samples directly from the control device to the server is unacceptable.

1) All trend data shall be available for use in third-party personal computer software.

2) Include a minimum of 24 MB of memory. Maintain all trending information in non-volatile memory or 72-hour battery backed RAM. Each unit shall have an accurate real time clock that can be synchronized.

3) Any point, physical or calculated, may be designated for trending. Any point, regardless of physical location in the network, may be collected and stored.

2. The Secondary level network shall be engineered to meet the following criteria:

a. For office systems, assume 1/8 of all the points on the secondary level network are being trended at 5-minute intervals. PSC and network design shall allow trend collection of all points with no loss of trend data and be capable of storing data for a minimum of 7 days before data is overwritten.

b. For any laboratory or ABSL-2 or 3 systems, assume 1/2 of all the points on the secondary level network are being trended at 5-minute intervals. PSC and network design shall allow trend collection of all points with no loss of trend data and be capable of storing data for a minimum of 7 days before data is overwritten.

3. If a SC is available from the BMS manufacturer with I/O point capacity, the SC may be provided with point (I/O) capacity as defined in the (PSC) specification section. The SCs shall also comply with all the requirements of the Programmable System Controller (PSC) if the SC is provided with I/O point capacity.

B. Programmable System Controller (PSC):

1. General Requirements:

a. The PSC shall reside on either the Secondary level network backbone or the Primary level network. PSCs communicating on the Secondary level network backbone shall communicate at a minimum rate of 76 kilobits per second (Kbps). PSCs communicating on the Primary level network shall communicate at a minimum rate of 10/100 Megabits per second (Mbps). Regardless of which network the PSC resides, all PSCs shall successfully communicate to the server and workstations.

b. Provide one PSC per air handling unit (AHU), Heat Recovery Unit (HRU), and any major Mechanical system shown on BMS Network Architecture.

c. Include minimum 1 MB of memory. Maintain programming and point database in non-volatile memory (EEPROM) or 72-hour battery backed RAM. Each unit shall have an accurate real time clock that can be synchronized.

d. Permit readout of variables, override of control, modification of attributes and scheduling changes while printing messages, trends, reports, or alarms.

e. Each PSC shall contain analog inputs (AI), binary inputs (BI), analog outputs (AO), or binary outputs (BO).

f. Incorporate LED status lights in PSC to indicate operational position of binary outputs (ON/OFF).

g. Controllers shall provide operators with the ability to manually override automatic or centrally executed commands at the PSC via local, point discrete on-board Hand/Off/Auto override switches for binary control type points and gradual switches for

analog control type points. Override switches shall be operable whether the panel processor is operational or not.

1) Switches shall be mounted either within the PSC key accessed enclosure or externally mounted with each switch keyed to prevent unauthorized overrides.
2) PSC shall monitor the status of all overrides and inform the operator that automatic control has been inhibited.

h. PSC shall count/accumulate/totalize multiple pulse type inputs (kW meters, steam flow meters, water meters and similar inputs) and convert those pulse signals into engineered values for control and read-out.

i. A PID control loop algorithm shall provide accurate control of sensed variable.

j. Transmit messages to other units on communication network. Messages transmitted shall be positively acknowledged as received or negatively acknowledged as not received. Negative acknowledgements shall immediately force retransmission of message.

2. Controllers:
   a. Stand-alone, multi-tasking, multi-user, minimum 16-bit CPU-based controllers for all applications. All controllers shall provide for direct interface to industry standard sensors and input devices.
   b. Control Loop Scan Frequency: Less than one second.
3. Points:
   a. Input Types:
      1) RTD (100- or 1000-ohm platinum).
      2) Thermistors
      3) Contact open/closed.
      4) 4-20 mA.
      5) 3-15 psi.
      6) 0-12 VDC.
      7) Pulse accumulator.
   b. Output Types:
      1) 0-12 VDC.
      2) Pulse-width modulation.
      3) Maintained/momentary on/off.
      4) 4-20 mA.
      5) 3-15 psi.
4. Software:
   a. Provide integral software with required control algorithms and alarm routines.
   b. Permit programming of PSC database from: a laptop, PSCs on the primary level network, server, or any operator workstation.
   c. Each PSC shall perform normal control and energy management routines as defined by the operator.
   d. Normal Control Routines:
      1) Distributed digital control of system temperature, humidity, pressure, and flow.
      2) Three mode PID (proportional, integral, and derivative) control.
      3) Logging and alarm logic.
      4) Normal Power restoration sequential restart program.
      5) Emergency Power sequential start program.
      6) Non-volatile control strategies.

7) High and low limits with alarms for analog input/output points of each controlled variable.
8) Adjustable on-off delays.
9) Totalization of analog/binary values.
10) Pulse totalization.
11) Reset of receiver controller setpoints.
12) Trend information and storage.
13) Equipment Alternation.

e. Energy Management Routines:
1) Time of day scheduling.
2) Start/stop time optimization.
3) Peak demand limiting.
4) Economizer control.
5) Enthalpy changeover.
6) Event initiated programs.
7) Lighting Control Time based occupied/unoccupied modes.

f. Execute temperature control functions within unit. Execute loop control via direct digital control algorithms. Allow user to customize control strategies, sequences of control, define control loop algorithms and choose optimum loop parameters for loop control. Control loops shall support full proportional, integral, and derivative control applications.

g. Permit creation, modification, or removal of control algorithms within a PSC, while operating and performing other control functions. Each control loop shall be user definable in terms of:
1) Sensors/actuators as part of control strategy.
2) Control mode.
3) Gain.
4) Control action.
5) Sampling time.

h. Permit user to create customized control strategies based upon arithmetic, Boolean or time delay logic. Arithmetic functions shall permit simple relationships between variables (i.e., +, -, /, x) as well as more complex relationships (i.e., square root).

i. Data Sharing: PSCs shall share appropriate point information such that control sequences or control loops, executed at one unit, receive input signals from appropriate sensors connected to other units within network. When data highway fails or other PSCs malfunction, control loop shall continue to function using last value received from network.

j. Fail-Safe Operation:
1) Provide self-diagnostics that continuously monitor operation of unit. Automatically report malfunction of controller, distributed module, or associated communication link. Display failure condition with time and date.
2) Upon detection of a memory error, each processor shall correct error or halt to prevent erroneous operation. Report "halts" as an alarm on the BMS. Upon communication being reconnected, a "Return to Normal" message shall be generated at both locations.
3) Upon power restoration after failure, provide automatic sequential restart of equipment based on current program time and program requirements without operator intervention. Provide prioritized restart of systems and equipment as defined on Contract Documents.

4) A dedicated fail-safe relay in PSC controller shall change state on a hardware and/or software fault. Relay contacts shall be used to set a fixed fail-safe position for designated output-controlled devices.

k. Alarm Management:

1) Monitor and direct alarm information to operator devices. Each PSC shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network communications traffic, and prevent alarms from being lost. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of six priority levels shall be provided for each point.

2) Direct alarms to the server and workstations for annunciation or printout, as directed by Owner. Provide the ability to acknowledge alarms from any workstation, as allowed by operator security settings. Provide time and date of acknowledgment.

5. PSC shall provide high resolution sampling capability for verification of control loop performance. Operator initiated automatic and manual loop tuning algorithms shall be provided for operator selected PID control loops. Provide ability to view or print trend and tuning reports.

a. In automatic mode, controller shall perform a step response test with a minimum one-second resolution, evaluate trend data, calculate new PID gains and input these values into the selected loop.

b. For troubleshooting in manual mode, operator shall be able to select variables to override default values. Calculated PID gains shall then be reviewed before they are inserted into the selected loop.

c. Loop tuning shall be capable of being initiated either locally at PSC, from the server or any workstation. For all loop tuning functions, access shall be limited to authorized personnel through password protection.

6. PSC shall automatically accumulate and store run-time hours for all major mechanical equipment (AHUs, EFs, Pumps, etc.).

7. Nameplates: Laminated plastic nameplates shall be provided for each PSC. Each nameplate shall identify the function, network address and identifier of the server or workstation. Laminated plastic shall be 0.125 inches thick, black with white letters. Nameplates shall be a minimum of 1 by 3 inches with minimum 0.25 inches high engraved block lettering. All nameplates shall be attached to the device in conspicuous location.

C. Application Specific Controller (ASC):

1. Controllers:

a. ASC shall operate as a standalone controller capable of performing its specified control responsibilities independently of other controllers in the network. ASC shall be a microprocessor based, multi-tasking, real time digital control processor. ASC shall provide control of the terminal device independent of the manufacturer of the terminal device. ASC shall not be used to control AHUs, HRUs, or major pieces of mechanical equipment, such as, but not limited to: Preheat or Reheat systems, or Exhaust Fan systems.

b. Provide each ASC with sufficient memory to accommodate point databases, operating programs, local alarming, and local trending. All databases and programs shall be stored in non-volatile EEPROM and EPROM, or minimum of 72-hour battery backup shall be provided. The controllers shall be able to return to full normal operation without user intervention after a power failure of unlimited duration.

c. Controller shall be part of a secondary level network for interface to industry standard air terminal equipment.

d. Provide wiring terminals, input/output points, local communication, and electrical power.

e. Processor shall be minimum 12 bit, with communication rate of 9600 baud or higher.

f. Input/Output System: Provide required input/output point types necessary to accomplish sequence of operations provided in Section 25 9000 – BMS Sequence of Operation, and as shown on contract drawings.

g. The installed application shall be suitable for the piece of equipment and shall function as specified in the sequence of operations.

h. Assign and change setpoints and control parameters using a laptop or through manual commands at any operator workstation.

i. Provide operator with ability to remotely monitor or adjust controlled variables.

j. The BMS shall provide power to all ASCs via a power trunk. No more than 80 percent of the capacity of any given transformer shall be utilized.

k. ASCs installed on terminal units which re-calibrate daily by modulating the terminal unit damper shall re-calibrate in a staggered fashion. The ASCs shall be programmed to re-calibrate in 5-minute increments so that no more than one ASC, associated with a system, re-calibrates at the same time. The programming shall be stored in non-volatile EEPROM and EPROM, or minimum of 72-hour battery backup shall be provided, the programming shall that not be lost in the event of a power failure or controller failure.

l. ASCs installed on terminal units serving critical areas (such as vivarium and laboratories) shall not re-calibrate daily by modulating the damper. Provide ASCs which re-calibrate without disrupting the airflow into the critical area. If the BMS manufacturer does not offer this option, the terminal units shall be controlled by a PSC with the use of differential pressure transmitters for monitoring terminal unit air flow. Floating control is not acceptable.

2. Air Velocity Transducer:

a. Air velocity sensor (Pitot-tube or "Crossflow"), provided by terminal unit manufacturer (Section 23 3600), connects to differential pressure transmitter, and measures average differential pressure. This value is converted to airflow through a square root function.

b. Measurement Range: 400 to 4000 fpm.

c. Measurement Resolution: Plus or minus 16 fpm.

d. Measurement Repeatability: Plus or minus 32 fpm.

e. Measurement Accuracy: 400 to 4000 fpm: Plus or minus 5 percent of measured value.

2.8 SURGE PROTECTION

A. Power-Line Surge Protection: Equipment connected to AC circuits shall be protected against or withstand power-line surges. Equipment protection shall meet the requirements of IEEE C62.41.1. Fuses shall not be used for surge protection.

B. Surge Protection for Transmitter and Control Wiring:

1. DDC hardware shall be protected against or withstand surges induced on control and transmitter wiring installed outdoors and as shown. The equipment protection shall be protected against the following two waveforms:

2. A waveform with a 10-microsecond rise time, a 1,000-microsecond decay time and a peak current of 60 amps.

3. A waveform with an 8-microsecond rise time, a 20-microsecond decay time and a peak current of 500 amperes.

C. Transient Surge Protection:

1. Provide each controller and sensor with means of suppression of transients from inductive devices in system, capable of generating or sustaining transients.

2. Provide the server and workstations with immunity from electrical sags, surges, transients, noise, and outages with uninterruptable power supplies.

PART 3 - EXECUTION

3.1 PROJECT MANAGEMENT

A. Provide a designatedproject manager who will be responsible for the following:

1. Construct and maintain project schedule.
2. On-site coordination with all applicable trades, subcontractors, and other integration vendors.
3. Authorized to accept and execute orders or instructions from Owner.
4. Attend project meetings as necessary to avoid conflicts and delays.
5. Make necessary field decisions relating to this scope of work.
6. Coordination/Single point of contact.

3.2 CONTROL SYSTEM INSTALLATION

A. General Installation Requirements:

1. The BMS shall be completely installed, tested and ready for operation. Dielectric isolation shall be provided where dissimilar metals are used for connection and support. Penetrations through and mounting holes in the building exterior shall be made watertight. The BMS installation shall provide clearance for control system maintenance by maintaining access space required to calibrate, remove, repair, or replace control system devices. The BMS installation shall not interfere with the clearance requirements for mechanical and electrical system maintenance.
2. The control equipment shall be installed in a control enclosure mounted on the terminal unit or adjacent to the terminal unit in an accessible location. The contractor's responsibilities include but are not limited to all interconnecting wiring, all interconnecting tubing, factory calibration, all field wiring, all field tubing, and all linkage connections between the actuator and the terminal unit.

B. Installation:

1. Prior to activating any BMS controller, the BMS contractor shall provide a plan for the startup of all BMS controllers as well as a plan for all point-to-point checkout procedures to the construction manager, mechanical contractor, and Owner to work in a synergy manner to start up HVAC equipment within project schedule deadlines.
2. Provide supervision of installation of all control components to ensure conformity with manufacturer's instructions and reviewed submittals, including components furnished but installed by others. Verify locations to ensure that accurate primary signals will be obtained.
3. Refer to Divisions 23, 25 and 26 for additional methods and materials.
4. Calibrate airflow sensors with readings obtained from Test and Balance contractor. Verify that field mounted indicators display using the same engineering units as monitored by BMS.
5. Provide start-up, calibration, and adjustment of all airflow and pressure controls.
6. All devices shall be installed in accordance with manufacturer's recommendations and as specified and shown. Control devices to be installed in piping and ductwork shall be provided with required gaskets, flanges, thermal compounds, insulation, piping, fittings, and manual valves for shutoff, equalization, purging, and calibration. Strap-on temperature sensing elements shall not be used. Spare thermowells shall be installed adjacent to each thermowell containing a sensor and as shown.
7. All devices and instruments located outdoors shall be provided in NEMA 4 enclosures. Heat load calculations shall be performed to determine if the device's ambient temperature range will be exceeded. Wherever the temperature range is exceeded, provide enclosure heating and cooling. Where it is unfeasible to provide a NEMA 4 enclosure provide a three-sided instrumentation and device shelter. All equipment installed outdoors shall be rated for the full range of outdoor ambient conditions.

8. Provide minimum 10 feet of extra cabling for temperature and relative humidity sensors located in common areas to accommodate relocation. Neatly coil and fasten extra sensor wiring in accessible area above sensor location.
9. All wall mounted sensors and thermostats shall be mounted to be accessible in accordance with ADA Guidelines unless otherwise noted on the contract drawings. Coordinate final locations of all wall-mounted sensors/thermostats with the Owner prior to installation.
10. All alarm and indicating devices must follow NFPA 72 codes for signaling, including synchronization of strobe lights in a common area.
11. All valves installed outdoors shall be provided with NEMA 4 actuator housings and heaters if required by the manufacturer.
12. Mount the sensors for monitoring outdoor air conditions (e.g., outdoor temperature and humidity transmitters) in an instrument shelter, located on roof. Refer to the contract documents for location.
13. Where control devices are to be surface mounted on components scheduled to be insulated, provide insulation between device and component to prevent condensation or heat transfer.
14. Verify location of room thermostats, room temperature/humidity sensors, duct temperature/humidity transmitters, airflow stations, static pressure probes, control panels, and other exposed control equipment with contract drawings before installation. Provide an insulated backplate for thermostats and wall mounted temperature sensors installed on exterior walls.
15. Mount low limit temperature detectors (freeze stats) using flanges and element holders. Wire multiple contacts in series. Mount thermostats on full width and height support rack within custom air handling units.
16. Duct Penetrations: Where instruments penetrate ductwork, provide gaskets, flanges, and apply sealant to create an airtight seal.
17. All BMS junction box wall penetrations in gypsum wall board (GWB) within containment areas provide the following:
    a. Conform to all means and methods specified in Division 26.
    b. Provide a finished GWB zip strip bead around the entire perimeter of the wall opening. The zip bead is to be finished with GWB spackle, at exposed wall surface, to be flush with adjacent surface.
    c. Maintain a 1/4 inches joint between the zip bead framing and exterior perimeter of the junction box. The 1/4 inches gap is to be infilled with a backer rod material and a minimum of 1/4 inches deep sealant at the exterior surface of the gap. Final finish of sealant to be flush with junction box.
    d. All junction boxes are to be mounted so that the edge of the box is flush with the final GWB finish, to allow the cover plate to be installed flush to the final finish.
    e. Provide cover plates to extend past the sealed perimeter joint by a minimum of 1/4 inches.
    f. Set cover plate in a bed of sealant at perimeter. Final finish exterior of cover place with a bead of sealant.
18. Provide multi-section dampers with interconnecting hardware or jackshaft for unison operation when required.
19. Mount SCs and PSCs controlling large pieces of HVAC and mechanical equipment adjacent to associated equipment on vibration free walls or freestanding angle iron supports. Do not mount on AHU housing. Coordinate final location of all Controllers and Enclosures with all other trades prior to installation. Provide nametags for instruments and controls inside the control enclosure and identify associated system on face of the enclosure. Mount a laminated copy of panel of As-Built drawing(s) inside each cabinet.

