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SUSTAINABILITY REQUIREMENTS AND REPORTING

02/21

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SECTION 01 33 29

SUSTAINABILITY REQUIREMENTS AND REPORTING
02/21

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

COUNCIL ON ENVIRONMENTAL QUALITY (CEQ) (WHITE HOUSE)

HPSB Guiding Principles	(2016) Guiding Principles for Sustainable Federal Buildings and Determining Compliance with the Guiding Principles for Sustainable Federal Buildings

GREEN BUILDING INITIATIVE (GBI)

GBI DOD GP Compliance	(2017) GBI Department of Defense Guiding Principles Compliance Program for New Construction

INTERNATIONAL CODE COUNCIL (ICC)

ICC IgCC	(2021) International Green Construction Code

U.S. DEPARTMENT OF AGRICULTURE (USDA)

FSRIA 9002	Farm Security and Rural Investment Act Section 9002 (USDA BioPreferred Program)

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 1-200-02	(2020; with Change 1, 2020; Change 2, 2022) High Performance and Sustainable Building Requirements
UFC 3-600-01	(2016; with Change 6, 2021) Fire Protection Engineering for Facilities

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 247	Comprehensive Procurement Guideline for Products Containing Recovered Materials

1.2 SUMMARY

This section includes requirements for Sustainability documentation and reporting submittals per the federally mandated High Performance and Sustainable Building (HPSB) or HPSB "Guiding Principles" (GP), and Third Party Certification (TPC) requirements, in accordance with UFC 1-200-02 High Performance and Sustainable Building Requirements, and other identified requirements.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Preliminary High Performance and Sustainable Building Checklist; G

Sustainability Action Plan; G

Preliminary Sustainability eNotebook; G

SD-11 Closeout Submittals

Final High Performance and Sustainable Building Checklist; G

Final Sustainability eNotebook; G

Amended Final Sustainability eNotebook; G

Amended Final High Performance and Sustainable Building Checklist; G

Third Party Certification Certificate, Assessment, or Validation and Compliance Report; G

[*Am-1]The Sustainability eNotebook shall include all relevant documentation pertaining to HPSB and TPC compliance including, but not limited to:

Commissioning Reports
Energy Efficient Products
Indoor Water Use
Low Emitting Materials
Bio-Based Products
Recycled Content
Certification of EPA Designated Items
Certification of USDA Designated Items
Construction Waste Management
Sustainability Submittals[**Am-1]

1.4 GUIDING PRINCIPLES VALIDATION (GPV)

Provide the following sustainability activities and documentation to verify achievement of HPSB Guiding Principles Validation (GPV):

a. Analysis of each Guiding Principle Requirement and how project complies. Include final government approved narrative(s) in the HPSB Checklist submittal. Multiple checklists indicate multiple buildings that require individual HPSB Checklist tracking.

b. No changes to the HPSB Checklist are allowed without approval from the Contracting Officer, in accordance with Section 01 33 00 SUBMITTAL REQUIREMENTS. Immediately bring to the attention of the Contracting Officer any project changes that impact meeting the approved HPSB Guiding Principles Requirements for this project. Demonstrate the change will not increase the life-cycle cost and maintains or improves the building performance.

c. Documentation of all work required to incorporate the applicable HPSB Guiding Principles requirements indicated on the HPSB Checklist and in this contract.

d. Sustainability Action Plan.

e. Construction related documentation for the project Sustainability eNotebook and keep updated with regularly-scheduled Construction Quality Control Meetings. Include construction related documentation containing the following components:

(1) HPSB Checklist(s)

(2) Sustainability Action Plan

(3) Documentation illustrating HPSB Guiding Principles Requirements compliance

1.4.1 Sustainability Action Plan

Include the following information in the Sustainability Action Plan:

a. Analysis of each HPSB Guiding Principles Requirement and how project will comply. Final government approved narrative(s) must be included in the HPSB Checklist submittal.

b. Name and contact information for: Contractor's Point of Contact (POC) ensuring sustainability goals are accomplished and documentation is assembled. For TPC that include on-site visit by third party representative, provide list of required attendees.

c. Indoor Air Quality plan.

1.4.2 Calculations

Provide all calculations, product data, labels and product certifications required in this specification to demonstrate compliance with the HPSB Guiding Principles Requirements.

1.5 SUSTAINABILITY SUBMITTALS

Provide HPSB Checklist and other documentation in the Sustainability eNotebook to indicate compliance with the sustainability requirements of the project.

1.5.1 High Performance Sustainable Building (HPSB) Checklist

Provide construction documentation that provides proof of, and supports compliance with, the completed HPSB Checklist.

1.5.1.1 HPSB Checklist Submittals

Submit updated HPSB Checklist, Attachment 1 at the end of this section, with each Sustainability eNotebook submittal. Include the final HPSB Checklist(s) with the interim DD1354 Real Property Record Submittal.

1.5.2 Sustainability eNotebook

The Sustainability eNotebook is an electronic organizational file that serves as a repository for all required sustainability submittals. To support documentation of compliance with an approved HPSB and TPC checklist Attachment 2 at the end of this section, provide and maintain a comprehensive and current Sustainability eNotebook. Include all required data in Sustainability eNotebook, to support full compliance with the HPSB Guiding Principles Requirements, including:

a. HPSB checklist

b. Sustainability Action Plan

c. Calculations

d. Labels

e. Certifications, assessments, or validations and compliance report

f. TPC documentation required in paragraph THIRD PARTY CERTIFICATION (TPC).

1.5.2.1 Sustainability eNotebook Format

Provide Sustainability eNotebook in the form of an Adobe PDF file; bookmark each HPSB Guiding Principles Requirement, TPC requirement, and sub-bookmark at each document. Match format to HPSB Guiding Principles numbering system indicated herein. Maintain up-to-date information, such as spreadsheets, templates, with each current submittals. For TPC projects, provide a second Table of Contents using TPC numbering system, for maintaining documentation unique to TPC.

Contracting Officer may deduct from the monthly progress payment accordingly if Sustainability eNotebook information is not current and on track per project goals.

1.5.2.2 Sustainability eNotebook Submittal Schedule

Provide Sustainability eNotebook Submittals at the following milestones of the project:

a. Preliminary Sustainability eNotebook

Submit preliminary Sustainability eNotebook with updated Preliminary High Performance and Sustainable Building Checklist and TPC checklist at the first post award meeting.

b. Construction Quality Control Meetings.

Provide up-to-date GP and TPC documentation in the Sustainability eNotebook and TPC Online tool for each meeting.

c. Final Sustainability eNotebook

Submit updated Sustainability eNotebook with updated Final High Performance and Sustainable Building Checklist with TPC Checklist at Beneficial Occupancy Date (BOD). Final progress payment retainage may be held by Contracting Officer until Final Sustainability construction phase documentation is complete.

d. Amended Final Sustainability eNotebook

Amend and resubmit the Amended Final Sustainability eNotebook with Amended Final High Performance and Sustainable Building Checklist and amended TPC Checklist, to include post-occupancy corrections, updates, and requirements. Final progress payment retainage may be held by Contracting Officer until amended final sustainability documentation is complete. Submit the Amended Final Sustainability eNotebook Submittal on DVDs to the Contracting Officer no later than 30 days after final GP, TPC determination.

1.6 DOCUMENTATION REQUIREMENTS

a. Incorporate each of the following HPSB Guiding Principles requirements into project and provide documentation that proves compliance with each listed requirement. Items below are organized by HPSB Guiding Principles. For life-cycle cost analysis requirements, one document with all analyses is acceptable, with Contracting Officer approval.

b. For each of the following paragraphs that require the use of products listed on Government-required websites, provide documentation of the process used to select products, or process used to determine why listed products do not meet project performance requirements.

1.6.1 Commissioning (Cx)

Develop and incorporate Commissioning requirements into the documents, in accordance with Section 01 91 00.15 10 TOTAL BUILDING COMMISSIONING.

1.6.2 Energy Efficient Products

Provide only energy-using products that are Energy Star rated or have Federal Energy Management Program (FEMP) recommended efficiency. Where Energy Star or FEMP recommendations have not been established, provide most efficient products that are life-cycle cost-effective. Provide only energy using products that meet FEMP requirements for low standby power consumption. Energy efficient products can be found at: https://www.energy.gov/eere/femp/federal-energy-management-program and http://www.energystar.gov/.

For construction submittal documentation, provide proof that product is labeled energy efficient and complies with the cited requirements.

1.6.3 Building-level Power Metering

Provide building-level meters for electricity, natural gas, and steam where applicable.

1.6.3.1 Construction Submittal Documentation

Provide manufacturer's data validating compatibility with base-wide system and component advanced meter requirements.

1.6.4 Indoor Water Use

Provide Construction Documentation proof that fixtures are labeled EPA WaterSense, for products available with EPA WaterSense labeling; for all other fixtures, proof they comply with EPA WaterSense efficiency requirements.

1.6.5 Indoor Water Metering

Provide building-level meters for potable water use. Provide the requirements cited in the following paragraphs:

1.6.5.1 Construction Submittal Documentation

Provide manufacturer's data validating compatibility with base-wide system and component advanced meter requirements.

1.6.6 Moisture Control

Provide the following:

1.6.6.1 Construction Submittal Documentation

Ensure construction materials are separated and protected in accordance with other sections in this contract document, with adequate humidity controls during construction. In accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA, includes plan for ongoing building moisture control.

Coordinate with the moisture control requirements of Section 01 45 00.00 10 QUALITY CONTROL.

1.6.7 Reduce Volatile Organic Compounds (VOC) (Low-Emitting Materials)

Meet the requirements of Table 3-1 at the end of this specification.

For Construction submittal documentation, provide certifications or labels that demonstrate compliance with cited requirements, based on the attached TABLE 3-1.

1.6.8 Indoor Air Quality During Construction

Prior to construction, create indoor air quality plan. Develop and implement an IAQ construction management plan during construction and flush building air before occupancy.

For new construction and for renovation of unoccupied existing buildings, meet the requirements of ICC IgCC 1001.3.1.5 (10.3.1.4) Indoor Air Quality (IAQ) Construction Management.

Provide documentation showing that after construction ends and prior to occupancy, HVAC filters were replaced and building air was flushed out in accordance with the cited standard.

1.6.9 Recycled Content

Comply with 40 CFR 247. Refer to: https://www.epa.gov/smm/comprehensive-procurement-guideline-cpg-program for assistance identifying products cited in 40 CFR 247. Selected products must comply with non-proprietary requirements of the Federal Acquisition Regulation and must meet performance requirements.

1.6.9.1 Construction Submittal Documentation

a. Provide manufacturers' documents stating the recycled content by material, or written justification for claiming one of the exceptions allowed on the cited website.

b. Substitutions: Submit for Government approval for proposed alternative products or systems that provide equivalent performance and appearance and have greater contribution to project recycled content requirements. For all such proposed substitutions, submit with the Sustainability Action Plan accompanied by product data demonstrating equivalence.

[*Am-1]c. In order to complete compliance with FAR 52.223-9 Estimate of Percentage of Recovered Material Content for EPA Designated Items and FAR 52-223-17 Affirmative Procurement of EPA designated items in Service and Construction Contracts, submit the Certification of EPA Designated Items as part of the Final Sustainability eNotebook. Include on the certification form the following information: project name, project number, Contractor name, license number, Contractor address, and certification. The certification will read as follows and be signed and dated by the Contractor. "I hereby certify the information provided herein is accurate and that the requisition/procurement of all materials listed on this form comply with current EPA standards for recycled/recovered materials content. The following exemptions may apply to the non-procurement of recycled/recovered content materials:

(1) The product does not meet appropriate performance standards;

(2) The product is not available within a reasonable time frame;

(3) The product is not available competitively (from two or more sources);

(4) The product is only available at an unreasonable price (compared with a comparable non-recycled content product)."

Record each product used in the project that has a requirement or option of containing recycled content, noting total price, total value of post-industrial recycled content, total value of post-consumer recycled content, exemptions (1), (2), (3), or (4), as indicated, and comments. Recycled content values may be determined by weight or volume percent, but must be consistent throughout.[**Am-1]

1.6.10 Bio-Based Products

Provide products and materials composed of the highest percentage of bio-based materials (including rapidly renewable resources and certified sustainably harvested products), consistent with FSRIA 9002 USDA BioPreferred Program, to the maximum extent possible without jeopardizing the intended end use or detracting from the overall quality delivered to the end user and when available at a reasonable cost. Use only supplies and materials of a type and quality that conform to applicable specifications and standards.

Comply with FSRIA 9002 USDA BioPreferred Program. Refer to www.biopreferred.gov for the product categories and BioPreferred Catalog. Selected products must comply with non-proprietary requirements of the Federal Acquisition Regulation and must meet performance requirements. Provide the following documentation:

a. USDA BioPreferred label for each product; for bio-based products used on project but not listed with BioPreferred program, provide bio-based content and percentage.

[*Am-1]b. In order to complete compliance with FAR 52.223-1 Biobased Product Certification, refer to submittal requirement for biobased products in FSRIA 9002.[**Am-1]

1.6.11 Waste Material Management (Recycling - Construction)

Divert demolition and construction debris in accordance with Section 01 74 19 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL.

1.6.12 Additional Sustainability Requirements

Provide the additional sustainability requirements cited in this paragraph.

1.6.12.1 Third Party Certification (TPC) Documentation

Third Party Certification certificate, assessment, or validation, and compliance report requirements are in addition to all requirements under header above GUIDING PRINCIPLES VALIDATION (GPV).

1.6.12.1.1 TPC Registration

This project has been designed for, and must be constructed to achieve GBI DOD GP Compliance. Project is already registered with the TPC Organization. Provide construction related sustainability documentation, in the format required by the TPC Organization, to the Contracting Officer for approval, and for final approval by the TPC organization. Third Party Certification is met when Government receives TPC organization certificate, assessment, or validation and compliance report. Execute the following:

a. Refer to TPC Checklist at the end of this specification section. (Multiple checklists indicate multiple buildings that require TPC.)

b. Immediately bring to the attention of the Contracting Officer any project changes that impact meeting the approved TPC Requirements for this project. Demonstrate the change will not increase the life-cycle cost and maintains or improves the building performance.

c. Complete all work required to incorporate the applicable TPC Requirements.

d. Maintain the construction related information in the Sustainability eNotebook pertaining to additions and changes to the approved sustainability requirements. Maintain the Sustainability eNotebook in electronic format. For more explanation, refer to paragraph SUSTAINABILITY eNOTEBOOK. Provide the following components in the Sustainability eNotebook, in addition to the GPV components above:

(1) TPC Checklist

(2) Provide construction documentation required to achieve third party certification

e. Provide the following information in the Sustainability Action Plan. Provide this TPC information in addition to the GPV Action Plan items above:

(1) Planned method to achieve each TPC requirement.

(2) For each TPC requirement that is attempted but not achieved, provide narrative explaining how mission or activity precludes achieving specific sustainability requirement or goal. Provide analysis of particular requirement and level to which project is able to comply.

(3) Provide name and contact information for: Sustainability Point of Contact (POC) and other names of sustainability professionals responsible for ensuring TPC sustainability goals are accomplished and documentation is assembled. Sustainability POCs are also responsible for ensuring GPV required in paragraph GUIDING PRINCIPLES VALIDATION (GPV) above.

f. Bear all costs associated with construction changes that affect sustainability design requirements, constructing, demonstrating, and documenting that project complies with approved TPC requirements, including but not limited to:

(1) TPC coordination with Government's AE and other consultants, TPC website requirements, and management for construction related documentation.

(2) Construction work required to incorporate TPC requirements.

(3) Submittals required to demonstrate compliance with Government approved TPC checklists.

(4) Documentation illustrating compliance with TPC requirements and additional documentation required by the TPC.

g. Provide all calculations, product data, and certifications, assessments, or validations required in this contract to demonstrate compliance with the TPC Requirements of this section.

1.6.12.2 Third Party Certification (TPC) Documentation

Third Party Certification certificate, assessment, or validation, and compliance report requirements are in addition to all requirements under

header above GUIDING PRINCIPLES VALIDATION (GPV).

1.6.12.2.1 TPC Already Registered

Project is already registered with TPC organization to achieve GBI DOD GP Compliance. When applicable, request TPC online access turnover from Government. Manage and provide all documentation for requirements of TPC and obtain Final Certification or validation. Third Party Certification is met when Government receives TPC organization certificate, assessment, or validation and compliance report.

1.6.12.2.2 TPC Management and Certification

Execute the following TPC Certification, assessment, or validation requirements:

a. Refer to TPC Checklist at the end of this specification section. (Multiple checklists indicate multiple buildings that require TPC.)

b. Immediately bring to the attention of the Contracting Officer any project changes that impact meeting the approved TPC Requirements for this project. Demonstrate the change will not increase the life-cycle cost and maintains or improves the building performance.

c. Complete all work required to incorporate the applicable TPC Requirements.

d. Maintain the construction related information in the Sustainability eNotebook pertaining to additions and changes to the approved sustainability requirements. When construction changes are made that affect design sustainability requirements, provide all required updates to affected design requirements and update in the Sustainability eNotebook. Maintain the Sustainability eNotebook in electronic format. For more explanation, refer to paragraph SUSTAINABILITY eNOTEBOOK. Provide the following components in the Sustainability eNotebook, in addition to the GPV components above:

(1) TPC Checklist

(2) Completed TPC forms. Transmit by the method required by the TPC organization.

(3) Copy of all correspondence with the TPC organization including proof of TPC registration

(4) Documentation illustrating compliance with TPC requirements and additional documentation as requested by the TPC

(5) TPC Award Certificate, assessment, or validation and compliance report.

e. Provide the following information in the Sustainability Action Plan. Provide this TPC information in addition to the Sustainability Action Plan items above:

(1) Planned method to achieve each TPC requirement.

(2) For each TPC requirement that is attempted but not achieved, provide narrative explaining how mission or activity precludes

achieving specific sustainability requirement or goal. Provide analysis of particular requirement and level to which project is able to comply.

(3) Provide name and contact information for: Sustainability point of contact (POC) and other names of sustainability professionals responsible for ensuring TPC sustainability goals are accomplished and documentation is assembled. Sustainability POCs are also responsible for ensuring GPV required in paragraph GUIDING PRINCIPLES VALIDATION (GPV) above.

f. Bear all costs associated with construction changes that affect sustainability design requirements, constructing, demonstrating, and documenting that project complies with approved TPC requirements, including but not limited to:

(1) Final TPC review, certification, assessment, or validation fees.

(2) Online (or offline with secure facilities) TPC management and documentation.

(3) Obtaining TPC certification or validation based on Government-approved sustainability goals.

(4) Construction work required to incorporate TPC requirements.

(5) Submittals required to demonstrate compliance with Government approved TPC checklists.

g. Provide all calculations, product data, and certifications, assessments, or validations required in this specification to demonstrate compliance with the TPC Requirements.

h. Provide all TPC management and documentation. Transmit TPC requirements by the method required by TPC organization.

i. Provide all required responses to third party organization.

j. Facilitate and participate in required TPC site visit. Coordinate with the Contract Officer to determine participating team members. Include Commissioning provider on applicable projects.

k. Provide TPC Certificate, assessment, or validation. Provide TPC compliance report that includes level achieved and reasons for non-compliance or not applicable elements. Use format below to create the Certificate, assessment or validation, compliance report, and Letter of Congratulations (when provided). Forward to parties designated by Contracting Officer:

(1) Certificate, Assessment or Validation:

Project Title, first line: P-(X); Form DD1391 Project Name).

Project Title, second line: UIC (Installation code)

(2) Letter Congratulations (when provided):

Address letter to Facility's Installation Commander Name. Address the letter to an individual person.

(3) Compliance Report:

Title page must cite Project title: P-(X); (1391 Project Name); Final Building Name if known; UIC (installation code); Owner Service; User organization if known; date of compliance.

Include TPC scoresheet if applicable.

l. Once Final Certification is achieved, turn over Administrative rights to online TPC to the Base Civil Engineer or designee, contact information provided by the Contracting Officer.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 SUSTAINABILITY COORDINATION

Provide sustainability focus and coordination at all meetings to achieve sustainability goals. Coordinate meeting requirements with other UFGS Sections meeting requirements in this project. Ensure the designated TPC accredited sustainability professional responsible for GP and TPC documentation participates in these meetings to coordinate documentation completion. Review GP and TPC sustainability requirements, HPSB Checklist and TPC documentation, Sustainability Action Plan, and completeness status of Sustainability eNotebook, and TPC status at the following meetings:

a. Pre-Construction Conference

b. Construction Quality Control Meetings

c. Facility Turnover Meetings

Conduct review no later than 60 days before final turnover and identify any outstanding issues that affect correct completion of all documentation and final TPC certification, assessment or validation, and actions that will achieve requirements. Conduct corrective actions prior to turnover, to ensure all requirements are achieved.

3.2 THIRD PARTY CERTIFICATION CERTIFICATE, ASSESSMENT, OR VALIDATION AND COMPLIANCE REPORT

Finalize the process requirements and obtain the TPC Certificate, assessment, or validation, and compliance report, indicating completion of the project's sustainability goals. Include TPC compliance report with final TPC scoresheet as applicable.

3.3 TABLE 3-1 VOLATILE ORGANIC COMPOUNDS (VOC) (LOW EMITTING MATERIALS) REQUIREMENTS

TABLE 3-1 Volatile Organic Compounds (VOC) (Low Emitting Materials) Requirements

Source: ICC IgCC Chapter 8 (Materials) (Interior Applications Only)

MATERIAL CATEGORY	EMISSIONS REQUIREMENT		MATERIALS WITH ADDED VOC REQUIREMENT	EMISSIONS REQUIREMENTS
Adhesives and Sealants	**CDPH/EHLB/Standard method V1.1 (California Section 01350)** (Use "office" or "classroom" space limits for all applications)	or	Adhesives (carpet, resilient, wood flooring; base cove; ceramic tile; drywall and panel; primers) Sealants (acoustical; firestop; HVAC Air duct; primers) Caulks	**SCAQMD Rule 1168** (Use "other" category for HVAC duct sealant) (for firestop adhesive, UFC 3-600-01 overrides conflicting requirements)
			Aerosol adhesives	**Section 3 of Green Seal Standard GS-36** (except: cleaners, solvent cements, and primers used with plastic piping and conduit in plumbing, fire suppression, and electrical systems; HVAC air duct sealants when the application space air temp is less than 40 F (4.5 C).

TABLE 3-1 Volatile Organic Compounds (VOC) (Low Emitting Materials) Requirements Source: ICC IgCC Chapter 8 (Materials) (Interior Applications Only)				
MATERIAL CATEGORY	**EMISSIONS REQUIREMENT**		**MATERIALS WITH ADDED VOC REQUIREMENT**	**EMISSIONS REQUIREMENTS**
Paints and Coatings	**CDPH/EHLB/Standard method V1.1 (California Section 01350)** (Use "office" or "classroom" space limits for all applications)	or	Flat and nonflat, nonflat high-gloss, specialty, basement specialty, fire-resistive, floor, low-solids, rust preventative, wood, reflective wall coatings; concrete/masonry sealers; primers; sealers; undercoaters; shellacs (clear and opaque); stains; varnishes; conjugated oil varnish; lacquer; clear brushing lacquer	**Green Seal Standard GS-11**

TABLE 3-1 Volatile Organic Compounds (VOC) (Low Emitting Materials) Requirements

Source: ICC IgCC Chapter 8 (Materials) (Interior Applications Only)

MATERIAL CATEGORY	EMISSIONS REQUIREMENT		MATERIALS WITH ADDED VOC REQUIREMENT	EMISSIONS REQUIREMENTS
Paints and Coatings	**CDPH/EHLB/Standard method V1.1 (California Section 01350)** (Use "office" or "classroom" space limits for all applications)	or	Concrete curing compounds; dry fog, faux finishing, graphic arts (sign paints), industrial maintenance, mastic texture, metallic pigmented, multicolor, recycled coatings; pretreatment wash primers, reactive penetrating sealers; specialty primers, wood preservatives, and zinc primers	**California Air Resources Board (CARB) Suggested Control Measure for Architectural Coatings** or **SCAQMD Rule 1113r**
Paints and Coatings	**CDPH/EHLB/Standard method V1.1 (California Section 01350)** (Use "office" or "classroom" space limits for all applications)	or	High-temperature coatings; stone consolidants; swimming-pool coatings; tub- and tile-refining coatings; and waterproofing membranes	**California Air Resources Board (CARB) Suggested Control Measure for Architectural Coatings**

TABLE 3-1 Volatile Organic Compounds (VOC) (Low Emitting Materials) Requirements

Source: ICC IgCC Chapter 8 (Materials) (Interior Applications Only)

MATERIAL CATEGORY	EMISSIONS REQUIREMENT		MATERIALS WITH ADDED VOC REQUIREMENT	EMISSIONS REQUIREMENTS
Floor Covering Materials	For carpet, all locations: **CDPH/EHLB/Standard Method V1.1 (California Section 01350)** or label for **Section 9** of **CDPH/EHLB/Standard Method V1.1 (California Section 01350)**		none	none
Insulation	**CDPH/EHLB/Standard method V1.1** (California Section 01350) (Use "office" or "classroom" space limits for all applications)		none	none

TABLE 3-1 Volatile Organic Compounds (VOC) (Low Emitting Materials) Requirements

Source: ICC IgCC Chapter 8 (Materials) (Interior Applications Only)

MATERIAL CATEGORY	EMISSIONS REQUIREMENT		MATERIALS WITH ADDED VOC REQUIREMENT	EMISSIONS REQUIREMENTS
Composite Wood, Wood Structural Panel, and Agrifiber Products, no added urea-formaldehyde resins including laminating adhesives for composite wood and agrifiber assemblies - particleboard, medium density fiberboard (MDF), wheatboard, strawboard, panel substrates, door cores	Third-party certification (approved by CARB) of **California Air Resource Board's (CARB) regulation**, Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products	or	none	**CDPH/EHLB/Standard method V1.1** (California Section 01350) (Use "office" or "classroom" space limits for all applications) (except: Structural panel components such as plywood, particle board, wafer board, and oriented strand board identified as "EXPOSURE 1," "EXTERIOR," or "HUD-APPROVED" are considered acceptable for interior use.)
Office Furniture Systems and Seating installed prior to occupancy	**ANSI/BIFMA X7.1 ANSI/BIFMA X7.1:** (95-percent of installed office furniture system workstations and seating units) **Section 7.6.2 of ANSI/BIFMA e3** (50-percent of office furniture system workstations and seating units)		none	none

TABLE 3-1 Volatile Organic Compounds (VOC) (Low Emitting Materials) Requirements

Source: ICC IgCC Chapter 8 (Materials) (Interior Applications Only)

MATERIAL CATEGORY	EMISSIONS REQUIREMENT		MATERIALS WITH ADDED VOC REQUIREMENT	EMISSIONS REQUIREMENTS
Ceiling and Wall assemblies and systems including: acoustical treatments; ceiling panels and tiles; tackable wall panels and coverings; wall coverings; wall and ceiling paneling and planking	**CDPH/EHLB/Standard method V1.1 (California Section 01350)** (Use "office" or "classroom" space limits for all applications)		none	none

-- End of Section --

Air Force Sustainability Requirements Scoresheet

HPSB COMPLIANCE (Updated Jan 2017)

* required entry

General Information

Federal Requirements Complete

FXBMTBD	Project ID (e.g. ABCD12345)
0000000000000000000	Real Property Unique ID (RPUID)
B7504	Facility Number
B-21:Weapons Loader Training Facility (WLT #1)	Building Name
Ellsworth AFB	Installation
Rapid City	City
SD	State
Yes	CONUS
ACC	MAJCOM
USACE	Construction Agent
TBD	AFCEC DM/CM (Last Name, First Name)
$15,000,000.00	PA
35,434	Building Size (SF)
2023	Program Year (FY####)
Design Complete	Project Phase
08/06/21	Design Started (MM/DD/YY)
04/28/23	BOD (MM/DD/YY)
GBI GP	Guiding Principles Compliance Certification Method
03/06/2023	Date Project Registered (MM/DD/YY)
	Date Project Certified (MM/DD/YY)
100%	HPSB Compliant
21%	Energy Efficiency Achieved (% below ANSI/ASHRAE/IESNA Standard 90.1-2013)
2017V1	Scoresheet version

Air Force Sustainability Requirements Scoresheet

HPSB COMPLIANCE (Updated Jan 2017)

* required entry

Color Coding: See Instructions Tab for more detail	
Drop-Down Box	Yes or N/A
No Entry Required	No
Custom Entry	Recommended not Required

90.1-2013

HPSB I: Employ Integrated Design Principles (UFC 1-200-02 para 2-2)

Total Points **2** — Possible Points 2

Yes	HPSB I.1	**Integrated Design**	1
Yes	HPSB I.2	**Commissioning**	1

HPSB II: Optimize Energy Performance (UFC 1-200-02 para 2-3)

Total Points **5** — Possible Points 5

N/A	HPSB II.1	**Energy Efficiency**	1
		N/A — Reduce energy use 30% below ANSI/ASHRAE/IESNA Standard 90.1-2013 or IECC, or if not - achieve maximum energy efficiency that is lifecycle cost effective	
		20.7% — Insert percentage below ANSI/ASHRAE/IESNA Standard 90.1-2013 or IECC, in terms of energy use (e.g. 32)	
		TBD — Insert building energy intensity (kBtu/yr-sqft) calculated IAW 10 CFR 433	
		N/A — Roof Attributes (Recommended)	
		Select roof types (Check below)	
		☐ Cool roof ☐ Solar electric ☐ Solar Passive ☐ Green roof ☐ Solar thermal	
		Energy Efficient Products — Yes	1
N/A	HPSB II.2	**On-site Renewable Energy**	1
		N/A — Installed renewable energy elements or projects were not lifecycle cost effective	
		Renewable energy types (check below)	
		☐ Solar PV ☐ Geothermal ☐ Hydro ☐ Waste to Energy ☐ Solar CP ☐ GSHP ☐ Wind ☑ Renewables were not lifecycle cost effective ☐ Solar Thermal Electric	
		0.0 — Insert generation capacity (kW)	
		0.0% — Insert percentage of total building	
N/A	HPSB II.3	**On-site Renewable Energy - Solar Hot Water Heater System**	1
		N/A — Installed solar hot water heater system or found installation not lifecycle cost effective	
		0.0 — Insert generation capacity (MMBtu/yr)	
		0.0% — Insert percentage of demand	
Yes	HPSB II.4	**Metering**	1
		Yes — Electric Metering: Select N/A if no service	
		Yes — Natural Gas Metering: Select N/A if no service	
		N/A — Steam Metering: Select N/A if no service	

HPSB III: Protect and Conserve Water (UFC 1-200-02 para 2-4)

Total Points **6** — Possible Points 6

Yes	HPSB III.1	**Indoor Water**	1
Yes		**Indoor Water Metering**	1
N/A	HPSB III.2	**Outdoor Water**	1
N/A		**Outdoor Water Metering**	1
N/A	HPSB III.3	**Alternative Water**	1
N/A	HPSB III.4	**Stormwater Management (LID Documentation per UFC 3-210-10)**	1
		0.0 — Change in Impervious Area (SF)	
		$0.00 — Pre-Award Cost Estimate ($)	
		N/A — Project addressed EISA 438	
		EISA Technical Constraints	
		☐ Retaining stormwater impact receving water flow ☐ Shallow bedrock, contaminated soil, high ground water table, underground utilities ☐ Soil infiltration capacity limited ☑ Site too small to infiltrate significant volume ☐ Non-potable water demand to small ☐ Structural, plumbing, and other mods not feasible ☐ State or local restrict water harvesting ☐ State or local restrict use of green ☐ Other	
		0.0% — Percent Increase in Stormwater Runoff for 95 Percentile Storm (%) - or- Percent Increase in Stormwater Runoff from continuous simulation model, published data, studies, or other established tools (Reference UFC 3-210-10 Figure 2-1 Implementation of EISA Section 438)	
		Off-Site — LID Features Locations	
		0 — Integrated Management Practices Employed	

Air Force Sustainability Requirements Scoresheet

HPSB COMPLIANCE (Updated Jan 2017)

* required entry

☐ Bio-Retention ☐ Dry Wells ☐ Filter Strips ☐ Grassed Swells
☐ Infiltration Trench ☐ Inlet Pollution Removal Device ☐ Permeable Pavement/Pavers ☐ Rain Barrels/Cisterns
☐ Soil Amendments ☐ Tree Box Filters ☐ Vegetated Buffers ☐ Vegetated Roof
☐ Other

$0.00	Final LID Construction Cost ($)
0	Post Construction Analysis (Name of DOR)

HPSB IV: Enhance Indoor Environmental Quality (UFC 1-200-02 para 2-5)				
Total Points	**8**		Possible Points	8
Yes	HPSB IV.1	**Thermal Comfort**		1
Yes	HPSB IV.2	**Ventilation**		1
N/A	HPSB IV.3	**Daylighting**		1
Yes	HPSB IV.4	**Moisture Control**		1
Yes	HPSB IV.5	**Low Emitting Materials**		1
Yes	HPSB IV.6	**Protect Indoor Air Quality during Construction**		1
Yes	HPSB IV.7	**Environmental Tobacco Smoke Control**		1
Yes	HPSB IV.8	**Occupant Health and Wellness**		1
HPSB V: Reduce Environmental Impact of Materials (UFC 1-200-02 para 2-6)				
Total Points	**5**		Possible Points	5
Yes	HPSB V.1	**Recycled Content**		1
Yes	HPSB V.2	**Biologically-based Products**		1
Yes	HPSB V.3	**Ozone Depleting Substances**		1
Yes	HPSB V.4	**Waste and Materials Management - Recycling**		1
Yes	HPSB V.5	**Waste and Materials Management - Divert 60% from Disposal**		1

Yes	60% or greater diverted
60.0%	Insert percentage diverted from landfill

HPSB VI: Address Climate Change Risk (UFC 1-200-02 para 2-7)				
Total Points	**1**		Possible Points	1
Yes	HPSB VI.1	**Address Climate Change Risk**		1
			Possible Points	**27**
27	**Federal Requirements - Yes or N/A**			
0	**Federal Requirements - No**			
100%	**Percentage of Federal Requirements Met**			

Federal Requirements for High Performance and Sustainable Buildings (HPSB) & UFC 1-200-02				
Instructions: Provide a common or project specific justification for an element to be non-applicable, when completed, the Scoresheet tab will allow an N/A response.				
Justification for Non-Applicable Answers		**Common Justification**	**Project Specific Justification**	**Complete?**
HPSB I: Employ Integrated Design Principles (UFC 1-200-02, 2-2)				
HPSB I.1	**Integrated Design**			Applicable
HPSB I.2	**Commissioning**			Applicable
HPSB II: Optimize Energy Performance (UFC 1-200-02, 2-3)				
HPSB II.1	**Energy Efficiency**	Mission preclusion / Scope of work		**Yes**
HPSB II.1	**Energy Efficient Products**			Applicable
HPSB II.2	**On-site Renewable Energy**	Mission Preclusion and Building/site issue		**Yes**
HPSB II.3	**On-site Renewable Energy - Solar Hot Water Heater System**	Not LCCE		**Yes**
HPSB II.4	**Metering**			
HPSB II.4	Electric Metering: Select N/A if no service			Applicable
HPSB II.4	Natural Gas Metering: Select N/A if no service			Applicable
HPSB II.4	Steam Metering: Select N/A if no service	Location conditions		**Yes**
HPSB III: Protect and Conserve Water (UFC 1-200-02, 2-4)				
HPSB III.1	**Indoor Water**			Applicable
HPSB III.1	Indoor Water Metering: Select N/A if no service			Applicable
HPSB III.2	**Outdoor Water**	Mission preclusion		**Yes**
HPSB III.2	Outdoor Water Metering: Select N/A if no service	Mission preclusion		**Yes**
HPSB III.3	**Alternative Water**	Location Conditions		**Yes**
HPSB III.4	**Stormwater Management**			
HPSB III.4	Project addressed EISA 438	Mission preclusion		**Yes**
HPSB IV: Enhance Indoor Environmental Quality (UFC 1-200-02, 2-5)				
HPSB IV.1	**Thermal Comfort**			Applicable
HPSB IV.2	**Ventilation**			Applicable
HPSB IV.3	**Daylighting**	Mission preclusion		**Yes**
HPSB IV.4	**Moisture Control**			Applicable
HPSB IV.5	**Low Emitting Materials**			Applicable
HPSB IV.6	**Protect Indoor Air Quality during Construction**			Applicable
HPSB IV.8	**Occupant Health and Wellness**			Applicable
HPSB V: Reduce Environmental Impact of Materials (UFC 1-200-02, 2-6)				
HPSB V.1	**Recycled Content**			Applicable
HPSB V.2	**Biologically based products**			Applicable
HPSB V.3	**Ozone Depleting Substances**			Applicable
HPSB V.4	**Waste and Materials Management - Recycling**			Applicable
HPSB V.5	**Waste and Materials Management - Divert 60% from Disposal**			Applicable
HPSB VI: Adress Climate Change Riskd (UFC 1-200-02, 2-7)				
HPSB VI.1	**Address Climate Change Risk**			Applicable

Department of Defense
Guiding Principles Compliance for
New Construction & Comprehensive Replacement
Scoping Checklist

Instructions

This DOD GPC NC Scoping Checklist is for use during the planning stage to identify all goals for the project to meet the requirements set forth in UFC 1-200-02 High Performance and Sustainable Building Requirements and the Guiding Principles for Sustainable Federal Buildings.

Refer to UFC 1-200-02 for the full text of each element. After identifying requirements that are not applicable to the project (see Answer Selections below), the remaining elements must all be met, including partial compliance (with percentages) and non-applicables.

This DOD review is in alignment with UFC 1-200-02 for the purposes of this validation. "Guiding Principles" are met when the requirements of UFC 1-200-02 are met.

UFC Applicability
UFC 1-200-02 High Performance and Sustainable Building Requirements is effective for all projects. To obtain the latest version of UFC 1-200-02, visit the Whole Building Design Guide's web page:

http://www.wbdg.org/ffc/dod/unified-facilities-criteria-ufc/ufc-1-200-02

Projects that have a delay - either planned or unintentional - of more than 18 months between design completion and the solicitation of offers for construction must be re-evaluated to determine if any design revision is necessary due to changes in criteria (including codes and standards) or site infrastructure (e.g. water supply for fire department vehicle access).

DOD GPC NC Program Applicability

GBI's DOD GPC NC program applies to new construction and comprehensive replacement that require addition of Third Party Certification (TPC) (as described in UFC 1-200-02, Table 1-1) per one of the following:

☐ New building or stand-alone addition ≥10,000 GSF, with construction cost >$3M.
OR
☐ Comprehensive replacement* in an existing building that is ≥10,000 GSF, with total cost >$3M, and 50% or more enhanced replacement cost (ERC). *Note that all three thresholds must be met to require TPC for a comprehensive replacement project.*

*Comprehensive replacement to a building includes significant opportunities for improvement in: energy and water efficiency (such as HVAC, lighting, building envelope, and other building components); indoor air quality, other requirements in UFC 1-200-02; and additions that are part of the comprehensive replacement.

Total cost for comprehensive replacement includes addition, operations and maintenance, sustainment, restoration, and modernization associated with an existing building comprehensive replacement.

To inquire about an existing building project, please contact GBI at (503) 274-0448 or info@thegbi.org to determine eligibility.

Answer Selections:
"Yes" means an element will be fully achieved, or highest resource efficiency achieved, with Life-Cycle Cost Analysis (LCCA) supporting documentation (when applicable).

Per UFC 1-200-02, "partially compliant" means:

"the requirement is compliant to the greatest degree possible, based on LCCE (e.g., SDHW serves only 20% of water use, per LCCE); mission restriction (e.g., 24/7 operation); location/regional restriction (e.g., availability of high-efficiency equipment service); or locale restriction (e.g., proximity of existing buildings restricts daylighting), or safety (example: building orientation restriction for anti-terrorism due to existing infrastructure), and is marked 'Yes' with justification."

"Not Applicable" ("N/A") is to be used only when:
Mission precludes the element (e.g. facility mission prohibits the use of windows);
Location of installation restricts or precludes achievement of element (e.g. there is no local recycling);
Location conditions mean that the element is not part of the project (e.g. there is no meter for steam because there is no steam);
Safety (e.g. building orientation restriction for anti-terrorism due to existing infrastructure); or
LCCA does not support any compliance with this requirement.

Justification must be provided during third-party assessment for each element marked "N/A", including any LCCA supporting partial compliance (based on a percentage) or no compliance to a requirement.

Unless otherwise noted, all line items must be indicated. If a choice has not been selected, include a note. The project's achievement from third-party assessment will not be negatively impacted as a result of indicating "N/A," or where LCCA supports partial compliance (with percentages) or no compliance to a requirement. The intent is for the project team to determine during the design stage if any of the Guiding Principles (UFC 1-200-02 requirements) are not applicable, and that the remaining requirements must be fully met including partial compliance with LCCA.

UFC, UFGS, and ASHRAE Applicability		
Applicable ASHRAE Standards		
ASHRAE 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings	Link	Yes
2018 International Green Construction Code (IgCC)	Link	Yes
Applicable Unified Facilities Criteria (UFC)		
UFC 1-200-02 High Performance and Sustainable Building Requirements	Link	Yes
UFC 2-100-01 Installation Master Planning	Link	Yes
UFC 3-101-01 Architecture	Link	Yes
UFC 3-201-01 Civil Engineering	Link	Yes
UFC 3-201-02 Landscape Architecture	Link	Yes
UFC 3-210-10 Low Impact Development	Link	Yes
UFC 3-410-01 Heating, Ventilation, and Air Conditioning Systems	Link	Yes
UFC 3-440-01 Facility-Scale Renewable Energy Systems	Link	Not Applicable - Mission Preclusion and Building/site issue
UFC 3-530-01 Interior and Exterior Lighting Systems and Controls	Link	Yes
UFC 4-010-06 Cybersecurity Of Facility-Related Control Systems	Link	Yes
UFC 4-510-01 Design: Military Medical Facilities	Link	Not Applicable - Mission Preclusion
Applicable Unified Facilities Guide Specifications (UFGS)		
UFGS 01 33 29 Sustainability Requirements and Reporting	Link	Yes
ARMY/USACE executed projects: UFGS 01 45 00.00 10 Quality Control	Link	Not Applicable - Air Force project
Navy/NAVFAC executed projects: UFGS 01 45 00.00 20 Quality Control	Link	Not Applicable - Air Force project
UFGS 01 74 19 Construction Waste Management and Disposal	Link	Yes
UFGS 01 78 00 Closeout Submittals	Link	Yes
UFGS 01 78 23 Operation and Maintenance Data	Link	Yes
Army/USACE executed projects: UFGS 01 91 00.15 10 Total Building Commissioning	Link	Yes
Navy/NAVFAC executed projects: UFGS 01 91 00.15 20 Total Building Commissioning	Link	Not Applicable - Air Force project
UFGS 23 08 00.00 20 Commissioning of Mechanical [And Plumbing] Systems	Link	Not Applicable - Air Force project

i. LIFE-CYCLE COST ANALYSIS (LCCA)		Notes and Justifications
i.a LCCA Format		
i.a.1 UFC 1-200-02: Life-Cycle Cost Analysis (LCCA)	*Partially*	Partially not Applicable - Mission Preclusion and Building/site issue

1 EMPLOY INTEGRATED DESIGN PRINCIPLES		Notes and Justifications
1.a Integrated Design		
1.a.1 UFC 1-200-02: Integrated Design	*Yes*	
1.a.2 UFC 1-200-02: Integrated Planning	*Yes*	
1.a.3 UFC 1-200-02: Evaluation for Design Strategies	*Yes*	
1.a.4 UFC 1-200-02: Evaluation of the Site	*Not Applicable*	Not Applicable - Site is already selected per the 1391
1.a.5 UFC 1-200-02: Site Integration and Design of the Building	*Yes*	

1.b Commissioning		
1.b.1 UFC 1-200-02: Commissioning	*Yes*	
2 OPTIMIZE ENERGY PERFORMANCE		**Notes and Justifications**
2.a Energy Efficiency		
2.a.1.A UFC 1-200-02: Commercial and Multi-Family High-Rise Residential Buildings	*Partially*	Mission preclusion / Scope of work - Currently achieving 13% energy efficiency
2.a.1.B UFC 1-200-02: Low-Rise Residential Buildings	*Not a Low-Rise Residential Building*	
2.a.1.C UFC 1-200-02: Comprehensive Replacement and SRM	*Not a Comprehensive Replacement or SRM Project*	
2.a.2 UFC 1-200-02: Energy Efficient Products	*Yes*	
2.a.3 UFC 1-200-02: Standby Powered Devices	*Yes*	
2.b Onsite Renewable Energy		
2.b.1 UFC 1-200-02: On-Site Renewable Energy	*Not Applicable*	Not Applicable - Mission Preclusion and Building/site issue
2.b.2 UFC 1-200-02: Solar Domestic Hot Water (SDHW)	*Not Applicable*	Not Applicable - Mission Preclusion and Building/site issue
2.c Metering		
2.c.1 UFC 1-200-02: Metering	*Yes*	
3 PROTECT AND CONSERVE WATER		**Notes and Justifications**
3.a Indoor Water Use		
3.a.1 UFC 1-200-02: Indoor Water	*Yes*	
3.a.2 UFC 1-200-02: Indoor Water Metering	*Yes*	
3.b Outdoor Water Use		
3.b.1 UFC 1-200-02: Landscaping	*Not Applicable*	Not Applicable - Mission preclusion
3.b.2 UFC 1-200-02: Outdoor Water Metering	*Not Applicable*	Not Applicable - No permanent irrigation provided
3.c Alternative Water		
3.c.1 UFC 1-200-02: Alternative Water	*Not Applicable*	Not Applicable - Location Conditions
3.d Stormwater Management		
3.d.1 UFC 1-200-02, 2-4.4 Stormwater Management	*Yes*	
4 ENHANCE INDOOR ENVIRONMENTAL QUALITY		**Notes and Justifications**
4.a Ventilation and Thermal Comfort		
4.a.1 UFC 1-200-02: Ventilation and Thermal Comfort	*Yes*	
4.b Daylighting and Lighting Controls		
4.b.1 UFC 1-200-02: Daylighting and Lighting Controls	*Not Applicable*	Not Applicable - Mission preclusion
4.c Indoor Air Quality		
4.c.1 UFC 1-200-02: Moisture Control	*Yes*	
4.c.2 UFC 1-200-02: Reduce Volatile Organic Compounds (VOC) (Low-Emitting Materials)	*Yes*	
4.c.3 UFC 1-200-02: Protect Indoor Air Quality during Construction	*Yes*	
4.c.4 UFC 1-200-02: Environmental Tobacco Smoke Control	*Yes*	
***** Occupant Health and Wellness**		
*** UFC 1-200-02: Occupant Health and Wellness *(Covered by 1.a.5 UFC 1-200-02: Site Integration and Design of the Building)*		

5 REDUCE ENVIRONMENTAL IMPACT OF MATERIALS		Notes and Justifications
5.a Material Content and Performance		
5.a.1 UFC 1-200-02: Recycled Content	*Yes*	
5.a.2 UFC 1-200-02: Biologically-Based Products	*Yes*	
5.a.3 UFC 1-200-02: Ozone Depleting Substances	*Yes*	
5.b Waste Diversion and Materials Management		
5.b.1 UFC 1-200-02: Storage of Recyclables	*Yes*	
5.b.2 UFC 1-200-02: Waste Diversion	*Yes*	

6 ASSESS AND CONSIDER CLIMATE CHANGE RISKS		Notes and Justifications
6.a Address Climate Change Risks		
6.a.1 UFC 1-200-02: Address Climate Change Risk	*Yes*	

NEXT STEPS

Third-Party Guiding Principles Compliance Assessment

For third-party assessment of compliance to Guiding Principles, contact Green Building Initiative (GBI) at 503.274.0448. Registering and ordering a third-party assessment from GBI allows access to the DOD GPC NC Survey and Technical Reference Manual. Each Department of Defense GPC NC assessment includes a third-party review of the completed DOD GPC NC Survey and supporting documentation as part of the 100% Design Submittal phase, as well as two options for the final assessment: Onsite Assessment or Post-Construction Document Review. Supplementary reviews can be purchased for an additional fee if the team prefers to have a document review prior to 100% submittals.

Contact GBI to get started: 503.274.0448

SECTION TABLE OF CONTENTS

DIVISION 02 - EXISTING CONDITIONS

SECTION 02 61 13

EXCAVATION AND HANDLING OF CONTAMINATED MATERIAL

02/10, CHG 1: 02/21

-- End of Section Table of Contents --

SECTION 02 61 13

EXCAVATION AND HANDLING OF CONTAMINATED MATERIAL
02/10, CHG 1: 02/21

PART 1 GENERAL

1.1 MEASUREMENT AND PAYMENT

1.1.1 Measurement

Measurement for excavation and onsite transportation shall be based on the actual number of cubic yards of contaminated material in-place prior to excavation. Determination of the volume of contaminated material excavated shall be based on cross-sectional volume determination reflecting the differential between the original elevations of the top of the contaminated material and the final elevations after removal of the contaminated material. Measurement for backfilling of excavated areas shall be based on in-place cubic yards of compacted fill. Measurement for construction of stockpile areas shall be based on the number of square yards of stockpile liner constructed.

1.1.2 Payment

1.1.2.1 Excavation and Transportation

Compensation for excavation and onsite transportation of contaminated material will be paid as a unit cost. This unit cost shall include any other items incidental to excavation and handling not defined as having a specific unit cost.

1.1.2.2 Backfilling

Compensation for backfill soil, transportation of backfill, backfill soil conditioning, backfilling, compaction, and geotechnical testing will be paid as a single unit cost.

1.1.2.3 Stockpiling

Compensation for construction of stockpile areas will be paid for as a unit cost. This unit cost shall include all aspects of grading, preparation, handling, placement, maintenance, removal, treatment, and disposal of stockpile cover materials and liner materials and all other items incidental to construction of stockpiles.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D5434	(2012) Field Logging of Subsurface Explorations of Soil and Rock

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2014) Safety -- Safety and Health Requirements Manual

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1926	Safety and Health Regulations for Construction
40 CFR 302	Designation, Reportable Quantities, and Notification

1.3 DESCRIPTION OF WORK

Notify the Contracting Officer within 24 hours, and before excavation, if contaminated material is discovered that has not been previously identified or if other discrepancies between data provided and actual field conditions are discovered. Backfill material is not available onsite. Required sampling and chemical analysis shall be conducted in accordance with state and local regulations pertaining to waste characterization sampling. Additionally, frequency of sampling for waste characterization and disposal will be based off the requirements of the waste acceptance facility. The waste acceptance facility may also have additional characterization sampling requirements.

[*Am-1]Excess soil anticipated to be encountered during construction has been divided into the following categories:

a. Category 1: soil that can be reused without restriction.

b. Category 2A: soil with reuse restrictions based on perfluorooctanoic acid (PFOA)/ perfluorooctane sulfonate (PFOS).

c. Category 2B: soil with reuse restriction based on total petroleum hydrocarbon (TPH).

d. Category 3: soil requiring offsite disposal.

Category 1 soil is defined as soil that can be reused without restriction.

Category 2A soil is defined as soil with:

a. PFOA/PFOS concentrations above the LOD but below 1,260 ng/g,

b. Arsenic concentrations below the applicable background threshold values (BTVs) (23.7 mg/kg arsenic for surficial soil and 34.6 mg/kg for subsurface soil).

c. Concentrations of the remaining constituents below other applicable screening levels.

Soil that meets the definition of Category 2A soil can be reused onsite without restrictions. If excess Category 2A soil, beyond what can be reused onsite is generated, it must be disposed offsite at a permitted South Dakota Subtitle D municipal waste landfill.

Category 2B soil is defined as soil with:

a. TPH concentrations (DRO and GRO either individually or in total) between 10 and 500 mg/kg.

b. Arsenic concentrations below the applicable BTVs (23.7 mg/kg arsenic for surficial soil and 34.6 mg/kg for subsurface soil).

c. Concentrations of the remaining constituents below other applicable screening levels.

Soil that meets the definition of Category 2B soil can be reused onsite without restrictions. If excess Category 2B soil, beyond what can be reused onsite is generated, it must be disposed offsite at a permitted South Dakota Subtitle D municipal waste landfill. Coordination with the specific disposal facility and SD DENR Waste Management Program will be required in advance to secure approval of Category 2 soil disposal. Depending on the outcome of those conversations, soil with TPH concentrations over 100 mg/kg may require alternative means of disposal.

If soil qualifies as Category 2B and has PFOA/PFOS concentrations above the LOD but below the 1,260 ng/g, it should be handled as Category 2B soil.

Category 3 soil is defined as soil with:

a. One or more polycyclic aromatic hydrocarbons (PAHs) detected above their respective United States Environmental Protection Agency (USEPA) Residential Regional Screening Level (RSL).

b. TPH concentrations (DRO and GRO either individually or in total) between 10 and 500mg/kg.

c. Concentrations of the remaining constituents below other applicable screening levels including the PFOA/PFOS screening level of 1,260 ng/g.

Category 3 soil must be disposed of offsite at a permitted South Dakota Subtitle D municipal waste landfill, provided the soil is not contaminated with PFOA and/or PFOS. If the soil is contaminated with PFOA and/or PFOS, the disposal of this soil must follow Air Force Policy AFGM 2020-32-02. Coordination with the specific disposal facility, SD DENR Waste Management Program and Air Force Civil Engineer Center (AFCEC) Restoration personnel located at Ellsworth AFB will be required to confirm these requirements are met for disposal and secure approval in advance of disposal.[**Am-1]

1.3.1 Scheduling

Notify the Contracting Officer at least 14 calendar days prior to the start of excavation of contaminated material. The Contracting Officer will be responsible for contacting regulatory agencies in accordance with the applicable reporting requirements.

1.3.2 Work Plan

Submit a Work Plan within 30 calendar days after notice to proceed. No work at the site, with the exception of site inspections and surveys, shall be performed until the Work Plan is approved. Allow 30 calendar days in the schedule for the Government's review. No adjustment for time or money will be made if resubmittals of the Work Plan are required due to deficiencies in the plan. At a minimum, the Work Plan shall include:

a. Schedule of activities.

b. Method of excavation and equipment to be used.

c. Shoring or side-wall slopes proposed.

d. Dewatering plan.

e. Storage methods and locations for liquid and solid contaminated material.

f. Borrow sources and haul routes.

g. Decontamination procedures.

h. Spill contingency plan.

1.3.3 Other Submittal Requirements

Submit separate cross-sections of each area before and after excavation and after backfilling, test results, and copies of the Closure Report within 14 calendar days of work completion at the site.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Work Plan

SD-02 Shop Drawings

Surveys; G-AE

SD-06 Test Reports

Compaction

Closure Report

1.5 REGULATORY REQUIREMENTS

1.5.1 Permits and Licenses

Obtain required federal, state, and local permits for excavation and storage of contaminated material. Permits shall be obtained at no additional cost to the Government.

1.5.2 Air Emissions

Air emissions shall be monitored and controlled in accordance with Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS.

PART 2 PRODUCTS

2.1 SPILL RESPONSE MATERIALS

Provide appropriate spill response materials including, but not limited to the following: containers, adsorbents, shovels, and personal protective equipment. Spill response materials shall be available at all times when contaminated materials/wastes are being handled or transported. Spill response materials shall be compatible with the type of materials and contaminants being handled.

2.2 BACKFILL

Refer to 31 00 00 EARTHWORK for backfill instructions.

Do not use material for backfill until borrow source chemical and physical test results have been submitted and approved.

PART 3 EXECUTION

3.1 SURVEYS

Perform surveys immediately prior to and after excavation of contaminated material to determine the volume of contaminated material removed. Also, perform surveys immediately after backfill of each excavation. Provide cross-sections on 25 foot intervals and at break points for all excavated areas. Locations of confirmation samples shall also be surveyed and shown on the drawings.

3.2 EXISTING STRUCTURES AND UTILITIES

No excavation shall be performed until site utilities have been field located. Take the necessary precautions to ensure no damage occurs to existing structures and utilities. Damage to existing structures and utilities resulting from the Contractor's operations shall be repaired at no additional cost to the Government. Utilities encountered that were not previously shown or otherwise located shall not be disturbed without approval from the Contracting Officer.

3.3 CLEARING

Clearing shall be performed to the limits shown on the drawings.

3.4 CONTAMINATED MATERIAL REMOVAL

3.4.1 Excavation

Areas of contamination shall be excavated to the depth and extent shown on the drawings and not more than 0.2 ft beyond the depth and extent shown on the drawings unless directed by the Contracting Officer. Excavation shall be performed in a manner that will limit spills and the potential for contaminated material to be mixed with uncontaminated material. An excavation log describing visible signs of contamination encountered shall be maintained for each area of excavation. Excavation logs shall be prepared in accordance with ASTM D5434.

[*Am-1]Soils may be reused on site or may require off-site disposal based on the soil category. Refer to Section 1.3.2 Work Plan for more information on soil categories and management.[**Am-1]

3.4.2 Shoring

If workers must enter the excavation, it shall be evaluated, shored, sloped or braced as required by EM 385-1-1 and 29 CFR 1926 section 650.

3.4.3 Dewatering

Surface water shall be diverted to prevent entry into the excavation. Dewatering shall be limited to that necessary to assure adequate access, a safe excavation, prevent the spread of contamination, and to ensure that compaction requirements can be met.

3.5 CONFIRMATION SAMPLING AND ANALYSIS

The Contracting Officer shall be present to inspect the removal of contaminated material from each site. After all material suspected of being contaminated has been removed, the excavation shall be examined for evidence of contamination. If the excavation appears to be free of contamination, field analysis shall be used to determine the presence of contamination using a real time vapor monitoring instrument. Excavation of additional material shall be as directed by the Contracting Officer.

3.6 CONTAMINATED MATERIAL STORAGE

Material shall be placed in temporary storage immediately after excavation. The following paragraphs describe acceptable methods of material storage. Storage units shall be in good condition and constructed of materials that are compatible with the material or liquid to be stored. If multiple storage units are required, each unit shall be clearly labeled with an identification number and a written log shall be kept to track the source of contaminated material in each temporary storage unit.

3.6.1 Stockpiles

Stockpiles shall be constructed to isolate stored contaminated material from the environment. Stockpiles shall be constructed to include:

a. A chemically resistant geomembrane liner free of holes and other damage. Non-reinforced geomembrane liners shall have a minimum thickness of 20 mils. Scrim reinforced geomembrane liners shall have a minimum weight of 40 lbs/1000 square feet. The ground surface on which the geomembrane is to be placed shall be free of rocks greater than 0.5 inches in diameter and any other object which could damage the membrane.

b. Geomembrane cover free of holes or other damage to prevent precipitation from entering the stockpile. Non-reinforced geomembrane covers shall have a minimum thickness of 10 mils. Scrim reinforced geomembrane covers shall have a minimum weight of 26 lbs/1000 square feet. The cover material shall be extended over the berms and anchored or ballasted to prevent it from being removed or damaged by wind.

c. Berms surrounding the stockpile, a minimum of 12 inches in height. Vehicle access points shall also be bermed.

d. The liner system shall be sloped to allow collection of leachate.

Storage and removal of liquid which collects in the stockpile, in accordance with paragraph Liquid Storage.

3.6.2 Roll-Off Units

Roll-off units used to temporarily store contaminated material shall be water tight. A cover shall be placed over the units to prevent precipitation from contacting the stored material. The units shall be located as shown on the drawings. Liquid which collects inside the units shall be removed and stored in accordance with paragraph Liquid Storage. Roll-off will be covered at all times except when actively being filled.

3.6.3 Liquid Storage

Liquid collected from excavations and stockpiles shall be temporarily stored in 55 gallon barrels or appropriate sized water storage tanks. Liquid storage containers shall be water-tight and shall be located as indicated.

3.7 SAMPLING

3.7.1 Sampling of Stored Material

Samples of stored material shall be collected at a frequency as determined by the waste disposal facility. Waste characterization sampling parameters will be determined by the waste disposal facility, and applicable state and federal rules and regulations.