20. Coordinate control wiring and safety contacts required for motor control centers and VFD controllers with Division 26 and shown on electrical details. Wire safeties so that they will not be overridden when hand-off-auto (HOA) switches are in hand position.

C. Software Installation:

1. Install software as follows:
   a. Operating System (OS): Install the OS on each Server and Workstation and configure usernames and passwords.
   b. Office Automation Software: Install the office automation software on each server and workstation.
   c. Monitoring and Control Software: Install the monitoring and control software as shown. The server version of the software shall be installed on server hardware, and client versions shall be installed on the workstations.

D. Control Enclosure Installation:

1. Unitized cabinet type for each system under automatic control. Provide quantity of enclosures required to house all relays, transducers, solenoid valves, pneumatic devices, and other interface controls. Mount temperature, humidity, airflow, and pressure indicators, (or operator interface display with keypad), pressure gauges, pilot lights, pushbuttons, and switches flush on cabinet panel face.
2. Provide NEMA-1 general purpose enclosure for all applications where panel will be installed indoors. Any control panel for use in wash-down locations or installed outdoors shall be rated NEMA-4. Enclosures installed outdoors shall be provided with heating or cooling to meet the operating temperature requirements of the equipment within the enclosure. All cabinets shall use a common key. Provide means of storing control system instructions and drawings inside cabinet.
3. Provide surface mounted or freestanding, steel supported types for mechanical equipment rooms. Provide fully recessed wall-mounted types elsewhere.
4. All enclosures shall be fully recessed in walls, except in mechanical equipment rooms and above ceilings.
5. Interior arrangement of control enclosure components shall be such that tubing, and wire raceways shall be separated and aligned horizontally and vertically, in a fashion that allows for an organized appearance and a practical means for the tubing/wire to exit the raceway to its intended component.
6. All tubing shall enter the enclosure through standard bulkhead compression fittings. All tubing lines shall be labeled using "Brady" markers or similar at both ends of the tubing.
7. All wire shall enter the enclosure via conduit fittings. All wires shall terminate on terminal blocks and then continue from the terminal block to the device. Direct connection to the device is not permitted. Use of wire nuts is not permitted, except in applications in which a control device is provided from the factory with "pigtails". All wires shall be labeled using "Brady" markers or similar at both ends of the terminal blocks.
8. Terminal blocks which are not integral to other equipment shall be insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanism, shall be suitable for rail mounting, and shall have end plates and partition plates for separation or shall have enclosed sides.
9. Each enclosure shall include a convenience duplex receptacle, a circuit breaker, and a local disconnect.
10. Refer to Section “Equipment Tags” for additional requirements.

3.3 WIRING INSTALLATION

A. Standard Wire and Cable:

1. Wire and Cable shall be installed without splices between control devices and in accordance with NFPA 70 and NFPA 90A. Refer to Section 26 for means, methods and materials. Instrumentation grounding shall be installed per the device manufacturer's instructions and as necessary to prevent ground loops, noise, and surges from adversely affecting operation of the system. Ground rods installed by the contractor shall be tested as specified in IEEE Std 142. Cables and conductor wires shall be tagged at both ends, with the identifier shown on the shop drawings. Wiring external to enclosures shall be run as follows:
    a. Wiring other than low-voltage control and low-voltage network wiring shall be installed in raceways.
    b. Low-voltage control and low-voltage network wiring not in suspended ceilings over occupied spaces shall be installed in raceways, except that nonmetallic-sheathed cables or metallic-armored cables may be installed as permitted by NFPA 70.
    c. Low-voltage control and low-voltage network wiring in suspended ceilings over occupied spaces shall be installed in raceways, except:
        1) Nonmetallic-sheathed cables or metallic-armored cables may be installed as permitted by NFPA 70.
        2) Plenum rated cable in suspended ceilings over occupied spaces may be run without raceways.
    d. Per NEC Article 725 (excluding thermocouple wiring). Control or signal circuits not run entirely in conduit, in areas classified as plenum space and vertical shafts shall be energized from listed Class 2 power supplies and shall be installed in Type "CL2P" listed plenum cable exclusively. Plenum rated cable shall be permitted in applications above an accessible ceiling or in between drywall where there is no insulation.
    e. For Hazardous location circuits, refer to NFPA Article 500 for installation requirements.
2. All wiring in plenums and above a suspended ceiling shall be secured to the structure and routed through J-hooks. Under no circumstances may the cabling be laid upon the top of a suspended ceiling.

B. Conduit: Provide EMT conduit for all exposed wiring installed inside the building. Plenum rated cable, without conduit, can be used only above accessible ceilings. For spaces that are inaccessible, such as shafts, EMT conduit is required. Use rigid conduit for all wiring outside or underground.

C. Terminal Blocks: Terminal blocks which are not integral to other equipment shall be insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanism, shall be suitable for rail mounting, and shall have end plates and partition plates for separation or shall have enclosed sides.

D. Control Wiring for Binary/Analog Signals: Provide the manufacturer recommended wire type for all analog and binary control signals. Control Wiring for Analog Signals shall be copper, single or multiple-twisted, minimum 2 inches lay of twist, 100 percent shielded pairs (as required), and shall have a 300-volt insulation. If shielding is required by the manufacturer, the cables shall have an overall aluminum-polyester or tinned-copper cable-shield tape, overall tinned-copper cable drain wire, and overall cable insulation. Acceptable Manufacturers: Anixter or Belden. Substitutions require approval prior to installation.

E. Wiring for 120-Volt Circuits: Division 26 shall provide 120VAC power for BMS use at junction boxes at locations shown on the electrical power drawings. Division 25 contractor shall extend power to all BMS control equipment and devices from the nearest junction box. Provide power to all controllers, devices, and instruments which serve HVAC and mechanical equipment fed by normal power. Wiring for 120-volt circuits shall be 14 AWG or thicker stranded copper and shall be rated for 600-volt service.

F. Wiring for 24-Volt Power trunks: The Division 25 contractor shall provide power to all ASCs via a power trunk. Division 26 shall provide 120 VAC power at junction boxes for BMS use at locations shown on the electrical power drawings. Division 25 Contractor shall extend 120 VAC

power to local stepdown transformers/power supplies. Division 25 Contractor shall provide stepdown transformers/power supplies and 24 vac power trunks wiring as required to power all ASC. No more than 80 percent of the capacity of any given transformer shall be utilized.

1. It is acceptable to use local step-down transformers at terminal equipment where power is provided.

G. Primary Level Network Wiring Specification:

1. Provide all cables, switches, and signal repeaters to ensure a fully functional Ethernet network.
2. Design the network to accommodate all of the PSCs, SCs, Ethernet gateways, and workstations/servers provided for the BMS system. The appropriate quantity of switches and signal repeaters shall be provided to meet the network requirements; the locations shall be coordinated with the A/E and other trades. Provide 120 VAC to all network equipment. If any portion of the BMS is on UPS, then all network hardware shall be UPS powered.
3. Interior LAN Copper Cable: Interior Copper LAN cable shall meet or exceed all requirements of Category 6 cable as specified in TIA/CEA-568-B.1. Terminations, patch panels, and other hardware shall meet or exceed Category 6 specifications and shall be as specified in Division 27. Cabling products shall be tested and certified for use at data speeds up to at least 100 Mbps. Other types of media commonly used within IEEE Std 802.3 LANs (e.g., 10Base-T and 10Base-2) shall be used only in cases to interconnect with existing media. Short lengths of media and transceivers may be used in these applications. Provide separately orderable media, taps and connectors.
4. Coordinate: node names, IP addresses, access privileges, and system configuration with the Owner prior to start-up.
5. Provide modular 8-pin, Category 6 information outlets at all controllers communicating on the primary level network. The cable shall be terminated inside the field panel at the information outlet. Division 25 contractor to provide a patch cable to connect the field panel to the information outlet.
6. Ethernet cable shall be provided to connect the operator workstation/server to each PSC. The Ethernet network shall meet the following criteria:
    a. Do not exceed 328 feet 100 meters from the PSC to the nearest hub, router, switch, or signal repeater. This shall include the length of the patch cable between the information outlet and the PSC.
    b. All new Ethernet networks shall be a minimum of Category 6 certified 1Mb Base-T Ethernet cable, for future expansion.
    c. Use plenum-certified Ethernet cable when run through a plenum.
    d. Ethernet cable shall only be buried in an insulated electrical tunnel. Ethernet wiring is not certified for direct burial.

H. Secondary Level Control Network:

1. Provide all wires, and network equipment to ensure a fully functional secondary network.
2. All cable characteristics and wiring lengths shall conform to the manufacturer’s cable and wiring specifications.

3.4 EQUIPMENT TAGS

A. Tags shall be keyed to the unique identifiers shown on the contractor's as-built drawings. All enclosures and DDC Hardware shall be labeled. All sensors and devices not located in finished office spaces shall be provided with plastic tags. All sensors and devices located in finished office spaces shall be provided with "Brady" marker, indicating the unique identifier only. Airflow measurement arrays shall be tagged to show flow rate range for signal output range, duct size, and pitot tube AFMA flow coefficient. Duct static pressure taps shall be tagged at the location of the pressure tap. Tags shall be plastic and shall be mechanically attached directly to each device or attached by a stainless steel chain or wire.

B. Device and sensor tags shall display the following information: the unique identifier, 16-character device description, PSC / ASC No. which device is controlled from. Device descriptions shall be consistent across HVAC and mechanical equipment.

C. Tags shall be a minimum of 1 by 3 inches with minimum 0.25 inches high engraved block lettering. Laminated plastic shall be 0.125 inches thick, black with white letters.

D. Tags external to protective enclosures shall be engraved plastic and mechanically attached to the enclosure or DDC Hardware.

E. Tags inside protective enclosures may be attached using adhesive.

F. Tags provided for low pressure gauges provided in spaces for locally monitoring room differential pressure may be attached using adhesive. Coordinate tag location with Owner prior to installation.

G. Provide labels for all information outlets provided by the contractor. The label shall indicate the IP address of each port.

H. All tags shall be attached to the device in a conspicuous location.

I. All identification tagging shall be consistent and correlate across system details, drawings, points list, and sequence of operations.

3.5 CONTROLLER INTEGRATION TO EXISTING BMS NETWORK

A. Confirm there are no duplicate software point names between the existing BMS and new BMS. Confirm no node names or addresses are duplicated. Confirm that the existing BMS is 100 percent compatible with the new BMS. Take corrective action to resolve all potential problems with the integration process prior to physically connecting the two systems together.

B. Once the new BMS is commissioned, the contractor shall assist the Owner's representative to make the physical connection to the existing network.

C. Once the tie-in is complete, confirm communication with the existing server.

D. Upload all data to the existing server. Preferably upload one controller at a time until all controller information is uploaded to the existing server.

E. Verify there were no anomalies created during the integration process and that no new alarms or failed points were created. If so, take corrective action to resolve issues.

F. Create graphics, trends, alarm definitions and reports as specified herein.

3.6 CONTROLLER TUNING

A. Tune each controller in a manner consistent with that described in the ASHRAE Fundamentals Handbook. Tuning shall consist of adjustment of the proportional, integral, and where applicable, the derivative (PID) settings to provide stable closed-loop control. Each loop shall be tuned while the system or plant is operating at a high gain (worst case) condition, where high gain can generally be defined as a low-flow or low-load condition. Upon final adjustment of the PID settings, in response to a change in controller setpoint, the controlled variable shall settle out at the new setpoint with no more than two (2) oscillations above and below setpoint. Upon settling out at the new setpoint the controller output shall be steady.

3.7 TESTING AND BALANCING SUPPORT

A. Provide dedicated labor and any necessary physical BMS tool to support and verify work performed by the testing and balancing (TAB) contractor. Provide interface software to the TAB, so that the TAB can access and manipulate the air flow values of all DDC hardware provided for this project.

B. Provide a trend report, by each AHU/EF system, listing all the supply and exhaust air valve airflows. Include the air valve setpoints and output position signals. Trends shall be provided

per area/floor summarizing the airflow quantities to assist the building TAB contractor in determining any duct leakage or the building peak zone static pressure requirements.

C. Assist TAB contractor to perform system pressure mapping to identify pressure reading used to determine system static setpoints. Assist TAB contractor in adjusting balancing devices in distribution systems to provide uniform static pressure profile. Terminal boxes/valves, etc. will not be allowed to be used as pressure reducing devices.

3.8 VERIFICATION TEST

A. Perform the following performance verification tests (PVT) for each control system to ensure that the described control system components are installed and functioning per this specification.

B. Verification test procedures, testing and activities shall be developed and conducted so as not to cause personal injury, damage to components, damage to systems, or damage the building or other property.

C. General Requirements:

1. Intent of the PVT procedure is to demonstrate that the exact functions of control systems meet requirements outlined by approved shop drawings and written Sequence of Operation.
2. Verify each air handling unit, equipment system, steam, and hydronic system in automatic mode of operation, utilizing actual field devices and final control elements. Tune each control loop to minimize cycling of outputs around setpoint and eliminate overshooting on start-up.
3. Indicate type and cause of failures, as well as required remedial actions, on test report. Requested tests, not outlined herein, will be evaluated for feasibility and impact on schedule and cost prior to implementation.
4. Systems will not be accepted by the Owner or A/E without approval of tests and required remedial action.
5. Provide a schedule to the Owner for execution of the PVT. The Owner shall participate in any or all of the contractor's PVT at the Owner's discretion.

D. Control System Static Check:

1. Prior to static check of system, identify each SC, PSC, and ASC by description, tag number, and address. Verify proper system communication with these devices, as well as values indicated.
2. Operational static check shall include verification of all field wiring associated with SCs, PSCs, and ASCs. Include continuity testing between wiring from field device (sensor, actuator, or other components) to appropriate block on terminal strip in appropriate enclosure. Verify control loop wiring diagrams and panel wiring diagrams for the following:
   a. Binary Inputs: Energize each binary input (smoke detector, end switch, control relay, flow switch, differential pressure switch, or other components) in field. Verify at panel.
   b. Binary Outputs: Manually override each binary output (solenoid valve, motor starter, control relay, or other components) at control panel. Field-verify corresponding final element for proper stroke/status. Release override for each binary output point to allow BMS program control after testing.
   c. Analog Inputs: Compare field reading of each analog input (transmitters, thermistor, or other components) with that displayed on graphic screens, and auxiliary panels.
   d. Analog Outputs: Manually override each analog output (I/P) to values of 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent. Field-verify corresponding final element (valve or damper) positions from fully closed to open, based upon stated spring range. Release override for each binary output point to allow BMS program control after testing.

e. Provide static system checkout sheets which lists every physical point in the BMS in a tabular format. The list shall include the following fields: unique point identifier, software address, associated PSC or SC, associated room number (where applicable), check column indicating ID tag affixed and information is correct, actual value, initials of person performing verification, and date verification was completed successfully. The actual value is sensed by a testing instrument (for analog points) and visual indication (for binary points).

3. Calibration of Test Instruments:

a. Use calibrated test instruments for all point checks as specified herein. The calibration of the test instruments shall be traceable to the National Institute of Standards and Technology (NIST) standards. A static system checkout shall be performed on a BMS instrument if the date of the test instrument calibration is within one year of the date of the check. Recalibrate test instruments annually and submit the NIST traceable instrument reports along with the static system checkout sheets.

E. Control System Dynamic Check:

1. Operational dynamic check shall include verification that control system, including sensors and actuators, performed as specified while interconnected to the process.
2. Verify proper system communication with controllers and the ability to reset setpoints remotely from operator workstations.
3. Verify the operation of each air handling unit, equipment system, steam, and hydronic systems in automatic.
4. Test: system failures, start-up sequences for air handling units, exhaust fans, heat recovery units, and Hydronic systems. Verify warnings and fail to start logic. Simulate power failure and restart software for controlled equipment and systems.
5. Verify and demonstrate that operator workstation interface graphic screens are displayed consistent with the drawings. Verify the status of each binary and analog value on every graphic screen is consistent with expected color convention and actual field device reading. Use only graphic screens accepted by the A/E and Owner.
6. Test each control loop to verify that it indicates proper percent of scale and correct scaling of engineering units.
7. Verify stability of all control loops. Record and print graphical trends for each control loop to verify loop stability is within specified limits. Each trend shall be in 2-minute increments for no less than 12 hours.

F. Alarms: Test each alarm identified in the contract documents. Verify that control system displays proper indication. Test and verify proper acknowledgement of alarms from operator workstation.

G. Performance Reports:

1. Provide static system checkout sheets which lists every physical point in the BMS and any integrated third-party communication systems in a tabular format. The list shall include the following fields: unique point identifier, software address, associated PSC or SC, associated room number (where applicable), check column indicating ID tag affixed and information is correct, actual value, initials of person performing verification, and date verification was completed successfully. The actual value is sensed by a testing instrument (for analog points) and visual indication (for binary points).
2. Submit Dynamic Performance Test Sheets indicating operating conditions after detailed dynamic checkout of the systems. The dynamic performance test sheets shall represent the contractor's sequence of operations. Each paragraph shall be tested, upon successful completion of the dynamic test the person performing verification shall initial and date verification test form adjacent to the paragraph tested. Once all of the sequences are tested, the test sheets shall be submitted for record.