Stored material with contaminant levels that exceed the action levels shall be treated offsite. Analyses for contaminated material to be taken to an offsite treatment facility shall conform to local, state, and federal criteria as well as to the requirements of the treatment facility. Documentation of all analyses performed shall be furnished to the Contracting Officer. Additional sampling and analyses to the extent required by the approved offsite treatment, storage or disposal (TSD) facility shall be the responsibility of the Contractor and shall be performed at no additional cost to the Government.

3.7.2 Sampling Liquid

Liquid collected from excavations and decontamination facilities shall be sampled at a frequency as determined by the liquid waste disposal facility.

Liquid with contaminant levels that exceed action levels shall be treated offsite. Analyses for contaminated liquid to be taken to an offsite treatment facility shall conform to local, state, and federal criteria as well as to the requirements of the treatment facility. Documentation of all analyses performed shall be furnished to the Contracting Officer. Additional sampling and analysis to the extent required by the approved offsite treatment, storage or disposal (TSD) facility receiving the material shall be the responsibility of the Contractor and shall be performed at no additional cost to the Government.

3.7.3 Sampling Beneath Storage Units

Samples from beneath each storage unit shall be collected prior to construction of and after removal of the storage unit. Samples shall be collected at a frequency as determined by the waste disposal facility and applicable state and federal rules and regulations, and from a depth

interval of 0 to 0.5 feet and shall be tested.

Based on test results, soil which has become contaminated above action levels shall be removed at no additional cost to the Government. Contaminated material which is removed from beneath the storage unit shall be handled in accordance with paragraph Sampling of Stored Material. As directed by the Contracting Officer and at no additional cost to the Government, additional sampling and testing shall be performed to verify areas of contamination found beneath stockpiles have been cleaned up to below action levels.

3.8 SPILLS

In the event of a spill or release of a hazardous substance (as designated in 40 CFR 302), pollutant, contaminant, or oil (as governed by the Oil Pollution Act (OPA), 33 U.S.C. 2701 et seq.), notify the Contracting Officer immediately. If the spill exceeds the reporting threshold, follow the pre-established procedures as described in the Base Wide Contingency Plan for immediate reporting and containment. Immediate containment actions shall be taken to minimize the effect of any spill or leak. Cleanup shall be in accordance with applicable federal, state, and local regulations. As directed by the Contracting Officer, additional sampling and testing shall be performed to verify spills have been cleaned up. Spill cleanup and testing shall be done at no additional cost to the Government.

3.9 BACKFILLING

3.9.1 Confirmation Test Results

Excavations shall be backfilled immediately after all contaminated materials have been removed and confirmation test results have been approved. Backfill shall be placed and compacted to the lines and grades shown on the drawings.

3.9.2 Compaction

Refer to 31 00 00 EARTHWORK for compaction instructions.

3.10 DISPOSAL REQUIREMENTS

Offsite disposal of contaminated material shall be in accordance with Section 02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS.

3.11 CLOSURE REPORT

Submit two copies of a Closure Report within 14 calendar days of completing work at the site. The report shall be labeled with the contract number, project name, location, date, name of general Contractor, and the Corps of Engineers District contracting for the work. The Closure Report shall include the following information as a minimum:

a. A cover letter signed by a responsible company official who is certifying that all services involved have been performed in accordance with the terms and conditions of the contract documents and regulatory requirements.

b. A narrative report including, but not limited to, the following:

(1) site conditions, ground water elevation, and cleanup criteria;

(2) excavation logs;

(3) field screening readings;

(4) quantity of materials removed from each area of contamination;

(5) quantity of water/product removed during dewatering;

(6) sampling locations and sampling methods;

(7) sample collection data such as time of collection and method of preservation;

(8) sample chain-of-custody forms; and

(9) source of backfill.

c. Copies of all chemical and physical test results.

d. Copies of all manifests and land disposal restriction notifications.

e. Copies of all certifications of final disposal signed by the responsible disposal facility official.

f. Waste profile sheets.

g. Scale drawings showing limits of each excavation, limits of contamination, known underground utilities within 50 feet of excavation, sample locations, and sample identification numbers. On-site stockpile, storage, treatment, loading, and disposal areas shall also be shown on the drawings.

h. Progress Photographs. Color photographs shall be used to document progress of the work. A minimum of four views of the site showing the location of the area of contamination, entrance/exit road, and any other notable site conditions shall be taken before work begins. After work has been started, activities at each work location shall be photographically recorded daily. Photographs shall be a minimum of 3 by 5 inches and shall include:

(1) Soil removal and sampling.

(2) Dewatering operations.

(3) Unanticipated events such as spills and the discovery of additional contaminated material.

(4) Contaminated material/water storage, handling, treatment, and transport.

(5) Site or task-specific employee respiratory and personal protection.

(6) Fill placement and grading.

(7) Post-construction photographs. After completion of work at each site, take a minimum of four views of each excavation site.

A digital version of all photos shown in the report shall be included with the Closure Report. Photographs shall be a minimum of 3 inches by 5 inches and shall be mounted back-to-back in double face plastic sleeves punched to fit standard three ring binders. Each print shall have an information box attached. The box shall be typewritten and arranged as follows:

Project Name:	Direction of View:
Location:	Date/Time:
Photograph No.:	Description of View:

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 09 00

INSTRUMENTATION AND CONTROL FOR HVAC

02/19, CHG 3: 05/21

ATTACHMENTS:

QC Checklist for BACnet Systems

QC Checklist for Niagara Framework Based BACnet Systems

QC CHECKLIST FOR BACNET SYSTEMS

-- End of Section Table of Contents --

SECTION 23 09 00

INSTRUMENTATION AND CONTROL FOR HVAC
02/19, CHG 3: 05/21

PART 1 GENERAL

1.1 SUMMARY

Provide a complete Direct Digital Control (DDC) system suitable for the control of the heating, ventilating and air conditioning (HVAC) and other building-level systems as indicated and shown and in accordance with Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC and Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for BACnet or Niagara BACnet systems, and other referenced Sections.

1.1.1 System Requirements

Provide systems meeting the requirements this Section and other Sections referenced by this Section, and which have the following characteristics:

a. The system implements the control sequences of operation shown in the Contract Drawings using DDC hardware to control mechanical and electrical equipment

b. The system meet the requirements of this specification as a stand-alone system and does not require connection to any other system.

c. Control sequences reside in DDC hardware in the building. The building control network is not dependent upon connection to a Utility Monitoring and Control System (UMCS) Front End or to any other system for performance of control sequences. To the greatest extent practical, the hardware performs control sequences without reliance on the building network, unless otherwise pre-approved by the Contracting Officer.

d. The hardware is installed such that individual control equipment can be replaced by similar control equipment from other equipment manufacturers with no loss of system functionality.

e. All necessary documentation, configuration information, programming tools, programs, drivers, and other software are licensed to and otherwise remain with the Government such that the Government or their agents are able to perform repair, replacement, upgrades, and expansions of the system without subsequent or future dependence on the Contractor, Vendor or Manufacturer.

f. Sufficient documentation and data, including rights to documentation and data, are provided such that the Government or their agents can execute work to perform repair, replacement, upgrades, and expansions of the system without subsequent or future dependence on the Contractor, Vendor or Manufacturer.

g. Hardware is installed and configured such that the Government or their agents are able to perform repair, replacement, and upgrades of individual hardware without further interaction with the Contractor,

Vendor or Manufacturer.

1.1.2 End to End Accuracy

Select products, install and configure the system such that the maximum error of a measured value as read from the DDC Hardware over the network is less than the maximum allowable error specified for the sensor or instrumentation.

1.1.3 Verification of Dimensions

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

1.1.4 Drawings

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

1.2 RELATED SECTIONS

Related work specified elsewhere:

a. Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for BACnet systems with or without Niagara Framework.

b. Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

[*Am-1]c. Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION for the integration of local BAS into the base-wide EMCS.

d.[**Am-1] Section 25 05 11.23 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS ENERGY MANAGEMENT AND CONTROL SYSTEM

1.3 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 135	(2016) BACnet—A Data Communication Protocol for Building Automation and Control Networks
ASHRAE FUN IP	(2021) Fundamentals Handbook, I-P Edition

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41	(1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power

Circuits

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2020; TIA 22-1; ERTA 1 2022) National Electrical Code
NFPA 90A	(2021) Standard for the Installation of Air Conditioning and Ventilating Systems

UNDERWRITERS LABORATORIES (UL)

UL 5085-3	(2006; Reprint Jan 2022) UL Standard for Safety Low Voltage Transformers - Part 3: Class 2 and Class 3 Transformers

1.4 DEFINITIONS

The following list of definitions includes terms used in Sections referenced by this Section and are included here for completeness.The definitions contained in this Section may disagree with how terms are defined or used in other documents, including documents referenced by this Section. The definitions included here are the authoritative definitions for this Section and all Sections referenced by this Section.

After each term the protocol related to that term is included in parenthesis.

1.4.1 Alarm Generation (All protocols)

Alarm Generation is the monitoring of a value, comparison of the value to alarm conditions and the creation of an alarm when the conditions set for the alarm are met.

1.4.2 Building Automation and Control Network (BACnet) (BACnet)

The term BACnet is used in two ways. First meaning the BACnet Protocol Standard - the communication requirements as defined by ASHRAE 135 including all annexes and addenda. The second to refer to the overall technology related to the ASHRAE 135 protocol.

1.4.3 BACnet Advanced Application Controller (B-AAC) (BACnet)

A hardware device BTL Listed as a B-AAC, which is required to support BACnet Interoperability Building Blocks (BIBBs) for scheduling and alarming, but is not required to support as many BIBBs as a B-BC.

1.4.4 BACnet Application Specific Controller (B-ASC) (BACnet)

A hardware device BTL Listed as a B-ASC, with fewer BIBB requirements than a B-AAC. It is intended for use in a specific application.

1.4.5 BACnet Building Controller (B-BC) (BACnet)

A hardware device BTL Listed as a B-BC. A general-purpose, field-programmable device capable of carrying out a variety of building automation and control tasks including control and monitoring via direct digital control (DDC) of specific systems and data storage for trend information, time schedules, and alarm data. Like the other BTL Listed controller types (B-AAC, B-ASC etc.) a B-BC device is required to support the server ("B") side of the ReadProperty and WriteProperty services, but unlike the other controller types it is also required to support the client ("A") side of these services. Communication between controllers requires that one of them support the client side and the other support the server side, so a B-BC is often used when communication between controllers is needed.

1.4.6 BACnet Broadcast Management Device (BBMD) (BACnet)

A communications device, typically combined with a BACnet router. A BBMD forwards BACnet broadcast messages to BACnet/IP devices and other BBMDs connected to the same BACnet/IP network. Each IP subnet that is part of a BACnet/IP network must have at least one BBMD. Note there are additional restrictions when multiple BBMDs share an IP subnet.

1.4.7 BACnet/IP (BACnet)

An extension of BACnet, Annex J, defines the use of a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnets that share the same BACnet network number. See also paragraph BACNET BROADCAST MANAGEMENT DEVICE.

1.4.8 BACnet Internetwork (BACnet)

Two or more BACnet networks, connected with BACnet routers. In a BACnet Internetwork, there exists only one message path between devices.

1.4.9 BACnet Interoperability Building Blocks (BIBBs) (BACnet)

A BIBB is a collection of one or more ASHRAE 135 Services intended to define a higher level of interoperability. BIBBs are combined to build the BACnet functional requirements for a device in a specification. Some BIBBs define additional requirements (beyond requiring support for specific services) in order to achieve a level of interoperability. For example, the BIBB DS-V-A (Data Sharing-View-A), which would typically be used by a front-end, not only requires the client to support the ReadProperty Service, but also provides a list of data types (Object / Properties) which the client must be able to interpret and display for the user.

In the BIBB shorthand notation, -A is the client side and -B is the server side.

The following is a list of some BIBBs used by this or referenced Sections:	
DS-COV-A	Data Sharing-Change of Value (A side)
DS-COV-B	Data Sharing-Change of Value (B side)

The following is a list of some BIBBs used by this or referenced Sections:	
NM-RC-B	Network Management-Router Configuration (B side)
DS-RP-A	Data Sharing-Read Property (A side)
DS-RP-B	Data Sharing-Read Property (B side)
DS-RPM-A	Data Sharing-Read Property Multiple (A Side)
DS-RPM-B	Data Sharing-Read Property Multiple (B Side)
DS-WP-A	Data Sharing-Write Property (A Side)
DM-TS-B	Device Management-Time Synchronization (B Side)
DM-UTC-B	Device Management-UTC Time Synchronization (B Side)
DS-WP-B	Data Sharing-Write Property (B side)
SCHED-E-B	Scheduling-External (B side)
DM-OCD-B	Device Management-Object Creation and Deletion (B side)
AE-N-I-B	Alarm and Event-Notification Internal (B Side)
AE-N-E-B	Alarm and Event-Notification External (B Side)
T-VMT-I-B	Trending-Viewing and Modifying Trends Internal (B Side)
T-VMT-E-B	Trending-Viewing and Modifying Trends External (B Side)

1.4.10 BACnet Network (BACnet)

In BACnet, a portion of the control Internetwork consisting of one or more segments connected by repeaters. Networks are separated by routers.

1.4.11 BACnet Operator Display (B-OD) (BACnet)

A basic operator interface with limited capabilities relative to a B-OWS. It is not intended to perform direct digital control. A B-OD profile could be used for LCD devices, displays affixed to BACnet devices, handheld terminals or other very simple user interfaces.

1.4.12 BACnet Segment (BACnet)

One or more physical segments interconnected by repeaters (ASHRAE 135).

1.4.13 BACnet Smart Actuator (B-SA) (BACnet)

A simple actuator device with limited resources intended for specific applications.

1.4.14 BACnet Smart Sensor (B-SS) (BACnet)

A simple sensing device with limited resources.

1.4.15 BACnet Testing Laboratories (BTL) (BACnet)

Established by BACnet International to support compliance testing and interoperability testing activities and consists of BTL Manager and the BTL Working Group (BTL-WG). BTL also publishes Implementation Guidelines.

1.4.16 BACnet Testing Laboratories (BTL) Listed (BACnet)

A device that has been listed by BACnet Testing Laboratory. Devices may be certified to a specific device profile, in which case the listing indicates that the device supports the required capabilities for that profile, or may be listed as "other".

1.4.17 Binary (All protocols)

A two-state system where an "ON" condition is represented by a high signal level and an "OFF" condition is represented by a low signal level. 'Digital' is sometimes used interchangeably with 'binary'.

1.4.18 Broadcast (BACnet)

Unlike most messages, which are intended for a specific recipient device, a broadcast message is intended for all devices on the network.

1.4.19 Building Control Network (BCN) (All protocols)

The network connecting all DDC Hardware within a building (or specific group of buildings).

1.4.20 Building Point of Connection (BPOC) (All protocols)

A FPOC for a Building Control System. (This term is being phased out of use in preference for FPOC but is still used in some specifications and criteria. When it was used, it typically referred to a piece of control hardware. The current FPOC definition typically refers instead to IT hardware.)

1.4.21 Commandable (All protocols)

See Overridable.

1.4.22 Commandable Objects (BACnet)

Commandable Objects have a Commandable Property, Priority_Array, and Relinquish_Default Property as defined in ASHRAE 135, Clause 19.2, Command Prioritization.

1.4.23 Configurable (All protocols)

A property, setting, or value is configurable if it can be changed via hardware settings on the device, via the use of engineering software or over the control network from the front end, and is retained through (after) loss of power.

In a BACnet system, a property, setting, or value is configurable if it

can be changed via one or more of:
1) via BACnet services (including proprietary BACnet services)
2) via hardware settings on the device

Note this is more stringent than the ASHRAE 135 definition.

1.4.24 Control Logic Diagram (All protocols)

A graphical representation of control logic for multiple processes that make up a system.

1.4.25 Device (BACnet)

A Digital Controller that contains a BACnet Device Object and uses BACnet to communicate with other devices.

1.4.26 Device Object (BACnet)

Every BACnet device requires one Device Object, whose properties represent the network visible properties of that device. Every Device Object requires a unique Object Identifier number on the BACnet Internetwork. This number is often referred to as the device instance or device ID.

1.4.27 Device Profile (BACnet)

A collection of BIBBs determining minimum BACnet capabilities of a device, defined in ASHRAE 135. Standard device profiles include BACnet Advanced Workstations (B-AWS), BACnet Building Controllers (B-BC), BACnet Advanced Application Controllers (B-AAC), BACnet Application Specific Controllers (B-ASC), BACnet Smart Actuator (B-SA), and BACnet Smart Sensor (B-SS).

1.4.28 Digital Controller (All protocols)

An electronic controller, usually with internal programming logic and digital and analog input/output capability, which performs control functions.

1.4.29 Direct Digital Control (DDC) (All protocols)

Digital controllers performing control logic. Usually the controller directly senses physical values, makes control decisions with internal programs, and outputs control signals to directly operate switches, valves, dampers, and motor controllers.

1.4.30 Field Point of Connection (FPOC) (All protocols)

The FPOC is the point of connection between the UMCS IP Network and the field control network (either an IP network, a non-IP network, or a combination of both). The hardware at this location which provides the connection is generally an IT device such as a switch, IP router, or firewall.

In general, the term "FPOC Location" means the place where this connection occurs, and "FPOC Hardware" means the device that provides the connection. Sometimes the term "FPOC" is used to mean either and its actual meaning (i.e. location or hardware) is determined by the context in which it is used.

1.4.31 Gateway (All protocols)

A device that translates from one protocol application data format to another. Devices that change only the transport mechanism of the protocol - "translating" from TP/FT-10 to Ethernet/IP or from BACnet MS/TP to BACnet over IP for example - are not gateways as the underlying data format does not change. Gateways are also called Communications Bridges or Protocol Translators.

1.4.32 IEEE 802.3 Ethernet (All protocols)

A family of local-area-network technologies providing high-speed networking features over various media, typically Cat 5, 5e or Cat 6 twisted pair copper or fiber optic cable.

1.4.33 Internet Protocol (IP, TCP/IP, UDP/IP) (All protocols)

A communication method, the most common use is the World Wide Web. At the lowest level, it is based on Internet Protocol (IP), a method for conveying and routing packets of information over various LAN media. Two common protocols using IP are User Datagram Protocol (UDP) and Transmission Control Protocol (TCP). UDP conveys information to well-known "sockets" without confirmation of receipt. TCP establishes connections, also known as "sessions", which have end-to-end confirmation and guaranteed sequence of delivery.

1.4.34 Input/Output (I/O) (All protocols)

Physical inputs and outputs to and from a device, although the term sometimes describes network or "virtual" inputs or outputs. See also "Points".

1.4.35 I/O Expansion Unit (All protocols)

An I/O expansion unit provides additional point capacity to a digital controller

1.4.36 IP subnet (All protocols)

A group of devices which share a defined range IP addresses. Devices on a common IP subnet can share data (including broadcasts) directly without the need for the traffic to traverse an IP router.

1.4.37 Local-Area Network (LAN) (All protocols)

A communication network that spans a limited geographic area and uses the same basic communication technology throughout.

1.4.38 Local Display Panels (LDPs) (All protocols)

A DDC Hardware with a display and navigation buttons, and must provide display and adjustment of points as shown on the Points Schedule and as indicated.

1.4.39 MAC Address (All protocols)

Media Access Control address. The physical device address that identifies a device on a Local Area Network.

1.4.40 Master-Slave/Token-Passing (MS/TP) (BACnet)

Data link protocol as defined by the BACnet standard. Multiple speeds (data rates) are permitted by the BACnet MS/TP standard.

1.4.41 Monitoring and Control (M&C) Software (All protocols)

The UMCS 'front end' software which performs supervisory functions such as alarm handling, scheduling and data logging and provides a user interface for monitoring the system and configuring these functions.

1.4.42 Network Number (BACnet)

A site-specific number assigned to each network. This network number must be unique throughout the BACnet Internetwork.

1.4.43 Object (BACnet)

An ASHRAE 135 Object. The concept of organizing BACnet information into standard components with various associated Properties. Examples include Analog Input objects and Binary Output objects.

1.4.44 Object Identifier (BACnet)

A grouping of two Object properties: Object Type (e.g. Analog Value, Schedule, etc.) and Object Instance (in this case, a number). Object Identifiers must be unique within a device.

1.4.45 Object Instance (BACnet)

See paragraph OBJECT IDENTIFIER

1.4.46 Object Properties (BACnet)

Attributes of an object. Examples include present value and high limit properties of an analog input object. Properties are defined in ASHRAE 135; some are optional and some are required. Objects are controlled by reading from and writing to object properties.

1.4.47 Operator Configurable (All protocols)

Operator configurable values are values that can be changed from a single common front end user interface across multiple vendor systems.

For non Niagara-based BACnet systems, a property, setting, or value in a device is Operator Configurable when it is Configurable and is either:

a. a Writable Property of a Standard BACnet Object; or

b. a Property of a Standard BACnet Object that is Writable when Out_Of_Service is TRUE and Out_Of_Service is Writable.

1.4.48 Override (All protocols)

Changing the value of a point outside of the normal sequence of operation where the change has priority over the sequence and where there is a mechanism for releasing the change such that the point returns to the normal value. Overrides persist until released or overridden at the same or higher priority but are not required to persist through a loss of power.

Overrides are often used by operators to change values, and generally originate at a user interface (workstation or local display panel).

1.4.49 Packaged Equipment (All protocols)

Packaged equipment is a single piece of equipment provided by a manufacturer in a substantially complete and operable condition, where the controls (DDC Hardware) are factory installed, and the equipment is sold and shipped from the manufacturer as a single entity. Disassembly and reassembly of a large piece of equipment for shipping does not prevent it from being packaged equipment. Package units may require field installation of remote sensors. Packaged equipment is also called a "packaged unit".

Note industry may use the term "Packaged System" to mean a collection of equipment that is designed to work together where each piece of equipment is packaged equipment and there is a network that connects the equipment together. A "packaged system" of this type is NOT packaged equipment; it is a collection of packaged equipment, and each piece of equipment must individually meet specification requirements.

1.4.50 Packaged Unit (All protocols)

See packaged equipment.

1.4.51 Performance Verification Test (PVT) (All protocols)

The procedure for determining if the installed BAS meets design criteria prior to final acceptance. The PVT is performed after installation, testing, and balancing of mechanical systems. Typically the PVT is performed by the Contractor in the presence of the Government.

1.4.52 Physical Segment (BACnet)

A single contiguous medium to which BACnet devices are attached (ASHRAE 135).

1.4.53 Polling (All protocols)

A device periodically requesting data from another device.

1.4.54 Points (All protocols)

Physical and virtual inputs and outputs. See also paragraph INPUT/OUTPUT (I/O).

1.4.55 Proportional, Integral, and Derivative (PID) Control Loop (All protocols)

Three parameters used to control modulating equipment to maintain a setpoint. Derivative control is often not required for HVAC systems (leaving "PI" control).

1.4.56 Proprietary (BACnet)

Within the context of BACnet, any extension of or addition to object types, properties, PrivateTransfer services, or enumerations specified in ASHRAE 135. Objects with Object_Type values of 128 and above are Proprietary Objects. Properties with Property_Identifier of 512 and above

are proprietary Properties.

1.4.57 Protocol Implementation Conformance Statement (PICS) (BACnet)

A document, created by the manufacturer of a device, which describes which portions of the BACnet standard may be implemented by a given device. ASHRAE 135 requires that all ASHRAE 135 devices have a PICS, and also defines a minimum set of information that must be in it. A device as installed for a specific project may not implement everything in its PICS.

1.4.58 Repeater (All protocols)

A device that connects two control network segments and retransmits all information received on one side onto the other.

1.4.59 Router (All protocols)

A device that connects ASHRAE 135 networks (in a BACnet system) and controls traffic between the two by retransmitting signals received from one side onto the other based on the signal destination. Routers are used to subdivide a BACnet internetwork and to limit network traffic.

1.4.60 Segment (All protocols)

A 'single' section of a control network that contains no repeaters or routers. There is generally a limit on the number of devices on a segment, and this limit is dependent on the topology/media and device type.

1.4.61 Standard BACnet Objects (BACnet)

Objects with Object_Type values below 128 and specifically enumerated in Clause 21 of ASHRAE 135. Objects which are not proprietary. See paragraph PROPRIETARY.

1.4.62 Standard BACnet Properties (BACnet)

Properties with Property_Identifier values below 512 and specifically enumerated in Clause 21 of ASHRAE 135. Properties which are not proprietary. See Proprietary.

1.4.63 Standard BACnet Services (BACnet)

ASHRAE 135 services other than ConfirmedPrivateTransfer or UnconfirmedPrivateTransfer. See paragraph PROPRIETARY.

1.4.64 UMCS (All protocols)

UMCS stands for Utility Monitoring and Control System. The term refers to all components by which a project site monitors, manages, and controls real-time operation of HVAC and other building systems. These components include the UMCS "front-end" and all field building control systems connected to the front-end. The front-end consists of Monitoring and Control Software (user interface software), browser-based user interfaces and network infrastructure.

The network infrastructure (the "UMCS Network"), is an IP network connecting multiple building or facility control networks to the Monitoring and Control Software.

1.4.65 UMCS Network (All protocols)

The UMCS Network connects multiple building or facility control networks to the Monitoring and Control Software.

1.4.66 Writable Property (BACnet)

A Property is Writable when it can be changed through the use of one or more of the WriteProperty services defined in ASHRAE 135, Clause 15 regardless of the value of any other Property. Note that in the ASHRAE 135 standard, some Properties may be writable when the Out of Service Property is TRUE; for purposes of this Section, Properties that are only writable when the Out of Service Property is TRUE are not considered to be Writable.

1.5 PROJECT SEQUENCING

TABLE II: PROJECT SEQUENCING lists the sequencing of submittals as specified in paragraph SUBMITTALS (denoted by an 'S' in the 'TYPE' column) and activities as specified in PART 3 EXECUTION (denoted by an 'E' in the 'TYPE' column). TABLE II does not specify overall project milestone and completion dates; these dates are specified in the contract documents.

a. Sequencing for Submittals: The sequencing specified for submittals is the deadline by which the submittal must be initially submitted to the Government. Following submission there will be a Government review period as specified in Section 01 33 00 SUBMITTAL PROCEDURES. If the submittal is not accepted by the Government, revise the submittal and resubmit it to the Government within 14 days of notification that the submittal has been rejected. Upon resubmittal there will be an additional Government review period. If the submittal is not accepted the process repeats until the submittal is accepted by the Government.

b. Sequencing for Activities: The sequencing specified for activities indicates the earliest the activity may begin.

c. Abbreviations: In TABLE II the abbreviation AAO is used for 'after approval of' and 'ACO' is used for 'after completion of'.

TABLE II. PROJECT SEQUENCING

ITEM #	TYPE	DESCRIPTION	SEQUENCING (START OF ACTIVITY OR DEADLINE FOR SUBMITTAL)
1	S	Existing Conditions Report	
2	S	DDC Contractor Design Drawings	
3	S	Manufacturer's Product Data	
4	S	Pre-construction QC Checklist	
5	E	Install Building Control System	AAO #1 thru #4

TABLE II. PROJECT SEQUENCING			
ITEM #	TYPE	DESCRIPTION	SEQUENCING (START OF ACTIVITY OR DEADLINE FOR SUBMITTAL)
6	E	Start-Up and Start-Up Testing	ACO #5
7	S	Post-Construction QC Checklist	ACO #6
8	S	Programming Software Configuration Software	ACO #6
10	S	Start-Up Testing Report	ACO #6
11	S	PVT Procedures	before schedule start of #12 and AAO #10
12	S,E	Execute PVT PVT Testing Activities	AAO #9 and #11 As indicated in PART 3 of this Section
13	S	PVT Report	ACO #12 As indicated in PART 3 of this Section
14	S	Controller Application Programs Controller Configuration Settings	AAO #13
15	S	Final As-Built Drawings	AAO #13
16	S	O&M Instructions	AAO #15
17	S	Training Documentation	AAO #10 and before scheduled start of #18
18	E	Training	AAO #16 and #17
19	S	Closeout QC Checklist	ACO #18

1.6 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

DDC Contractor Design Drawings; G-AE

Final As-Built Drawings; G-AE

SD-03 Product Data

Programming Software; G-AE

Controller Application Programs; G-AE

Configuration Software; G-AE

Controller Configuration Settings; G-AE

Manufacturer's Product Data; G-AE

SD-06 Test Reports

Existing Conditions Report

Pre-Construction Quality Control (QC) Checklist; G-RO

Post-Construction Quality Control (QC) Checklist; G-RO

Start-Up Testing Report; G-RO

PVT Procedures; G-RO

PVT Report; G-RO

SD-10 Operation and Maintenance Data

Operation and Maintenance (O&M) Instructions; G-RO

Training Documentation; G-RO

SD-11 Closeout Submittals

Enclosure Keys; G-RO

Password Summary Report; G-RO

Closeout Quality Control (QC) Checklist; G-RO

1.7 DATA PACKAGE AND SUBMITTAL REQUIREMENTS

Technical data packages consisting of technical data and computer software (meaning technical data which relates to computer software) which are specifically identified in this project and which may be defined/required in other specifications must be delivered strictly in accordance with the CONTRACT CLAUSES and in accordance with the Contract Data Requirements List, DD Form 1423. Data delivered must be identified by reference to the particular specification paragraph against which it is furnished. All submittals not specified as technical data packages are considered 'shop drawings' under the Federal Acquisition Regulation Supplement (FARS) and must contain no proprietary information and be delivered with unrestricted rights.

1.8 SOFTWARE FOR DDC HARDWARE AND GATEWAYS

Provide all software related to the programming and configuration of DDC Hardware and Gateways as indicated. License all Software to the project

site. The term "controller" as used in these requirements means both DDC Hardware and Gateways.

1.8.1 Configuration Software

For each type of controller, provide the configuration tool software in accordance with Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Submit hard copies of the software user manuals for each software with the software submittal.

Submit Configuration Software on CD-ROM as a Technical Data Package. Submit 4 hard copies of the software user manual for each piece of software.

1.8.2 Controller Configuration Settings

For each controller, provide copies of the installed configuration settings as source code compatible with the configuration tool software for that controller in accordance with Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

Submit Controller Configuration Settings on CD-ROM as a Technical Data Package. Include on the CD-ROM a list or table of contents clearly indicating which files are associated with each device. Submit 2 copies of the Controller Configuration Settings CD-ROM.

1.8.3 Programming Software

For each type of programmable controller, provide the programming software in accordance with Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Submit hard copies of software user manuals for each software with the software submittal.

Submit Programming Software on CD-ROM as a Technical Data Package. Submit 4 hard copies of the software user manual for each piece of software.

1.8.4 Controller Application Programs

For each programmable controller, provide copies of the application program as source code compatible with the programming software for that controller in accordance with Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

Submit Controller Application Programs on CD-ROM as a Technical Data Package. Include on the CD-ROM a list or table of contents clearly indicating which application program is associated with each device. Submit 2 copies of the Controller Application Programs CD-ROM.

1.9 QUALITY CONTROL CHECKLISTS

The QC Checklist for BACnet Systems in APPENDIX A of this Section must be completed by the Contractor's Chief Quality Control (QC) Representative and submitted as indicated.

The QC Checklist for Niagara Framework Based BACnet Systems in APPENDIX A of this Section must be completed by the Contractor's Chief Quality Control (QC) Representative and submitted as indicated.

The QC Representative must verify each item indicated and initial in the

space provided to indicate that the requirement has been met. The QC Representative must sign and date the Checklist prior to submission to the Government.

1.9.1 Pre-Construction Quality Control (QC) Checklist

Complete items indicated as Pre-Construction QC Checklist items in the QC Checklist. Submit four copies of the Pre-Construction QC Checklist.

1.9.2 Post-Construction Quality Control (QC) Checklist

Complete items indicated as Post-Construction QC Checklist items in the QC Checklist. Submit four copies of the Post-Construction QC Checklist.

1.9.3 Closeout Quality Control (QC) Checklist

Complete items indicated as Closeout QC Checklist items in the QC Checklist. Submit four copies of the Closeout QC Checklist.

PART 2 PRODUCTS

Provide products meeting the requirements of Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC, Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for BACnet or Niagara BACnet systems, other referenced Sections, and this Section.

2.1 GENERAL PRODUCT REQUIREMENTS

Units of the same type of equipment must be products of a single manufacturer. Each major component of equipment must have the manufacturer's name and address, and the model and serial number in a conspicuous place. Materials and equipment must be standard products of a manufacturer regularly engaged in the manufacturing of these and similar products. The standard products must have been in a satisfactory commercial or industrial use for two years prior to use on this project. The two year use must include applications of equipment and materials under similar circumstances and of similar size. DDC Hardware not meeting the two-year field service requirement is acceptable provided it has been successfully used by the Contractor in a minimum of two previous projects. The equipment items must be supported by a service organization. Items of the same type and purpose must be identical, including equipment, assemblies, parts and components.

2.2 PRODUCT DATA

Provide manufacturer's product data sheets documenting compliance with product specifications for each product provided under Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC, Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS, or this Section. Provide product data for all products in a single indexed compendium, organized by product type.

For all BACnet hardware: for each manufacturer, model and version (revision) of DDC Hardware provide the Protocol Implementation Conformance Statement (PICS) in accordance with Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

Submit Manufacturer's Product Data on CD-ROM.

2.3 OPERATION ENVIRONMENT

Unless otherwise specified, provide products rated for continuous operation under the following conditions:

a. Pressure: Pressure conditions normally encountered in the installed location.

b. Vibration: Vibration conditions normally encountered in the installed location.

c. Temperature:

(1) Products installed indoors: Ambient temperatures in the range of 32 to 112 degrees F and temperature conditions outside this range normally encountered at the installed location.

(2) Products installed outdoors or in unconditioned indoor spaces: Ambient temperatures in the range of -35 to +151 degrees F and temperature conditions outside this range normally encountered at the installed location.

d. Humidity: 10 to 95 percent relative humidity, noncondensing and humidity conditions outside this range normally encountered at the installed location.

2.4 WIRELESS CAPABILITY

For products incorporating any wireless capability (including but not limited to radio frequency (RF), infrared and optical), provide products for which wireless capability can be permanently disabled at the device. Optical and infrared capabilities may be disabled via a permanently affixed opaque cover plate.

2.5 ENCLOSURES

Enclosures supplied as an integral (pre-packaged) part of another product are acceptable. Provide two Enclosure Keys for each lockable enclosure on a single ring per enclosure with a tag identifying the enclosure the keys operate. Provide enclosures meeting the following minimum requirements:

2.5.1 Outdoors

For enclosures located outdoors, provide enclosures meeting NEMA 250 Type 3 requirements.

2.5.2 Mechanical and Electrical Rooms

For enclosures located in mechanical or electrical rooms, provide enclosures meeting NEMA 250 Type 2 requirements.

2.5.3 Other Locations

For enclosures in other locations including but not limited to occupied spaces, above ceilings, and in plenum returns, provide enclosures meeting NEMA 250 Type 1 requirements.

2.6 WIRE AND CABLE

Provide wire and cable meeting the requirements of NFPA 70 and NFPA 90A in addition to the requirements of this specification and referenced specifications.

2.6.1 Terminal Blocks

For terminal blocks which are not integral to other equipment, provide terminal blocks which are insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanism, suitable for DIN rail mounting, and which have enclosed sides or end plates and partition plates for separation.

2.6.2 Control Wiring for Binary Signals

For Control Wiring for Binary Signals, provide 18 AWG copper or thicker wire rated for 300-volt service.

2.6.3 Control Wiring for Analog Signals

For Control Wiring for Analog Signals, provide 18 AWG or thicker, copper, single- or multiple-twisted wire meeting the following requirements:

a. minimum 2 inch lay of twist

b. 100 percent shielded pairs

c. at least 300-volt insulation

d. each pair has a 20 AWG tinned-copper drain wire and individual overall pair insulation

e. cables have an overall aluminum-polyester or tinned-copper cable-shield tape, overall 20 AWG tinned-copper cable drain wire, and overall cable insulation.

2.6.4 Power Wiring for Control Devices

For 24-volt circuits, provide insulated copper 18 AWG or thicker wire rated for 300 VAC service. For 120-volt circuits, provide 14 AWG or thicker stranded copper wire rated for 600-volt service.

2.6.5 Transformers

Provide UL 5085-3 approved transformers. Select transformers sized so that the connected load is no greater than 80 percent of the transformer rated capacity.

PART 3 EXECUTION

3.1 EXISTING CONDITIONS

3.1.1 Existing Conditions Survey

Perform a field survey, including testing and inspection of the equipment to be controlled and submit an Existing Conditions Report documenting the current status and its impact on the Contractor's ability to meet this specification. For those items considered nonfunctional, document the

deficiency in the report including explanation of the deficiencies and estimated costs to correct the deficiencies. As part of the report, define the scheduled need date for connection to existing equipment. Make written requests and obtain Government approval prior to disconnecting any controls and obtaining equipment downtime.

Submit four copies of the Existing Conditions Report.

3.1.2 Existing Equipment Downtime

Make written requests and obtain Government approval prior to disconnecting any controls and obtaining equipment downtime.

3.1.3 Existing Control System Devices

Inspect, calibrate, and adjust as necessary to place in proper working order all existing devices which are to be reused.

3.2 INSTALLATION

Fully install and test the control system in accordance Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC, Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for BACnet or Niagara BACnet systems, and this Section.

3.2.1 Dielectric Isolation

Provide dielectric isolation where dissimilar metals are used for connection and support. Install control system in a matter that provides clearance for control system maintenance by maintaining access space required to calibrate, remove, repair, or replace control system devices. Install control system such that it does not interfere with the clearance requirements for mechanical and electrical system maintenance.

3.2.2 Penetrations in Building Exterior

Make all penetrations through and mounting holes in the building exterior watertight.

3.2.3 Device Mounting Criteria

Install devices in accordance with the manufacturer's recommendations and as indicated and shown. Provide a weathershield for all devices installed outdoors. Provide clearance for control system maintenance by maintaining access space required to calibrate, remove, repair, or replace control system devices. Provide clearance for mechanical and electrical system maintenance; do not not interfere with the clearance requirements for mechanical and electrical system maintenance.

3.2.4 Labels and Tags

Key all labels and tags to the unique identifiers shown on the As-Built drawings. For labels exterior to protective enclosures provide engraved plastic labels mechanically attached to the enclosure or DDC Hardware. Labels inside protective enclosures may be attached using adhesive, but must not be hand written. For tags, provide plastic or metal tags mechanically attached directly to each device or attached by a metal chain or wire.

a. Label all Enclosures and DDC Hardware.

b. Tag Airflow measurement arrays (AFMA) with flow rate range for signal output range, duct size, and pitot tube AFMA flow coefficient.

c. Tag duct static pressure taps at the location of the pressure tap

3.2.5 Surge Protection

3.2.5.1 Power-Line Surge Protection

Protect equipment connected to AC circuits to withstand power-line surges in accordance with IEEE C62.41. Do not use fuses for surge protection.

3.2.5.2 Surge Protection for Transmitter and Control Wiring

Protect DDC hardware against or provided DDC hardware capable of withstanding surges induced on control and transmitter wiring installed outdoors and as shown. Protect equipment against the following two waveforms:

a. A waveform with a 10-microsecond rise time, a 1000-microsecond decay time and a peak current of 60 amps.

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

3.2.6 Basic Cybersecurity Requirements

3.2.6.1 Passwords

For all devices with a password, change the password from the default password. Do not use the same password for more than one device. Coordinate selection of passwords with RO. Provide a Password Summary Report documenting the password for each device and describing the procedure to change the password for each device.

Provide two hardcopies of the Password Summary Report, each copy in its own sealed envelope.

3.2.6.2 Wireless Capability

Unless otherwise indicated, disable wireless capability (including but not limited to radio frequency (RF), infrared and optical) for all devices with wireless capability. Optical and infrared capabilities may be disabled via a permanently affixed opaque cover plate. Password protecting a wireless connections does not meet this requirement; the wireless capability must be disabled.

3.2.6.3 IP Network Physical Security

Install all IP Network media in conduit. Install all IP devices including but not limited to IP-enabled DDC hardware and IP Network Hardware in lockable enclosures.

3.3 DRAWINGS AND CALCULATIONS

Provide drawings in the form and arrangement indicated and shown. Use the same abbreviations, symbols, nomenclature and identifiers shown. Assign a

unique identifier as shown to each control system element on a drawing. When packaging drawings, group schedules by system. When space allows, it is permissible to include multiple schedules for the same system on a single sheet. Except for drawings covering all systems, do not put information for different systems on the same sheet.

Submit hardcopy drawings on ISO A1 34 by 22 inches or A3 17 by 11 inches sheets, and electronic drawings in PDF and in AutoCAD Autodesk Revit 2013 format. In addition, submit electronic drawings in editable Excel format for all drawings that are tabular, including but not limited to the Point Schedule and Equipment Schedule.

a. Submit DDC Contractor Design Drawings consisting of each drawing indicated with pre-construction information depicting the intended control system design and plans. Submit DDC Contractor Design Drawings as a single complete package: Six hard copies and four copies on CD-ROM.

b. Submit Final As-Built Drawings consisting of each drawing indicated updated with all final as-built data. Final As-Built Drawings as a single complete package: Six hard copies and four copies on CD-ROM.

3.3.1 Sample Drawings

Sample drawings in electronic format are available at the Whole Building Design Guide page for this section: http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-23-09-00 These drawings may prove useful in demonstrating expected drawing formatting and example content and are provided for illustrative purposes only. Note that these drawings do not meet the content requirements of this Section and must be completed to meet project requirements.

3.3.2 Drawing Index and Legend

Provide an HVAC Control System Drawing Index showing the name and number of the building, military site, State or other similar designation, and Country. In the Drawing Index, list all Contractor Design Drawings, including the drawing number, sheet number, drawing title, and computer filename when used. In the Design Drawing Legend, show and describe all symbols, abbreviations and acronyms used on the Design Drawings. Provide a single Index and Legend for the entire drawing package.

3.3.3 Thermostat and Occupancy Sensor Schedule

Provide a thermostat and occupancy sensor schedule containing each thermostat's unique identifier, room identifier and control features and functions as shown. Provide a single thermostat and occupancy sensor schedule for the entire project.

3.3.4 Valve Schedule

Provide a valve schedule containing each valve's unique identifier, size, flow coefficient Kv (Cv), pressure drop at specified flow rate, spring range, positive positioner range, actuator size, close-off pressure to torque data, dimensions, and access and clearance requirements data. In the valve schedule include actuator selection data supported by calculations of the force required to move and seal the valve, access and clearance requirements. Provide a single valve schedule for the entire project.

3.3.5 Damper Schedule

Provide a damper schedule containing each damper's unique identifier, type (opposed or parallel blade), nominal and actual sizes, orientation of axis and frame, direction of blade rotation, actuator size and spring ranges, operation rate, positive positioner range, location of actuators and damper end switches, arrangement of sections in multi-section dampers, and methods of connecting dampers, actuators, and linkages. Include the AMCA 511 maximum leakage rate at the operating static-pressure differential for each damper in the Damper Schedule. Provide a single damper schedule for the entire project.

3.3.6 Project Summary Equipment Schedule

Provide a project summary equipment schedule containing the manufacturer, model number, part number and descriptive name for each control device, hardware and component provided under this specification. Provide a single project equipment schedule for the entire project.

3.3.7 Equipment Schedule

Provide system equipment schedules containing the unique identifier, manufacturer, model number, part number and descriptive name for each control device, hardware and component provided under this specification. Provide a separate equipment schedule for each HVAC system.

3.3.8 Occupancy Schedule

Provide an occupancy schedule drawing containing the same fields as the occupancy schedule Contract Drawing with Contractor updated information. Provide a single occupancy schedule for the entire project.

3.3.9 DDC Hardware Schedule

Provide a single DDC Hardware Schedule for the entire project and including following information for each device.

3.3.9.1 DDC Hardware Identifier

The Unique DDC Hardware Identifier for the device.

3.3.9.2 HVAC System

The system "name" used to identify a specific system (the name used on the system schematic drawing for that system).

3.3.9.3 BACnet Device Information

3.3.9.3.1 Device Object Identifier

The Device Object Identifier: The Object_Identifier of the Device Object

3.3.9.3.2 Network Number

The Network Number for the device.

3.3.9.3.3 MAC Address

The MAC Address for the device

3.3.9.3.4 BTL Listing

The BTL Listing of the device. If the device is listed under multiple BTL Profiles, indicate the profile that matches the use and configuration of the device as installed.

3.3.9.3.5 Proprietary Services Information

If the device uses non-standard ASHRAE 135 services as defined and permitted in Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS, indicate that the device uses non-standard services and include a description of all non-standard services used. Describe usage and content such that a device from another vendor can interoperate with the device using the non-standard service. Provide descriptions with sufficient detail to allow a device from a different manufacturer to be programmed to both read and write the non-standard service request:

a. read: interpret the data contained in the non-standard service and;

b. write: given similar data, generate the appropriate non-standard service request.

3.3.9.3.6 Alarming Information

Indicate whether the device is used for alarm generation, and which types of alarm generation the device implements: intrinsic, local algorithmic, remote algorithmic.

3.3.9.3.7 Scheduling Information

Indicate whether the device is used for scheduling.

3.3.9.3.8 Trending Information

Indicate whether the device is used for trending, and indicate if the device is used to trend local values, remote values, or both.

3.3.10 Points Schedule

Provide a Points Schedule in tabular form for each HVAC system, with the indicated columns and with each row representing a hardware point, network point or configuration point in the system.

a. When a Points Schedule was included in the Contract Drawing package, use the same fields as the Contract Drawing with updated information in addition to the indicated fields.

b. When Point Schedules are included in the contract package, items requiring contractor verification or input have been shown in angle brackets ("<" and ">"), such as <___> for a required entry or <value> for a value requiring confirmation. Complete all items in brackets as well as any blank cells. Do not modify values which are not in brackets without approval.

Points Schedule Columns must include:

3.3.10.1 Point Name

The abbreviated name for the point using the indicated naming convention.

3.3.10.2 Description

A brief functional description of the point such as "Supply Air Temperature".

3.3.10.3 DDC Hardware Identifier

The Unique DDC Hardware Identifier shown on the DDC Hardware Schedule and used across all drawings for the DDC Hardware containing the point.

3.3.10.4 Settings

The value and units of any setpoints, configured setpoints, configuration parameters, and settings related to each point.

3.3.10.5 Range

The range of values, including units, associated with the point, including but not limited to a zone temperature setpoint adjustment range, a sensor measurement range, occupancy values for an occupancy input, or the status of a safety.

3.3.10.6 Input or Output (I/O) Type

The type of input or output signal associated with the point. Use the following abbreviations for entries in this column:

a. AI: The value comes from a hardware (physical) Analog Input

b. AO: The value is output as a hardware (physical) Analog Output

c. BI: The value comes from a hardware (physical) Binary Input

d. BO: The value is output as a hardware (physical) Binary Output

e. PULSE: The value comes from a hardware (physical) Pulse Accumulator Input

f. NET-IN: The value is provided from the network (generally from another device). Use this entry only when the value is received from another device as part of scheduling or as part of a sequence of operation, not when the value is received on the network for supervisory functions such as trending, alarming, override or display at a user interface.

g. NET-OUT: The value is provided to another controller over the network. Use this entry only when the value is transmitted to another device as part of scheduling or as part of a sequence of operation, not when the value is transmitted on the network for supervisory functions such as trending, alarming, override or display at a user interface.

3.3.10.7 Object and Property Information

The Object Type and Instance Number for the Object associated with the point. If the value of the point is not in the Present_Value Property, then also provide the Property ID for the Property containing the value of the point. Any point that is displayed at the front end or on an LDP, is trended, is used by another device on the network, or has an alarm condition must be documented here.

3.3.10.8 Network Data Exchange Information (Gets Data From, Sends Data To)

Provide the DDC Hardware Identifier of other DDC Hardware the point is shared with.

3.3.10.9 Override Information (Object Type and Instance Number)

For each point requiring an Override and not residing in a Niagara Framework Supervisory Gateway, indicate if the Object for the point is Commandable or, if the use of a separate Object was specifically approved by the Contracting Officer, provide the Object Type and Instance Number of the Object to be used in overriding the point.

3.3.10.10 Trend Object Information

For each point requiring a trend, indicate if the trend is Local or Remote, the trend Object type and the trend Object instance number. For remote trends provide the DDC Hardware Identifier for the device containing the trend Object in the Points Schedule notes.

3.3.10.11 Alarm Information

Indicate the Alarm Generation Type, Event Enrollment Object Instance Number, and Notification Class Object Instance Number for each point requiring an alarm. (Note that not all alarms will have Event Enrollment Objects.)

3.3.10.12 Configuration Information

Indicate the means of configuration associated with each point. For points in a Niagara Framework Supervisory Gateway, indicate the point within the Niagara Framework Supervisory Gateway used to configure the value. For other points:

a. For Operator Configurable Points indicate BACnet Object and Property information (Name, Type, Identifiers) containing the configurable value. Indicate whether the property is writable always, or only when Out_Of_Service is TRUE.

b. For Configurable Points indicate the BACnet Object and Property information as for Operator Configurable points, or identification of the configurable settings from within the engineering software for the device or identification of the hardware settings on the device.

3.3.11 Riser Diagram

The Riser Diagram of the Building Control Network may be in tabular form, and must show all DDC Hardware and all Network Hardware, including network terminators. For each item, provide the unique identifier, common descriptive name, physical sequential order (previous and next device on

the network), room identifier and location within room. A single riser diagram must be submitted for the entire system.

3.3.12 Control System Schematics

Provide control system schematics in the same form as the control system schematic Contract Drawing with Contractor updated information. Provide a control system schematic for each HVAC system.

3.3.13 Sequences of Operation

Provide HVAC control system sequence of operation in the same format as the Contract Drawings. Within these drawings, refer to devices by their unique identifiers. Submit sequences of operation for each HVAC system.

3.3.14 Controller, Motor Starter and Relay Wiring Diagram

Provide controller wiring diagrams as functional wiring diagrams which show the interconnection of conductors and cables to each controller and to the identified terminals of input and output devices, starters and package equipment. Show necessary jumpers and ground connections and the labels of all conductors. Identify sources of power required for control systems and for packaged equipment control systems back to the panel board circuit breaker number, controller enclosures, magnetic starter, or packaged equipment control circuit. Show each power supply and transformer not integral to a controller, starter, or packaged equipment. Show the connected volt-ampere load and the power supply volt-ampere rating. Provide wiring diagrams for each HVAC system.

3.4 CONTROLLER TUNING

Tune each controller in a manner consistent with that described in the ASHRAE FUN IP and in the manufacturer's instruction manual. Tuning must consist of adjustment of the proportional, integral, and where applicable, the derivative (PID) settings to provide stable closed-loop control. Each loop must 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 must 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 must be steady. With the exception of naturally slow processes such as zone temperature control, the controller must settle out at the new setpoint within five (5) minutes. Set the controller to its correct setpoint and record and submit the final PID configuration settings with the O&M Instructions and on the associated Points Schedule.

3.5 START-UP

3.5.1 Start-Up Test

Perform the following startup tests for each control system to ensure that the described control system components are installed and functioning per this specification.

Adjust, calibrate, measure, program, configure, set the time schedules, and otherwise perform all necessary actions to ensure that the systems function as indicated and shown in the sequence of operation and other

contract documents.

3.5.1.1 Systems Check

An item-by-item check must be performed for each HVAC system

3.5.1.1.1 Step 1 - System Inspection

With the system in unoccupied mode and with fan hand-off-auto switches in the OFF position, verify that power and main air are available where required and that all output devices are in their failsafe and normal positions. Inspect each local display panel to verify that all displays indicate shutdown conditions.

3.5.1.1.2 Step 2 - Calibration Accuracy Check

Perform a two-point accuracy check of the calibration of each HVAC control system sensing element and transmitter by comparing the value from the test instrument to the network value provided by the DDC Hardware. Use digital indicating test instruments, such as digital thermometers, motor-driven psychrometers, and tachometers. Use test instruments with accuracy at least twice as accurate as the specified sensor accuracy and with calibration traceable to National Institute of Standards and Technology standards. Check one the first check point in the bottom one-third of the sensor range, and the second in the top one-third of the sensor range. Verify that the sensing element-to-DDC readout accuracies at two points are within the specified product accuracy tolerances, and if not recalibrate or replace the device and repeat the calibration check.

3.5.1.1.3 Step 3 - Actuator Range Check

With the system running, apply a signal to each actuator through the DDC Hardware controller. Verify proper operation of the actuators and positioners for all actuated devices and record the signal levels for the extreme positions of each device. Vary the signal over its full range, and verify that the actuators travel from zero stroke to full stroke within the signal range. Where applicable, verify that all sequenced actuators move from zero stroke to full stroke in the proper direction, and move the connected device in the proper direction from one extreme position to the other. For valve actuators and damper actuators, perform the actuator range check under normal system pressures.

3.5.1.2 Weather Dependent Test

Perform weather dependent test procedures in the appropriate climatic season.

3.5.2 Start-Up Testing Report

Submit 4 copies of the Start-Up Testing Report. The report may be submitted as a Technical Data Package documenting the results of the tests performed and certifying that the system is installed and functioning per this specification, and is ready for the Performance Verification Test (PVT).

3.6 PERFORMANCE VERIFICATION TEST (PVT)

3.6.1 PVT Procedures

Prepare PVT Procedures explaining step-by-step, the actions and expected results that will demonstrate that the control system performs in accordance with the sequences of operation, and other contract documents. Submit 4 copies of the PVT Procedures. The PVT Procedures may be submitted as a Technical Data Package.

3.6.1.1 Sensor Accuracy Checks

Include a one-point accuracy check of each sensor in the PVT procedures.

3.6.1.2 Temporary Trending Hardware

Unless trending capability exists within the building control system or the building control system is connected to a UMCS or other system which can perform trending, temporarily install hardware on the building control network to perform trending during the endurance test as indicated. Remove the temporary hardware at the completion of all commissioning activities.

3.6.1.3 Endurance Test

Include a one-week endurance test as part of the PVT during which the system is operated continuously.

Use the building control system BACnet Trend Log or Trend Log Multiple Objects to trend all points shown as requiring a trend on the Point Schedule for the entire endurance test. If insufficient buffer capacity exists to trend the entire endurance test, upload trend logs during the course of the endurance test to ensure that no trend data is lost.

3.6.1.4 PVT Equipment List

Include in the PVT procedures a control system performance verification test equipment list that lists the equipment to be used during performance verification testing. For each piece of equipment, include manufacturer name, model number, equipment function, the date of the latest calibration, and the results of the latest calibration

3.6.2 PVT Execution

Demonstrate compliance of the control system with the contract documents. Using test plans and procedures approved by the Government, software capable of reading and writing COV Notification Subscriptions, Notification Class Recipient List Properties, event enrollments, demonstrate all physical and functional requirements of the project. Show, step-by-step, the actions and results demonstrating that the control systems perform in accordance with the sequences of operation. Do not start the performance verification test until after receipt of written permission by the Government, based on Government approval of the PVT Plan and Draft As-Builts and completion of balancing. UNLESS GOVERNMENT WITNESSING OF A TEST IS SPECIFICALLY WAIVED BY THE GOVERNMENT, PERFORM ALL TESTS WITH A GOVERNMENT WITNESS. Do not conduct tests during scheduled seasonal off periods of base heating and cooling systems. If the system experiences any failures during the endurance test portion of the PVT, repair the system repeat the endurance test portion of the PVT until the

system operates continuously and without failure for the specified endurance test period.

3.6.3 PVT Report

Prepare and submit a PVT report documenting all tests performed during the PVT and their results. Include all tests in the PVT procedures and any additional tests performed during PVT. Document test failures and repairs conducted with the test results.

Submit four copies of the PVT Report. The PVT Report may be submitted as a Technical Data Package.

3.7 OPERATION AND MAINTENANCE (O&M) INSTRUCTIONS

Provide HVAC control System Operation and Maintenance Instructions which include:

a. "Data Package 3" as indicated in Section 01 78 23 OPERATION AND MAINTENANCE DATA for each piece of control equipment.

b. "Data Package 4" as described in Section 01 78 23 OPERATION AND MAINTENANCE DATA for all air compressors.

c. HVAC control system sequences of operation formatted as indicated.

d. Procedures for the HVAC system start-up, operation and shut-down including the manufacturer's supplied procedures for each piece of equipment, and procedures for the overall HVAC system.

e. As-built HVAC control system detail drawings formatted as indicated.

f. Routine maintenance checklist. Provide the routine maintenance checklist arranged in a columnar format, where the first column lists all installed devices, the second column states the maintenance activity or that no maintenance required, the third column states the frequency of the maintenance activity, and the fourth column is used for additional comments or reference.

g. Qualified service organization list, including at a minimum company name, contact name and phone number.

h. Start-Up Testing Report.

i. Performance Verification Test (PVT) Procedures and Report.

Submit 2 copies of the Operation and Maintenance Instructions, indexed and in booklet form. The Operation and Maintenance Instructions may be submitted as a Technical Data Package.

3.8 TRAINING

Conduct a training course for 8 operating staff members designated by the Government in the maintenance and operation of the system, including specified hardware and software. Conduct 32 hours of training at the project site within 30 days after successful completion of the performance verification test. The Government reserves the right to make audio and visual recordings (using Government supplied equipment)of the training sessions for later use. Provide audiovisual equipment and other training

materials and supplies required to conduct training. A training day is defined as 8 hours of classroom instruction, including two 15 minute breaks and excluding lunchtime, Monday through Friday, during the daytime shift in effect at the training facility.

3.8.1 Training Documentation

Prepare training documentation consisting of:

a. Course Attendee List: Develop the list of course attendees in coordination with and signed by the HVAC shop supervisor.

b. Training Manuals: Provide training manuals which include an agenda, defined objectives for each lesson, and a detailed description of the subject matter for each lesson. When presenting portions of the course material by audiovisuals, deliver copies of those audiovisuals as a part of the printed training manuals.

3.8.2 Training Course Content

For guidance in planning the required instruction, assume that attendees will have a high school education, and are familiar with HVAC systems. During the training course, cover all of the material contained in the Operating and Maintenance Instructions, the layout and location of each controller enclosure, the layout of one of each type of equipment and the locations of each, the location of each control device external to the panels, the location of the compressed air station, preventive maintenance, troubleshooting, diagnostics, calibration, adjustment, commissioning, tuning, and repair procedures. Typical systems and similar systems may be treated as a group, with instruction on the physical layout of one such system. Present the results of the performance verification test and the Start-Up Testing Report as benchmarks of HVAC control system performance by which to measure operation and maintenance effectiveness.

3.8.3 Training Documentation Submittal Requirements

Submit hardcopy training manuals and all training materials on CD-ROM. Provide one hardcopy manual for each trainee on the Course Attendee List and 2 additional copies for archive at the project site. Provide 2 copies of the Course Attendee List with the archival copies. Training Documentation may be submitted as a Technical Data Package.

APPENDIX A

QC CHECKLIST FOR BACNET SYSTEMS

This checklist is not all-inclusive of the requirements of this specification and should not be interpreted as such.

Instructions: Initial each item in the space provided (|____|) verifying that the requirement has been met.