3.9 TRAINING

A. Provide system demonstration and instructions under provisions of Section 01 7900 - Demonstration and Training.

B. For each system, demonstrate:

1. Cold start.
2. Sequence of operation.
3. Seasonal control.

C. Provide complete demonstration of equipment or systems requiring seasonal operation, during operating season. Perform multiple demonstrations when required within six months.

D. Provide training on-site, within one year of Owner acceptance of BMS installation. Coordinate scheduling and duration with Owner; training days may not be consecutive.

E. Provide experienced instructors to teach Owner's personnel operation, adjustment, testing, trouble shooting and maintenance of the system. Include detailed instruction manuals which contain any operations specific to this project.

3.10 CLEANING

A. The contractor shall clean up all debris resulting from their activities daily. The contractor shall remove all cartons, containers, crates, etc., under their control as soon as the contents have been removed. Waste shall be collected and placed in a designated location.

B. At the completion of work in any area, the contractor shall clean all work, equipment, etc., keeping it free from dust, dirt, and debris, etc.

C. At the completion of work, all equipment furnished under this section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to match the adjacent areas. Any cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

3.11 CLOSEOUT ACTIVITIES

A. Refer to Section 01 8133 - Cyber-Security Requirements for cyber security related closeout requirements.

END OF SECTION

SECTION 26 3290

GENERATOR CONNECTION CABINET (Issued in its entirety AD2)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Single Purpose Generator Docking Station.

B. Related Sections include but are not necessarily limited to:

1. Section 26 0010 - Electrical General Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (600 Volts Maximum).
2. Underwriters Laboratories, Inc. (UL):
   a. 50, Enclosures for Electrical Equipment.
   b. 1008, Transfer Switch Equipment.

1.3 SUBMITTALS

A. Shop Drawings:

1. Product technical data:
   a. Provide submittal data for all products specified in PART 2 of this Specification Section.
2. Fabrication and/or layout drawings.
3. Test reports.

B. Contract Closeout Information:

1. Operation and Maintenance Data:
   a. See Specification Section 01 7823 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

1.4 DELIVERY, STORAGE, AND HANDLING

A. See Specification Section 26 0010.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Dual Purpose Generator Docking Station:
   a. Trystar.

B. Other manufacturers desiring approval shall submit a substitution request., comply with Section 01 6100.

2.2 DUAL PURPOSE GENERATOR DOCKING STATION

A. Ratings:

1. Voltage and amperage: As indicated on the Drawings.

2. Short circuit withstand: 14 kAIC unless noted otherwise on drawings.

B. Construction:

1. Bus material: Silver plated copper.
2. Neutral bus: Rated 100 percent of phase bus.
3. Ground bus: 50% of phase bus.
4. Bus supported with UL Recognized Component insulators.
5. Permanent bus connection:
   a. Mechanical set screw lugs located behind physical barrier.
   b. Quantity: As required for the number of conductors indicated on the Drawings.
6. Field wiring connection at docking station for connection to portable generator:
   a. Mounted on gland plate.
   b. Quantity: As required for the number of conductors indicated on the Drawings.

C. Enclosure:

1. Wall mount.
2. NEMA 3R rated.
3. Material: 304 GA Aluminum.
4. Paint after fabrication powder coat. Hammertone Gray.
5. Padlockable front door with hinged access plate at bottom for entry of cables from portable generator or portable load bank. NEMA 3R integrity shall be maintained with access plate open for cable entry.
6. Front access panel shall provide access to front and side for maintenance.
7. Front access panel shall provide access to top, side, and bottom for permanent cabling.

D. Factory Installed Phase Rotation Monitor Device:

1. Phase monitoring relay to be Siemens 3U4512-1AR20 or approved equal, and be factory installed.

E. One-Line Arrangement:

1. DBDS-5.

F. Circuit Breaker Disconnects:

1. Provide circuit breaker disconnects as indicated on Drawings.
2. Breakers shall be UL 489 listed.
3. Breakers shall be removable for service and maintenance.
4. Breakers shall be 100% rated.

G. Additional Accessories:

1. Two wire auto start.
2. Strip heater and thermostat.
3. 120V, 20A GFCI duplex receptacle.
4. 120V, 30A, L5-30R receptacle.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install as indicated and in accordance with manufacturer's recommendations and instructions.

B. Connect as indicated in one-line diagram.

C. Label enclosure in accordance with section 26 0553.

D. Provide with warning sign to identify the type of derived system per NEC 702.7(C).

3.2 FIELD QUALITY CONTROL

A. Circuit breakers shall be tested via primary current injection.

1. Perform inspections and tests per NETA ATS 7.6.1.1.

B. Test load dump receptacle to ensure load bank is dropped upon loss of utility power and call to start signal by ATSs.

C. Test kirk key circuit breaker interlock for proper functionality.

END OF SECTION

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SECTION 28 1001

ACCESS CONTROL (Revised AD-2)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Material and installation requirements for a complete and fully functional access control system, to allow access to authorized personnel within pre-determined areas of the site, based on time and/or authority level.
2. Specifications require that access control reader interface devices and field devices to be interfaced with other security systems outlined in the Division 28 Sections.
3. Section 28 0501 - Common Work Results for Electronic Safety and Security provides requirements that apply to the work of this section.

B. Related Specification Sections but not necessarily limited to:

1. Section 28 0501 – Common Work Results for Electronic Security Systems
2. Section 28 2001 - Video Surveillance System

1.2 REFERENCES

A. Reference Standards: Standards referenced in this section include, but are not necessarily limited to the following:

1. American National Standards Institute (ANSI)/Telecommunications Industry Association (TIA).
   a. ANSI/TIA--569-E – Telecommunications Pathways and Spaces.
2. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
3. UL Solutions. (UL).

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination

1. Coordinate installation of readers and integrate into special assemblies for narrow jamb frames and pedestal mounts.
2. Elevator Readers.
   a. Coordinate the required types, sizes, and quantities of conductors for the traveling cable with elevator contractor.
   b. Coordinate card reader interface from elevator cab to elevator equipment room demarcation interface.
   c. Coordinate interfacing elevator equipment to card access equipment with elevator contractor.
   d. Coordinate installation of readers and integrate into elevator call panels/cab.
   e. Coordinate with the Owner and Vertical Transportation Contractor the output time duration requirements to activate call and floor buttons.
   f. Security features shall not affect emergency firefighter’s services.

1.4 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturers:

a. See Specification Section 28 0501 for additional requirements.

2. Installers:
   a. See Specification Section 28 0501 for additional requirements.

1.5 SYSTEM ARCHITECTURE AND DESCRIPTION

A. The existing owner's Avigilon system shall be utilized for both access control and video surveillance. Coordinate with the owner to add new devices to the owners existing system. Provide all licenses required for the new devices to be added to the existing systems.

1. The Intrusion detection system shall integrate with the owner's existing intrusion detection systems installed on the campus, coordinate with the owner to add the new buildings to the system.

AD-2: Section 28 1001; 09/25/2024: Added Paragraph 1.5, A, 2 and 3.

2. The existing Avigilon system was installed in 2020, it uses the Avigilon AC-APP-128R-ENT-6 128-reader licensed PACS appliance with the following licenses:

a. (1) AC-SW-LIC-16RCU-6-P 16 count reader license.
b. (1) AC-SW-LIC-BDGE-6-P badging license.

3. Provide Avigilon Access Control Manager ACM7 PACS appliance with the following license to upgrade the existing system:

a. (1) Avigilon UA-APP-ENT-7
b. (1) Avigilon UA-SW-LIC-BASE-PACK
c. (1) Avigilon UA-SW-LIC-100DOORD
d. (2) Avigilon UA-SW-LIC-10DOORS
e. (4) Avigilon US-SW-LIC-1DOOR
f. (1) Avigilon UA-SW-LIC-ALL-IN-ADDON

B. System.

1. The alarm monitoring client workstation shall communicate with, and monitor, access control hardware devices, such as access control readers and access control panels. Administrative tasks including defining credential holder information, access groups, time zones, intrusion detection devices, configuring digital video cameras and recording devices, generating reports, creating maps, floor plans, site plans etc. shall be provided from any licensed client workstation on the network.
2. All system data shall reside on a single database on the server and be accessible in real time to all licensed system workstations connected to the network, to allow for automatic change propagation to all client workstations on the system, as well as to provide a common database to consolidate all information.

C. Access Control:

1. The system shall be programmed to provide access granted or denied decisions, define access levels, and set time zones and holidays. An input/output linkage feature shall allow linking of monitor zone points to output control points within Access control panels.

D. Alarm Monitoring:

1. Alarms are to be prioritized. The main alarm window shall provide information to include the time and location of the alarm, along with its priority. The main alarm window shall be able to sort pending and/or insert new alarms based on any of the following attributes: priority, date/time, alarm description, Access control panel, Card Reader, Input Module or cardholder.

E. Network Video Management:

1. The system shall include a seamlessly integrated network-based video management module, to allow for the central administration, monitoring, and archiving of network based video and the associated cameras. The system shall support network based video servers from multiple manufacturers.

F. Third Party Interfaces:

1. The system shall integrate with a number of third-party hardware and software products. The system shall provide seamless integration with fire alarm systems, personal safety systems, video intercom systems, emergency assistance stations, elevator control interface and video systems.

G. System Administration:

1. System Administrative tasks such as defining client workstation & System Operator permissions set-up, access groups, time zones, reports, maps, etc. shall be provided from any client workstation on the network. Initial setup of the cardholder screen layout shall occur on the database server. The system shall support an unlimited number of access control readers, input points, video cameras, intrusion detection points, and relay outputs.

H. Application Programming Interfaces:

1. The system shall provide a set of standard Application Programming Interfaces (API's) and supporting documentation that allows hardware manufacturers and software application developers to integrate their products into the system. The Application Programming Interfaces shall allow requests from the end user to integrate a third party hardware or software solution based on system open architecture and system device independence.

I. Upgrades:

1. All systems shall be upward compatible. Access control hardware shall be compatible with all systems. Access control hardware (Access control panels, Input Control Modules, Access Control Readers, etc.) shall not require replacement or upgrades as the Owner migrates from the existing system level to a newer version.

1.6 APPLICATION DESIGN

A. Open Architecture:

1. The system shall have an open architecture design to support industry standards for databases, networks, credential printers, and video cameras.

B. Open Database Connectivity Compliance:

1. The system shall be Open Database Connectivity (ODBC) compliant. The system shall support a relational database management system with the proper 32-bit ODBC drivers.

C. Network Support:

1. The system shall be designed to support industry standard network protocols TCP/IP. The system shall also support peer-to-peer and FTP server capabilities.

1.7 DESIGN REQUIREMENTS

A. System shall consist of a server, one or more networked client workstations and access control and alarm monitoring processors, interfaced to the Owner’s building network.

1. System Software: 64-bit, latest version Windows operating system and application software. Software shall have the following capabilities:

a. Graphical user interface to show pull-down menus and a menu tree format that complies with interface guidelines of Microsoft Windows operating system.

b. System license shall be for the entire system and shall include capability for future additions that are within the indicated system size limits specified in this Section.

c. System shall have open architecture that allows importing and exporting of data and interfacing with other systems that are compatible with Microsoft Windows operating system.

d. Password-protected operator login and access.

B. Distributed Processing: System shall be a fully distributed processing system so that information, including time, date, valid codes, access levels, and similar data, is downloaded to access control processors to allow each access control processor to make access-control decisions for its location. Intermediate access control processors used to store access control information is not acceptable. In the event that communications to the server is lost, all access control and alarm monitoring processors shall automatically buffer event transactions until communications are restored, at which time buffered events shall be uploaded to the Server.

C. Server/workstations shall provide operator interface, interaction, display, control, and dynamic and real-time monitoring. Server shall control system networks to interconnect all system components, including workstations and field-installed access control and alarm monitoring processors.

D. The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of control panels, readers, sensors, etc.

E. Coordinate color of devices and readers with Architect to blend with surrounding environment prior to procuring. If color options of device are not acceptable to Architect, furnish the devices that have a paintable surface and coordinate with the painting contractor the requirements to paint the devices prior to installation.

F. Systems that require annual license renewal shall not be acceptable.

G. Communication.

1. Network connecting the Server and workstations shall be by the Owner.
2. Field equipment shall include access control/alarm monitoring processors, sensors, and controls. Access control/alarm monitoring processors shall serve as an interface between the Server and sensors and controls. Data exchange between the Server and the access control/alarm monitoring processors shall include down-line transmission of commands, software, and databases to access control/alarm monitoring processors. The up-line data exchange from the access control/alarm monitoring processor to the Server shall include status data such as intrusion alarms, status reports, and entry-control records. Access control/alarm monitoring processors are classified as alarm-annunciation or entry-control type.

H. Access Control/Alarm Monitoring Processors.

1. Access control field devices shall have an onboard UPS to allow for independent operation during power loss periods.
   a. Provide battery back up to all access control/alarm monitoring processors and power supplies, where Division 26 UPS power is not available. Refer to the Division 26 plans and specifications for UPS power circuit schedules and locations.
2. Equipment enclosures in the field shall be key-lockable, and equipped with tamper switches, to annunciate at monitoring workstations.
3. Locate access control panels adjacent to power supplies and door hardware power supplies in dedicated equipment rooms or communications rooms. Locating the panels at the door location is unacceptable.

I. The system shall comply with Underwriters Laboratories (UL) standards and shall carry the UL labels for UL 294 Access Control System Units.

1. The access control system shall operate within the limits of Class 2 remote-control and signal circuits as defined by Article 725 of the National Electrical Code, NFPA 70.

J. Integration with other trades.

1. Interface Readers into Elevator Lobby Call Stations to provide elevator call authorization upon presentation of a valid credential.
2. Integrate Readers into Precast and Construction Walls, Door Frames, etc.
3. Door Hardware Interface: Coordinate with Division 08 Sections that specify door hardware required to be monitored or controlled by the security access system. The access control/alarm monitoring processors in this Section shall have electrical characteristics that match the signal and power requirements of door hardware. Integrate door hardware specified in Division 08 Sections to function with the hardware in this Section.
   a. Provide interface to integral Request to Exit (REX) switch in the door hardware.
   b. In Line Power/Continuous Duty Protection Devices.
      1) Provide protection devices with built-in surge protection and voltage regulation at each electric hardware device to protect the relays and sensitive electronics of the system from the electrical spike that occurs when electric hardware locks or unlocks. The equipment shall also provide protection to door which are programmed for continuous duty operation, reducing the output voltage by 25 percent to extend the life of the electric locks. Design Basis: HES model 2005 - SMART PAC II or approved equal.
4. Fire Alarm Interface. Provide interface from the fire alarm release directly to the hardware or hardware interface to release delayed egress equipment and locked doors in the path of egress in compliance with UL and Life Safety requirements. The fire alarm release shall not interface through security equipment.

K. PIN Codes:

1. PIN readers shall be provided at areas indicated on drawings. Accessing a door shall require entering a valid PIN in conjunction with presenting a valid card. A separate duress code shall be available to each credential holder to notify the operator at the security monitoring screen, as well as initiate an automatic alarm sequence when the duress code is entered.

L. Request to Exit Motion Detectors (where indicated on drawings)

1. Adjust request to exit motion detector timers to 1-2 seconds. The access control systems shall govern the duration time of door unlocks and door held opens.
2. Request to exit motion detectors shall be programmed to shunt door position switches only, unless life safety codes require the affected door to be unlocked.

M. Cable Requirements.

1. Sensor and card reader cable shall be a minimum 22 AWG
2. Lock cable shall be a minimum 18 AWG, however, shall be sized larger base on distance and current rating.

1.8 PERFORMANCE REQUIREMENTS

A. System Response to Alarms: Field device network shall provide a system end-to-end response time of 1 second or less for every device connected to the system. Alarms shall be annunciated at the monitoring station within 1 second of the alarm occurring at an access control/alarm monitoring processor or device controlled by a local Access control panel, and within 100 ms if the alarm occurs at the Server. Alarm and status changes shall be displayed within 100 ms after receipt of data by the monitoring station. All graphics shall be displayed, including graphics-generated map displays, on the console monitor within 5 seconds of alarm receipt at the security console. The response times shall be maintained during system heavy load.

B. Acknowledgeable Events: Any user programmed alarm event shall cause the card access system workstation to provide an audible and visual alarm requiring the operator to acknowledge the event and enter via the keyboard a report of the event and cause.

C. Handicap Entrances:

1. Interface to electric locks and automatic door opening equipment at handicapped access locations. Presentation of a valid card shall unlock the door, and enable the door open button. The credential holder shall then have the option to press the door open button, or manually open the door. The card access system shall not disable the egress door-open button.

D. Elevator Readers:

1. Provide readers adjacent to elevator call button locations as indicated. The call buttons at reader locations shall be disabled under normal conditions. Presenting a valid card shall enable the elevator call buttons, allowing the credential holder to select the direction of intended travel.
2. Provide readers in elevator cars locations indicated. The system shall restrict the credential holder's access to areas on a per-floor basis. The floor selection buttons within the elevator car shall be disabled under normal conditions. The presentation of a valid card shall enable the floor buttons the credential holder is authorized to access. Floor restrictions per cardholder shall be modified through the programming in the access control system.