This checklist is for (circle one:)

Pre-Construction QC Checklist Submittal

Post-Construction QC Checklist Submittal

Close-out QC Checklist Submittal

Items verified for Pre-Construction, Post-Construction and Closeout QC Checklist Submittals:

1	All DDC Hardware is numbered on Control System Schematic Drawings.	|____|
2	Signal lines on Control System Schematic are labeled with the signal type.	|____|
3	Local Display Panel (LDP) Locations are shown on Control System Schematic drawings.	|____|

Items verified for Post-Construction and Closeout QC Checklist Submittals:

4	All sequences are performed as specified using DDC Hardware.	|____|
5	Training schedule and course attendee list has been developed and coordinated with shops and submitted.	|____|

Items verified for Closeout QC Checklist Submittal:

6	Final As-built Drawings, including all Points Schedule drawings, accurately represent the final installed system.	|____|
7	Programming software has been submitted for all programmable controllers.	|____|
8	All software has been licensed to the Government.	
9	O&M Instructions have been completed and submitted.	|____|

	QC CHECKLIST FOR BACNET SYSTEMS	
10	Training course has been completed.	|____|
11	All DDC Hardware is installed on a BACnet ASHRAE 135 network using either MS/TP in accordance with Clause 9 or IP in accordance with Annex J.	|____|
12	All DDC Hardware is BTL listed.	|____|
13	Communication between DDC Hardware is only via BACnet using standard services, except as specifically permitted by the specification. Non-standard services have been fully documented in the DDC Hardware Schedule.	|____|
14	Scheduling, Alarming, and Trending have been implemented using the standard BACnet Objects for these functions.	|____|
15	All Properties indicated as required to be Writable are Writable and Overrides have been provided as indicated	|____|
	_____ _____	
	(QC Representative Signature) (Date)	

-- End of Section --

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INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

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SECTION 23 09 13

INSTRUMENTATION AND CONTROL DEVICES FOR HVAC
11/15, CHG 2: 05/21

PART 1 GENERAL

1.1 SUMMARY

This section provides for the instrumentation control system components excluding direct digital controllers, network controllers, gateways etc. that are necessary for a completely functional automatic control system. When combined with a Direct Digital Control (DDC) system, the Instrumentation and Control Devices covered under this section must be a complete system suitable for the control of the heating, ventilating and air conditioning (HVAC) and other building-level systems as specified and indicated.

a. Install hardware to perform the control sequences as specified and indicated and to provide control of the equipment as specified and indicated.

b. Install hardware such that individual control equipment can be replaced by similar control equipment from other equipment manufacturers with no loss of system functionality.

c. Install and configure hardware such that the Government or their agents are able to perform repair, replacement, and upgrades of individual hardware without further interaction with the installing Contractor.

1.1.1 Verification of Dimensions

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

1.1.2 Drawings

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

1.2 RELATED SECTIONS

Related work specified elsewhere.

Section 23 30 00 HVAC AIR DISTRIBUTION

Section 23 05 15 COMMON PIPING FOR HVAC

Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM

1.3 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 500-D	(2018) Laboratory Methods of Testing Dampers for Rating
AMCA 511	(2010; R 2016) Certified Ratings Program for Air Control Devices

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.15	(2018) Cast Copper Alloy Threaded Fittings Classes 125 and 250
ASME B16.34	(2021) Valves - Flanged, Threaded and Welding End

ASTM INTERNATIONAL (ASTM)

ASTM A536	(1984; R 2019; E 2019) Standard Specification for Ductile Iron Castings

FLUID CONTROLS INSTITUTE (FCI)

FCI 70-2	(2021) Control Valve Seat Leakage

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 142	(2007; Errata 2014) Recommended Practice for Grounding of Industrial and Commercial Power Systems - IEEE Green Book

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2020; TIA 22-1; ERTA 1 2022) National Electrical Code
NFPA 90A	(2021) Standard for the Installation of Air Conditioning and Ventilating Systems

UNDERWRITERS LABORATORIES (UL)

UL 5085-3	(2006; Reprint Jan 2022) UL Standard for Safety Low Voltage Transformers - Part 3: Class 2 and Class 3 Transformers

1.4 SUBMITTALS

Submittal requirements are specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

1.5 DELIVERY AND STORAGE

Store and protect products from the weather, humidity, and temperature

variations, dirt and dust, and other contaminants, within the storage condition limits published by the equipment manufacturer.

1.6 INPUT MEASUREMENT ACCURACY

Select, install and configure sensors, transmitters and DDC Hardware such that the maximum error of the measured value at the input of the DDC hardware is less than the maximum allowable error specified for the sensor or instrumentation.

PART 2 PRODUCTS

2.1 EQUIPMENT

2.1.1 General Requirements

All products used to meet this specification must meet the indicated requirements, but not all products specified here will be required by every project. All products must meet the requirements both Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC and this Section.

2.1.2 Operation Environment Requirements

Unless otherwise specified, provide products rated for continuous operation under the following conditions:

2.1.2.1 Pressure

Pressure conditions normally encountered in the installed location.

2.1.2.2 Vibration

Vibration conditions normally encountered in the installed location.

2.1.2.3 Temperature

a. Products installed indoors: Ambient temperatures in the range of 32 to 112 degrees F and temperature conditions outside this range normally encountered at the installed location.

b. Products installed outdoors or in unconditioned indoor spaces: Ambient temperatures in the range of -35 to +151 degrees F and temperature conditions outside this range normally encountered at the installed location.

2.1.2.4 Humidity

10 to 95 percent relative humidity, non-condensing and also humidity conditions outside this range normally encountered at the installed location.

2.2 WEATHERSHIELDS

Provide weathershields constructed of galvanized steel painted white, unpainted aluminum, aluminum painted white, or white PVC.

2.3 WIRE AND CABLE

Provide wire and cable meeting the requirements of NFPA 70 and NFPA 90A in addition to the requirements of this specification and referenced specifications.

2.3.1 Terminal Blocks

For terminal blocks which are not integral to other equipment, provide terminal blocks which are insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanism, suitable for DIN rail mounting, and which have enclosed sides or end plates and partition plates for separation.

2.3.2 Control Wiring for Binary Signals

For Control Wiring for Binary Signals, provide 18 AWG copper or thicker wire rated for 300-volt service.

2.3.3 Control Wiring for Analog Signals

For Control Wiring for Analog Signals, provide 18 AWG or thicker, copper, single- or multiple-twisted wire meeting the following requirements:

a. minimum 2 inch lay of twist

b. 100 percent shielded pairs

c. at least 300-volt insulation

d. each pair has a 20 AWG tinned-copper drain wire and individual overall pair insulation

e. cables have an overall aluminum-polyester or tinned-copper cable-shield tape, overall 20 AWG tinned-copper cable drain wire, and overall cable insulation.

2.3.4 Power Wiring for Control Devices

For 24-volt circuits, provide insulated copper 18 AWG or thicker wire rated for 300 VAC service. For 120-volt circuits, provide 14 AWG or thicker stranded copper wire rated for 600-volt service.

2.3.5 Transformers

Provide UL 5085-3 approved transformers. Select transformers sized so that the connected load is no greater than 80 percent of the transformer rated capacity.

2.4 AUTOMATIC CONTROL VALVES

Provide valves with stainless-steel stems and stuffing boxes with extended necks to clear the piping insulation. Provide valves with bodies meeting ASME B16.34 or ASME B16.15 pressure and temperature class ratings based on the design operating temperature and 150 percent of the system design operating pressure. Unless otherwise specified or indicated, provide valves meeting FCI 70-2 Class IV leakage rating. Provide valves rated for modulating or two-position service as indicated, which close against a differential pressure indicated as the Close-Off pressure and which are

Normally-Open, Normally-Closed, or Fail-In-Last-Position as indicated.

2.4.1 Valve Type

2.4.1.1 Liquid Service 150 Degrees F or Less

Use either globe valves or ball valves except that butterfly valves may be used for sizes 4 inch and larger.

2.4.2 Valve Flow Coefficient and Flow Characteristic

2.4.2.1 Two-Way Modulating Valves

Provide the valve coefficient (Cv) indicated. Provide equal-percentage flow characteristic for liquid service except for butterfly valves. Provide linear flow characteristic for steam service except for butterfly valves.

2.4.2.2 Three-Way Modulating Valves

Provide the valve coefficient (Cv) indicated. Provide linear flow characteristic with constant total flow throughout full plug travel.

2.4.3 Two-Position Valves

Use full line size full port valves with maximum available (Cv).

2.4.4 Globe Valves

2.4.4.1 Liquid Service Not Exceeding 150 Degrees F

a. Valve body and body connections:

(1) valves 1-1/2 inches and smaller: brass or bronze body, with threaded or union ends

(2) valves from 2 inches to 3 inches inclusive: brass, bronze, or iron bodies. 2 inch valves with threaded connections; 2-1/2 to 3 inches valves with flanged connections

b. Internal valve trim: Brass or bronze.

c. Stems: Stainless steel.

d. Provide valves compatible with a solution of 50 percent ethylene or propylene glycol.

2.4.5 Ball Valves

2.4.5.1 Liquid Service Not Exceeding 150 Degrees F

a. Valve body and connections:

(1) valves 1-1/2 inches and smaller: bodies of brass or bronze, with threaded or union ends

(2) valves from 2 inches to 3 inches inclusive: bodies of brass, bronze, or iron. 2 inch valves with threaded connections; valves from 2-1/2 to 3 inches with flanged connections.

b. Ball: Stainless steel or nickel-plated brass or chrome-plated brass.

c. Seals: Reinforced Teflon seals and EPDM O-rings.

d. Stem: Stainless steel, blow-out proof.

e. Provide valves compatible with a solution of 50 percent ethylene or propylene glycol.

2.4.6 Butterfly Valves

Provide butterfly valves which are threaded lug type suitable for dead-end service and modulation to the fully-closed position, with carbon-steel bodies or with ductile iron bodies in accordance with ASTM A536. Provide butterfly valves with non-corrosive discs, stainless steel shafts supported by bearings, and EPDM seats suitable for temperatures from -20 to +250 degrees F. Provide valves with rated Cv of the Cv at 70 percent (60 degrees) open position. Provide valves meeting FCI 70-2 Class VI leakage rating.

2.4.7 Pressure Independent Control Valves (PICV)

Provide pressure independent control valves which include a regulator valve which maintains the differential pressure across a flow control valve. Pressure independent control valves must accurately control the flow from 0-100 percent full rated flow regardless of changes in the piping pressure and not vary the flow more than plus or minus 5 percent at any given flow control valve position when the PICV differential pressure lies between the manufacturer's stated minimum and maximum. The rated minimum differential pressure for steady flow must not exceed 5 psid across the PICV. Provide either globe or ball type valves meeting the indicated requirements for globe and ball valves. Provide valves with a flow tag listing full rated flow and minimum required pressure drop. Provide valves with factory installed Pressure/Temperature ports ("Pete's Plugs") to measure the pressure drop to determine the valve flow rate.

2.4.8 Duct-Coil and Terminal-Unit-Coil Valves

For duct or terminal-unit coils provide control valves with either flare-type or solder-type ends. Provide flare nuts for each flare-type end valve.

2.5 DAMPERS

2.5.1 Damper Assembly

Provide single damper sections with blades no longer than 48 inches and which are no higher than 72 inches and damper blade width of 8 inches or less. When larger sizes are required, combine damper sections. Provide dampers made of steel, or other materials where indicated and with assembly frames constructed of 0.07 inch minimum thickness stainless steel channels with mitered and welded corners. Steel channel frames constructed of 0.06 inch minimum thickness are acceptable provided the corners are reinforced.

a. Flat blades must be made rigid by folding the edges. Blade-operating linkages must be within the frame so that blade-connecting devices within the same damper section must not be located directly in the air

stream.

b. Damper axles must be 1/2 inch minimum, plated steel rods supported in the damper frame by stainless steel or bronze bearings. Blades mounted vertically must be supported by thrust bearings.

c. Provide dampers which do not exceed a pressure drop through the damper of 0.04 inches water gauge at 1000 ft/min in the wide-open position. Provide dampers with frames not less than 2 inch in width. Provide dampers which have been tested in accordance with AMCA 500-D.

2.5.2 Operating Linkages

For operating links external to dampers, such as crank arms, connecting rods, and line shafting for transmitting motion from damper actuators to dampers, provide links able to withstand a load equal to at least 300 percent of the maximum required damper-operating force without deforming. Rod lengths must be adjustable. Links must be brass, bronze, zinc-coated steel, or stainless steel. Working parts of joints and clevises must be brass, bronze, or stainless steel. Adjustments of crank arms must control the open and closed positions of dampers.

2.5.3 Damper Types

2.5.3.1 Flow Control Dampers

Provide parallel-blade or opposed blade type dampers for outside air, return air, relief air, exhaust, face and bypass dampers as indicated on the Damper Schedule. Blades must have interlocking edges. The channel frames of the dampers must be provided with jamb seals to minimize air leakage. Unless otherwise indicated, dampers must meet AMCA 511 Class 1A requirements. [*Am-1]For outdoor air application, dampers must be constructed with extruded aluminum blade and frame and outside[**Am-1] air damper seals must be suitable for an operating temperature range of -40 to +167 degrees F. Dampers must be rated at not less than 2000 ft/min air velocity.

2.5.3.2 Mechanical Rooms and Other Utility Space Ventilation Dampers

Provide utility space ventilation dampers as indicated. Unless otherwise indicated provide AMCA 511 class 3 dampers. Provide dampers rated at not less than 1500 ft/min air velocity.

2.6 SENSORS AND INSTRUMENTATION

Unless otherwise specified, provide sensors and instrumentation which incorporate an integral transmitter. Sensors and instrumentation, including their transmitters, must meet the specified accuracy and drift requirements at the input of the connected DDC Hardware's analog-to-digital conversion.

2.6.1 Analog and Binary Transmitters

Provide transmitters which match the characteristics of the sensor. Transmitters providing analog values must produce a linear 4-20 mAdc, 0-10 Vdc signal corresponding to the required operating range and must have zero and span adjustment. Transmitters providing binary values must have dry contacts rated at 1A at 24 Volts AC.

2.6.2 Network Transmitters

Sensors and Instrumentation incorporating an integral network connection are considered DDC Hardware and must meet the DDC Hardware requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS when used in a BACnet network.

2.6.3 Temperature Sensors

Provide the same sensor type throughout the project. Temperature sensors may be provided without transmitters. Where transmitters are used, the range must be the smallest available from the manufacturer and suitable for the application such that the range encompasses the expected range of temperatures to be measured. The end to end accuracy includes the combined effect of sensitivity, hysteresis, linearity and repeatability between the measured variable and the end user interface (graphic presentation) including transmitters if used.

2.6.3.1 Sensor Accuracy and Stability of Control

2.6.3.1.1 Conditioned Space Temperature

Plus or minus 0.5 degree F over the operating range.

2.6.3.1.2 Unconditioned Space Temperature

a. Plus or minus 1 degree F over the range of 30 to 131 degrees F AND

b. Plus or minus 4 degrees F over the rest of the operating range.

2.6.3.1.3 Duct Temperature

Plus or minus 0.5 degree F

2.6.3.1.4 Outside Air Temperature

a. Plus or minus 2 degrees F over the range of -30 to +130 degrees F AND

b. Plus or minus 1 degree F over the range of 30 to 130 degrees F.

2.6.3.1.5 Heating Hot Water

Plus or minus 2 degrees F.

2.6.3.2 Transmitter Drift

The maximum allowable transmitter drift: 0.25 degrees F per year.

2.6.3.3 Point Temperature Sensors

Point Sensors must be encapsulated in epoxy, series 300 stainless steel, anodized aluminum, or copper.

2.6.3.4 Temperature Sensor Details

2.6.3.4.1 Room Type

Provide the sensing element components within a decorative protective cover suitable for surrounding decor.

2.6.3.4.2 Duct Probe Type

Ensure the probe is long enough to properly sense the air stream temperature.

2.6.3.4.3 Duct Averaging Type

Continuous averaging sensors must be one foot in length for each 1 square foot of duct cross-sectional area, and a minimum length of 5 feet.

2.6.3.4.4 Pipe Immersion Type

For pipes with larger than 3 inch diameter, provide minimum 3 inch immersion. For pipes with less than 3 inch diameter, provide immersion at least half the diameter of the pipe. Provide each sensor with a corresponding pipe-mounted sensor well, unless indicated otherwise. Sensor wells must be stainless steel when used in steel piping, and brass when used in copper piping.

2.6.3.4.5 Outside Air Type

Provide the sensing element rated for outdoor use

2.6.4 Relative Humidity Sensor

Relative humidity sensors must use bulk polymer resistive or thin film capacitive type non-saturating sensing elements capable of withstanding a saturated condition without permanently affecting calibration or sustaining damage. The sensors must include removable protective membrane filters. Where required for exterior installation, sensors must be capable of surviving below freezing temperatures and direct contact with moisture without affecting sensor calibration. When used indoors, the sensor must be capable of being exposed to a condensing air stream (100 percent relative humidity) with no adverse effect to the sensor's calibration or other harm to the instrument. The sensor must be of the wall-mounted or duct-mounted type, as required by the application, and must be provided with any required accessories. Sensors used in duct high-limit applications must have a bulk polymer resistive sensing element. Duct-mounted sensors must be provided with a duct probe designed to protect the sensing element from dust accumulation and mechanical damage. Relative humidity (RH) sensors must measure relative humidity over a range of 0 percent to 100 percent with an accuracy of plus or minus 2 percent. RH sensors must function over a temperature range of 40 to 135 degrees F and must not drift more than 1 percent per year.

2.6.5 Carbon Dioxide (CO2) Sensors

Provide photometric type CO2 sensors with integral transducers and linear output. Carbon dioxide (CO2) sensors must measure CO2 concentrations between 0 to 2000 parts per million (ppm) using non-dispersible infrared (NDIR) technology with an accuracy of plus or minus 50 ppm and a maximum response time of 1 minute. The sensor must be rated for operation at ambient air temperatures within the range of 32 to 122 degrees F and relative humidity within the range of 20 to 95 percent (non-condensing). The sensor must have a maximum drift of 2 percent per year. The sensor chamber must be manufactured with a non-corrosive material that does not affect carbon dioxide sample concentration. Duct mounted sensors must be provided with a duct probe designed to protect the sensing element from

dust accumulation and mechanical damage. The sensor must have a calibration interval no less than 5 years.

2.6.6 Differential Pressure Instrumentation

2.6.6.1 Differential Pressure Sensors

Provide Differential Pressure Sensors with ranges as indicated or as required for the application. Pressure sensor ranges must not exceed the high end range indicated on the Points Schedule by more than 50 percent. The over pressure rating must be a minimum of 150 percent of the highest design pressure of either input to the sensor. The accuracy must be plus or minus 1 percent of full scale. The sensor must have a maximum drift of 2 percent per year

2.6.6.2 Differential Pressure Switch

Provide differential pressure switches with a user-adjustable setpoint which are sized for the application such that the setpoint is between 25 percent and 75 percent of the full range. The over pressure rating must be a minimum of 150 percent of the highest design pressure of either input to the sensor. The switch must have two sets of contacts and each contact must have a rating greater than it's connected load. Contacts must open or close upon rise of pressure above the setpoint or drop of pressure below the setpoint as indicated.

2.6.7 Flow Sensors

2.6.7.1 Airflow Measurement Array (AFMA)

2.6.7.1.1 Airflow Straightener

Provide AFMAs which contain an airflow straightener if required by the AFMA manufacturer's published installation instructions. The straightener must be contained inside a flanged sheet metal casing, with the AFMA located as specified according to the published recommendation of the AFMA manufacturer. In the absence of published documentation, provide airflow straighteners if there is any duct obstruction within 5 duct diameters upstream of the AFMA. Air-flow straighteners, where required, must be constructed of 0.125 inch aluminum honeycomb and the depth of the straightener must not be less than 1.5 inches.

2.6.7.1.2 [*Am-1]Airflow Measurement

Provide high performance, thermal dispersion type air flow measuring station (AFMS). Pitot tubes, arrays, Piezo rings and other differential pressure based devices are not acceptable. AFMS must contain an airflow straightener if required by the AFMS manufacturer's published installation instructions.

a. Resistance to airflow. The resistance to air flow through the AFMS, including the airflow straightener must not exceed 0.08 inch water gauge at an airflow of 2,000 fpm. AFMS construction must be suitable for operation at airflows of up to 5,000 fpm.

b. Outside air temperature. In outside air measurement or in low-temperature air delivery applications, the AFMS must be certified by the manufacturer to be accurate as specified over a temperature range of -20 +120 degrees F.

c. Sensing probe must be constructed of extruded aluminum or of stainless steel tubes. The operating humidity range must be 0 to 99% RH and direct exposure to water must not damage the sensing elements. The sensing elements must be distributed across the duct cross section in the quantity and pattern specified by the published application data of the AFMS manufacturer.

d. AFMSs must have an accuracy of +/- 2% of reading with air velocityrange of 0 to 5,000 fpm.

e. The transmitter must have local LCD display, continuously displaying airflow and temperature and be calibrated for the appropriate operating range based on the required operating range. The output signal must be transmitted in an analog 4-20 mA, 0-10 VDC or 0-5 VDC format. The transmitter must have a local span and zero with field configurable low and high limits and operating temperature range of -20 +120 degrees F.[**Am-1]

2.6.7.2 [*Am-1]Inline Type Electromagnetic Flow Meter

Provide electromagnetic type flow meters as shown on the mechanical sheets and described hereinafter. The flow meter shall have the DC powered electromagnetic coils and electrodes, and measure the induced voltage across the electrodes as a conductive fluid flows through the magnetic fields. The voltage is proportional to the average flow velocity of the fluid and then amplified and processed digitally by the converter to produce the signal for flow rate and totalization. Provide flow meters and transducers located in the pipe as shown on the drawings. Locate meter to provide the most efficient reading point.

a. Flow Range: 0.1 ~ 39.4 feet/seconds
b. Pipe size range: 4" through 8" nominal
c. Flow Direction: Unidirectional or Bidirectional
d. Provide remote transmitter with mounted hardware and the necessary cable
e. Alphanumeric LCD displays total flow, flow rate, flow direction and alarm conditions
f. Output signal: 4-20 mA or 0-10V analog output for flow rate
g. Accuracy: 0.4% of calibrated span for liquids
h. Fluid conductivity: 5 µS/cm minimum
i. Maximum fluid temperature: 140 deg F
j. Ambient temperature range: -4 to 140 deg F
k. Maximum operating pressure: 400PSI
l. Stainless steel electrode and tube with PTFE liner
m. Housing: NEMA 4X
n. Body: Wafer to match piping style or ANSI flanged specification
o. Power Supply Options: 90 to 265 VAC, 45 to 60 Hz, and 35 mA maximum [**Am-1]

2.6.7.3 [*Am-1]Insertion Type Electromagnetic Flow Meter

Provide electromagnetic type flow meters as shown on the mechanical sheets and described hereinafter. The flow meter shall have the DC powered electromagnetic coils and electrodes, and measure the induced voltage across the electrodes as a conductive fluid flows through the magnetic fields. The voltage is proportional to the average flow velocity of the fluid and then amplified and processed digitally by the converter to produce the signal for flow rate and totalization. Provide flow meters and

transducers located in the pipe as shown on the drawings. Locate meter to provide the most efficient reading point. The flow measuring sensors shall be of the hot tap insertion type. The flow meter shall be provided with all necessary accessories including, but not limited to, mounting adapter, sitting, hot tap mount/tools with ball-type isolation valve, and flow transmitter.

a. Flow Range: 0.1 ~ 20 feet/seconds
b. Pipe size range: 4" through 12" nominal
c. Flow Direction: Unidirectional or Bidirectional
d. Provide remote transmitter with mounted hardware and the necessary cable
e. Alphanumeric LCD displays total flow, flow rate, flow direction and alarm conditions
f. Output signal: 4-20 mA or 0-10V analog output for flow rate
g. Accuracy: 1% of calibrated span for liquids
h. Fluid conductivity: 20 µS/cm minimum
i. Maximum fluid temperature: 140 deg F
j. Ambient temperature range: -4 to 140 deg F
k. Maximum operating pressure: 400PSI
l. All wetted metal parts shall be constructed of 316 stainless steel
m. Pressure Drop: 0.1 psi @ 12 feet/seconds
n. Power Supply Options: 20 to 28 VAC, 60 Hz
o. Provide hot tap with ball valve assembly to allow for meter removal

[**Am-1]

2.6.7.4 Flow Switch

Flow switch must have a repetitive accuracy of plus or minus 10 percent of actual flow setting. Switch actuation must be adjustable over the operating flow range, and must be sized for the application such that the setpoint is between 25 percent and 75 percent of the full range.. The switch must have Form C snap-action contacts, rated for the application. The flow switch must have non flexible paddle with magnetically actuated contacts and be rated for service at a pressure greater than the installed conditions. Flow switch for use in sewage system must be rated for use in corrosive environments encountered.

2.6.7.5 Gas Flow Meter

Gas flow meter must be diaphragm or bellows type (gas positive displacement meters) for flows up to 2500 SCFH and axial flow turbine type for flows above 2500 SCFH, designed specifically for natural gas supply metering, and rated for the pressure, temperature, and flow rates of the installation. Meter must have a minimum turndown ratio of 10 to 1 with an accuracy of plus or minus 1 percent of actual flow rate. The meter index must include a direct reading mechanical totalizing register and electrical impulse dry contact output for remote monitoring. The electrical impulse dry contact output must not require field adjustment or calibration. The electrical impulse dry contact output must have a minimum resolution of 100 cubic feet of gas per pulse and must not exceed 15 pulses per second at the design flow.

2.6.8 Electrical Instruments

Provide Electrical Instruments with an input range as indicated or sized for the application. Unless otherwise specified, AC instrumentation must be suitable for 60 Hz operation.

2.6.8.1 Current Transducers

Current transducers must accept an AC current input and must have an accuracy of plus or minus 0.5 percent of full scale. The device must have a means for calibration. Current transducers for variable frequency applications must be rated for variable frequency operation.

2.6.8.2 Current Sensing Relays (CSRs)

Current sensing relays (CSRs) must provide a normally-open contact with a voltage and amperage rating greater than its connected load. Current sensing relays must be of split-core design. The CSR must be rated for operation at 200 percent of the connected load. Voltage isolation must be a minimum of 600 volts. The CSR must auto-calibrate to the connected load or be adjustable and field calibrated. Current sensors for variable frequency applications must be rated for variable frequency operation.

2.6.8.3 Voltage Transducers

Voltage transducers must accept an AC voltage input and have an accuracy of plus or minus 0.25 percent of full scale. The device must have a means for calibration. Line side fuses for transducer protection must be provided.

2.6.9 pH Sensor

The sensor must be suitable for applications and chemicals encountered in water treatment systems of boilers, chillers and condenser water systems. Construction, wiring, fittings and accessories must be corrosion and chemical resistant with fittings for tank or suspension installation. Housing must be polyvinylidene fluoride with O-rings made of chemical resistant materials which do not corrode or deteriorate with extended exposure to chemicals. The sensor must be encapsulated. Periodic replacement must not be required for continued sensor operation. Sensors must use a ceramic junction and pH sensitive glass membrane capable of withstanding a pressure of 100 psig at 150 degrees F. The reference cell must be double junction configuration. Sensor range must be 0 to 12 pH, stability 0.05, sensitivity 0.02, and repeatability of plus or minus 0.05 pH value, response of 90 percent of full scale in one second and a linearity of 99 percent of theoretical electrode output measured at 76 degrees F.

2.6.10 Oxygen Analyzer

Oxygen analyzer must consist of a zirconium oxide sensor for continuous sampling and an air-powered aspirator to draw flue gas samples. The analyzer must be equipped with filters to remove flue air particles. Sensor probe temperature rating must be 815 degrees F. The sensor assembly must be equipped for flue flange mounting.

2.6.11 Carbon Monoxide Analyzer

Carbon monoxide analyzer must consist of an infrared light source in a weather proof steel enclosure for duct or stack mounting. An optical detector/analyzer in a similar enclosure, suitable for duct or stack mounting must be provided. Both assemblies must include internal blower systems to keep optical windows free of dust and ash at all times. The third component of the analyzer must be the electronics cabinet. Automatic flue gas temperature compensation and manual/automatic zeroing

devices must be provided. Unit must read parts per million (ppm) of carbon monoxide in the range of 0 to 300 ppm and the response time must be less than 3 seconds to 90 percent value. Unit measurement range must not exceed specified range by more that 50 percent. Repeatability must be plus or minus 1 percent of full scale with an accuracy of plus or minus 1 percent of full scale.

2.6.12 Vibration Switch

Vibration switch must be solid state, enclosed in a NEMA 250 Type 4 or Type 4X housing with sealed wire entry. Unit must have two independent sets of Form C switch contacts with one set to shutdown equipment upon excessive vibration and a second set for monitoring alarm level vibration. The vibration sensing range must be a true rms reading, suitable for the application. The unit must include either displacement response for low speed or velocity response for high speed application. The frequency range must be at least 3 Hz to 500 Hz. Contact time delay must be 3 seconds. The unit must have independent start-up and running delay on each switch contact. Alarm limits must be adjustable and setpoint accuracy must be plus or minus 10 percent of setting with repeatability of plus or minus 2 percent.

2.6.13 Conductivity Sensor

Sensor must include local indicating meter and must be suitable for measurement of conductivity of water in boilers, chilled water systems, condenser water systems, distillation systems, or potable water systems as indicated. Sensor must sense from 0 to 10 microSeimens per centimeter (µS/cm) for distillation systems, 0 to 100 µS/cm for boiler, chilled water, and potable water systems and 0 to 1000 µS/cm for condenser water systems. Contractor must field verify the ranges for particular applications and adjust the range as required. The output must be temperature compensated over a range of 32 to 212 degrees F. The accuracy must be plus or minus 2 percent of the full scale reading. Sensor must have automatic zeroing and must require no periodic maintenance or recalibration.

2.6.14 NOx Monitor

Monitor must continuously monitor and give local indication of boiler stack gas for NOx content. It must be a complete system designed to verify compliance with the Clean Air Act standards for NOx normalized to a 3 percent oxygen basis and must have a range of from 0 to 100 ppm. Sensor must be accurate to plus or minus 5 ppm. Sensor must output NOx and oxygen levels and binary output that changes state when the NOx level is above a locally adjustable NOx setpoint. Sensor must have normal, trouble and alarm lights. Sensor must have heat traced lines if the stack pickup is remote from the sensor. Sensor must be complete with automatic zero and span calibration using a timed calibration gas system, and must not require periodic maintenance or recalibration.

2.6.15 Temperature Switch

2.6.15.1 Duct Mount Temperature Low Limit Safety Switch (Freezestat)

Duct mount temperature low limit switches (Freezestats) must be manual reset, low temperature safety switches at least 1 foot long per square foot of coverage which must respond to the coldest 18 inch segment with an accuracy of plus or minus 3.6 degrees F. The switch must have a

field-adjustable setpoint with a range of at least 30 to 50 degrees F. The switch must have two sets of contacts, and each contact must have a rating greater than its connected load. Contacts must open or close upon drop of temperature below setpoint as indicated and must remain in this state until reset.

2.6.15.2 Pipe Mount Temperature Limit Switch (Aquastat)

Pipe mount temperature limit switches (aquastats) must have a field adjustable setpoint between 60 and 90 degrees F, an accuracy of plus or minus 3.6 degrees F and a 10 degrees F fixed deadband. The switch must have two sets of contacts, and each contact must have a rating greater than its connected load. Contacts must open or close upon change of temperature above or below setpoint as indicated.

2.6.16 Damper End Switches

Each end switch must be a hermetically sealed switch with a trip lever and over-travel mechanism. The switch enclosure must be suitable for mounting on the duct exterior and must permit setting the position of the trip lever that actuates the switch. The trip lever must be aligned with the damper blade.

End switches integral to an electric damper actuator are allowed as long as at least one is adjustable over the travel of the actuator.

2.7 OUTPUT DEVICES

2.7.1 Actuators

Actuators must be electric (electronic). All actuators must be normally open (NO), normally closed (NC) or fail-in-last-position (FILP) as indicated. Normally open and normally closed actuators must be of mechanical spring return type. Electric actuators must have an electronic cut off or other means to provide burnout protection if stalled. Actuators must have a visible position indicator. Actuators must smoothly and fully open or close the devices to which they are applied. Electric actuators must have a full stroke response time in both directions of 90 seconds or less at rated load. Electric actuators must be of the foot-mounted type with an oil-immersed gear train or the direct-coupled type. Where multiple electric actuators operate from a common signal, the actuators must provide an output signal identical to its input signal to the additional devices. All actuators must be rated for their operating environment. Actuators used outdoors must be designed and rated for outdoor use. Actuators under continuous exposure to water, such as those used in sumps, must be submersible.

2.7.1.1 Valve Actuators

Valve actuators must provide shutoff pressures and torques as indicated on the Valve Schedule.

2.7.1.2 Damper Actuators

Damper actuators must provide the torque necessary per damper manufacturer's instructions to modulate the dampers smoothly over its full range of operation and torque must be at least 6 inch-pounds/1 square foot of damper area for opposed blade dampers and 9 inch-pounds/1 square foot of damper area for parallel blade dampers.

2.7.1.3 Electric Actuators

Each actuator must have distinct markings indicating the full-open and full-closed position Each actuator must deliver the torque required for continuous uniform motion and must have internal end switches to limit the travel, or be capable of withstanding continuous stalling without damage. Actuators must function properly within 85 to 110 percent of rated line voltage. Provide actuators with hardened steel running shafts and gears of steel or copper alloy. Fiber or reinforced nylon gears may be used for torques less than 16 inch-pounds..

a. Two-position actuators must be single direction, spring return, or reversing type. Two position actuator signals may either be the control power voltage or line voltage as needed for torque or appropriate interlock circuits.

b. Modulating actuators must be capable of stopping at any point in the cycle, and starting in either direction from any point. Actuators must be equipped with a switch for reversing direction, and a button to disengage the clutch to allow manual adjustments. Provide the actuator with a hand crank for manual adjustments, as applicable. Modulating actuator input signals can either be a 4 to 20 mAdc or a 0-10 VDC signal.

c. Floating or pulse width modulation actuators are acceptable for non-fail safe applications unless indicated otherwise provided that the floating point control (timed actuation) must have a scheduled re-calibration of span and position no more than once a day and no less than once a week. The schedule for the re-calibration should not affect occupied conditions and be staggered between equipment to prevent falsely loading or unloading central plant equipment.

2.7.2 Relays

Relays must have contacts rated for the intended application, indicator light, and dust proof enclosure. The indicator light must be lit when the coil is energized and off when coil is not energized.

Control relay contacts must have utilization category and ratings selected for the application. Each set of contacts must incorporate a normally open (NO), normally closed (NC) and common contact. Relays must be rated for a minimum life of one million operations.

2.8 MULTIFUNCTION DEVICES

Multifunction devices are products which combine the functions of multiple sensor, user input or output devices into a single product. Unless otherwise specified, the multifunction device must meet all requirements of each component device. Where the requirements for the component devices conflict, the multifunction device must meet the most stringent of the requirements.

2.8.1 Current Sensing Relay Command Switch

The Current Sensing Relay portion must meet all requirements of the Current Sensing Relay input device. The Command Switch portion must meet all requirements of the Relay output device except that it must have at least one normally-open (NO) contact.

Current Sensing Relays used for Variable Frequency Drives must be rated for Variable Frequency applications unless installed on the source side of the drive. If used in this situation, the threshold for showing status must be set to allow for the VFD's control power when the drive is not enabled and provide indication of operation when the drive is enabled at minimum speed.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 General Installation Requirements

Perform the installation under the supervision of competent technicians regularly employed in the installation of DDC systems.

3.1.1.1 Device Mounting Criteria

All devices must be installed in accordance with manufacturer's recommendations and as specified and indicated. Control devices to be installed in piping and ductwork must 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 must not be used except as specified. Spare thermowells must be installed adjacent to each thermowell containing a sensor and as indicated. Devices located outdoors must have a weathershield.

3.1.1.2 Labels and Tags

Match labels and tags to the unique identifiers indicated on the As-Built drawings. Label all enclosures and instrumentation. Tag all sensors and actuators in mechanical rooms. Tag airflow measurement arrays to show flow rate range for signal output range, duct size, and pitot tube AFMA flow coefficient. Tag duct static pressure taps at the location of the pressure tap. Provide plastic or metal tags, mechanically attached directly to each device or attached by a metal chain or wire. Labels exterior to protective enclosures must be engraved plastic and mechanically attached to the enclosure or instrumentation. Labels inside protective enclosures may attached using adhesive, but must not be hand written.

3.1.2 Weathershield

Provide weathershields for sensors located outdoors. Install weathershields such that they prevent the sun from directly striking the sensor and prevent rain from directly striking or dripping onto the sensor. Install weather shields with adequate ventilation so that the sensing element responds to the ambient conditions of the surroundings. When installing weathershields near outside air intake ducts, install them such that normal outside air flow does not cause rainwater to strike the sensor.

3.1.3 Room Instrument Mounting

Mount room instruments, including but not limited to wall mounted non-adjustable space sensor modules and sensors located in occupied spaces, 60 inches above the floor unless otherwise indicated. Install adjustable

devices to be ADA compliant unless otherwise indicated.

3.1.4 Switches

3.1.4.1 Temperature Limit Switch

Provide a temperature limit switch (freezestat) to sense the temperature at the location indicated. Provide a sufficient number of temperature limit switches (freezestats) to provide complete coverage of the duct section but no less than 1 foot in length per square foot of cross sectional area. Install manual reset limit switches in approved, accessible locations where they can be reset easily. Install temperature limit switch (freezestat) sensing elements in a side-to-side (not top-to-bottom) serpentine pattern with the relay section at the highest point and in accordance with the manufacturer's installation instructions.

3.1.4.2 Hand-Off Auto Switches

Wire safety controls such as smoke detectors and freeze protection thermostats to protect the equipment during both hand and auto operation.

3.1.5 Temperature Sensors

Install temperature sensors in locations that are accessible and provide a good representation of sensed media. Installations in dead spaces are not acceptable. Calibrate and install sensors according to manufacturer’s instructions. Select sensors only for intended application as designated or recommended by manufacturer.

3.1.5.1 Room Temperature Sensors

Mount the sensors on interior walls to sense the average room temperature at the locations indicated. Avoid locations near heat sources such as copy machines or locations by supply air outlet drafts. Mount the center of all user-adjustable sensors 5 feet above the finished floor. Non user-adjustable sensors can be mounted as indicated in paragraph ROOM INSTRUMENT MOUNTING.

3.1.5.2 Duct Temperature Sensors

3.1.5.2.1 Probe Type

Place tip of the sensor in the middle of the airstream or in accordance with manufacturer's recommendations or instructions.Provide a gasket between the sensor housing and the duct wall. Seal the duct penetration air tight. When installed in insulated duct, provide enclosure or stand off fitting to accommodate the thickness of duct insulation to allow for maintenance or replacement of the sensor and wiring terminations. Seal the duct insulation penetration vapor tight.

3.1.5.2.2 Averaging Type

Weave the sensing element in a serpentine fashion from side to side perpendicular to the flow, across the duct or air handler cross-section, using durable non-metal supports in accordance with manufacturer's installation instructions. Avoid tight radius bends or kinking of the sensing element. Prevent contact between the sensing element and the duct or air handler internals. Provide a duct access door at the sensor location. The access door must be hinged on the side, factory insulated,

have cam type locks, and be as large as the duct will permit, maximum 18 by 18 inches. For sensors inside air handlers, the sensors must be fully accessible through the air handler's access doors without removing any of the air handler's internals.

3.1.5.3 Immersion Temperature Sensors

Provide thermowells for sensors measuring piping, tank, or pressure vessel temperatures. Locate wells to sense continuous flow conditions. Do not install wells using extension couplings. When installed on insulated piping, provide stand enclosure or stand off fitting to accommodate the thickness of the pipe insulation and allow for maintenance or replacement of the sensor or wiring terminations. Where piping diameters are smaller than the length of the wells, provide wells in piping at elbows to sense flow across entire area of well. Wells must not restrict flow area to less than 70 percent of pipe area. Increase piping size as required to avoid restriction. Provide the sensor well with a heat-sensitive transfer agent between the sensor and the well interior ensuring contact between the sensor and the well.

3.1.5.4 Outside Air Temperature Sensors

Provide outside air temperature sensors on the building's north side with a protective weather shade that does not inhibit free air flow across the sensing element, and protects the sensor from snow, ice, and rain. Location must not be near exhaust hoods and other areas such that it is not influenced by radiation or convection sources which may affect the reading. Provide a shield to shade the sensor from direct sunlight.

3.1.6 Air Flow Measurement Arrays (AFMA)

Locate Outside Air AFMAs downstream from the Outside Air filters.

Install AFMAs with the manufacturer's recommended minimum distances between upstream and downstream disturbances. Airflow straighteners may be used to reduce minimum distances as recommended by the AFMA manufacturer.

3.1.7 Duct Static Pressure Sensors

Locate the duct static pressure sensing tap at 75 percent of the distance between the first and last air terminal units as indicated on the design documents. If the transmitter output is a 0-10Vdc signal, locate the transmitter in the same enclosure as the air handling unit (AHU) controller for the AHU serving the terminal units. If a remote duct static pressure sensor is to be used, run the signal wire back to the controller for the air handling unit.

3.1.8 Relative Humidity Sensors

Install relative humidity sensors in supply air ducts at least 10 feet downstream of humidity injection elements.

3.1.9 Meters

3.1.9.1 Flowmeters

Install flowmeters to ensure minimum straight unobstructed piping for at least 10 pipe diameters upstream and at least 5 pipe diameters downstream

of the flowmeter, and in accordance with the manufacturer's installation instructions.

3.1.10 Dampers

3.1.10.1 Damper Actuators

Provide spring return actuators which fail to a position that protects the served equipment and space on all control dampers related to freeze protection or force protection. For all outside, makeup and relief dampers provide dampers which fail closed. Terminal fan coil units, terminal VAV units, convectors, and unit heaters nay be non-spring return unless indicated otherwise. Do not mount actuators in the air stream. Do not connect multiple actuators to a common drive shaft. Install actuators so that their action seal the damper to the extent required to maintain leakage at or below the specified rate and so that they move the blades smoothly throughout the full range of motion.

3.1.10.2 Damper Installation

Install dampers straight and true, level in all planes, and square in all dimensions. Dampers must move freely without undue stress due to twisting, racking (parallelogramming), bowing, or other installation error. External linkages must operate smoothly over the entire range of motion, without deformation or slipping of any connecting rods, joints or brackets that will prevent a return to it's normal position. Blades must close completely and leakage must not exceed that specified at the rated static pressure. Provide structural support for multi-section dampers. Acceptable methods of structural support include but are not limited to U-channel, angle iron, corner angles and bolts, bent galvanized steel stiffeners, sleeve attachments, braces, and building structure. Where multi-section dampers are installed in ducts or sleeves, they must not sag due to lack of support. Do not use jackshafts to link more than three damper sections. Do not use blade to blade linkages. Install outside and return air dampers such that their blades direct their respective air streams towards each other to provide for maximum mixing of air streams.

3.1.11 Valves

Install the valves in accordance with the manufacturer's instructions.

3.1.11.1 Valve Actuators

Provide spring return actuators on all control valves where freeze protection is required. Spring return actuators for terminal fan coil units, terminal VAV units, convectors, and unit heaters are not required unless indicated otherwise.

3.1.12 Wire and Cable

Provide complete electrical wiring for the Control System, including wiring to transformer primaries. Wire and Cable must be installed without splices between control devices and in accordance with NFPA 70 and NFPA 90A. Instrumentation grounding must 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. Test installed ground rods as specified in IEEE 142. Cables and conductor wires must be tagged at both ends, with the identifier indicated on the shop drawings. Electrical work must be as specified in Section 26 20 00 INTERIOR

DISTRIBUTION SYSTEM and as indicated. Wiring external to enclosures must be run in raceways, except low-voltage control and low-voltage network wiring may be installed as follows:

a. plenum rated cable in suspended ceilings over occupied spaces may be run without raceways

b. nonmetallic-sheathed cables or metallic-armored cables may be installed as permitted by NFPA 70.

Install control circuit wiring not in raceways in a neat and safe manner. Wiring must not use the suspended ceiling system (including tiles, frames or hangers) for support. Where conduit or raceways are required, control circuit wiring must not run in the same conduit/raceway as power wiring over 50 volts. Run all circuits over 50 volts in conduit, metallic tubing, covered metal raceways, or armored cable.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 09 23.02

BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS

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SECTION 23 09 23.02

BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS
02/19, CHG 1: 02/20

PART 1 GENERAL

1.1 SUMMARY

Provide a complete Direct Digital Control (DDC) system, except for the front end which is specified in Section 25 10 10 UTILITY MONITORING AND CONTROL (UMCS) FRONT END AND INTEGRATION, suitable for the control of the heating, ventilating and air conditioning (HVAC) and other building-level systems as specified and shown and in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

1.1.1 Compatibility

Provide systems compatible Honeywell Comfort Point Open Studio BACnet in order to integrate into Ellsworth's Honeywell EBI R500 or newer front end with full read and write capabilities on all of the data points to be monitored. All new DDC control hardware/software must have permission to operate under the current Ellsworth ATO (Authorization to Operate).

[*Am-1]Functionality of local control systems including graphical displays, programming, database and other supervisory features must be fully integrated into the existing front-end currently utilized for the base-wide EMCS. Using third-party front-end software, applications and/or other tools on the existing EMCS server is not acceptable and is strictly prohibited.[**Am-1]

1.1.2 System Requirements

Provide a system meeting the requirements of both Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC and this Section and with the following characteristics:

a. Except for Gateways, the control system must be an open implementation of BACnet technology using ASHRAE 135 as the communications protocol. The system must use standard ASHRAE 135 Objects and Properties. The system must use standard ASHRAE 135 Services exclusively for communication over the network. Gateways to packaged units must communicate with other DDC hardware using ASHRAE 135 exclusively and may communicate with packaged equipment using other protocols. The control system must be installed such that any two devices on the Internetwork can communicate using standard ASHRAE 135 Services.

b. Install and configure control hardware to provide ASHRAE 135 Objects and Properties as indicated and as needed to meet the requirements of this specification.

1.1.3 Verification of Specification Requirements

Review all specifications related to the control system installation and advise the Contracting Officer of any discrepancies before performing any work. If Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC or any other Section referenced in this specification is not included in the

project specifications advise the Contracting Officer and either obtain the missing Section or obtain Contracting Officer approval before performing any work.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 135	(2016) BACnet—A Data Communication Protocol for Building Automation and Control Networks

BACNET INTERNATIONAL (BTL)

BTL Guide	(v.49; 2017) BACnet Testing Laboratory Implementation Guidelines

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 802.3	(2018) Ethernet

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-485	(1998a; R 2012) Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems

U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)

FCC Part 15	Radio Frequency Devices (47 CFR 15)

UNDERWRITERS LABORATORIES (UL)

UL 916	(2015; Reprint Oct 2021) UL Standard for Safety Energy Management Equipment

1.3 DEFINITIONS

For definitions related to this section, see Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

1.4 SUBMITTALS

Submittal requirements related to this Section are specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

PART 2 PRODUCTS

All products used to meet this specification must meet the indicated requirements, but not all products specified here will be required by every project. All products must meet the requirements both Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC and this Section.

2.1 NETWORK HARDWARE

2.1.1 BACnet Router

All BACnet Routers must be BACnet/IP Routers and must perform layer 3 routing of ASHRAE 135 packets over an IP network in accordance with ASHRAE 135 Annex J and Clause 6. The router must provide the appropriate connection to the IP network and connections to one or more ASHRAE 135 MS/TP networks. Devices used as BACnet Routers must meet the requirements for DDC Hardware and devices used as BACnet routers must support the NM-RC-B BIBB.

2.1.2 BACnet Gateways

In addition to the requirements for DDC Hardware, the BACnet Gateway must meet the following requirements:

a. It must perform bi-directional protocol translation from one non-ASHRAE 135 protocol to ASHRAE 135. BACnet Gateways must incorporate a network connection to an ASHRAE 135 network (either BACnet over IP in accordance with Annex J or MS/TP) and a separate connection appropriate for the non-ASHRAE 135 protocol and media.

b. It must retain its configuration after a power loss of an indefinite time, and must automatically return to their pre-power loss state once power is restored.

c. It must allow bi-directional mapping of data between the non-ASHRAE 135 protocol and Standard Objects as defined in ASHRAE 135. It must support the DS-RP-B BIBB for Objects requiring read access and the DS-WP-B BIBB for Objects requiring write access.

d. It must support the DS-COV-B BIBB.

Although Gateways must meet DDC Hardware requirements they are not DDC Hardware and must not be used when DDC Hardware is required.

2.1.3 Ethernet Switch

Ethernet Switches must autoconfigure between 10,100 and 1000 megabits per second (MBPS).

2.2 CONTROL NETWORK WIRING

a. BACnet MS/TP communications wiring must be in accordance with ASHRAE 135. The wiring must use shielded, three wire (twisted-pair with reference) cable with characteristic impedance between 100 and 120 ohms. Distributed capacitance between conductors must be less than 30 pF per foot.

b. Building Control Network Backbone IP Network must use Ethernet media. Ethernet cables must be CAT-5e at a minimum and meet all requirements of IEEE 802.3.

2.3 DIRECT DIGITAL CONTROL (DDC) HARDWARE

2.3.1 General Requirements

All DDC Hardware must meet the following requirements:

a. It must be locally powered and must incorporate a light to indicate the device is receiving power.

b. It must conform to the BTL Guide

c. It must be BACnet Testing Laboratory (BTL) Listed.

d. The Manufacturer's Product Data submittal for each piece of DDC Hardware must include the Protocol Implementation Conformance Statement (PICS) for that hardware as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

e. It must communicate and be interoperable in accordance with ASHRAE 135 and have connections for BACnet IP or MS/TP control network wiring.

f. Other than devices controlling terminal units or functioning solely as a BACnet Router, it must support DS-COV-B, DS-RPM-A and DS-RPM-B BIBBs.

g. Devices supporting the DS-RP-A BIBB must also support the DS-COV-A BIBB.

h. Application programs, configuration settings and communication information must be stored in a manner such that they persist through loss of power:

(1) Application programs must persist regardless of the length of time power is lost.

(2) Configured settings must persist for any loss of power less than 2,500 hours.

(3) Communication information, including but not limited to COV subscriptions, event reporting destinations, Notification Class Object settings, and internal communication settings, must persist for any loss of power less than 2,500 hours.

i. Internal Clocks:

(1) Clocks in DDC Hardware incorporating a Clock must continue to function for 120 hours upon loss of power to the DDC Hardware.

(2) DDC Hardware incorporating a Clock must support the DM-TS-B or DM-UTC-B BIBB.

j. It must have all functionality indicated and required to support the application (Sequence of Operation or portion thereof) in which it is used, including but not limited to providing Objects or Niagara Framework Points as specified and as indicated on the Points Schedule.

k. In addition to these general requirements and the DDC Hardware Input-Output (I/O) Function requirements, all DDC Hardware must also meet any additional requirements for the application in which it is used (e.g. scheduling, alarming, trending, etc.).

l. It must meet FCC Part 15 requirements and have UL 916 or equivalent safety listing.

m. Device must support Commandable Objects to support Override

requirements as detailed in PART 3 EXECUTION

n. User interfaces which allow for modification of Properties or settings must be password-protected.

o. Devices communicating BACnet MS/TP must meet the following requirements:

(1) Must have a configurable Max_Master Property.

(2) DDC Hardware other than hardware controlling a single terminal unit must have a configurable Max_Info_Frames Property.

(3) Must respond to any valid request within 50 msec with either the appropriate response or with a response of "Reply Postponed".

(4) Must use twisted pair with reference and shield (3-wire media) wiring, or twisted pair with shield (2-wire media) wiring and use half-wave rectification.

p. Devices communicating BACnet/IP must use UDP Port 0xBAC0. Devices with configurable UDP Ports must default to 0xBAC0.

q. All Device IDs, Network Numbers, and BACnet MAC addresses of devices must be fully configurable without limitation, except MS/TP MAC addresses may be limited by ASHRAE 135 requirements.

r. DDC Hardware controlling a single terminal unit must have:

(1) Objects (including the Device Object) with an Object Name Property of at least 8 characters in length.

(2) A configurable Device Object Name.

(3) A configurable Device Object Description Property at least 16 characters in length.

s. DDC Hardware controlling a single terminal unit, all Objects (including Device Objects) must:

(1) Have a configurable Object Name Property of at least 12 characters in length.

(2) Have a configurable Object Description Property of at least 24 characters in length.

t. For programmable DDC Hardware, provide and license to the project site all programming software required to program the Hardware in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

u. For programmable DDC Hardware, provide copies of the installed application programs (all software that is not common to every controller of the same manufacturer and model) as source code compatible with the supplied programming software in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. The submitted application program must be the complete application necessary for controller to function as installed and be sufficient to allow replacement of the installed controller with another controller of the same type.

2.3.2 Hardware Input-Output (I/O) Functions

DDC Hardware incorporating hardware input-output (I/O) functions must meet the following requirements:

2.3.2.1 Analog Inputs

DC Hardware analog inputs (AIs) must be implemented using ASHRAE 135 Analog Input Objects and perform analog to digital (A-to-D) conversion with a minimum resolution of 8 bits plus sign or better as needed to meet the accuracy requirements specified in Section 23 09 00. Signal conditioning including transient rejection must be provided for each analog input. Analog inputs must be capable of being individually calibrated for zero and span. Calibration via software scaling performed as part of point configuration is acceptable. The AI must incorporate common mode noise rejection of at least 50 dB from 0 to 100 Hz for differential inputs, and normal mode noise rejection of at least 20 dB at 60 Hz from a source impedance of 10,000 ohms.

2.3.2.2 Analog Outputs

DDC Hardware analog outputs (AOs) must be implemented using ASHRAE 135 Analog Output Objects and perform digital to analog (D-to-A) conversion with a minimum resolution of 8 bits plus sign, and output a signal with a range of 4-20 mAdc or 0-10 Vdc. Analog outputs must be capable of being individually calibrated for zero and span. Calibration via software scaling performed as part of point configuration is acceptable. DDC Hardware with Hand-Off-Auto (H-O-A) switches for analog outputs must provide for overriding the output through the range of 0 percent to 100 percent.

2.3.2.3 Binary Inputs

DDC Hardware binary inputs (BIs) must be implemented using ASHRAE 135 Binary Input Objects and accept contact closures and must ignore transients of less than 5 milli-second duration. Protection against a transient 50VAC must be provided.

2.3.2.4 Binary Outputs

DDC Hardware binary outputs (BOs) must be implemented using ASHRAE 135 Binary Output Objects and provide relay contact closures or triac outputs for momentary and maintained operation of output devices. DDC Hardware with H-O-A switches for binary outputs must provide for overriding the output open or closed.

2.3.2.4.1 Relay Contact Closures

Closures must have a minimum duration of 0.1 second. Relays must provide at least 180V of isolation. Electromagnetic interference suppression must be provided on all output lines to limit transients to 50 Vac. Minimum contact rating must be 0.5 amperes at 24 Vac.

2.3.2.4.2 Triac Outputs

Triac outputs must provide at least 180 V of isolation. Minimum contact rating must be 0.5 amperes at 24 Vac.

2.3.2.5 Pulse Accumulator

DDC Hardware pulse accumulators must be implemented using either an ASHRAE 135 Accumulator Object or an ASHRAE 135 Analog Value Object where the Present_Value is the totalized pulse count. Pulse accumulators must accept contact closures, ignore transients less than 5 msec duration, protect against
transients of 50 VAC, and accept rates of at least 20 pulses per second.

2.3.2.6 ASHRAE 135 Objects for Hardware Inputs and Outputs

The requirements for use of ASHRAE 135 objects for hardware input and outputs includes devices where the hardware sensor or actuator is integral to the controller (e.g. a VAV box with integral damper actuator, a smart sensor, a VFD, etc.)

2.3.3 Local Display Panel (LDP)

The Local Display Panels (LDPs) must be DDC Hardware with a display and navigation buttons or a touch screen display, and must provide display and adjustment of Niagara Framework points or ASHRAE 135 Properties as indicated on the Points Schedule and as specified. LDPs must be either BTL Listed as a B-OD, B-OWS, B-AWS, or be an integral part of another piece of DDC Hardware listed as a B-BC. For LDPs listed as B-OWS or B-AWS, the hardware must be BTL listed and the product must come factory installed with all applications necessary for the device to function as an LDP.

The adjustment of values using display and navigation buttons must be password protected.

2.3.4 Expansion Modules and Tethered Hardware

A single piece of DDC Hardware may consist of a base unit and also:

a. An unlimited number of hardware expansion modules, where the individual hardware expansion modules are designed to directly connect, both mechanically and electrically, to the base unit hardware. The expansion modules must be commercially available as an optional add-on to the base unit.

b. A single piece of hardware connected (tethered) to a base unit by a single cable where the cable carries a proprietary protocol between the base unit and tethered hardware. The tethered hardware must not contain control logic and be commercially available as an optional add-on to the base unit as a single package.

   Note that this restriction on tethered hardware does not apply to sensors or actuators using standard binary or analog signals (not a communications protocol); sensors or actuators using standard binary or analog signals are not considered part of the DDC Hardware.

Hardware capable of being installed stand-alone, or without a separate base unit, is DDC Hardware and must not be used as expansion modules or tethered hardware.

2.3.5 Supervisory Control Requirements

2.3.5.1 Scheduling Hardware

DDC Hardware used for scheduling must meet the following requirements:

a. It must be BTL Listed as a B-BC and support the SCHED-E-B BIBB.

b. It is preferred, but not required, that devices support the DM-OCD-B BIBB on all Calendar and Schedule Objects, such that a front end BTL listed as a B-AWS may create or delete Calendar and Schedule Objects. It is also preferred but not required that devices supporting the DM-OCD-B BIBB accept any valid value for properties of Calendar and Schedule Objects. Note that there are additional requirements in the EXECUTION Part of this Section for Devices which do not support the DM-OCD-B BIBB as specified.

c. The Date_List property of all Calendar Objects must be writable.

d. The Present_Value Property of Schedule must support the following values: 1, 2, 3, 4.

2.3.5.2 Alarm Generation Hardware

Non-Niagara Framework DDC Hardware used for alarm generation must meet the following requirements:

a. Device must support the AE-N-I-B BIBB

b. The Recipient_List Property must be Writable for all Notification Class Objects used for alarm generation.

c. For all Objects implementing Intrinsic Alarming, the following Properties must be Writable:

(1) Time_Delay
(2) High_Limit
(3) Low_Limit
(4) Deadband
(5) Event_Enable
(6) If the issue date of this project specification is after 1 January 2016, Time_Delay_Normal must be writable.

d. It is preferred, but not required, that devices support the DM-OCD-B BIBB on all Notification Class Objects. It is also preferred, but not required that devices supporting the DM-OCD-B BIBB accept any valid value as an initial value for properties of Notification Class Objects.

d. For Event Enrollment Objects used for alarm generation, the following Properties must be Writable:

(1) Event_Parameters
(2) Event_Enable
(3) If the issue date of this project specification is after 1 January 2016, Time_Delay_Normal must be writable.

e. It is preferred, but not required, that devices support the DM-OCD-B BIBB on all Notification Class Objects and Event Enrollment Objects, such that a front end BTL listed as a B-AWS may create or delete

Notification Class Objects and Event Enrollment Objects. It is also preferred, but not required that devices supporting the DM-OCD-B BIBB accept any valid value as an initial value for properties of Notification Class Objects and Event Enrollment Objects. Note that there are additional requirements in the EXECUTION Part of this Section for devices which do not support the DM-OCD-B BIBB as specified.

f. Devices provided to meet the the requirements indicated under "Support for Future Alarm Generation" in the EXECUTION part of this specification must support the AE-N-E-B BIBB.

2.3.5.3 Trending Hardware

DDC Hardware used for collecting trend data must meet the following requirements:

a. Device must support Trend Log or Trend Log Multiple Objects.

b. Device must support the T-VMT-I-B BIBB.

c. Devices provided to meet the EXECUTION requirement for support of Future Trending must support the T-VMT-E-B BIBB.

d. The following properties of all Trend Log or Trend Log Multiple Objects must be present and Writable:
Start_Time
Stop_Time
Log_DeviceObjectProperty
Log Interval Log interval must support an interval of at least 60 minutes duration.

e. Trend Log Objects must support using Intrinsic Reporting to send a BUFFER_FULL event.

f. The device must have a Notification Class Object for the BUFFER_FULL event. The Recipient_List Property must be Writable.

g. Devices must support values of at least 1,000 for Buffer_Size Properties.

h. It is preferred, but not required, that devices support the DM-OCD-B BIBB on all Trend Log Objects, such that a front end BTL listed as a A-AWS may create or delete Trend Log Objects. It is also preferred, but not required that devices supporting the DM-OCD-B BIBB accept any valid value as an initial value for properties of Trend Log Objects. Note that there are additional EXECUTION requirements for devices which do not support the DM-OCD-B BIBB as specified.

PART 3 EXECUTION

3.1 CONTROL SYSTEM INSTALLATION

3.1.1 Building Control Network (BCN)

Install the Building Control Network (BCN) as a single BACnet Internetwork consisting of a single IP network as the BCN Backbone and zero or more BACnet MS/TP networks. Note that in some cases there may only be a single device on the BCN Backbone.