E. ADA Accommodation.

1. Cards designated for ADA access shall be programmed to an extended door unlock time to allow sufficient time for handicapped individuals to open the door.

1.9 SUBMITTALS

A. Action Submittals

1. Shop Drawings:
   a. Fabrication and/or layout drawings:
      1) Routing, size, and fittings.
      2) Seismic location installation details.
2. Product data.
   a. Provide submittal data for all products specified in PART 2 of this Specification Section.
   b. See Specification Section 28 0501 for additional requirements.

B. Informational Submittals:

1. Cable tray fill calculations.
2. Cable schedule of number and type of cables in cable trays.
3. Project planning documents.

C. Closeout Submittals

1. Operation and Maintenance Data
   a. Contract closeout information:
      1) Provide schematic drawings depicting type and location of interface equipment/components, number of cables and conductors, types of connectors, circuit requirements and type and dimensions of enclosures.

D. Maintenance Material Submittals:

1. Furnish the following items and submit documentation of delivery to and acceptance of such items by Owner
   a. One card reader of each type used as a spare.
   b. One access control/alarm monitoring processor as a spare.
   c. One reader interface module for each type used as a spare.
   d. One power supply of each type used as a spare.

e. Backup software and database programs upon completion of the programming of all access control information. Demonstrate to the Owner that the copies provided can be accessed by the Owner and that the entire database is contained on the disks. Demonstrate to the Owner the procedure for restoring the system using the backup disks.

f. One factory box for each component, addressed to the manufacturer to facilitate factory return for repair authorizations.

g. Written procedures for obtaining return authorizations. (If not required, state so in writing.)

1.10 PROJECT DELIVERY, STORAGE AND HANDLING

A. Refer to Section 28 0501.

1.11 WARRANTY

A. Comply with the requirements of Section 28 0501 - Warranty.

B. User Cards shall be warranted for a period of five years from the date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with Contract requirements, furnish products of one of the following listed manufacturers.

B. Access Control Equipment:

1. Avigilon

C. Request to Exit Motion Equipment:

1. Interlogix - Model RCR-REX
2. Securitron - Model XMS
3. Visonic
4. Or Equal.

D. Card Reader:

1. Avigilon
2. HID Corp.
3. Or Equal.

E. Motion Detection Equipment:

1. Interlogix
2. Detection Systems
3. Honeywell International
4. Or Equal.

F. Door Position Switches:

1. Magnasphere
2. GRI, Inc
3. Honeywell
4. Aleph International
5. Flair Electronics
6. Or Equal.

G. Power Supplies.

1. LifeSafety Power
2. Alarm Saf
3. Altronix.
4. Or Equal.

H. Intrusion Detection Panels

1. Bosch
2. DMP
3. Honeywell

I. Enclosures:

1. Hoffman
2. Rittal Corporation
3. Hammond
4. Middle Atlantic Products
5. Stantron
6. Bud
7. Or Equal.

2.2 OPERATIONS

A. Inputs in system shall have two icon representations, one for the normal state and one for the abnormal state.

B. When viewing and controlling inputs, displayed icons shall automatically change to the proper icon to display the current system state in real time. Icons shall also display the input's state, whether armed or bypassed, and if the input is in the armed or bypassed state due to a time zone or a manual command.

C. Outputs in system shall have two icon representations, one for the secure (locked) state and one for the open (unlocked) state.

D. Icons displaying status of the I/O points shall be constantly updated to show their current real-time condition without prompting by the operator.

E. The operator shall be able to scroll the list of I/Os and press the appropriate toolbar button, or right click, to command the system to perform the desired function.

F. Graphic maps or drawings containing inputs, outputs, and override groups shall include the following:

1. Database to import and store full-color maps or drawings and allow for input, output, and override group icons to be placed on maps.
2. Maps to provide real-time display animation and allow for control of points assigned to them.
3. System to allow inputs, outputs, and override groups to be placed on different maps.
4. Software to allow changing the order or priority in which maps will be displayed.

G. Operator Commands:

1. Command Input: Plain-language words and acronyms shall allow operators to use the system without extensive training or data-processing backgrounds. System prompts shall be a word, a phrase, or an acronym.
2. Command inputs shall be acknowledged, and processing shall start in not less than 1 second.

3. Tasks that are executed by operator's commands shall include the following:
    a. Acknowledge Alarms: Used to acknowledge that the operator has observed the alarm message.
    b. Place Zone in Access: Used to remotely disable intrusion alarm circuits emanating from a specific zone. System shall be structured so that console operator cannot disable tamper circuits.
    c. Place Zone in Secure: Used to remotely activate intrusion alarm circuits emanating from a specific zone.
    d. System Test: Allows the operator to initiate a system-wide operational test.
    e. Zone Test: Allows the operator to initiate an operational test for a specific zone.
    f. Print reports.
    g. Change Operator: Used for changing operators.
    h. Display Graphics: Used to display any graphic displays implemented in the system. Graphic displays shall be completed within 20 seconds from time of operator command.
    i. Run system tests.
    j. Generate and format reports.

H. Alarms:
1. System Setup:
    a. Assign manual and automatic responses to incoming point status change or alarms.
2. Animated Response Graphics: Highlight alarms with flashing icons on graphic maps; display and constantly update the current status of alarm inputs and outputs in real time through animated icons.
3. Multimedia Alarm Annunciation: WAV files to be associated with alarm events for audio annunciation or instructions.
4. Alarm Handling: Each input may be configured so that an alarm cannot be cleared unless it has returned to normal, with options of requiring the operator to enter a comment about disposition of alarm. Allow operator to silence alarm sound when alarm is acknowledged.
5. Video Surveillance Alarm Interface: Allow commands to be sent to video surveillance systems during alarms (or input change of state).
6. Camera Control: Provides operator ability to select and control cameras from graphic maps.

I. Alarm Monitoring: Monitor sensors and access control panels, and notify operators of an alarm condition. Display higher-priority alarms first and, within alarm priorities, display the oldest unacknowledged alarm first. Operator acknowledgment of one alarm shall not be considered acknowledgment of other alarms nor shall it inhibit reporting of subsequent alarms.
1. Displayed alarm data shall include type of alarm, location of alarm, and secondary alarm messages.
2. Printed alarm data shall include type of alarm, location of alarm, date and time (to nearest second) of occurrence, and operator responses.
3. Maps shall automatically display the alarm condition for each input assigned to that map, if that option is selected for that input location.
4. Alarms initiate a status of "pending" and require the following two handling steps by operators:
    a. First Operator Step: "Acknowledged." This action shall silence sounds associated with the alarm. The alarm remains in the system "Acknowledged" but "Un-Resolved."
    b. Second Operator Step: Operators enter the resolution or operator comment, giving the disposition of the alarm event. The alarm shall then clear.
5. Each workstation shall display the total pending alarms and total unresolved alarms.

6. Each alarm point shall be programmable to disallow the resolution of alarms until the alarm point has returned to its normal state.
7. Alarms shall transmit to Server in real time.
8. Alarms shall be displayed and managed from a minimum of four different windows.
    a. Input Status Window: Overlay status icon with a large red blinking icon. Selecting the icon will acknowledge the alarm.
    b. History Log Transaction Window: Display name, time, and date in red text. Selecting red text will acknowledge the alarm.
    c. Alarm Log Transaction Window: Display name, time, and date in red. Selecting red text will acknowledge the alarm.
    d. Graphic Map Display: Display a steady colored icon representing each alarm input location. Change icon to flashing red when the alarm occurs. Change icon from flashing red to steady red when the alarm is acknowledged.
9. Once an alarm is acknowledged, the operator shall be prompted to enter comments about the nature of the alarm and actions taken. Operator's comments may be manually entered or selected from a programmed predefined list, or a combination of both.
10. For locations where there are regular alarm occurrences, provide programmed comments. Selecting that comment shall clear the alarm.
11. The time and name of the operator who acknowledged and resolved the alarm shall be recorded in the database.

J. Monitor Display: Display text and graphic maps that include zone status integrated into the display. Colors are used for the various components and current data. Colors shall be uniform throughout the system.

1. Color Code:
    a. FLASHING RED: Alerts operator that a zone has gone into an alarm or that primary power has failed.
    b. STEADY RED: Alerts operator that a zone is in alarm and alarm has been acknowledged.
    c. YELLOW: Advises operator that a zone is in access.
    d. GREEN: Indicates that a zone is secure and that power is on.
2. Graphics:
    a. Support a minimum of 100 graphic display maps and allow import of maps from a minimum of 16 standard formats from a graphics program.
    b. Allow I/O to be placed on graphic maps by the drag-and-drop method.
    c. Operators shall be able to view the inputs, outputs, and the point's name by moving the mouse cursor over the point on graphic map.
    d. Inputs or outputs may be placed on multiple graphic maps. The operator shall be able to toggle to view graphic map associated with inputs or outputs.
    e. Each graphic map shall have a display-order sequence number associated with it to provide a predetermined order when toggled to different views.
    f. Camera icons shall have the ability to be placed on graphic maps that, when selected by an operator, will open a video window, display the camera associated with that icon, and provide pan-tilt-zoom control.
    g. Input, output, or camera placed on a map shall allow the ability to arm or bypass an input, open or secure an output, or control the pan-tilt-zoom function of the selected camera.

K. Entry-Control Enrollment Software: Database management functions that allow operators to add, delete, and modify access data as needed.

1. Provide multiple, password-protected access levels. Database management and modification functions shall require a higher operator access level than personnel enrollment functions.
2. The program shall provide means to disable the enrollment station when it is unattended to prevent unauthorized use.
3. The program shall provide a method to enter personnel identifying information into the entry-control database files through enrollment stations. In the case of personnel identity verification subsystems, this shall include biometric data. Allow entry of personnel identifying information into the system database using menu selections and data fields. The data field names shall be customized during setup to suit user and site needs. Personnel identity verification subsystems selected for use with the system shall fully support the enrollment function and shall be compatible with the entry-control database files.
4. Cardholder Data: Provide 99 user-defined fields. System shall have the ability to run searches and reports using any combination of these fields. Each user-defined field shall be configurable, using any combination of the following features:
    a. MASK: Determines a specific format that data must comply with.
    b. REQUIRED: Operator is required to enter data into field before saving.
    c. UNIQUE: Data entered must be unique.
    d. DEACTIVATE DATE: Data entered will be evaluated as an additional deactivate date for all cards assigned to this cardholder.
    e. NAME ID: Data entered will be considered a unique ID for the cardholder.
5. Personnel Search Engine: A report generator with capabilities such as search by last name, first name, group, or any predetermined user-defined data field; by codes not used in definable number of days; by skills; or by seven other methods.
6. Multiple Deactivate Dates for Cards: User-defined fields to be configured as additional stop dates to deactivate any cards assigned to the cardholder.
7. Default card data can be programmed to speed data entry for sites where most card data are similar.
8. Enhanced ACSII File Import Utility: Allows the importing of cardholder data and images.
9. Card Expire Function: Allows readers to be configured to deactivate cards when a card is used at selected devices.

L. Access control/alarm monitoring processors shall be capable of communicating with the host computer and other panels via RS232, RS485, fiberoptics and LAN/WAN - TCP/IP.

2.3 CARD READER FUNCTIONS

A. The system shall support a variety of card readers that must encompass a wide functional range. The system may combine any compatible card readers for installations requiring multiple types of card reader capability (i.e., card only, card and/or PIN, supervised inputs, etc.). Card readers shall be available in Open Supervised Device Protocol (OSDP) output format and Wiegand. All card readers shall include card reader back boxes for conduit installations.

B. The use of keypads with the card reader will require the user to enter a personal identification number in conjunction with the card to obtain authorized access.

2.4 READERS

A. Contactless Technology.

B. Exterior readers shall be weatherproof. Seal all openings and penetrations with manufacturer approved sealant.

C. No special housing shall be required for those readers designated for outdoor use.

D. Electrical connections and cabling from the reader assembly to the system interface shall be per manufacturer’s specifications.

E. All card readers shall be installed on an electrical include electrical back boxes for conduit installations.

F. Card readers shall provide audible feedback to indicate access granted/denied decisions. Upon a card swipe, two beeps shall indicate access granted and three beeps shall indicate access denied. All keypad buttons shall provide tactile audible feedback.

2.5 REQUEST TO EXIT MOTION DETECTOR

A. The request to exit motion detector shall include as a minimum the following features:

1. Dual technology passive infrared and microwave.
2. Adjustable time delay.
3. Tamper output.
4. Microwave frequency: 5.8 GHz.
5. Range, depth: 3 to 15 feet, adjustable.
6. Range, width: 7.9 feet.
7. Range, PIR: 15 feet (4.6 m), adjustable.
8. Relay output - Form “C”.
9. Approximate dimensions (HxWxD): 1.76 x 7.395 x 1.85 inches.
10. Provide a trim plate to mount between the request to exit motion and the mounting surface. The trim plate shall be approximately 1/8 inches in depth, and shall be sized approximately 1/2 IN - 3/4 inches larger than the motion detector mounting surface and large enough to cover the backbox opening. The trim plate shall be supplied by the manufacturer. If a trim plate is not available from the manufacturer, one shall be fabricated using ABS plastic. The trim plate color shall match the existing surface.

2.6 MOTION DETECTION SENSORS

A. Ceiling Mounted.

1. Dual optic technology.
2. 60 feet diameter coverage.
3. Ceiling mount.
4. 360 degree coverage.
5. Mask all unused curtain areas.
6. Utilize recessed mounting kit.
7. Powered by 7 to 18 volts DC.

B. Wall Mounted:

1. Dual Tech: (Honeywell DT7450 basis of design)
2. Passive infrared motion detector with self-contained microprocessor employing dual technology motion detection.
3. Integral bug guard.
4. Form C, 125mA max, 25VDC (minimum) alarm output.
5. Integral combination cover/ tamper switch.
6. Digitally adjust thresholds to account for room disturbances
7. Fresnel lens shall provide the same sensitivity for human targets at the edge of the pattern as exists directly in front of the sensor.
8. Continuous internal signal diagnostic supervision.
9. PIR supervision performed once every hour.
10. Temperature compensation monitored and updated every 30seconds.
11. Additional minimum requirements:

a. Range: 50 feet x 60 feet (short range - wall mounted), 100 inches x 25 feet (long range - wall mounted), 50 feet x 360 degree (ceiling mounted)
b. Alarm Relay: Energized Form C @125 mA, 25 VDC, w/20 Ohm series resistor.
c. Tamper: (NC) 50 mA, 24 VDC.
d. Power Requirements: 8.0 - 16 VDC.
e. Frequency: 24.125 GHz (K-Band).
f. PIR White Light Immunity: 6,500 lux typical.
g. Fluorescent Light Filter: 50 Hz or 60 Hz, selectable.
h. RFI Immunity: 30 V/m, 10 MHz - 1000 MHz.
i. Operating Temperature: 14 degrees to 131 degrees F @ 5 percent - 95 percent relative humidity (non-condensing)
j. PIR Fields of View: 22 long range edges, 12 intermediate edges, Six lower edges.
k. Four look-down edges.
l. Maximum Dimension: 4.685 inches x 2.795 inches x 1.654 inches.
m. Sensitivity: Standard: 3-4 steps Intermediate: 2-3 steps.

2.7 DOOR POSITION SWITCHES

A. Concealed Magnetic door position switches – Provided by Door Hardware.

B. Magnetic door position switches - Surface Mount Overhead Door - Magnasphere model MSS Series used as Basis of Design, any/all substitution request shall meet the following criteria:

1. Anodized aluminum housing.
2. UL 634 Listed.
3. Resistant to defeat by placing magnet against frame.
4. Resistant to arcing and fusing from lighting and voltage spikes.
5. Weatherproof, fully sealed.
6. 0.25 Watt contact rating.
7. Double Pole-Single Throw (DPST)
8. 24 inches Armored Cable.
9. Closed-loop configuration.
10. Coordinate color to match door frame.

2.8 ACCESS CONTROL AND DOOR HARDWARE POWER SUPPLIES

A. Power Supplies for door hardware and access control hardware shall be designed specifically for the system equipment installed. Power supplies shall be regulated, isolated versions for the access control panel, I/O Modules, Readers, Door Locking Hardware and the security monitoring peripheral equipment. Each version shall be available in UPS with battery back-up and non-UPS models. All power supplies shall be housed in locked enclosures that also allow mounting space for the access control panels, I/O Modules, single reader modules, dual interface modules or other device/panel required.

1. Provide separate power supplies for the access control equipment and door locking hardware.
2. The power supplies shall be UL listed for use with the specified access control system.
3. Electric lock power supplies shall be UL listed for use with the specified lock manufacturer.
   a. Coordinate with Division 08 for electric lock manufacturer.
   b. The Contractor has the option to combine more than one door on one power supply. Coordinate with Division 08, the power requirements for each lock to determine the size of power supply required.

4. Power supplies for doors with high current electric latch retraction will be provided by Division 08.

2.9 SURGE AND TAMPER PROTECTION

A. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor-entry connection to components.

1. Minimum Protection for Power Connections 120 V and More: Auxiliary panel suppressors complying with requirements in Division 26 Section "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits."
2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Connections: Comply with requirements in Division 26 Section "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits" as recommended by manufacturer for type of line being protected.

B. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal at the security monitoring screen when unit is opened or partially disassembled. Control-station control-unit alarm display shall identify tamper alarms and indicate locations.

PART 3 - EXECUTION

3.1 PREPARATION

A. Obtain detailed Project planning forms from manufacturer of access-control system; develop custom forms to suit Project. Fill in all data available from Project plans and specifications and submit as Project planning documents for review and approval by Owner and Architect.

1. Record setup data for control station and workstations.
2. For each location, record setup of Access control panel features and access requirements.
3. Propose start and stop times for time zones and holidays, and match up access levels for doors.
4. Set up groups, facility codes, linking, and list inputs and outputs for each Access control panel.
5. Assign action message names and compose messages.
6. Set up alarms. Establish interlocks between alarms, intruder detection, and video surveillance features.
7. Prepare and install alarm graphic maps.
8. Develop user-defined fields.
9. Develop screen layout formats.
10. Complete system diagnostics and operation verification.
11. Prepare a specific plan for system testing, startup, and demonstration.
12. Develop acceptance test concept and, on approval, develop specifics of the test.
13. Develop cable and asset management system details; input data from construction documents. Include system schematics and Visio Technical Drawings.

B. In meetings with Architect and Owner, present Project planning documents and review, adjust, and prepare final setup documents. Use final documents to set up system software.

3.2 INSTALLATION

A. Comply with the requirements of Section 28 0501.

B. Coordinate all work with the Owner prior to the commencement of the scope of work as specified herein.

C. Apply for, and obtain any and all permits required by federal, state, county, city, or other authority having jurisdiction over the work.

D. Install and terminate all security circuits to the door hardware supplied and installed by Division 08. Coordinate with the Division 08 contractor the installation and termination of all cabling and security devices.

E. Coordinate the conduit/raceway installation with the Division 26 contractor. Conduit to be provided beyond what is shown on the project drawings shall be the responsibility of the Security Contractor.

F. Install equipment and devices in accordance with manufacturer's specifications.

G. Coordinate with the Owner the complete system configuration requirements of the Owner.

1. The installer/contractor shall be responsible for configuring/programming the system to meet the operational requirements of the Owner.

H. Install readers and integrate into special assemblies as may be required for elevator call panels, narrow jamb frames and pedestal mounts.

3.3 FIELD QUALITY CONTROL

A. Field Tests and Inspections

1. Test and inspect all system components and cabling to assure compliance with manufacturer's requirements for operation in accordance with the requirements in Section 28 0501.

3.4 SYSTEM STARTUP

A. Coordinate with the manufacturer's services and requirements.

3.5 DEMONSTRATION AND TRAINING

A. Comply with requirements in Section 28 0501.

END OF SECTION

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SECTION 28 2001

VIDEO SURVEILLANCE SYSTEM (Revised AD-2)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Material and installation requirements include system expandability to accommodate the addition of multiple monitors, as well as multiple cameras and increased coverage areas and integration of the system with the access control system to allow automatic camera call-up during alarm events. The system allows for the surveillance/viewing of remote areas from one or more local and remote-control stations.

B. Related Specification Sections but not necessarily limited to:

1. Section 28 0501 - Common Work Results for Electronic Security.Systems.
2. Section 28 1001 - Access Control

1.2 REFERENCES

A. Reference Standards: Standards referenced in this section include, but are not necessarily limited to the following:

1. American National Standards Institute (ANSI)/Telecommunications Industry Association (TIA).
   a. ANSI/TIA--569-E – Telecommunications Pathways and Spaces.
2. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
3. UL Solutions. (UL).

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturers:
   a. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.
   b. See Specification Section 28 0501 for additional requirements.
2. Installers:
   a. Comply with ANSI/NFPA 70 – National Electric Code.
   b. Comply with ANSI/TIA-569E Standard and the BICSI Telecommunications Distribution Methods Manual (TDMM) for the installation of Communication Pathways.
   c. See Specification Section 28 0501 for additional requirements.

1.4 SYSTEM DESCRIPTION

A. The system specified herein shall include all components necessary for a complete and operating video system, interfaced to the Owner's building network. The hardware shall include but not limited to, encoders, decoders, servers, workstations, display monitors, video storage units, and management software. The system shall include an intuitive computerized graphical user interface for system configuration, diagnostics, and video surveillance.

B. Include all programming and configuration, for the complete set up, operation and administration of the system.

C. Include all programming for graphical map representation of each camera location. The graphical maps, floor/site plans, shall be the same as used by the card access control system.

D. Design Requirements:

1. The existing owner's Avigilon system shall be utilized for both access control and video surveillance. Coordinate with the owner to add new devices to the owners existing system. Provide all licenses required for the new devices to be added to the existing systems.
2. Provide an interface from the video management system to the access control system for alarm assessment camera call up, and review of video events prior and during the alarm.
3. Visit the project site prior to the bid date to verify the existing site conditions.

E. Performance Requirements:

1. All cameras shall be environmentally rated for its intended installed location. The Security Contractor shall be responsible for visiting the project site prior to bid to evaluate each camera location to verify the environmental camera housing requirement.
2. All cameras shall be continuously recorded on the network video recorders.
3. Provide network video storage for each camera installed on the project.
   a. Network video storage shall include the storage of each video signal at a minimum frame rate of 15 images per second at 2-megapixel resolution for 30 days.

AD-2: Section 28 2001; 09/25/2024: Added Paragraph 1.4, F.

F. Existing System:

1. The video surveillance system is an Avigilon system installed in 2015.
2. Network video recorder in an Avigilon 15.0TB-HD-NVR2 with 15 TB of hard drive space.

a. Provide new Avigilon 15 TB network video recorder as a part of this project to replace the existing as the HD-NVR2 is no longer supported by the manufacturer.

3. Video management software is Avigilon Control Center 6, ACC6-STD

a. Provide new UNITY8-STD licenses for the existing 34 cameras as the ACC6-STD are no longer supported be the manufacturer.

4. Remote monitoring workstations are Avigilon RM5-WKS-2MN-NA

a. Provide (2) Avigilon RM7-WKS-2MN-NA remote workstations to replace the existing as they are no longer supported be the manufacturer.

1.5 SUBMITTALS

A. Action Submittals

1. Shop Drawings:
   a. Fabrication and/or layout drawings:
      1) Routing, size, and fittings.
      2) Seismic location installation details.
2. Product technical data.
   a. Provide submittal data for all products specified in PART 2 of this Specification Section.
   b. See Specification Section 28 0501 for additional requirements.
3. Testing Plans, Procedures, and Testing Limitations:
   a. Project planning document: Submit 2 weeks prior to the Project planning document review meeting.

B. Informational Submittals:

1. Cable tray fill calculations.
2. Cable schedule of number and type of cables in cable trays.

C. Maintenance Material Submittals:

1. Furnish the following items and submit documentation of delivery to and acceptance of such items by Owner.
   a. One camera housing for each type utilized on the project as spares.
   b. One power supply for each type utilized on the project as spares.
   c. Two cameras for each type utilized on the project as spares.
   d. Two lenses for each type utilized on the project as spares.
   e. One factory box for each component, addressed to the manufacturer to facilitate factory returns for repair.
   f. Written procedures for obtaining return authorizations (If not required, state so in writing).

1.6 ADMINISTRATIVE REQUIREMENTS

A. Project planning documents review meeting: Met with Owner and Engineer to review project planning document.

1.7 PROJECT DELIVERY, STORAGE AND HANDLING

A. Refer to Section 28 0501

1.8 WARRANTY

A. Comply with the requirements of 28 0501.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers of Integrated Dome Color &B&W Camera Systems:

1. Avigilon

B. Manufacturers of Camera System Mounting Adapters.

1. Avigilon

C. Manufacturers of Camera Power Supplies:

1. Hirschmann
2. Or equal.

2.2 VIDEO SURVEILLANCE CAMERAS

A. Interior Mini Dome Camera – Ceiling Mount.

1. 5 Megapixel resolution.
2. Image Sensor: Progressive Scan CMOS 1/2.8-inch.
3. Lens: Varifocal, Remote focus and zoom, P-Iris Control, IR corrected.
4. Day and Night: Automatically removable infrared-cut filter.
5. Minimum Illumination:
   a. Color: 0.015 lux, F1.4, 30IRE.
   b. B&W: 0.0015 lux, F1.4, 30 IRE
6. Camera Angle Adjustment: Pan 360 degrees, tilt 160 degrees, rotation 340 degrees.
7. Video Compression: H.265 and H.264 Baseline and Main Profile, MJPEG.
8. Frame Rate: 60fps H.265 and H.264, 30fps MJPEG.
9. Resolution: Adjustable to 1920x1080 maximum.
10. Casing: Tamper-resistant polycarbonate transparent cover and casing, Aluminum inner camera module with encapsulated electronics.

11. Color: White.
12. Memory: 512GB Micro SD/SDHC/SDXC card slot.
13. Power: Power over Ethernet IEEE 802.3af/802.3at Type 1, Class 2, max. 5.9 Watts., 12VDC, 24VAC.
14. Connectors: RJ45 10BASE-T/100BASE-TX PoE.
15. Operating Conditions: -40 degrees F to 131 degrees F, Humidity 10-100% RH (condensing).
16. Furnish Pendant kit, wall mount, and pole adapter with each camera.

B. Exterior Dome Camera – Wall Mount.

1. 8 Megapixel resolution.
2. Image Sensor: Progressive Scan CMOS 1/2.8-inch.
3. Lens: Varifocal, Remote focus and zoom, P-Iris Control, IR corrected.
4. Day and Night: Automatically removable infrared-cut filter.
5. Minimum Illumination:
   a. Color: 0.015 lux, F1.4, 30IRE.
   b. B&W: 0.0015 lux, F1.4, 30 IRE
6. Camera Angle Adjustment: Pan 360 degrees, tilt 160 degrees, rotation 340 degrees.
7. Video Compression: H.265 and H.264 Baseline and Main Profile, MJPEG.
8. Frame Rate: 60fps H.265 and H.264, 30fps MJPEG.
9. Resolution: Adjustable to 1920x1080 maximum.
10. Casing: Tamper-resistant polycarbonate transparent cover and casing, Aluminum inner camera module with encapsulated electronics.
11. Color: White.
12. Memory: 512GB Micro SD/SDHC/SDXC card slot.
13. Power: Power over Ethernet IEEE 802.3af/802.3at Type 1, Class 2, max. 5.9 Watts., 12VDC, 24VAC.
14. Connectors: RJ45 10BASE-T/100BASE-TX PoE.
15. Operating Conditions: -40 degrees F to 131 degrees F, Humidity 10-100% RH (condensing).
16. Furnish Pendant kit, wall mount, and pole adapter with each camera.
17. Design basis: Avigilon H6A Dome Camera.

C. Exterior Multisensor Dome Camera – Corner Mount

1. The network integrated dome camera dome shall operate in a Power over Ethernet Network environment and accept open architecture connectivity for third-party software recording solutions.
2. Resolution: 8 Megapixel.
3. Scanning System: Progressive Scan.
4. Frame rate:
   a. 30fps, H.264
   b. 15fps, MJPEG
5. Pixels:
   a. 1952 (H) x 1116 (V) total; 1944 (H) x 1104 (V) effective.
6. Lens:
   a. F1.5- F1.9 (f=4.44-102 mm, 23X optical zoom)
7. Electronic Shutter Speed:

a. 2 - 1/12,000 sec.

8. Zoom Speed:
   a. 4.2 seconds.
9. Focus:
   a. Automatic with manual override.
10. Synchronization System:
    a. Internal/ AC line lock phase adjustable via remote control, V-sync.
11. White Balance:
    a. Automatic with manual override.
12. Iris Control:
    a. Automatic with manual override.
13. Gain Control:
    a. Automatic/ Off.
14. Video Encoding:
    a. H.264 Main and High Profile, MJPEG.
15. Video Signal-to-Noise ratio >50dB.
16. Video Streams: 10, simultaneous
    a. Video Resolutions: Variable.
       1) 1920 x 1080
       2) 1280 x1024
       3) 1280 x 960
       4) 1024 x768
       5) 800 x 600
       6) 640 x 480
       7) 320 x 180 Minimum.
17. Power:
    a. Sources.
       1) 24 VAC +/- 10%
       2) PoE+: IEEE 802.3af, Class 4
    b. Power Consumption:
       1) 24V AC: Max. 65W (24V AC heater on & PoE heater on)
       2) PoE+: Max. 25W (24V AC heater off / PoE heater on)
18. Furnish Pendant kit, wall corner mount, and pole adapter with each camera.
19. Design Basis: Avigilon Unity H5A Multisensor Camera.

2.3 NETWORK VIDEO RECORDER

A. Capable of 32 channels, 32MP resolution camera support.

B. Capable of 400Mbps network camera recording.

C. Dual HDMI display video out.

D. Dynamic Event support.

E. Bookmark management for easy retrieval and protection of video clips (Up to 100 bookmarks)

F. H.265, H.264, MJPEG compression support.

G. Supports 16 SATA HDDs, up to 10Tb each (Maximum capacity 160TB)

H. External iSCSI storage.

I. Compression - H.265, H.264, MJPEG

J. Fisheye De-warping.

K. Web viewer.

L. Local viewing with manufacturer's software.

M. Resolution - 32MP (15fps, H.265 Only), 12MP (30fps, H.265 Only), 8.3MP(120fps), 1080p(480fps), 720P(960fps), D1(960fps)

N. Provide viewing workstations with 24" monitors that meet the manufacturer's minimum requirements.

O. Basis of Design: Avigilon

AD-2: Section 28 2001; 09/25/2024: Added Paragraph 2.3, P.

P. Provide (1) network video recorder for the EVOC and (1) network video recorder for the fire range building

2.4 POE EXTENDER

A. POE Extender

1. Design Basis: Axis Long Range POE Extender Kit
2. Provide POE Extenders for cameras further than 100m from network switch.

2.5 POWER SUPPLIES

A. Power Over Ethernet Midspan.

1. Design Basis: L-Com, BTD-CAT5-P4J
2. Quad Port Passive PoE Midspan with integral Surge Protection.
3. Extended Temperature Range.
4. Operating Temperature: -40 degrees C to +70 degrees C.
5. Operating voltage: +/- 55V, Maximum current 1 Amp.
6. Enclosure Dimensions: 2.5 inches H x 4.5 inches W x 1.5 inches D Nominal.
7. Cast aluminum enclosure with Din Rail Mounting clip.
8. 8 RJ45 Ports.
9. Grounding Lug.

B. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal at the security monitoring screen when unit is opened or partially disassembled. Control-station control-unit alarm display shall identify tamper alarms and indicate locations.

2.6 CAMERA SYSTEM MOUNTING ADAPTERS

A. Wall Corner Mount Arm.

1. The mounting adapter shall consist of a rugged wall mount arm designed specifically for use with the integrated positioning system pan & tilt units.
2. The mounting adapter shall consist of a rugged wall mount arm designed specifically for use with the integrated dome camera system pan & tilt units.
   a. The integrated dome camera mounting adapter shall be equipped with 1-1/2 inch NPT adapter to facilitate the mounting of pendant mount dome housings.
3. The adapter shall be capable of handling a load of up to 100 pounds.
4. The adapter shall be constructed of an aluminum casting and flat plate and shall be finished in a polyester powder coating.
5. The adapter shall weigh a maximum of 9 pounds.

6. The adapter shall be mounted via four user supplied 5/16 inches fasteners suitable for the mounting surface.

B. Pole Mount Adapter.

1. The pole mount shall facilitate the mounting of the integrated positioning system and integrated dome system to a pole with a minimum diameter of 3.00 inches.
2. The pole mount shall support up to 100 pounds.
3. The pole mount shall feature three mounting slots for the attachment of stainless steel straps for strapping to the pole.
4. The pole mount adapter shall be constructed of 5052H32 aluminum, .190 inches thick.
5. The pole mount adapter shall be finished in gray polyester powder coat.
6. The pole mount adapter shall weigh a maximum of 3 pounds.
7. Furnish the following hardware with each adapter.
   a. Two, 5 feet stainless steel straps.
   b. Two banding clips.
   c. Six hex head cap screws.
   d. Six flat and lock washers.
   e. Six hex nuts.

PART 3 - EXECUTION

3.1 PREPARATION

A. Obtain detailed Project planning forms from manufacturer of surveillance system; develop custom forms to suit Project. Fill in all data available from Project plans and specifications and publish as Project planning documents for review and approval by Owner and Engineer.

1. Record setup data for control station and workstations.
2. For each location, record setup of camera features and view requirements.
3. Assign action message names and compose messages.
4. Set up alarms. Establish interlocks between alarms, intruder detection, and video surveillance features.
5. Prepare and install camera graphic maps.
6. Develop user-defined fields.
7. Develop screen layout formats.
8. Complete system diagnostics and operation verification.
9. Prepare a specific plan for system testing, startup, and demonstration.
10. Develop acceptance test concept and, on approval, develop specifics of the test.
11. Develop cable and asset management system details, input data from construction documents. Include system schematics and Visio Technical Drawings.

B. In meetings with Engineer and Owner, present Project planning documents and review, adjust, and prepare final setup documents. Use final documents to set up system software.

3.2 INSTALLATION

A. Comply with the requirements of Section 28 0501.

B. Coordinate all work with the Owner prior to the commencement of the scope of work as specified herein.

C. Apply for, and obtain any and all permits required by federal, state, county, city, or other authority having jurisdiction over the work.