Except as permitted for the non-BACnet side of Gateways, use exclusively ASHRAE 135 networks.

3.1.1.1 Building Control Network IP Backbone

Install IP Network Cabling in conduit. Install Ethernet Switches in lockable enclosures. Install the Building Control Network (BCN) IP Backbone such that it is available at the Facility Point of Connection (FPOC) location as indicated. When the FPOC location is a room number, provide sufficient additional media to ensure that the Building Control Network (BCN) IP Backbone can be extended to any location in the room.

Use UDP port 0xBAC0 for all BACnet traffic on the IP network.

3.1.1.2 BACnet MS/TP Networks

When using MS/TP, provide MS/TP networks in accordance with ASHRAE 135 and in accordance with the ASHRAE 135 figure "Mixed Devices on 3-Conductor Cable with Shield" (Figure 9-1.4 in the 2012 version of ASHRAE 135). Ground the shield at the BACnet Router and at no other point. Ground the reference wire at the BACnet Router through a 100 ohm resistor and do not ground it at any other point. In addition:

a. Provide each segment in a doubly terminated bus topology in accordance with TIA-485.

b. Provide each segment with 2 sets of network bias resistors in accordance with ASHRAE 135, with one set of resistors at each end of the MS/TP network.

c. Use 3 wire (twisted pair and reference) with shield media for all MS/TP media installed inside. Use fiber optic isolation in accordance with ASHRAE 135 for all MS/TP media installed outside buildings, or between multiple buildings.

d. For 18 AWG cable, use segments with a maximum length of 4000 ft. When using greater distances or different wire gauges comply with the electrical specifications of TIA-485.

e. For each controller that does not use the reference wire provide transient suppression at the network connection of the controller if the controller itself does not incorporate transient suppression.

f. Install no more than 32 devices on each MS/TP segment. Do not use MS/TP to MS/TP routers.

g. Connect each MS/TP network to the BCN backbone via a BACnet Router.

h. For BACnet Routers, configure the MS/TP MAC address to 0. Assign MAC Addresses to other devices consecutively beginning at 1, with no gaps.

i. Configure the Max_Master Property of all devices to be 31.

3.1.1.3 Building Control Network (BCN) Installation

Provide a building control network meeting the following requirements:

a. Install all DDC Hardware connected to the Building Control Network.

b. Where multiple pieces of DDC Hardware are used to execute one sequence, install all DDC Hardware executing that sequence on a single MS/TP network dedicated to that sequence.

c. Traffic between BACnet networks must be exclusively via BACnet routers.

3.1.2 DDC Hardware

Install all DDC Hardware that connects to an IP network in lockable enclosure. Install other DDC Hardware that is not in suspended ceilings in lockable enclosures. For all DDC hardware with a user interface, coordinate with site to determine proper passwords and configure passwords into device.

a. Except for zone sensors (thermostats), install all Tethered Hardware within 6 feet of its base unit.

b. Install and configure all BTL-Listed devices in a manner consistent with their BTL Listing such that the device as provided still meets all requirements necessary for its BTL Listing.

c. Install and configure all BTL-Listed devices in a manner consistent with the BTL Device Implementation Guidelines such that the device as provided meets all those Guidelines.

3.1.2.1 Device Identifiers, Network Addresses, and IP addresses

a. Do not use any Device Identifier or Network Number already used by another BACnet system at the project site. Coordinate Device IDs and Network Numbers with the installation.

b. Coordinate device IP addresses with installation.

3.1.2.2 ASHRAE 135 Object Name Property and Object Description Property

Configure the Object_Names and Object_Descriptions properties of all ASHRAE 135 Objects (including Device Objects) as indicated on the Points Schedule (Point Name and Point Description) and as specified. At a minimum:

a. Except for DDC Hardware controlling a single terminal unit, configure the Object_Name and Object_Description properties of all Objects (including Device Objects) as indicated on the Points Schedule and as specified.

b. In DDC Hardware controlling a single terminal unit, configure the Device Object_Name and Device Object_Description as indicated on the Points Schedule and as specified.

When Points Schedule entries exceed the length limitations in the device, notify the RO and provide recommended alternatives for approval.

3.1.2.3 Hand-Off-Auto (H-O-A) Switches

Provide Hand-Off-Auto (H-O-A) switches for all DDC Hardware analog outputs and binary outputs used for control of systems other than terminal units, as specified and as indicated on the Points Schedule. Provide H-O-A switches that are integral to the controller hardware, an external device co-located with (in the same enclosure as) the controller, integral to the

controlled equipment, or an external device co-located with (in the same enclosure as) the controlled equipment.

a. For H-O-A switches integral to DDC Hardware, meet the requirements specified in paragraph DIRECT DIGITAL CONTROL (DDC) HARDWARE.

b. For external H-O-A switches used for binary outputs, provide for overriding the output open or closed.

c. For eternal H-O-A switches used for analog outputs, provide for overriding through the range of 0 percent to 100 percent.

3.1.2.4 Local Display Panels

Provide LDPs to display and override values of ASHRAE 135 Object Properties as indicated on the Points Schedule. Install LDPs displaying points for anything other than a terminal unit in the same room as the equipment. Install LDPs displaying points for only terminal units in a mechanical room central to the group of terminal units it serves. For LDPs using WriteProperty to commandable objects to implement an override, write values with priority 9.

3.1.2.5 MS/TP Slave Devices

Configure all MS/TP devices as Master devices. Do not configure any devices to act as slave devices.

3.1.2.6 Change of Value (COV) and Read Property

a. To the greatest extent possible, configure all devices to support the SubscribeCOV service (the DS-COV-B BIBB). At a minimum, all devices supporting the DS-RP-B BIBB, other than devices controlling only a single terminal unit, must be configured to support the DS-COV-B BIBB.

b. Whenever supported by the server side, configure client devices to use the DS-COV-A BIBB.

3.1.2.7 Engineering Units

Configure devices to use English (Inch-Pound) engineering units as follows:

a. Temperature in degrees F

b. Air or natural gas flows in cubic feet per minute (CFM)

c. Water in gallons per minute (GPM)

d. Differential Air pressures in inches of water column (IWC)

e. Water, steam, and natural gas pressures in PSI

f. Enthalpy in BTU/lb

g. Heating and cooling energy in MBTU (1MBTU = 1,000,000 BTU))

h. Cooling load in tons (1 ton = 12,000 BTU/hour)

i. Heating load in MBTU/hour (1MBTU = 1,000,000 BTU)

j. Electrical Power: kilowatts (kW)

k. Electrical Energy: kilowatt-hours (kWh)

3.1.2.8 Occupancy Modes

Use the following correspondence between value and occupancy mode whenever an occupancy state or value is required:

a. OCCUPIED mode: a value of one
b. UNOCCUPIED mode: a value of two
c. WARM-UP/COOL-DOWN (PRE-OCCUPANCY) mode: a value of three

Note that elsewhere in this Section the Schedule Object is required to also support a value of four, which is reserved for future use. Also note that the behavior of a system in each of these occupancy modes is indicated in the sequence of operation for the system.

3.1.2.9 Use of BACnet Objects

Use only standard non-proprietary ASHRAE 135 Objects and services to accomplish the project scope of work as follows:

a. Use Analog Input or Analog Output Objects for all analog hardware I/O. Do not use Analog Value Object for analog hardware I/O) .

b. Use Binary Input or Binary Output Objects for all binary hardware I/O. Do not use Binary Value Objects for binary hardware I/O.

c. Use Analog Value Objects for analog setpoints.

d. Use Accumulator Objects or Analog Value Objects for pulse inputs.

e. For occupancy modes, use Multistate Value Objects and the correspondence between value and occupancy mode specified in paragraph OCCUPANCY MODES.

f. Use Schedule Objects and Calendar Objects for all scheduling. Use Trend Log Objects or Trend Log Multiple Objects for all trending and Notification Class Objects for trend log upload. Use a combination of Event Enrollment Objects,Intrinsic Alarming, and Notification Class Objects for alarm generation.

f. Use a combination of Niagara Framework Alarm Extensions and Alarm Services, Intrinsic Alarming, and Notification Class Objects for alarm generation.

g. For all other points shown on the Points Schedule as requiring an ASHRAE 135 Object, use the Object type shown on the Points Schedule or, if no Object Type is shown, use a standard Object appropriate to the point.

3.1.2.10 Use of Standard BACnet Services

Except as noted in this paragraph, for all DDC Hardware (including Niagara Frameworks Supervisory Gateways when communicating with non-Niagara Framework DDC Hardware) use Standard BACnet Services as defined in this specification (which excludes some ASHRAE 135 services) exclusively for application control functionality and communication.

DDC Hardware that cannot meet this requirement may use non-standard services provided they can provide identical functionality using Standard BACnet Services when communicating with BACnet devices from a different vendor. When implementing non-standard services, document all non-standard services in the DDC Hardware Schedule as specified and as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

3.1.2.11 Device Application Configuration

a. For every property, setting or value shown on the Points Schedule or otherwise indicated as Configurable, provide a value that is retained through loss of power and can be changed via one or more of:

(1) BACnet services (including proprietary services)

(2) Hardware settings on the device

b. For every property, setting or value in non-Niagara Framework Hardware shown on the Points Schedule or otherwise indicated as Operator Configurable, provide a value that is retained through loss of power and can be changed via one or more of:

(1) A Writable Property of a standard BACnet Object

(2) A Property of a standard BACnet Object that is Writable when Out_Of_Service is TRUE and Out_Of_Service is Writable.

3.1.3 Scheduling, Alarming, Trending, and Overrides

3.1.3.1 Scheduling

Configure schedules in BACnet Scheduling Objects to schedule systems as indicated on the Points Schedule and as specified using the indicated correspondence between value and occupancy mode. If no devices supports both the SCHED-E-B and DM-OCD-B BIBBS for Schedule Objects, provide 5 blank Schedule Objects in DDC Hardware BTL listed as B-BCs and supporting the SCHED-E-B BIBB for later use by the site.

Provide a separate schedule for each AHU including it's associated Terminal Units and for each stand-alone Terminal Unit (those not dependent upon AHU service) or group of stand-alone Terminal Units acting according to a common schedule.

3.1.3.2 Configuration of Alarm Generation

a. Send alarm events as Alarms (not Events).

b. Use the ConfirmedNotification Service for alarm events.

c. For alarm generation, support two priority levels for alarms: critical and non-critical. Configure the Priority of Notification Class Objects to use Priority 112 for critical and 224 for non-critical alarms.

d. Number of Notification Class Objects for Alarm Generation:

(1) If the device implements non-critical alarms, or if any Object in the device supports Intrinsic Alarms, then provide a single

Notification Class Object specifically for (shared by) all non-critical alarms.

(2) If the device implements critical alarms, provide a single Notification Class Object specifically for (shared by) all critical alarms.

(3) If the device implements both critical and non-critical alarms, provide both Notification Class Objects (one for critical, one for non-critical).

(4) If the device controls equipment other than a single terminal unit, provide both Notification Class Objects (one for critical, one for non-critical) even if no alarm generation is required at time of installation.

e. For all intrinsic alarms configure the Limit_Enable Property to set both HighLimitEnable and LowLimitEnable to TRUE. If the specified alarm conditions are for a single-sided alarm (only High_Limit used or only Low_Limit used) assign a value to the unused limit such that the unused alarm condition will not occur.

f. For all objects supporting intrinsic alarming, even if no alarm generation is required during installation, configure the following Properties as follows:

(1) Notification_Class to point to the non-Critical Notification Class Object in that device.

(2) Limit_Enable to enable both the HighLimitEnable and LowLimitEnable

(3) Notify_Type to Alarm

g. Use of alarm generation types:

(1) Only use algorithmic alarm generation when intrinsic alarm generation is not supported by the device or object, or when the specific alarm conditions cannot be implemented using intrinsic alarm generation.

(2) Only use remote alarm generation when the alarm cannot be generated using intrinsic or local algorithmic alarm generation on the device containing the referenced property. If remote alarm generation is used, use the same DDC Hardware for all remote alarm generation within a single sequence.

3.1.3.3 Support for Future Alarm Generation

For every piece of DDC Hardware, support future alarm generation capabilities by supporting either intrinsic or additional algorithmic alarming. Provide one of the following:

a. Support intrinsic alarming for every Object used by the application in that device.

b. Support additional Event_Enrollment Objects. For DDC hardware controlling a single terminal unit, support at least one additional object. Otherwise, support at least 4 additional Objects. Support additional Event_Enrollment Objects via one of the following:

(1) Provide unused Event_Enrollment Objects on that device.

(2) Support the DM-OCD-B BIBB and the creation of sufficient Event_Enrollment Objects on that device.

(3) Provide one or more devices in the IP network that support the AE-N-E-B BIBB and have unused Event_Enrollment Objects.

(4) Provide one or more devices on the IP network that support the AE-N-E-B BIBB, the DM-OCD-B BIBB, and the creation of sufficient Event_Enrollment Objects.

The total number of Event_Enrollment Objects required by the project is the sum of the individual device requirements, and the distribution of Event_Enrollment Objects among devices is not further restricted. (Note this allows a single device to contain many Event_Enrollment Objects satisfying the requirements for multiple devices.)

3.1.3.4 Trend Log Configuration

a. Configure trends in Trend Log or Trend Log Multiple Objects as indicated on the Points Schedule and as specified.

b. Configure all trend logs (including any provided to support future trends) to save data on regular intervals using the BUFFER_FULL event to request trend upload from the front end.

c. Configure Trend Log Objects with a minimum Buffer_Size property value of 1,000 and Trend Log Multiple Objects with a minimum Buffer_Size property value of 1,000 per point trended (for example, a Trend Log Multiple Object used to trend 3 points must have a Buffer_Size Property value of at least 3,000).

d. Configure a Notification Class Object in devices doing trending (including devices supporting future trends) to handle the BUFFER_FULL event.

e. When possible, trend each point using an Object in the device containing the point. When it is necessary to trend using a an Object in another device, all trends not on the same Device as the Object being trended must be on a singe device (i.e. all Trend Log and Trend Log Multiple Objects used for remote trending within a sequence must be on the same device).

f. For each trend log, including any trend logs provided to support future trending, configure the following properties as specified:

(1) Logging_Type: Set to Polling

(2) Stop_When_Full: Set to Wrap Around

(3) Buffer_Size: Set to 400 or greater.

(4) Notification_Threshold: Set to 90 percent of full

(5) Notification_Class: Set to the Notification Class Object in that device

(6) Event_Enable: Set to TRUE

(7) Log_Interval: Set to 15 minutes.

g. Future Trending support. Provide support for future trending:

(1) Provide one or more devices on the Building Control Network Backbone IP network which support both the T-VMT-E-B and DM-OCD-B BIBBs for Trend Log Objects. Provide sufficient devices to support the creation of at least one additional Trend Log Object for every terminal unit plus 4 additional Trend Log Objects for every non-terminal unit.

(2) Provide one additional Trend Log Object for every terminal unit plus 4 additional Trend Log Objects for every non-terminal unit in one or more devices on the Building Control Network Backbone IP network that support the T-VMT-E-B BIBB for later use by the site.

(3) A combination of these two methods is permitted provided the total required number of Trend Log Objects is met.

3.1.3.5 Overrides

Provide an override for each point shown on the Points Schedule as requiring an override.

Unless otherwise approved, provide Commandable Objects to support all Overrides in non-Niagara Framework Supervisory Gateway DDC Hardware. With specific approval from the Contracting Officer, Overrides for points which are not hardware outputs and which are in DDC hardware controlling a single terminal unit may support overrides via an additional Object provided for the override. No other means of implementing Overrides may be used.

a. Where Commandable Objects are used, ensure that WriteProperty service requests with a Priority of 10 or less take precedence over the SEQUENCE VALUE and that WriteProperty service request with a priority of 11 or more have a lower precedence than the SEQUENCE VALUE.

b. For devices implementing overrides via additional Objects, provide Objects which are NOT Written to as part of the normal Sequence of Operations and are Writable when Out_Of_Service is TRUE and Out_Of_Service is Writable. Use this point as an Override of the normal value when Out_Of_Service is TRUE and the normal value otherwise. Note these Objects may be modified as part of the sequence via local processes, but must not be modified by local processes when Out_Of_Service is TRUE.

3.1.4 BACnet Gateways

The requirements in this paragraph do not themselves permit the installation of hardware not meeting the other requirements of this section. Except for proprietary systems specifically indicated in Section 23 09 00, all control hardware installed under this project must meet the requirements of this specification, including the control hardware providing the network interface for a package unit or split system specified under another section. Only use gateways to connect to pre-existing control devices, and to proprietary systems specifically permitted by Section 23 09 00.

3.1.4.1 General Gateway Requirements

Provide BACnet Gateways to connect non-BACnet control hardware in accordance with the following:

a. Configure gateways to map writable data points in the controlled equipment to Writable Properties of Standard Objects as indicated in the Points Schedule and as specified.

b. Configure gateway to map readable data points in the controlled equipment to Readable Properties of Standard Objects as indicated in the Points Schedule and as specified.

c. Configure gateway to support the DS-COV-B BIBB for all points mapped to BACnet Objects.

d. Do not use non-BACnet control hardware for controlling built-up units or any other equipment that was not furnished with factory-installed controls. (Note: A Niagara Framework Supervisory Gateway is BACnet control hardware.)

e. Do not use non-BACnet control hardware for system scheduling functions.

f. Each gateway must communicate with and perform protocol translation for non-BACnet control hardware controlling one and only one package unit or a single non-BACnet system specifically permitted by Section 23 09 00.

g. Connect one network port on the gateway to the Building Control Backbone IP Network or to a BACnet MS/TP network and the other port to the single piece of controlled equipment or the non-BACnet system specifically permitted by Section 23 09 00..

h. For gateways to existing package units or simple split systems, non-BACnet network wiring connecting the gateway to the package unit must not exceed 10 feet in length and must connect to exactly two devices: the controlled equipment (packaged unit) or split system interface and the gateway.

-- End of Section --

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ENERGY MONITORING AND CONTROL SYSTEM (EMCS) FRONT END AND INTEGRATION
02/19

PART 1 GENERAL

1.1 SUMMARY

Integrate new building systems into the existing Energy Monitoring and Control System (EMCS) which performs supervisory monitoring and supervisory control of building control systems and utility control systems using ASHRAE 135 (BACnet). Integrate ASHRAE 135 (BACnet) field control systems installed per Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS as specified.

1.1.1 System Requirements

Provide a EMCS as specified and indicated, and in accordance with the following characteristics:

1.1.1.1 Compatibility

[*AM-1]Provide systems that are fully compatible Honeywell Comfort Point Open Studio BACnet in order to integrate into Ellsworth's Honeywell EBI R500 or newer front end. Functionality of local control systems including graphical displays, programming, database and other supervisory features must be fully integrated into the existing front-end currently utilized for the base-wide EMCS. Using third-party front-end software, applications and/or other tools on the existing EMCS server is not acceptable and is strictly prohibited.

The operation of all mechanical and other building systems controlled and monitored by the local control system must operate as a whole and make no distinction between existing and new control systems. The contractor must be responsible to reconfigure and modify the local control system and programming, control points, graphical displays and database, as necessary, to maintain the settings, level of details, graphical displays and system functionality as currently configured in the base-wide EMCS. The new control system added to and integrated into the base-wide EMCS must operate seamlessly.[**AM-1]

1.1.1.2 General System Requirements

a. The system shall be integrated into the Base wide system. Integration shall provide full read and write capabilities from the base system on all of the data points to be monitored. Integration shall be performed by the Contractor.

b. The system performs supervisory monitoring and control functions including but not limited to Scheduling, Alarm Handling, Trending, Overrides, Report Generation, and Electrical Demand Limiting as specified.

c. The system includes a Graphical User Interface which allows for graphical navigation between systems, graphical representations of

systems, access to real-time data for systems, ability to override points in a system, and access to all supervisory monitoring and control functions.

d. All software used by the EMCS and all software used to install and configure the EMCS is licensed to and delivered to the installation. All licensing costs shall be included by the Contractor, including costs to add points to the base system.

e. Programming software must be provided and be able to integrate with the Base Control Shops laptop computers with an USAF Windows 10 operating system and not conflict with software from other manufacturers, including Honeywell software operating on the same laptop.

f. All necessary documentation, configuration information, configuration tools, programs, drivers, and other software is licensed to and otherwise remains with the Government such that the Government or their agents are able to repair, replace, upgrade, and expand the system without subsequent or future dependence on the Contractor. Software licenses must not require periodic fees and must be valid in perpetuity.

g. Provide sufficient documentation and data, including rights to documentation and data, such that the Government or their agents can execute work to repair, replace, upgrade, and expand the system without subsequent or future dependence on the Contractor.

h. The EMCS interfaces directly to ASHRAE 135, CEA-709.1-D, MODBUS Protocol, MODBUS TCP/IP, OPC DA, and Niagara Framework field control systems as specified and may interface to field control systems using other protocols via an M&C Software protocol driver or a Gateway.

i. For EMCS systems with Monitoring and Control Software functionality implemented in Monitoring and Control (M&C) Controller Hardware, provide sufficient additional controller hardware to support the full capacity requirements as specified.

1.1.1.3 BACnet Requirements

a. The EMCS must communicate using ASHRAE 135 Annex J over an IP network as specified.

b. All communication between the EMCS and ASHRAE 135 field control networks must be via the ASHRAE 135 protocol over the IP network.

c. All communication between the M&C Software and the field control system devices must be via standard ASHRAE 135 services other than PrivateTransfer and ConfirmedPrivateTransfer except as follows:

(1) PrivateTransfer and ConfirmedPrivateTransfer may be used for device configuration and device programming.

(2) PrivateTransfer and ConfirmedPrivateTransfer may be used for communication between the M&C Software and the field control system if and only if both the M&C Software and the field control system devices automatically (without requiring reconfiguration) revert to the use of other standard ASHRAE 135 services when one

of the components is modified or replaced.

1.1.2 General Cybersecurity Requirements

Address cybersecurity in accordance with AF ETL 11-1 and Section [*Am-1] 25 05 11.23[**Am-1] CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS ENERGY MANAGEMENT CONTROL SYSTEM (EMCS)[*Am-1][**Am-1].

1.1.3 Symbols, Definition and Abbreviations

Use symbols, definitions, and engineering unit abbreviations indicated in the contract drawings for displays, submittals and reports. For symbols, definitions and abbreviations not in the contract drawings use terms conforming at a minimum to IEEE Stds Dictionary and the ASHRAE FUN IP, as applicable.

1.1.4 System Units and Accuracy

Use English (inch-pound) units for displays, print-outs and calculations. Perform calculations with an accuracy of at least three significant figures. For displays and printouts present values to at least three significant figures.

1.1.5 Data Packages/Submittals Requirements

Technical data packages consisting of computer software and technical data (meaning technical data which relates to computer software) which are specifically identified in this project and which may be defined/required in other specifications must be delivered strictly in accordance with the CONTRACT CLAUSES and in accordance with the Contract Data Requirements List, DD Form 1423. Data delivered must be identified by reference to the particular specification paragraph against which it is furnished. All submittals not specified as technical data packages are considered shop drawings under the Federal Acquisition Regulation Supplement (FARS) and must contain no proprietary information and must be delivered with unrestricted rights.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 135	(2020; Errata 2021) BACnet—A Data Communication Protocol for Building Automation and Control Networks
ASHRAE FUN IP	(2017) Fundamentals Handbook, I-P Edition

CONSUMER ELECTRONICS ASSOCIATION (CEA)

CEA-709.1-D	(2014) Control Network Protocol Specification
CEA-852-C	(2014) Tunneling Device Area Network Protocols Over Internet Protocol Channels

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41	(1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits
IEEE Stds Dictionary	(2009) IEEE Standards Dictionary: Glossary of Terms & Definitions

MODBUS ORGANIZATION, INC (MODBUS)

MODBUS Protocol	(2012) Modbus Application Protocol Specification; Version 1.1b3
MODBUS TCP/IP	(2006) Modbus Messaging on TCP/IP Implementation Guide; Version V1.0b

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code
NFPA 262	(2019) Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces

OPC FOUNDATION (OPC)

OPC DA	(Ver 3.0; Errata) OPC Data Access (DA)

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-568-C.1	(2009; Add 2 2011; Add 1 2012) Commercial Building Telecommunications Cabling Standard
TIA-606	(2017c) Administration Standard for the Telecommunications Infrastructure
TIA-607	(2015c; Addendum 1 2017) Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises

TRIDIUM, INC (TRIDIUM)

Niagara Framework	(2012) NiagaraAX User's Guide

U.S. AIR FORCE (USAF)

AF ETL 11-1	(2011) Civil Engineer Industrial Control System Information Assurance Compliance

U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)

FCC EMC	(2002) FCC Electromagnetic Compliance Requirements

FCC Part 15 Radio Frequency Devices (47 CFR 15)

UNDERWRITERS LABORATORIES (UL)

UL 60950 (2000; Reprint Oct 2007) Safety of Information Technology Equipment

1.3 DEFINITIONS

The following list of definitions may contain terms not found elsewhere in this Section but are included here for completeness. Some terms are followed with a protocol reference in parenthesis indicating to which protocol the term and definition applies. Inclusion of protocol-specific definitions does not create a requirement to support that protocol, nor does it relax any requirements to support specific protocols as indicated elsewhere in this section.

1.3.1 Alarm Generation

The process of comparing a point value (the point being alarmed) with a pre-defined alarm condition (e.g., a High Limit) and performing some action based on the result of the comparison.

1.3.2 Alarm Handling

See Alarm Routing.

1.3.3 Alarm Routing

Alarm routing is M&C software functionality that starts with a notification that an alarm exists (typically as the output of an Alarm Generation process) and sends a specific message to a specific alarm recipient or device.

1.3.4 Application Generic Controller (AGC)(LonWorks)

A device that is furnished with a (limited) pre-established application that also has the capability of being programmed. Further, the ProgramID and XIF file of the device are fixed. The programming capability of an AGC may be less flexible than that of a General Purpose Programmable Controller (GPPC).

1.3.5 Application Specific Controller (ASC)(LonWorks)

A device that is furnished with a pre-established built in application that is configurable but not re-programmable. An ASC has a fixed factory-installed application program (i.e., Program ID) with configurable settings.

1.3.6 BACnet (BACnet)

The term BACnet is used in two ways. First meaning the BACnet Protocol Standard - the communication requirements as defined by ASHRAE 135 including all annexes and addenda. The second to refer to the overall technology related to the ASHRAE 135 protocol.

1.3.7 BACnet Advanced Application Controller (B-AAC)(BACnet)

A hardware device BTL Listed as a B-AAC. A control device which contains

BIBBs in support of scheduling and alarming but otherwise has limited resources relative to a B-BC. It may be intended for specific applications and supports some degree of programmability.

1.3.8 BACnet Advanced Operator Workstation (B-AWS)(BACnet)

Monitoring and Control (M&C) Software BTL Listed as an Advanced Operator Workstation and includes the ability to manage scheduling, alarming and trending in an open manner. The B-AWS is the advanced operator's window into a BACnet system. It is primarily used to monitor the performance of a system and to modify parameters that affect the operation of a system.

1.3.9 BACnet Application Specific Controller (B-ASC)(BACnet)

A hardware device BTL Listed as a B-ASC. A controller with limited resources relative to a B-AAC. It is intended for use in a specific application and supports limited programmability.

1.3.10 BACnet Building Controller (B-BC)(BACnet)

A hardware device BTL Listed as a B-BC. A general-purpose, field-programmable device capable of carrying out a variety of building automation and control tasks including control and monitoring via direct digital control (DDC) of specific systems and data storage for trend information, time schedules, and alarm data. Like the other BTL Listed controller types (B-AAC, B-ASC etc.) a B-BC device is required to support the server ("B") side of the ReadProperty and WriteProperty services, but unlike the other controller types it is also required to support the client ("A") side of these services. Communication between controllers requires that one of them support the client side and the other support the server side, so a B-BC is often used when communication between controllers is needed.

1.3.11 BACnet Internetwork (BACnet)

Two or more BACnet networks connected with BACnet routers. In a BACnet Internetwork, there exists only one message path between devices.

1.3.12 BACnet Interoperability Building Blocks (BIBBs) (BACnet)

A BIBB is a collection of one or more BACnet services intended to define a higher level of interoperability. BIBBs are combined to build the BACnet functional requirements for a device in a specification. Some BIBBs define additional requirements (beyond requiring support for specific services) in order to achieve a level of interoperability. For example, the BIBB DS-V-A (Data Sharing-View-A), which would typically be used by an M&C client, not only requires the client to support the ReadProperty Service, but also provides a list of data types (Object / Properties) which the client must be able to interpret and display for the user.

1.3.13 BACnet Operator Display (B-OD)(BACnet)

A hardware device BTL Listed as a B-OD. A basic operator interface with limited capabilities relative to a B-OWS. It is not intended to perform direct digital control. The B-OD profile could be used for wall-mounted LCD devices, displays affixed to BACnet devices; hand-held terminals or other very simple user interfaces.

1.3.14 BACnet Operator Workstation (B-OWS)(BACnet)

Monitoring and Control (M&C) Software BTL Listed as a B-OWS. An operator interface with limited capabilities relative to a B-AWS. The B-OWS is used for monitoring and basic control of a system, but differs from a B-AWS in that it does not support configuration activities, nor does it provide advanced troubleshooting capabilities.

1.3.15 BACnet Smart Actuator (B-SA)(BACnet)

A hardware device BTL Listed as a B-SA. A simple control output device with limited resources; it is intended for specific applications.

1.3.16 BACnet Smart Sensor (B-SS)(BACnet)

A hardware device BTL Listed as a B-SS. A simple sensing device with very limited resources.

1.3.17 BACnet Testing Laboratories (BTL)(BACnet)

Established by BACnet International to support compliance testing and interoperability testing activities and consists of BTL Manager and the BTL Working Group (BTL-WG). BTL also publishes Implementation Guidelines.

1.3.18 BACnet Testing Laboratories (BTL) Listed (BACnet)

A device that has been certified by BACnet® Testing Laboratory. Devices may be certified to a specific device profile, in which case the certification indicates that the device supports the required capabilities for that profile, or may be certified as "other".

1.3.19 Binary

A two-state system or signal; for example one where an "ON" condition is represented by a high signal level and an "OFF" condition is represented by a low signal level. 'Digital' is sometimes used interchangeably with 'binary'.