D. Install and terminate all security circuits to the cameras supplied and installed by this section.

E. Install equipment and devices in accordance with manufacturer's specifications.

F. Coordinate with the Owner the complete system configuration requirements of the Owner.

1. The installer/contractor shall be responsible for configuring/programming the system to meet the operational requirements of the Owner.

3.3 FIELD QUALITY CONTROL

A. Field Tests and Inspections

1. Test and inspect all system components and cabling to assure compliance with manufacturer's requirements for operation in accordance with the requirements in Section 28 0501.

3.4 SYSTEM STARTUP

A. Coordinate with the manufacturer's services and requirements.

3.5 ADJUSTING

A. Provide all adjustments in accordance with the manufacturer's recommendations and Owner's requirements, such as camera views.

3.6 DEMONSTRATION AND TRAINING

A. Comply with requirements in Section 28 0501.

END OF SECTION

SECTION 31 1000

SITE CLEARING (Revised AD-2)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Site clearing Work, including:
   a. General provisions for site clearing Work.
   b. Preparation for site clearing Work.
   c. Clearing and grubbing.

AD-2: Section 31 1000; 09/25/2024: Revise Paragraph 1.1, A, 1, d.

   d. Tree protection~~,~~ **and** selective removals~~, and selective trimming~~.
   e. Disposal and cleaning.
   f. Stripping and stockpiling of topsoil.

B. Related Requirements: Include but are not necessarily limited to:

1. Section 01 5705 – Temporary Controls.
2. Section 02 4100 - Demolition.
3. Section 31 2219 – Finish Grading.
4. Section 31 2305 – Excavation and Fill.

1.2 REFERENCES

A. Terminology:

1. Terms indicated below are not defined terms indicated with initial capital letters but, when used in this Section, have the meanings indicated below:
   a. “Arborist” means Subcontractor retained to perform Work requiring a specialist in trees, shrubs, brush, other vegetation of the types existing at the Site, and possessing not less than the required qualifications indicated in this Section.
   b. “Clearing and grubbing” means removing and disposing of all: (1) trees, brush, and other vegetation, logs, and similar items (“clearing”); and (2) stumps, roots, logs, rubbish, and debris on or in the soil (“grubbing”) after Clearing. Clearing and grubbing includes grinding and removing of stumps. When clearing and grubbing, topsoil stripping and stockpiling, and required demolition work is complete, the Site will be ready for grading and other new construction.
   c. “Demolition” means removal, whether in whole or in part, of existing human-made construction, such as removal of buildings, structures, and building systems; site work (such as pavement, curbs, sidewalks, gutters) and the like; Underground Facilities; and other existing construction.
   d. “Selective removal” means removal of specific trees, shrubs, brush, and other vegetation, whether as shown or indicated in the Contract Documents or as directed at the Site by Engineer.
   e. Selective trimming” means removal of selected parts of trees, shrubs, brush, and other vegetation, performed by arborist, for the purpose of either: (1) allowing installation of new construction adjacent to or through the tree, shrub, brush, or vegetation, or)2) removing damaged or unhealthy growth, to allow balance of the subject tree, shrub, brush, or vegetation to continue normal, healthy growth.
   f. “Site clearing” means all the Work required by this Section and related Drawings.

g. "Topsoil" means existing material at the Site, visible after clearing and grubbing, to be stripped, when such material is friable, clay loam, surface soil present in depth of not less than four inches. Topsoil shall be free of subsoil, clay lumps, stones, and other objects over two-inch diameter and other objectionable material. Topsoil required for planting and landscaping Work in the Specifications of Division 32 may differ from the meaning indicated in this Section.

B. Reference Standards:

1. ASTM International (ASTM):
   a. C700, Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated.
   b. D448, Standard Classification for Sizes of Aggregate for Road and Bridge Construction.
2. American National Standards Institute (ANSI):.
   a. A300, Standard for Tree Care Operations – Tree, Shrub, and Other Woody Plant Maintenance – Standard Practices.
3. International Society of Arboriculture (ISA):
   a. Container Rootball Shaving.
   b. Crown Correction.
   c. Balled and Burlapped Root Correction.
   d. Container Root Correction.
   e. High Branched Crown Observation.
   f. Low Branched Crown Observation.
   g. Multiple Low Branches Crown Observation.
   h. Balled and Burlapped Root Observation.
   i. Container Root Observation - Tree.
   j. Protection Maintenance.

1.3 QUALITY ASSURANCE

A. Qualifications:

AD-2: Section 31 1000; 09/25/2024: Revise Paragraph 1.3, A, 1.

1. Arborist:
   a. Where selective removal~~, selective trimming, or both are~~ **is** required or necessary, retain the services of, and employ in the Work, accredited arborist, possessing qualifications acceptable to Engineer.
   b. Arborist shall be skilled, trained, and possess documented experience in successfully protecting, trimming, and restorative care of trees and shrubs of the types necessary for the Work.
   c. Certification: Arborist shall be certified by either International Society of Arboriculture (ISA) or American Society of Consulting Arborists (ASCA).
   d. Arborist shall use in selective removal ~~and selective trimming~~
   e. Work only workers with specific skill and successful experience in this type of Work required. Such workers shall work under the direct, personal supervision of arborist.
   f. Submit to Engineer names, employer(s), certifications, other relevant qualifications and record of relevant experience, as indicated below, for not less than three successful projects involving same species of trees, shrubs, and vegetation as involved in the site clearing Work:
      1) Names and telephone numbers of site owners, architects or engineers responsible for projects.

2) Approximate contract price of the selective removal ~~and selective trimming~~ of trees, shrubs, and vegetation.

3) Approximate time of year work was performed on each referenced project.

4) Approximate quantity and types of selective removal ~~and selective trimming of~~ performed.

5) General indication of species of trees, shrubs, and vegetation involved.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
   a. Limits of Site Clearing Work: When limits of site clearing Work are not expressly shown on the Drawings, or where Contractor proposes alternative limits of site clearing Work, submit drawings, developed from the Drawings, clearly indicating proposed limits of site clearing Work, with dimensions indicated where appropriate.
   b. Where proposed limits of clearing and grubbing, selective removals, and topsoil stripping are not identical with each other, clearly and expressly indicate limits of each on the Shop Drawings.

B. Informational Submittals: Submit the following:

1. Permits and Approvals:
   a. Submit copy of each permit required and obtained for site clearing Work, issued by authority having jurisdiction.
   b. Where Owner's permission or approval is required for selected site clearing activities, submit copy of Owner's written permission or approval for such activity.
   c. When approval of owner of property (other than Owner) is required for selected site clearing activity, submit to Engineer written copy of such approval.
2. Certificates:
   a. Arborist's certification that trees and shrubs shown or indicated to remain were protected during the site clearing Work in accordance with the Contract Documents.
   b. Where trees or shrubs (shown or indicated to remain) were damaged during site clearing Work, submit arborist's certification that such trees and shrubs were promptly and properly treated or, where successful treatment was not feasible, were replaced.
3. Qualifications Statements:
   a. Arborist qualifications.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Tree Wound Dressing:

1. Provide tree wound dressing, waterproof, adhesive and elastic with an antiseptic, free from kerosene, coal tar, creosote, and other material injurious to life of tree or other plant.

B. Filter Fabric:

1. In accordance with requirements for temporary erosion and sediment controls indicated in Section 01 5705 - Temporary Controls.

C. Burlap:

1. Jute, not less than 7.2 ounces per square yard.

D. For other materials needed for site clearing Work, such as stone, topsoil, or other, comply with requirements of the Contract Documents.

PART 3 - EXECUTION

3.1 SITE CLEARING – GENERAL

A. Limits of Site Clearing Work:

1. Limits of site clearing Work are shown and indicated on the Drawings.

B. General Provisions for Site Clearing:

1. Contractor shall provide all labor, materials, equipment, tools, services, and incidentals necessary and required to perform site clearing Work in accordance with the Contract Documents.
2. Perform site clearing Work to avoid creating nuisances, pollution, and preventable adverse effects on the environment.
3. Comply with Section 01 7300 - Execution, and this Section's Article, "Tree Protection, Selective Removals, and Selective Trimming".
4. Excavation required for site clearing shall comply with Section 31 2305 – Excavation and Fill.
5. Requirements of Authorities Having Jurisdiction:
   a. Perform site clearing Work in accordance with Laws and Regulations.
   b. Obtain, pay for, and comply with permits required for site clearing Work. Obtain from authorities having jurisdiction and furnish copy of each permit as a Submittal.
6. Site clearing Work shall comply with ANSI A300 and applicable ISA standards indicated in this Section's "References" Article, unless the Contract Documents indicate more-stringent requirements.
7. Demolition Work is indicated in Section 02 4100 - Demolition, including removal of site improvements and Underground Facilities.

3.2 PREPARATION

A. Permits and Approvals:

1. Do not commence site clearing Work until necessary permits and approvals are obtained and copies furnished to Engineer as Submittals.

B. Delineation of Limits of Site Clearing Work Areas:

1. Locate and clearly flag at the Site:
   a. Limits of site clearing Work.
   b. Trees, shrubs, vegetation, and other materials to remain within limits of site clearing Work.
   c. Trees, shrubs, and vegetation to be selectively removed.
   d. Salvageable trees, shrubs, and vegetation (to be relocated) within limits of site clearing Work.
2. Flagging:
   a. Flagging shall be high-visibility type. Where necessary, provide lath or stakes driven into the ground, with flagging, to clearly delineate limits.
   b. Provide different-colored flagging for each type of delineation required by this Article.
   c. Promptly replace lost, moved, or destroyed flagging until Engineer concurs that flagging is no longer needed.
3. Review with Engineer:
   a. Before starting site clearing Work, other than flagging, review at the Site with Engineer.
   b. Make corrections as necessary.
   c. Review all trees, 6-inch diameter (measured one foot above ground) and larger, to be removed or selectively trimmed.

AD-2: Section 31 1000; 09/25/2024: Delete Paragraph 3.2, B, 3, d.

~~d. Review with Engineer at the Site trees and shrubs to be selectively trimmed, to reach mutual agreement on extent of selective trimming required.~~

C. Protection: Establish protection of trees, shrubs, and vegetation to remain, in accordance with this Section's Article, "Tree Protection, Selective Removals, and Selective Trimming", and other applicable provisions of the Contract Documents.

D. Temporary Erosion and Sediment Controls:

1. Provide applicable temporary erosion and sediment controls before commencing clearing and grubbing and topsoil stripping Work.
2. Comply with temporary erosion and sediment control requirements of Section 01 5705 - Temporary Controls.
3. Continue providing temporary erosion and sediment controls as clearing and grubbing and topsoil stripping and stockpiling Work progresses into previously uncleared, ungrubbed areas of the Site.

3.3 CLEARING AND GRUBBING

A. Clearing and Grubbing – General:

1. Remove and dispose of all materials constituting clearing and grubbing Work within limits shown and indicated in the Contract Documents.
2. After grubbing Work is complete, properly fill holes resulting from grubbing before commencing site grading Work.

B. Trees and Shrubs Improperly Destroyed or Damaged:

1. Refer to this Section's Article, "Tree Protection, Selective Removals, and Selective Trimming".

C. Trees and Shrubs to Remain:

1. Trees and shrubs to remain shall be protected, and trimmed where necessary or required, in accordance with this Section's Article, "Tree Protection, Selective Removals, and Selective Trimming".

3.4 TREE PROTECTION, SELECTIVE REMOVALS, AND SELECTIVE TRIMMING

A. General Provisions for Tree Protection, Selective Removals, and Selective Trimming:

1. Provide temporary fencing, barricades, or guarding measures, as recommended by arborist, outside drip line of trees and shrubs to remain.
2. Protect root systems from damage caused by noxious materials, storm water runoff, site clearing, planting and landscaping, other Work, and storage of materials and equipment. Protect root systems from flooding, erosion, and excessive wetting resulting from dewatering of excavations, drainage of tanks, and other construction activities.
3. Fires are not allowed under or adjacent to trees, shrubs, and other vegetation to remain.
4. Do not store matter resulting from site clearing or demolition, topsoil, or other excavated material within drip line of trees and shrubs to remain. Vehicles are not allowed within drip line. Restrict foot, vehicle and equipment traffic to prevent compaction of soil over root systems. Where such activities are unavoidable, and only as acceptable to Engineer, provide temporary, continuous, heavy-duty wood planking effectively fastened together and capable of distributing loads from such activities. Temporary planking shall be underlaid by layer of filter fabric covered with two-inch layer of gravel.
5. Cut branches and roots, when necessary, with sharp pruning instruments; do not break or chop. Fully paint cuts 1/2-inch and larger in size with tree wound dressing.

B. Excavation and Protection of Trees and Shrubs:

1. Excavate within drip line of trees only where shown.
2. Where trenching for utilities is required within drip line, tunnel under or around main lateral feeder roots by drilling, auger boring, pipe jacking, or digging by hand under supervision of arborist. Do not cut main lateral roots or tap roots; cut smaller roots, which interfere with installation of the Work.
3. Where excavation for the Work is required within drip line of trees or shrubs, hand excavate to minimize damage to root systems. Perform excavation under supervision of arborist. Provide temporary shoring or other protective support systems at excavations, to minimize sloping and benching of excavations. Use narrow tine spading forks and comb excavated material to expose roots.
4. Relocate roots in backfill areas wherever possible. If large, main lateral roots are encountered, expose beyond excavation limits as required to bend and relocate without breaking. If encountered immediately adjacent to location of construction and relocation is not practical, cut roots approximately three inches back from construction.
5. Do not allow exposed roots to dry out before permanent backfill is provided; provide temporary earth cover. Water and maintain in moist condition and temporarily support and protect from damage until permanently relocated and covered with earth.

C. Grade Adjustments and Tree Protection:

1. Maintain existing grade within drip line of trees, unless otherwise shown or indicated.
2. Lowering of Preconstruction Grade:
   a. Where required finish grade is below preconstruction grade around trees and shrubs, grade beyond drip line. Maintain preconstruction grade within drip line of trees and shrubs.
   b. Prune tree and shrub roots exposed during grade lowering, or provide permanent protections as recommended by arborist. Do not cut main or lateral roots or tap-roots; cut only smaller roots.
   c. Compensate for loss of roots and prune branches to stimulate root growth.
   d. Provide extended service through completion of the Contract correction period as recommended by arborist.

AD-2: Section 31 1000; 09/25/2024: Delete Paragraph 3.4, D and E.

~~D. Tree and Shrub Pruning (Selective Trimming):~~

~~1. Perform pruning and selective trimming under the supervision of arborist.~~
~~2. Remove branches from trees and shrubs to remain only after Engineer's concurrence, only to extent necessary to clear location of permanent construction, using branch removal methods in accordance with ANSI A300 and applicable ISA standards indicated in this Section's "References" Article.~~
~~3. Extend pruning operation to restore natural shape of entire tree or shrub where pruning is approved by Engineer and as recommended by arborist.~~
~~4. Prune branches to balance loss to root system caused by damage or cutting of root system.~~
~~5. Chip branches removed from trees and shrubs. Stockpile and spread chips as directed by Engineer, with arborist's recommendation.~~

~~E. Selective Trimming:~~

~~1. In addition to pruning (as required above), perform other selective trimming under direction of arborist.~~
~~2. Comply with ANSI A300 and applicable ISA standards indicated in this Section's "References" Article.~~
~~3. Where shown or indicated, and as directed by Engineer with arborist's recommendation, carefully remove larger branches, when necessary, using appropriate methods.~~

~~4. Repair cut branches in accordance with this Section.~~

~~5. During selective trimming, avoid damaging healthy (to remain) elements of trees and shrubs.~~

~~6. Dispose of trimmings as indicated in this Section's "Disposal and Cleaning" Article.~~

F. Selective Removals:

1. Perform selective removals under direction of arborist.
2. Comply with ANSI A300 and applicable ISA standards indicated in this Section's "References" Article.
3. Fully remove trees and shrubs shown or indicated for selective removal.
4. Remove stumps to not less than one feet below preconstruction ground surface.
5. During selective removals, avoid damaging adjacent trees and shrubs to remain, and other property.
6. Remove larger branches before cutting the trunk of tree or shrub being selectively removed.
7. Dispose of trees and shrubs selectively removed as indicated in this Section's "Disposal and Cleaning" Article.

AD-2: Section 31 1000; 09/25/2024: Revise Paragraph 3.4, G.

G. Repair and Replacement of Trees and Shrubs:

1. Perform tree and shrub repair under direction of arborist.
2. Cavity Repair:
   a. Remove decayed areas to depth that exposes healthy tissue.
   b. Shape cavities to provide drainage.
   c. Paint inside of cavity with antiseptic tree wound dressing material.
   d. Do not fill cavities.

~~e. When cavity's cross-section exceeds 60 percent of cross-section of tree or shrub branch, selectively trim subject branch. When cavity's cross-section exceeds 60 percent of cross-section of trunk of tree or shrub, remove tree or shrub upon Engineer's authorization. Engineer will consider arborist's recommendation. Comply with this Section's requirements for selective trimming and selective removals.~~

3. Repair trees and shrubs damaged by construction operations~~, or selectively trimmed,~~ within 24 hours of occurrence of such damage ~~or selective trimming~~. Treat damaged trunks, branches, and roots according to written instructions of arborist, in accordance with ANSI A300 and applicable ISA standards indicated in this Section's "References" Article.
4. Remove and replace trees and shrubs that are (1) dead or destroyed due to construction operations, or (2) damaged beyond reasonable hope of recovery (as determined by arborist) following repairs, or (3) damaged and determined by arborist to be incapable of resuming normal growth pattern after repairs.,
5. Obtain opinion from arborist regarding whether damaged trees, shrubs, and other vegetation is repairable with reasonable chance of success. Submit arborist's certification required in this Section's "Submittals" Article.
6. For each tree or shrub to remain but is destroyed or damaged (beyond repair) by Contractor:
   a. For trees 8 inches or more in diameter (measured one foot above preconstruction ground surface), provide two replacements of the same species. Each replacement shall be four inches diameter (measured one foot above top of root ball).
   b. For trees smaller than eight inches diameter, and for shrubs, provide one replacement for each, of same species. Replacements shall be equal in size to original, up to maximum oof four inches (measured one foot above root ball).

c. Provide replacement at locations at the Site as directed by Engineer.

d. Provide replacements in accordance with the Contract Documents, including Specifications on planting and landscaping.

3.5 DISPOSAL AND CLEANING

A. Disposal – General:

AD-2: Section 31 1000; 09/25/2024: Revise Paragraph 3.5, A, 1.

1. Dispose of matter resulting from clearing and grubbing~~,~~ **and** selective removals~~, and selective trimming,~~ at appropriate offsite location, unless otherwise expressly allowed by the Contract Documents or mutual agreement of Owner and Contractor.
2. Do not use cleared, grubbed, or trimmed material as fill, backfill, or in embankments.
3. Dispose of cleared, grubbed, and trimmed material, and other materials, rubbish, and debris, in accordance with Laws and Regulations.
4. Pay all costs associated with transporting and disposing of materials and debris resulting from site clearing Work.
5. Cleared lumber and trimmings from trees are Contractor's property and, at Contractor's option, may be sold or salvaged offsite.

B. Cleaning:

1. Perform progress cleaning and other cleaning Work, and disposal of resulting materials and debris, in accordance with all local laws and regulations.

C. Burning:

1. Burning of trees, shrubs, brush, other vegetation, and other materials at, or adjacent to, the Site, whether in-place or cut, is prohibited unless: (a) burning is not prohibited by Laws or Regulations, and (b) required permits, if any, are obtained by Contractor from authorities having jurisdiction and are furnished to Engineer as Submittals; and (c) written approval of Owner is obtained and furnished to Engineer as a Submittal; and (d) when burning will be performed on lands at the Site not owned by Owner, obtain and submit to Engineer as Submittals written approval of owners of such properties.
2. Before burning, alert local fire department (both orally and in writing) not less than 72 hours before burning, and provide at location of burning appropriate emergency materials, tools, and equipment to contain and extinguish fires. Use such items and furnish necessary labor to prevent fire from burning other than intended trees, shrubs, brush, and vegetation.
3. If burning is allowed, exercise appropriate care and judgement. Do not perform burning in high wind conditions. Do not perform burning when areas adjacent to burning are of dryness that will foster wildfires.
4. Promptly and fully extinguish fires before they burn unintended areas or materials, and when burning is completed.
5. Dispose of ashes and burned materials off-site at appropriate location.

3.6 TOPSOIL STRIPPING AND STOCKPILING

A. Stripping:

1. Before commencing topsoil stripping:
   a. Perform clearing and grubbing and selective removals.
   b. Remove grass and other vegetation that may remain following clearing and grubbing.
   c. Provide necessary and required temporary erosion and sediment controls.
2. Before stockpiling, separate objectionable material from topsoil.
3. Do not strip topsoil from within drip line of trees and shrubs to remain as part of the completed Project.

B. Stockpiling:

1. Stockpile topsoil in location selected by Contractor but approved by Owner.
   a. Construct storage piles to freely drain surface water.
   b. Seed or cover storage piles to prevent erosion.
   c. Install erosion and sediment control BMPs around the perimeter of all stockpiles in accordance with Section 01 5705.

C. Reuse of Stripped Topsoil:

1. Reuse in the finish grading and landscaping Work topsoil that complies with the Contract Documents for such Work.
2. Where topsoil stripped from the Site does not comply with the Contract Documents relative to quality required for use in finish grading and landscaping Work, provide appropriate soil amendment material, properly and fully mixed into topsoil stripped from the Site, so that amended material complies with quality requirements for topsoil required for finish grading and landscaping Work.

D. Disposal of Excess Topsoil:

1. Topsoil in excess of quantity required for finished Project becomes Contractor's property when Engineer indicates finish grading and landscaping Work is complete. Properly dispose of all excess topsoil offsite in accordance with all Federal, State, and local requirements. Contractor may sell excess topsoil at offsite location.

END OF SECTION

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SECTION 32 1216

ASPHALTIC CONCRETE VEHICULAR PAVING (Revised AD-2)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Asphaltic concrete vehicular paving.
2. Line painting.

AD-2: Section 32 1216; 09/25/2024: Delete Paragraph 1.1, B.

~~B. Related Specification Sections include but are not necessarily limited to:~~

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. Federal Specifications (FS):
   a. TT-P-1952F, Paint, Traffic and Airfield Marking, Waterborne.
2. Construction standards: State of Nebraska, Department of Transportation, "Standard Specifications for Highway Construction 2017, as amended to date.

1.3 SUBMITTALS

A. Shop Drawings:

1. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions.
   c. Asphalt design mix.

PART 2 - PRODUCTS

2.1 MATERIALS

AD-2: Section 32 1216; 09/25/2024: Revise Paragraph 2.1, A.

A. Asphaltic Concrete: NDOT Standard Specifications 2017, Section~~s~~ 1028 ~~and 1002~~.

B. Line Paint:

1. Nonreflective.
2. Color, refer to the Drawings.
3. FS TT-P-1952F.
4. Thermoplastic.

AD-2: Section 32 1216; 09/25/2024: Revise Paragraph 2.2, A.

2.2 MIXES

A. Mix design shall ~~comply with Nebraska DOT Standard Specification,~~ **be** Type **SPR for base course and Type SPH for surface course.**

AD-2: Section 32 1216; 09/25/2024: Add Paragraph 2.3.

2.3 BINDERS

A. Binder shall be PG 64-34 for base course and PG 70-34 for surface course.

PART 3 - EXECUTION

3.1 APPLICATION

A. Construct to line, grade and section as shown on Drawings and in accordance with referenced State Specifications.

B. Install a depth of compacted layer of asphaltic base course in accordance with the Drawings and NDOT Standard Specifications 2017.

AD-2: Section 32 1216; 09/25/2024: Revise Paragraph 3.1, C.

C. Spread a prime coat uniformly on compacted aggregate base course ~~at rate of 0.05 to 0.10 GAL per square yard~~ in accordance with NDOT Standard Specifications 2017.

D. Install a depth of binder and surface course according to NDOT Standard Specifications 2017.

E. Tolerance of Finished Grade: +0.10 feet from required elevations.

3.2 LINE PAINTING:

A. Thoroughly clean surfaces which are to receive paint.

B. Dry completely before paint is applied.

C. Do not paint until minimum of five days has elapsed from time surface is completed.

1. A longer period may be required if directed by Engineer.

D. Do not apply paint over wet surfaces, during wet or damp weather, or when temperature is below 40 degrees F.

E. Lay out markings and striping in accordance with Drawings.

1. Width of painted lines: 4 inches.

END OF SECTION

SECTION 32 1540

AD-2: Section 32 15 40; 09/25/2024: Revised name from Crushed Stone Surfacing to Crushed Rock Surfacing.

CRUSHED ROCK SURFACING (Revised AD-2)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

AD-2: Section 32 1540; 09/25/2024: Revised Paragraph 1.1, A, 1.

1. Crushed ~~Stone~~ Rock surfacing.
    a. Maintenance Road.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. American Association of State Highway and Transportation Officials (AASHTO):
    a. T2, Sampling Stone, Slag, Gravel, Sand and Stone Block for Use as Highway materials.
2. ASTM International (ASTM):
    a. C29, Standard Test Method for Bulk Density (“Unit Weight”) and Voids in Aggregate.
    b. C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
    c. D75, Standard Practice for Sampling Aggregates.
    d. D5821, Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate.
    e. NDOT Standard Specifications 2017.

1.3 SUBMITTALS

A. Product Data:

1. Acknowledgement that products submitted meet requirements of standards referenced.
2. Sieve analysis reports on all granular materials.
3. Source tests: submit certified test reports and service records to determine acceptability and application of stone materials.

PART 2 - PRODUCTS

AD-2: Section 32 1540; 09/25/2024: Revised Paragraph 2.1.

2.1 MATERIALS

A. Crushed ~~Stone~~ Rock Surfacing:

1. Refer to NDOT Standard Specifications 2017, Section ~~310~~ **1033**.

2.2 SOURCE QUALITY CONTROL

A. Furnish material from a single source.

B. Obtain samples per ASTM D75 from a local quarry that typically provides material to meet the specification requirements.

PART 3 - EXECUTION

3.1 PREPARATION

A. Trim and dress all areas to required cross sections.

B. Bring areas that are below allowable minus tolerance limit to grade by filling with material similar to adjacent material.

C. Compact to density specified for backfill in accordance with Specification Section 31 2305 - Excavation and Fill.

D. Do not place any stone on soft, muddy, or frozen material.

E. Prevent contamination of existing surfacing stone during excavation activities.

F. Do not place any stone material on prepared base prior to approval by Engineer.

3.2 PLACING

A. Place to required thickness and grades:

1. Depth: -0 inches, +6 inches.

B. Place to full thickness in a single operation to avoid displacing the underlying material.

AD-2: Section 32 1540; 09/25/2024: Revised Paragraph 3.2, C.

C. Compact material to **95% per ASTM D698**. ~~a firm uniform layer.~~

D. Maintain a neat and dust-free finish surface.

END OF SECTION

SECTION 33 1113

WATER MAIN CONSTRUCTION (Reissued in its entirety AD-2)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Coordination and interface with existing facilities and utilities.
2. Connections to existing water mains.
3. Testing, flushing and disinfection.
4. Dry-Barrel fire hydrant

B. Related Specification Sections include but are not necessarily limited to:

1. Section 31 2219 - Finish Grading.
2. Section 31 2305 Excavation and Backfill

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. American Water Work Association (AWWA):
   a. B300, Standard for Hypochlorites.
   b. B301, Standard for Liquid Chlorine.
   c. C502, Standard for Dry-Barrel Fire Hydrants.
   d. C651, Standard for Disinfecting Water Mains.
   e. M17, Installation, Operation and Maintenance of Fire Hydrants.
2. City of Grand Island Standard Specifications 2024.
   a. Pipe and all Pipe Fittings Requirements.

1.3 SUBMITTALS

A. Shop Drawings:

1. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions.
   c. Acknowledge and verify dimensions and provide list of integral parts and materials.
2. Prior to submission of fire hydrant shop drawings, submit one copy of complete submittal information direct to City of Grand Island Fire Department, Attn: Fire Chief, request and secure written approval of hydrant selection.
   a. Incorporate copies of written approval letter with submittals.

B. Submit results of the leakage tests, identifying the specific length of pipe tested, the test pressure, the duration of test and the amount of leakage.

C. Submit satisfactory bacteriological test reports on disinfection requirements.

D. Submit qualifications for lab performing disinfection analysis.

E. Contract Closeout Information:

1. Operation and Maintenance Data:
   a. See Specification Section 01 7823 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Pipe: In accordance with Grand Island Standard Specifications 2024, Section 31.01 Ductile Iron Pipe.

B. Fittings: In accordance with Grand Island Standard Specifications 2024, Section 31.02 Fittings

C. Coatings and Linings: In accordance with Grand Island Standard Specifications 2024, Section 31.01

D. In-Line Valves:

1. In accordance with Grand Island Standard Specifications 2024, Section 31.04 and Section.
2. Provide valve boxes in accordance with Grand Island Standard Specifications 2024, Section 31.07.
    a. Include price of valve boxes in price of valve installed complete.

E. Taping Sleeves and Tapping Valves: In accordance with Grand Island Standard Specifications 2024, Section 31.06 and 32.11

F. Fire Hydrants: In accordance with Grand Island Standard Specifications 2024; Section 31.10.

G. Water Service Pipe: Copper, Type K, in accordance with Grand Island Standard Specifications 2024, Section 31.16

1. Corporation Stop: In accordance with Grand Island Standard Specifications 2024, Section 31.13
2. Curb Stop: In accordance with Grand Island Standard Specifications 2024, Section 31.14
3. Water Service Valve Box: In accordance with Grand Island Standard Specifications 2024, Section 31.15
4. Service Saddle: In accordance with Grand Island Standard Specifications 2024, Section 31.17.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions and Grand Island Standard Specifications 2024, Section 32.

B. Install water main to the line and grade on the Drawings.

1. Water mains to be staked at a minimum 100 feet interval with depth of cuts monitored.

C. Field verify depth of utilities that will be crossed.

1. Adjust water main elevation as required during construction in accordance with Grand Island Standard Specifications 2024, Section 32.12.
2. No separate payment will be made for field verification or adjustment of main depths as required.

D. Contractor will restore all existing structures or services damaged by Contractor's operations at no cost to Owner.

3.2 INTERRUPTION OF SERVICE

A. Interruption of service to water users shall be in accordance with Grand Island Standard Specifications 2024, Section 32.07.

3.3 UNDERGROUND SERVICES

A. Notify utility representative prior to construction to obtain available information on location of existing utilities.

1. Contractor shall be responsible for locating all utilities.

3.4 PROTECTION OF EXISTING UTILITIES

A. Contractor to verify the location of all underground utilities.

1. Omission from, or the inclusion of utility locations on the plans is not to be considered as the nonexistence of or a definite location of existing underground utilities.

B. A representative of the underground utilities shall be notified 24 hours in advance of crossings.

3.5 CONNECTIONS TO EXISTING WATER MAINS

A. Make connections to existing water mains as shown on Drawings, by attaching to existing or changed fitting.

1. Cost for making connections shall include cost of all fittings including flexible couplings, and shall be included in the bid unit price of the water main.

B. Where the connection is made to an existing water main which can be adequately isolated from the distribution system, it shall be termed a "dry connection."

C. Contractor is responsible for controlling and disposing of water in the trench at no additional cost to the Owner.

3.6 WATER MAIN SEPARATION FROM UTILITIES

A. In accordance with Grand Island Standard Specifications 2024, Section 32.12.

3.7 TREES

A. Do not remove trees without written instructions from the Engineer unless tree removal is shown on drawings.

1. No separate payment will be made for tree removal and the cost shall be included in the bid unit price for transmission main.

3.8 FIELD QUALITY CONTROL

A. System Testing Requirements: In accordance with Grand Island Standard Specifications 2024, Section 32.09.

END OF SECTION

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SECTION 33 3111

GRAVITY SEWER PIPELINE AND MANHOLE CONSTRUCTION (Revised AD-2)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Installation and testing of sewer pipes, structures and appurtenances.
2. Connections to existing sewers.
3. Coordination and interface with existing facilities and utilities.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 31 2219 - Finish Grading.
2. Section 31 2305 – Excavation and Fill.
3. Section 32 1216 - Asphaltic Concrete Vehicular Paving.
4. Section 32 1313 – Concrete Pavement.

C. Alternates:

1. The following materials may be used at Contractor's option unless otherwise specified or shown on Drawings:
   a. Gasketed PVC per ASTM 3034, SDR 26.

1.2 REFERENCES

A. Referenced Standards:

1. ASTM International (ASTM):
   a. F1417, Standard Practice for Installation Acceptance of Plastic Non-pressure Sewer Lines Using Low-Pressure Air.
2. Occupational Safety and Health Administration (OSHA).
3. Grand Island Standard Specifications 2024.

1.3 SUBMITTALS

A. Action Submittals: Submit the following:

1. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Catalog data sheets for all materials.
   c. Details of all piping system components confirming that the pipe, fittings, and appurtenances conform to the specified requirements.
   d. Manufacturers' written recommendations for material handling, delivery, storage, installation, and minor repair of materials damaged in shipping.

AD-2: Section 33 3111; 09/25/2024: Deleted Paragraph 1.3, A, 1, e.

~~e. Recommended details for buoyancy restraint and for manhole/pipe connections.~~

   f. Fabrication and/or layout drawings as specified in individual pipe material specifications.
2. See individual pipe material specifications for additional required submittals.

B. Informational Submittals: Submit the following:

1. Submit Test Report of leakage tests results including the following:
   a. Test procedure.

b. Pipeline segment tested.
c. Length of pipe tested.
d. Test pressure.
e. Test duration
f. Amount of leakage.
g. Corrective action, if any.

C. Contract Closeout Information:

1. Operation and Maintenance Data.

1.4 DELIVERY, STORAGE, AND HANDLING OF PRODUCTS

A. In addition to the requirements specified in this section, see related paragraphs in individual pipe specifications.

B. Deliver, handle and store products in accordance with manufacturer's instructions.

C. Protect pipeline sections stored at the site from damage.

D. Store all products above the ground upon platforms, pallets, skids, or other supports supplied by the Contractor.

1. Store in a way to permit ready access for identification and inspection by the Engineer.

E. Keep products free from dirt and other foreign matter.

F. Provide suitable quantities of all lifting equipment to handle the pipe.

1. Do not utilize any equipment that is not rated to handle the intended loading or conditions of use to which it will be subjected, or which will damage or gouge the pipe.
2. Do not drag or drop pipe.

G. Place pipe lain directly on the ground prior to placement on an area free of loose stones or sharp objects.

H. Repair or replace any new pipe and fittings damaged before or during installation at Contractor’s expense, before proceeding further.

1. Utilize repairs methods as recommended by the manufacturer.
2. Replace damaged materials as directed by Owner’s project representative.

I. Protect PVC pipe from UV degradation if stored outside for more than 60 days.

PART 2 - PRODUCTS

AD-2: Section 33 3111; 09/25/2024: Revised Paragraph 2.1.

2.1 MATERIALS

A. Pipe:

1. See individual pipe material specifications listed in Paragraph 1.1 ~~B~~ **C** above.

B. Fill and backfill at manholes: See Specification Section 31 2305 **– Excavation and Backfill**.

C. Embedment and Bedding Materials for pipelines: See Section Specification 31 2305 **– Excavation and Backfill .**

D. Size mandrels to meet deflection requirements specified herein or in the individual pipe material specifications.

E. Pipe Joint Testing Equipment:

1. Utilize joint testing equipment capable of providing sufficient sealing pressure for air bladder to prevent leakage through bladder seals.
2. Include pressure gage to aid in verification of adequate applied pressure and joints ability to withstand the applied pressure without leaking.
3. Utilize joint testing equipment that encapsulates the full 360 degrees circumference of the joint and at least 6 inches each side of the joint.
4. Pipes furnished with an integral "testable" joint, consisting of two gaskets with fittings to pressure test between the two gaskets, will be tested using the test equipment and fittings recommended by the pipe manufacturer.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Furnish all construction materials and equipment required for installation and backfill.

B. Install the pipeline complete, including bends, stop logs, and other associated work and appurtenances, as shown on the Drawings or as herein specified.

C. Make all necessary connections to sewer lines shown on the Drawings and in accordance with the Specifications.

D. Construct all sewer piping, manholes, and structures to be free of visible ground water inflow.

1. Install sanitary sewer manholes and structures that are watertight.
    a. Repair or replace any manhole or structure showing infiltration of ground water through joined surfaces, pipe to manhole/structure connections or manhole/structure wall.
2. Install pipe with watertight pipe joints.
    a. Repair or replace any joint showing infiltration of ground water through pipe joints or pipe to manhole connections.

E. Alignment: Lay gravity sewer lines in straight alignment and uniform grade between manholes.

1. Install at grade as shown on drawings.

F. Brace and protect pipe sections to prevent deformation during installation and backfill.

G. Deflection: Pipe deflection after final backfill shall not exceed the specified limits detailed in the individual pipe specifications.

1. Remove and replace any pipe observed to be deflecting in excess of the specified limits.

H. Perform testing in accordance with requirements of this Section.

I. Provide Engineer with free access to work for inspection.

1. Such inspection shall not relieve the Contractor of his responsibility for performing Work in accordance with the Contract Documents.

3.2 PIPELINE INSTALLATION

A. Lateral shoring of the trench walls or other similar construction methods may be required.

1. Design and implement all such methods.
2. When required, install shoring in accordance with all applicable local, State and OSHA regulations.
3. Remove shoring prior to backfilling.

B. Grade bottoms of trenches such that when bedding is placed between the trench bottom and the pipe, each section of pipe is installed to the specified depth or elevation with uniform support.

C. Determine and fix alignment and grade or elevation of each pipeline from offset stakes or calibrated laser instruments.

D. Install pipelines on the line and grade shown on the drawings.

1. Calculate required elevation of each pipe joint and survey installed elevation at each joint prior to stabbing the next joint to verify grade.
2. Relay pipe to proper grade if any joint elevation deviates from the calculation by more than 0.01 feet.

E. Remove material at the bottom of the trench if determined to be unsuitable by the Engineer.

1. Backfill trench with approved subgrade material or bedding material to the specified depth or elevation as described in Specification Section 31 2305.

F. Install only clean pipe and fittings.

1. Provide physical barriers to protect open ends of sections of pipe in place from the entrance of trench water, mud, dirt, or other foreign substances with when pipe installation is not in progress.

G. Begin pipe laying at the lowest elevation with bell ends facing the direction of laying, except when reverse laying is permitted by Engineer.

H. Where the drawings require concrete encasement or flowable fill embedment and backfill, anchor pipe as required to prevent floatation.

1. Alternatively, Contractor may place concrete or flow fill materials in staged lifts allowing each lift to reach initial set prior to placing the subsequent lift to limit buoyancy effects and prevent floatation of the pipeline.

I. Pipeline may be backfilled as it is installed, provided all inspection and testing requirements are met.

J. Pipe, fittings, and special pieces will be subject to inspection by Engineer, prior to installation.

1. Report all damages not detected by Engineer but discovered by Contractor during installation to Engineer for corrective action or replacement.

K. Repair of pipe damaged during installation shall conform to the manufacturer’s repair procedures, with the concurrence of Engineer.

3.3 RESTORATION

A. Restore all existing structures or services damaged by Contractor's operations at no cost to Owner.

1. Repair or replace culverts that are damaged, removed or interfere with the work as part of restoration at no additional cost to Owner.

B. Restore all area disturbed by installation of the pipelined in accordance with the Specifications, the Drawings,

1. Provide slope protection, re-vegetation, and road restoration as necessary.

C. Driveway Removal and Replacement:

1. All Portland cement concrete and asphalt noted for removal and replacement shall be cut prior to removal.
   a. Cut by sawing, vertical cut to be 1 inch minimum.
   b. The remaining depth of section may be broken out in a manner subject to Engineer’s approval.
   c. Width of section removed to be either a width not greater than the outside diameter of the sewer plus 4 feet-0 inches or broken out to the nearest joint.

2. Replace Portland cement concrete and asphalt equal to or better than original paving.
   a. Replace with existing thickness + 2 inches.
3. Debris resulting from the above operations shall be removed and disposed offsite.
4. Include driveway removal and replacement in cost of the bid unit price of the sewer pipe.

AD-2: Section 33 3111; 09/25/2024: Deleted Paragraph 3.3, D and F.

~~D. Gravel Surfaced Drives and Roadways:~~

~~1. Restore all damaged gravel surfaced drives and roadways to a condition equal to or better than original.~~
~~2. Replacement gravel gradation to match existing.~~

E. Trees:

1. Do not remove trees without written instructions from the Engineer unless tree removal is shown on drawings.
2. No separate payment will be made for tree removal and the cost shall be included in the bid unit price sewer pipe.

~~F. Fences, Signs, Mailboxes, etc.:~~

~~1. Restore all damaged fences, signs, mailboxes, etc., to their original conditions.~~
~~a. No separate payment will be made for these items.~~

3.4 PROTECTION OF EXISTING UTILITIES

A. Verify the location of all underground utilities.
   1. Omission from, or the inclusion of utility locations on the plans is not to be considered as the nonexistence of or a definite location of existing underground utilities.

B. Notify utility representative prior to construction to obtain available information on location of existing utilities.
   1. Contractor shall be responsible for locating all utilities.

C. Notify representative of the underground utilities 24 hours in advance of crossings.

D. Existing water services and sewer services:
   1. Repair damage to existing water service using copper pipe and union the same size as existing service.

3.5 FIELD QUALITY CONTROL

A. General Testing Requirements:
   1. Furnish necessary personnel, materials, and equipment, including bulkheads, restraints, anchors, temporary connections, pumps, water, pressure gauges, and other means and facilities required to perform tests.
   2. Obtain Engineer's approval of methods and the equipment used for the tests prior to testing.
   3. Provide reasonable facilities and access for Engineer to inspect, test and obtain such information as required with respect to the materials used and the progress and condition of the Work and the results obtained.
      a. Work that is not performed in accordance with the procedure or does not comply with the requirements of the Specifications will be rejected.
   4. Coordinate testing schedules with Engineer.
      a. Perform all specified tests under observation of Engineer.

b. Provide a minimum of 24 hours advance notice prior to commencing any testing.

5. Perform testing as work progresses and as required to facilitate connections with existing sewers.
6. Obtain water for testing and cleaning at no additional cost to the Owner.
7. Test only those portions of pipes that have been installed as part of this Contract.
   a. Test new pipe sections prior to making final connections to existing piping.
   b. Furnish and install plugs, bulkheads, and restraints required to isolate new pipe sections.
8. Unsuccessful Tests:
   a. Where tests are not successful, correct defects or remove defective piping and appurtenances and install piping and appurtenances that comply with the specified requirements.
   b. Repeat testing until tests are successful at no additional cost to Owner.
9. Deflection:
   a. Check each section of pipe after backfilling for deflection by pulling a mandrel through the pipe.
   b. Conduct test after the final backfill has been in place at least 30 days.
   c. Maximum long-term deflection: less than 5% of the initial diameter.

B. Lamping:

1. Install each section of sewer line between manholes to be straight and uniformly graded.
2. Each section will be lamped by Engineer.
3. Furnish suitable assistants, materials and air monitoring to assist Engineer.

C. Low Pressure Air Testing:

1. Test all gravity sewer pipes up to 30-inch diameter with a low-pressure air test.
   a. Comply with ASTM F1417.
   b. Time elapsed for a 1 psi drop in air pressure: Per ASTM F1417.
   c. Maximum air loss: Per ASTM F1417.
2. Submit schedule to Engineer for approval prior to starting the tests.
3. Conduct air test after the final backfill has been in place for a minimum of 30 days.
4. Correct pipes failing air test and conduct second test after final backfill has been in place an additional 30 days.
5. If the length of sewer to be tested is fully or partially submerged in groundwater, increase test pressure as necessary to overcome the actual static pressure exerted by the groundwater.
   a. If a test pressure greater than 8 psi results, utilize water infiltration testing in lieu of air testing.
6. Locate leaks by testing short sections of pipe.
   a. Repair leaks and retest affected reach of sewer.

D. Deflection Testing: Test all flexible sewer pipes for deflection.

1. Perform the mandrel test with the Engineer in observance for all pipe sizes.
2. Deflection limits: as indicated in the individual pipe sections or as specified in article titled “General Testing Requirements” above, whichever is more stringent.
3. Conduct test after the final backfill has been in place at least 30 days.
4. Correct pipes failing deflection test and conduct second test after final backfill has been in place an additional 30 days.

AD-2: Section 33 3111; 09/25/2024: Deleted Paragraph 3.5, E.

~~E. Joint Testing:~~

~~1. Test all sewer pipe joints for pipe diameters 36 inches and greater.~~

~~2. Conduct test after final backfill has been in place for at least 30 days.~~

~~3. Supply pressure gages of type, calibration, accuracy acceptable to the Engineer.~~

~~a. Engineer may request certification of the gages by a reliable testing firm and may compare these gages with an Owner's gage at any time.~~

~~4. Repair or replace pipe joints that do not pass joint test and retest.~~

~~a. Conduct retests after repairs have been made and final backfill has been in place for 30 days.~~

~~5. Test procedure:~~

~~a. Center joint tester over joint to be tested and inflate seals.~~

~~b. Apply 3.5 psiG pressure to joint and allow pressure to stabilize.~~

~~c. If the pressure holds or drops less than 1 psi in 30 seconds, joint is acceptable.~~

~~6. When pipe materials are provided with a "testable joint", cap testing tube securely with a plug at testing port following successful completion of joint test and acceptance by Engineer.~~

F. Manhole Testing:

1. Vacuum test all manholes per ASTM C1244 for leakage after installation, before epoxy lining is placed, and prior to being backfilled.
2. Visually inspect all manholes for leaks and defects prior to vacuum testing.
3. Repair all leaks, defects or cracks discovered by visual inspection prior to vacuum testing.
4. Seal all pipes entering manholes at a point outside the manhole walls so as to include testing of the pipe/manhole joints.
5. Make all necessary repairs and retest the manhole.
   a. Inspect exterior of the manhole during this period for visible evidence of leakage.
   b. All repairs will be subject to acceptance by the Engineer.

END OF SECTION

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SECTION 33 4000

STORM DRAINAGE SYSTEM (Revised AD-2)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Storm drainage systems.
2. Storm drainage pipe.

AD-2: Section 33 4000; 09/25/2024: Revise Paragraph 1.1, A, 3.

3. ~~Inlets, headwalls, flumes and flared~~ **Inlet and Flared** end sections.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 31 2305 – Excavation and Fill.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. American Association of State Highway and Transportation Officials (AASHTO):
   a. M36, Standard Specification for Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains (Equivalent ASTM A760/A760M).
   b. M190, Standard Specification for Bituminous-Coated Corrugated Metal Culvert Pipe and Pipe Arches.
2. ASTM International (ASTM):
   a. A760/A760M, Standard Specification for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains.
   b. C14, Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe.
   c. C76, Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
   d. C361, Standard Specification for Reinforced Concrete Low-Head Pressure Pipe.
   e. F2510/F2510M, Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures and Corrugated Dual- and Triple-Wall Polyethylene and Polypropylene Pipes.
   f. F2648/F2648M, Standard Specification for 2 to 60 inches (50 to 1500 mm) Annular Corrugated Profile Wall Polyethylene (PE) Pipe and Fittings for Land Drainage Applications.
3. NDOT Standard Specifications 2017.

1.3 SUBMITTALS

A. Shop Drawings:

1. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
2. Certifications.
3. Test reports.
4. Submit all tests and certification in a single coordinated submittal.
   a. Partial submittals will not be accepted.

B. Submit schedules and details for structures and joints.

1.4 WARRANTY

A. Warrant that the infiltration will not exceed the amount specified in the Exfiltration Test paragraph in the FIELD QUALITY CONTROL Article in PART 3 of this Specification Section during the one year correction period.

PART 2 - PRODUCTS

AD-2: Section 33 4000; 09/25/2024: Revise Paragraph 2.1.

2.1 MATERIALS

A. Reinforced Concrete Pipe (RCP):

1. Reinforced concrete culvert, storm drain and sewer pipe: ASTM C76, Classes III, IV, and V.

B. RCP Joint Sealer:

1. Rubber gasket: ASTM C361.

C. Flared End Sections:

1. Conform to ~~State of Nebraska~~ **NDOT Standard Specifications**.
2. Bituminous coated: AASHTO M190, Type A.
3. Jointing: Same as pipe.

~~D. Corrugated Metal Pipe (CMP):~~

~~1. AASHTO M36 (ASTM A760/A760M), 16 GA.~~
~~2. Bituminous coated: AASHTO M190, Type A.~~
~~3. Jointing: Connecting bands of same base metal coated as pipe.~~

E. High Density Polyethylene Pipe (HDPE):

1. ASTM F2648/F2648M.
2. ASTM F2510/F2510M.

~~F. CMP Joint Sealer:~~

~~1. Cold applied asphalt joint compound.~~
~~2. Preformed flexible pipe joint sealing compound.~~

~~G. Concrete and Reinforcement for Inlets, Manholes, Junction Boxes, Headwalls, and Flumes:~~

~~1. Conform to Drawings and Details.~~

H. Concrete and Reinforcement for Concrete Flared End Sections:

1. Conform to **NDOT Standard Specifications and Standard Plans.** ~~Drawings and Details~~.

PART 3 - EXECUTION

AD-2: Section 33 4000; 09/25/2024: Revise Paragraph 3.1.

3.1 PREPARATION

A. Comply with Specification Section 31 2305 **- Excavation and Fill**.

AD-2: Section 33 4000; 09/25/2024: Revise Paragraph 3.2.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions **and NDOT Standard Specifications and Standard Plans**.

B. Comply with Specification Section 31 2305 **– Excavation and Fill.**

3.3 FIELD QUALITY CONTROL

A. Verify and coordinate installation.

B. Exfiltration Test:

1. Perform an exfiltration test on each reach of sewer between manholes.
   a. Test the first reach after backfilling and prior to installing any of the remaining pipe, or any additional reach.
   b. Single or multiple reaches may be tested thereafter, at Contractor's option.
   c. Subject each manhole to at least one test.
   d. Provide all necessary piping between the reach to be tested and the water supply, and other necessary materials and equipment.
   e. Air testing may be allowed.
      1) Submit complete information to Engineer for review describing the proposed test method, scheduling, and duration, including the method of testing manholes before beginning testing.
2. Procedure:
   a. Block off all manhole openings, except those connecting with the reach being tested.
   b. Fill the line.
      1) Average depth: 10 feet above invert, except as required by manhole depth.
      2) Depth at lower end: 25 feet maximum above crown.
      3) Depth at upper end: 5 feet minimum above crown.
   c. Add and measure water as required to maintain a constant level.
      1) Exfiltration: 100 GAL maximum per inch of nominal diameter per mile per day.
      2) Manholes are considered section of 48 inches pipe.
   d. Maintain test for at least 2 hours, or as long as necessary in Engineer's opinion, to locate all leaks.
3. Repair and retest any reach that exceeds the allowable exfiltration.

C. Infiltration Test:

1. If at any time prior to expiration of the correction or warranty period infiltration exceeds 200 GAL/IN of nominal diameter/mile/day, locate the leaks and make repairs.

D. In case of conflict, do not relocate piping without prior approval from the Engineer.

END OF SECTION

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