1.3.20 Broadcast

Unlike most messages, which are intended for a specific recipient device, a broadcast message is intended for all devices on the network.

1.3.21 Building Control Network (BCN)

The network used by the Building Control System. Typically the BCN is a BACnet ASHRAE 135 or LonWorks CEA-709.1-D network installed by the building control system contractor.

1.3.22 Building Control System (BCS)

One type of Field Control System. A control system for building electrical and mechanical systems, typically HVAC (including central plants) and lighting. A BCS generally uses Direct Digital Control (DDC) Hardware and generally does NOT include its own local front end.

1.3.23 Building Point of Connection (BPOC)

A FPOC for a Building Control System. (This term is being phased out of

use in preference for FPOC but is still used in some specifications and criteria. When it was used, it typically referred to a piece of control hardware. The current FPOC definition typically refers instead to IT hardware).

1.3.24 Commandable (BACnet)

A point (Object) is commandable if its Present_Value Property is writable and it supports the optional Priority_Array Property. This functionality is useful for Overrides.

1.3.25 Configuration Property (LonWorks)

Controller parameter used by the application which is usually set during installation/testing and seldom changed. For example, the P and I settings of a P-I control loop. Also see 'Standard Configuration Property Type (SCPT)'.

1.3.26 Control Logic Diagram

A graphical representation of control logic for multiple processes that make up a system.

1.3.27 Device Object (BACnet)

Every BACnet device requires one Device Object, whose properties represent the network visible properties of that device. Every Device Object requires a unique Object_Identifier number on the BACnet Internetwork. This number is often referred to as the device instance or device ID.

1.3.28 Explicit Messaging (LonWorks)

A non-standard and often vendor (application) specific method of communication between devices.

1.3.29 Field Point Of Connection (FPOC)

The FPOC is part of the EMCS IP network and acts as the point of connection between the EMCS IP Network and the field control IP network. The FPOC is an IT device such as a switch, IP router, or firewall, typically managed by the site IT staff. (Note that the field control IP network may consist of a single IP device, or that integration may require installation of a field control network IP device.)

1.3.30 Field Control Network

The network used by a field control system.

1.3.31 Field Control System (FCS)

A building control system or utility control system.

1.3.32 Fox Protocol (Niagara Framework)

The protocol used for communication between components in the Niagara Framework. By default, Fox uses TCP port 1911.

1.3.33 Gateway

A device that translates from one protocol to another. Devices that change only the transport mechanism of the protocol - "translating" from LonWorks over TP/FT-10 to LonWorks over IP for example - are not gateways as the underlying protocol (data format) does not change. Gateways are also called Communications Bridges or Protocol Translators.

1.3.34 General Purpose Programmable Controller (GPPC) (LonWorks)

Unlike an ASC or AGC, a GPPC is not furnished with a fixed application program and does not have a fixed ProgramID or XIF file. A GPPC can be (re-)programmed, usually using vendor-supplied software. When a change to the program affects the external interface (and the XIF file) the ProgramID will change.

1.3.35 Internetwork (BACnet)

See BACnet Internetwork.

1.3.36 JACE (Niagara Framework)

Java Application Control Engine. See Niagara Framework Supervisory Gateway.

1.3.37 LonWorks (LonWorks)

The term used to refer to the overall technology related to the CEA-709.1-D protocol (sometimes called "LonTalk"), including the protocol itself, network management, interoperability guidelines and products.

1.3.38 Modbus

A basic protocol for control network communications generally used in utility control systems. The Modbus protocol standard is maintained by The Modbus Organization.

1.3.39 Master-Slave/Token Passing (MS/TP)(BACnet)

Data link protocol as defined by the BACnet standard. Multiple speeds (data rates) are permitted by the BACnet MS/TP standard.

1.3.40 Monitoring and Control (M&C) Software

The EMCS 'front end' software which performs supervisory functions such as alarm handling, scheduling and data logging and provides a user interface for monitoring the system and configuring these functions.

1.3.41 Network (BACnet)

In BACnet, a portion of the control internetwork consisting of one or more segments of the same media connected by repeaters. Networks are separated by routers.

1.3.42 Network Variable (LonWorks)

See 'Standard Network Variable Type (SNVT)'.

1.3.43 Network Configuration Tool (LonWorks)

The software used to configure the control network and set device configuration properties. This software creates and modifies the control network database (LNS Database).

1.3.44 Niagara Framework

A set of hardware and software specifications for building and utility control owned by Tridium Inc. and licensed to multiple vendors. The Framework consists of front end (M&C) software, web based clients, field level control hardware, and engineering tools. While the Niagara Framework is not adopted by a recognized standards body and does not use an open licensing model, it is sufficiently well-supported by multiple HVAC vendors to be considered a de-facto Open Standard.

1.3.45 Niagara Framework Supervisory Gateway (Niagara Framework)

DDC Hardware component of the Niagara Framework. A typical Niagara architecture has Niagara specific supervisory gateways at the IP level and other (non-Niagara specific) controllers on field networks (TP/FT-10, MS/TP, etc.) beneath the Niagara supervisory gateways. The Niagara specific controllers function as a gateway between the Niagara framework protocol (Fox) and the field network beneath. These supervisory gateways may also be used as general purpose controllers and also have the capability to provide a web-browser based user interface.

Note that different vendors refer to this component by different names. The most common name is "JACE"; other names include "EC-BOS", "FX-40", and "UNC".

1.3.46 Node (LonWorks)

A device that communicates using the CEA-709.1-D protocol and is connected to a CEA-709.1-D network.

1.3.47 Object (BACnet)

A BACnet Object. The concept of organizing BACnet information into standard components with various associated Properties. Examples include Analog Input objects and Binary Output objects.

1.3.48 Override

To change the value of a point outside of the normal sequence of operation where this change has priority over the sequence. An override can be accomplished in one of two ways: The point itself may be Commandable and written to with a priority or there may be a separate point on the controller for the express purpose of implementing the override.

Typically this override is from the Energy Monitoring and Control System (EMCS) Monitoring and Control (M&C) Software. Note that this definition is not standard throughout industry.

1.3.49 Point, Calculated

A value within the M&C Software that is not a network point but has been calculated by logic within the software based on the value of network points or other calculated points. Calculated points are sometimes called

virtual points or internal points.

1.3.50 Point, Network

A value that the M&C Software reads from or writes to a field control network.

1.3.51 Polling

A requested transmission of data between devices, rather than an unrequested transmission such as Change-Of-Value (COV) or Binding where data is automatically transmitted under certain conditions.

1.3.52 Program ID (LonWorks)

An identifier (number) stored in the device (usually EEPROM) that identifies the node manufacturer, functionality of device (application & sequence), transceiver used, and intended device usage.

1.3.53 Property (BACnet)

A BACnet Property - a data element associated with an Object. Different Objects have different Properties, for example an Analog Input Object has a Present_Value Property (which provides the value of the underlying hardware analog input), a High_Limit Property (which contains a high limit for alarming), as well as other properties.

1.3.54 Protocol Implementation Conformance Statement (PICS)(BACnet)

A document, created by the manufacturer of a device, which describes which potions of the BACnet standard are implemented by a given device.

1.3.55 Repeater

A device that connects two control network segments and retransmits all information received on one side onto the other.

1.3.56 Router (BACnet)

A device that connects two or more BACnet networks and controls traffic between the networks by retransmitting signals received from one network onto another based on the signal destination. Routers are used to subdivide an internetwork and to control bandwidth usage.

1.3.57 Segment

A 'single' section of a control network that contains no repeaters or routers. There is generally a limit on the number of devices on a segment, and this limit is dependent on the topology/media and device type. For example, a TP/FT-10 segment with locally powered devices is limited to 64 devices, and a BACnet MS/TP segment is limited to 32 devices.

1.3.58 Service (BACnet)

A BACnet Service. A defined method for sending a specific type of data between devices. Services are always defined in a Client-Server manner, with a Client initiating a Service request and a Server Executing the Service. Some examples are ReadProperty (a client requests a data value from a server), WriteProperty (a client writes a data value to a server),

and CreateObject (a client requests that a server create a new object within the server device).

1.3.59 Standard BACnet Object/Property/Service (BACnet)

BACnet Objects, Properties, or Services that are standard Objects, Properties, or Services enumerated and defined in ASHRAE 135. Clause 23 of ASHRAE 135 defines methods to extend ASHRAE 135 to non-standard or proprietary information. Standard BACnet Objects/Properties/Services specifically exclude any vendor specific extensions.

1.3.60 Standard Network Variable Type (SNVT) (LonWorks)

Pronounced 'snivet'. A standard format type (maintained by LonMark International) used to define data information transmitted and received by the individual nodes. The term SNVT is used in two ways. Technically it is the acronym for Standard Network Variable Type, and is sometimes used in this manner. However, it is often used to indicate the network variable itself (i.e., it can mean "a network variable of a standard network variable type"). In general, the intended meaning should be clear from the context.

1.3.61 Supervisory Controller

A controller implementing a combination of supervisory logic (global control strategies or optimization strategies), scheduling, alarming, event management, trending, web services or network management. Note this is defined by use; many supervisory controllers have the capability to also directly control equipment.

1.3.62 Supervisory Gateway

A device that is both a supervisory controller and a gateway.

1.3.63 EMCS Network

An IP network connecting multiple field control systems to the Monitoring and Control Software using one or more of: LonWorks (CEA-709.1-D and CEA-852-C), BACnet (ASHRAE 135 Annex J), MODBUS Protocol, MODBUS TCP/IP or OPC DA.

1.3.64 Utility Control System (UCS)

One type of field control system. Used for control of utility systems such as an electrical substation, sanitary sewer lift station, water pump station, etc. Building controls are excluded from a UCS, however it is possible to have a Utility Control System and a Building Control System in the same facility, and for those systems to share components such as the FPOC. A UCS may include its own local front-end.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES and TABLE 1. PROJECT SEQUENCING:

SD-02 Shop Drawings

EMCS Contractor Design Drawings; G, AE

EMCS Contractor Design Drawings as a single complete package: 2 hard copies and 1 copy on CDROM. Submit hardcopy drawings on ISO A1 34 by 22 inches or A3 17 by 11 inches sheets, and electronic drawings in both PDF and AutoCAD format.

Draft As-Built Drawings; G RO

Draft As-Built Drawings as a single complete package: 2 hard copies and 1 copy on CDROM. Submit hardcopy drawings must on ISO A1 34 by 22 inches or A3 17 by 11 inches sheets, and electronic drawings in both PDF and AutoCAD format.

Final As-Built Drawings; G RO

Final As-Built Drawings as a single complete package: 2 hard copies and 1 copy on CDROM. Submit hardcopy drawings on ISO A1 34 by 22 inches or A3 17 by 11 inches sheets, and electronic drawings in both PDF and AutoCAD format.

SD-03 Product Data

Product Data Sheets; G, AE

Computer Software; G RO

The most recent versions of all computer software provided under this specification delivered as a Technical Data Package. Submit the user manuals for all software delivered for this project with the software.

[*Am-1][**Am-1]

SD-05 Design Data

EMCS IP Network Bandwidth Usage Estimate

Four copies of the EMCS IP Network Bandwidth Usage Estimate.

SD-06 Test Reports

Pre-Construction QC Checklist; G RO

Four copies of the Pre-Construction QC Checklist.

Post-Construction QC Checklist; G RO

Four copies of the Post-Construction QC Checklist.

PVT Phase I Procedures; G RO

Four copies of the PVT Phase I Procedures. The PVT Procedures may be submitted as a Technical Data Package.

PVT Phase I Report; G RO

Four copies of the PVT Phase I Report. The PVT Phase I Report may be submitted as a Technical Data Package.

PVT Phase II Report; G RO

Four copies of the PVT Phase II Report. The PVT Phase II Report may be submitted as a Technical Data Package.

SD-10 Operation and Maintenance Data

Operation and Maintenance (O&M) Instructions; G RO

Four bound O&M Instructions and 1 copy of the Instructions in PDF format on optical disc. Index and tab bound instructions. Submit instructions in PDF form as a single PDF file, or as multiple PDF files with a PDF file table of contents containing links to the other files. O&M Instructions may be submitted as a Technical Data Package.

Preventive Maintenance Work Plan; G RO

Four copies of the Preventive Maintenance Work Plan. The Preventive Maintenance Work Plan may be submitted as a Technical Data Package.

Basic Training Documentation; G RO

Training manuals for Basic Training delivered for each trainee on the Course Attendance List with two additional copies delivered for archival at the project site. Submit two copies of the Course Attendance List with the archival copies. The Basic Training Documentation may be submitted as a Technical Data Package.

Advanced Training Documentation; G RO

One set of training manuals delivered for each trainee on the Course Attendance List with two additional copies delivered for archival at the project site. Submit two copies of the Course Attendance List with the archival copies. The Advanced Training Documentation may be submitted as a Technical Data Package.

Refresher Training Documentation; G RO

One set of training manuals delivered for each trainee on the Course Attendance List with two additional copies delivered for archival at the project site. Submit two copies of the Course Attendance List with the archival copies. The Refresher Training Documentation may be submitted as a Technical Data Package.

SD-11 Closeout Submittals

Closeout QC Checklist; G RO

Four copies of the Closeout QC Checklist.

1.5 PROJECT SEQUENCING

TABLE I. PROJECT SEQUENCING specifies the sequencing of submittals as specified in paragraph SUBMITTALS (denoted by an 'S' in the 'TYPE' column)

and activities as specified in PART 3 EXECUTION (denoted by an 'E' in the 'TYPE' column).

1.5.1 Sequencing for Submittals

The sequencing specified for submittals is the deadline by which the submittal must be initially submitted to the Government. Following submission there will be a Government review period as specified in Section 01 33 00 SUBMITTAL PROCEDURES. If the submittal is not accepted by the Government, revise the submittal and resubmit it to the Government within 14 days of notification that the submittal has been rejected. Upon re-submittal there will be an additional Government review period. If the submittal is not accepted the process repeats until the submittal is accepted by the Government.

1.5.2 Sequencing for Activities

The sequencing specified for activities indicates the earliest the activity may begin.

1.5.3 Abbreviations

In TABLE I the abbreviation AAO is used for 'after approval of' and 'ACO' is used for 'after completion of'.

TABLE I. PROJECT SEQUENCING

ITEM	TYPE	DESCRIPTION	SEQUENCING (START OF ACTIVITY or DEADLINE FOR SUBMITTAL)
1		Notice to proceed	
3	S	Design Drawings	after #1
4	S	Product Data Sheets	after #1
5	S	EMCS IP Network Bandwidth Usage Estimate	after #1
6	S	Pre-construction QC Checklist	after #1
7	E	Install EMCS	AAO #2 thru #6
8	E	Start-Up and Start-Up Testing	ACO #7
9	S	Post-Construction QC Checklist	ACO #8

TABLE I. PROJECT SEQUENCING

ITEM	TYPE	DESCRIPTION	SEQUENCING (START OF ACTIVITY or DEADLINE FOR SUBMITTAL)
10	S	Computer Software	ACO #8
11	S	Start-Up and Start-Up Testing Report	ACO #8
12	S	Draft As-Built Drawings	ACO #8
13	S	PVT Phase I Procedures	before scheduled start of #14 and AAO #11
14	E	PVT Phase I	AAO #13 and #12
15	S	PVT Phase I Report	ACO #14
16	S	Preventive Maintenance Work Plan	AAO #11
17	S	O&M Instructions	AAO #11
18	S	Basic Training Documentation	AAO #11 and before scheduled start of #19
19	E	Basic Training (PVT Phase II)	AAO #16, #17 and #18
20	S	PVT Phase II Report	ACO #19
21	S	Final As-Built Drawings	AAO #20
22	S	Advanced Training Documentation	before schedule start of #23 and AAO #18
23	E	Advanced Training	ACO #19, AAO #22, and no later than 60 days ACO #19
24	S	Refresher Training Documentation	before #25 and AAO #18 and #22
25	E	Refresher Training	ACO #19 and AAO #24
26	S	Closeout QC Checklist	ACO #23

1.6 QUALITY CONTROL (QC) CHECKLISTS

The Contractor's Chief Quality Control (QC) Representative must complete the QC Checklist in APPENDIX A, and must submit the Pre-Construction QC

Checklist, Post-Construction QC Checklist and Closeout QC Checklist as specified. The QC Representative must verify each item in the Checklist and initial in the provided area to indicate that the requirement has been met. The QC Representative must sign and date the Checklist prior to submission to the Government.

The APPENDIX A QC Checklist is available as an editable file at http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-10-10.

1.7 OPERATION AND MAINTENANCE (O&M) INSTRUCTIONS

Provide EMCS Operation and Maintenance Instructions which include:

a. Procedures for the EMCS system start-up, operation and shut-down.

b. Final As-Built drawings.

c. Routine maintenance checklist, arranged in a columnar format: The first column listing all installed devices, the second column stating the maintenance activity or stating that no maintenance required, the third column stating the frequency of the maintenance activity, and the fourth column providing any additional comments or reference.

d. Qualified service organization list including points of contact with phone numbers.

e. Start-Up and Start-Up Testing Report.

f. Performance Verification Test (PVT) Procedures and Reports.

PART 2 PRODUCTS

2.1 EQUIPMENT REQUIREMENTS

2.1.1 Product Certifications

For computing devices, as defined in FCC Part 15, supplied as part of the EMCS provide devices which are certified to comply with the requirements of Class B computing devices.

2.1.2 Product Sourcing

For units of the same type of equipment, provide products of a single manufacturer. For each major component of equipment provide equipment with the manufacturer's name and the model and serial number in a conspicuous place. For materials and equipment, provide new standard unmodified products of a manufacturer regularly engaged in the manufacturing of such products.

2.1.3 General Requirements

Provide components that meet the following requirements:

a. Portions of the data communications equipment system installed in unconditioned spaces must operate properly in an environment with ambient temperatures between 32 and 120 degrees F and ambient relative humidity between 10 percent and 90 percent noncondensing.

b. Components must accept 100 to 125 volts AC (Vac), 60 Hz, single phase, three wire with a three-pronged, dedicated circuit outlet or be provided with a transformer to meet the component's power requirements.

c. The equipment must meet the requirements of NFPA 70, UL 60950, NFPA 262, FCC EMC, and FCC Part 15.

2.1.4 Nameplates

Provide nameplates of laminated plastic identifying the function, network address, if applicable, and identifier of the device. Laminated plastic must be at least 0.125 inch thick, white with black center core. Nameplates must be a minimum of 1 by 3 inch with minimum 0.25 inch high engraved block lettering.

2.1.5 Product Data Sheets

For all products (equipment) specified in PART 2 and supplied under this contract, submit copies of all manufacturer catalog cuts and specification sheets to indicate conformance to product requirements. For Monitoring and Control (M&C) Software also include the PICS verifying BTL Listing as a B-AWS.

2.2 CONTROL HARDWARE

2.2.1 Control Protocol Routers

2.2.1.1 BACnet/IP Router

Provide BACnet/IP Routers which perform layer 3 routing of ASHRAE 135 packets over an IP network in accordance with ASHRAE 135 Annex J and Clause 6. The router must provide the appropriate connection to the IP network and connections to a ASHRAE 135 MS/TP network. Devices used as BACnet/IP Routers must be BTL Listed and must support the Network Management-Router Configuration-B (NM-RC-B) BIBB.

2.3 COMPUTER SOFTWARE

2.3.1 Monitoring and Control (M&C) Software

The existing monitoring and control (M&C) software communicates via Honeywell Comfort Point Open Studio BACnet. Verify that the software meets the specifications in this section. Notify the Government if modifications are required and gain written approval prior to making such modifications.

Contractor shall integrate the new building control system including set up of the Scheduling, Alarming, Trending, Graphical System Display, and System Display Editor functionality. Other specified M&C functionality may be implemented in the same software package or in additional software packages. As specified in PART 3 EXECUTION, the M&C Software must operate on Server hardware, except that software for Point Calculations and Demand Limiting may operate on M&C Controller Hardware.

2.3.1.1 M&C Software License

License the M&C Software as specified. Use of multiple copies of M&C Server software working in coordination and sharing data between them such that they function as, and appear to an operator as, a single M&C Server

is permitted to meet these requirements.

2.3.1.1.1 Network Points

Provide M&C Software and licensing to support no less than 50,000 network points, and to be capable of expansion.

2.3.1.1.2 Web Clients

Provide M&C Software and licensing to support no less than 10 simultaneous web clients with no limit on the total number of web clients. M&C Software must be capable of expansion to support no less than 30 simultaneous web clients.

2.3.1.1.3 Calculations

Provide M&C Software and licensing to support no less than one calculated point for every ten network points (see "Network Points" above).

2.3.1.1.4 Other Points

For installations using M&C Software installed on M&C Controller Hardware (as opposed to Server hardware), provide additional licensing to support additional network points for the communications between portions of the M&C Software installed on different hardware. For example, if the Calculations requirement is performed by M&C Software installed on Controller hardware, the M&C Software must be licensed for additional network points to cover the network points required for communication between the Controller hardware and the Server hardware.

2.3.1.1.5 Alarming

Provide M&C Software and licensing to support the handling (routing) of alarms for no less than 10,000 ASHRAE 135 Alarm Event Notifications.

2.3.1.1.6 Trending

Provide M&C Software and licensing to support a minimum of 8,000 simultaneous trends.

2.3.1.2 M&C Software Update Licensing

In addition to all other licensing requirements, provide M&C Software licensing which includes licensing of the following software updates for a period of no less than 5 years:

a. Security and bug-fix patches issued by the M&C Software manufacturer.

b. Security patches to address any vulnerability identified in the National Vulnerability Database at http://nvd.nist.gov with a Common Vulnerability Scoring System (CVSS) severity rating of MEDIUM or higher.

2.3.1.3 Point Information

Every point, both network and internal, in the M&C Software must contain the following fields:

2.3.1.3.1 Name

A configurable name used for identification of the point within the M&C Software.

2.3.1.3.2 Description

A configurable description of no less than 80 alpha-numeric characters.

2.3.1.3.3 Value

A field containing the current point value.

2.3.1.3.4 Units

A field containing the engineering units.

2.3.1.3.5 Source

A field identifying the source of the point. For network points, this is generally the address or identification of the field device (for example, the Domain-Subnet-Node address for LonWorks field control devices or the DeviceID for BACnet devices).

2.3.1.4 Passwords

Provide M&C software with user-based access control to M&C functionality. The M&C Software must recognize at least 100 separate users and have at least 4 levels of user permissions. User permission levels (from most restrictive to most permissive) must include:

a. Permission Level 1: View-only access to the graphical user interface.

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 override points and set up (configure) alarms, schedules and demand limiting.

d. Permission Level 4: Permission Level 3 plus create and modify Graphical System Displays using the System Display Editor.

Passwords must not be displayed and must not be logged. The system must maintain a disk file on the server hardware logging all activity of the system. This file must maintain, as a minimum, a record of all operators logged onto the system, alarm acknowledgments, commands issued and all database modifications. If the file format is not plain ASCII text, provide a means to export or convert the file to plain ASCII text. Provide a mechanism for archiving the log files for long term record storage.

2.3.1.5 Graphical System Displays

Provide graphical displays consisting of building system (air handler units, VAV boxes, chillers, cooling towers, boilers, etc.) graphic displays. Data associated with an active display must be updated at least once every 5 seconds.

2.3.1.5.1 Navigation Scheme

System graphic displays of building systems and points must be hierarchical displays using a building-to-equipment point-and-click navigation scheme which allows navigation from a garrison-wide display, through a building-wide display to the individual units. Each display must show the building name and number. Each display must show system wide data such as outside air temperature and humidity in the case of an HVAC system application.

a. For each Building or Building Sub-Area display, show the building foot print and basic floor plan, and clearly show and distinguish between the individual zones and the equipment serving each zone and space. Show all space sensor and status readings, as applicable, for the individual zones such as space temperature, humidity, occupancy status, etc. Show the locations of individual pieces of monitored and controlled equipment.

b. For each equipment display show a one-line diagram control schematic or 3-dimensional representation of the individual pieces of equipment using the symbols and M&C point data types as specified. Use different colors and textures to indicate various components and real time data. Use consistent color and texture meanings across all displays.

c. Provide displays which clearly distinguish between the following point data types and information:

(1) Real-time data.

(2) Other user-entered data.

(3) Devices in alarm (unacknowledged).

(4) Out-of-range, bad, or missing data.

(5) Points which are overridden.

2.3.1.5.2 Navigation Commands

Provide system displays which 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 must be usable from any operator workstation with individual operator passwords as specified.

2.3.1.6 Alarms

a. The creation, modification, and handling (routing) of alarms must be fully accessible and fully adjustable from the graphical user interface.

b. Alarm Data. Alarm data to be displayed and stored must include:

(1) Identification of alarm including building, system (or sub-system), and device name.

(2) Date and time to the nearest second of occurrence.

(3) Alarm type:

(a) Unreliable: Indicates that the source device has failed due to the sensing device or alarm parameter being out-of-range or bad data.

(b) High Alarm.

(c) Low Alarm.

(4) Current value or status of the alarm point, including engineering units.

(5) Alarm limits, including engineering units.

(6) Alarm priority.

(7) Alarm Message: A unique message with a field of at least 60 characters. Assignment of messages to an alarm must be an operator editable function.

(8) Acknowledgement status of the alarm including the time, date and user of acknowledgement.

2.3.1.7 Trending

a. The M&C Software must include a graphical display for trend configuration, creation and deletion accessible through the graphical user interface. Each trend must be user-configurable for:

(1) Point to trend.

(2) Sampling interval: Adjustable between 1 second and 1 hour.

(3) Start and Stop Time of Trend: Start and stop times determined by one or more of the following methods:

(a) Start time and stop time.

(b) Start time and duration.

(c) Start time and number of samples.

2.3.1.8 Report Generation

Integrate to make M&C Software capable of generating, saving and printing reports. Dynamic operation of the system must not be interrupted to generate a report. The report must contain the time and date when the samples were taken, and the time and date when the report was generated.

2.3.1.9 Custom Report Generation

2.3.1.9.1 M&C Software Override Report

Points overridden by the M&C Software, including time overridden, and identification of operator overriding the point.

2.3.1.9.2 Run Time Reports

A report totalizing the accumulated run time of individual pieces of equipment. The operator must be able to define equipment groupings and to generate reports based on these groupings.

2.3.1.9.3 Chiller usage Report

A report of the operation of each chiller as shown on a daily and monthly basis, for each of at least 10 discrete loading levels. The report must include:

a. Average power for the month at each level in kW.

b. Total monthly energy use in kWh at each level.

c. Total monthly energy use in kWh for the chiller (all levels).

d. Total daily run hours at each level.

e. Total Monthly run hours at each level.

2.3.1.9.4 Device Offline Report

A report listing all offline devices in all ASHRAE 135 building control systems integrated to the M&C Software.

PART 3 EXECUTION

3.1 DRAWINGS AND CALCULATIONS

3.1.1 EMCS IP Network Bandwidth Usage Estimate

Provide a EMCS IP Network Bandwidth Usage Estimate for a small, medium or large systems. In this estimate account for field control systems using all M&C required protocols and the integration of field control system via gateways. Define all assumptions used to create the estimate, including but not limited to: Trending, fast trends for commissioning, schedules, alarms, display of system graphics and load shedding.

3.1.2 EMCS Contractor Design Drawings

Revise and update the Contract Drawings to include details of the system design and all hardware components, including Contractor provided and Government furnished components. Details to be shown on the Design Drawing include:

a. The logical structure of the network, including but not limited to the location of all Control Hardware (including but not limited to each BACnet Supervisory Controller, Control Protocol Gateway, Control Protocol Router, and Monitoring and Control (M&C) Controller).

b. Manufacturer and model number for each piece of Control Hardware.

c. Physical location for each piece of Control Hardware.

d. Version and service pack number for all software and for all Control Hardware firmware.

3.1.3 As-Built Drawings

Prepare draft as-built drawings consisting of Points Schedule drawings for the entire EMCS, including Points Schedules for each Gateway, and an updated Design Drawing including details of the actual installed system as it is at the conclusion of Start-Up and Start-Up Testing. Provide As-Built Drawings which include details of all hardware components, including Contractor provided and Government furnished components. In addition to the details shown in the design drawings, the as-built drawing must include:

a. IP address(es) and Ethernet MAC address(es) as applicable for each piece of Control Hardware (including but not limited to each BACnet Supervisory Controller, Control Protocol Gateway, Control Protocol Router, and Monitoring and Control (M&C) Controller).

b. IP address and Ethernet MAC address for each computer server, workstation, and networked printer.

c. List of ports, protocols and network services for each device connected to an IP network.

d. Network Addresses: ASHRAE 135 address and Object_ID of the Device Object for all Control Hardware using ASHRAE 135.

Prepare Draft As-Built Drawings upon the completion of Start-Up and Start-Up Testing and Final As-Built Drawings upon completion of PVT Phase II.

3.2 INSTALLATION OF EQUIPMENT

3.2.1 Wire and Cable Installation

Install system components and appurtenances in accordance with NFPA 70, manufacturer's instructions and as indicated. Provide necessary interconnections, services, and adjustments required for a complete and operable signal distribution system. Label components in accordance with TIA-606. Firestop Penetrations in fire-rated construction in accordance with Section 07 84 00 FIRESTOPPING. Install conduits, outlets and raceways in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Install wiring in accordance with TIA-568-C.1 and as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Mark wiring terminal blocks and outlets in accordance with TIA-606. Do not install non-fiber-optic cables in the same cable tray, utility pole compartment, or floor trench compartment with power cables. Properly secure and install neat in appearance cables not installed in conduit or raceways.

3.2.2 Grounding

Install signal distribution system ground in accordance with TIA-607 and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Connect equipment racks to the electrical safety ground.

3.2.3 Power-Line Surge Protection

Protect equipment connected to ac circuits must be protected against or withstand power-line surges. Provide equipment protection which meets the requirements of IEEE C62.41. Do not use fuses for surge protection.

3.2.4 IP Addresses

For all Control Hardware requiring an IP address on the EMCS IP Network, coordinate with the representative identified by the Contracting Officer to obtain IP addresses.

3.2.5 Computer Hardware and Software

3.2.5.1 Software Installation

Install software as follows:

a. BACnet Network Browser: Install the BACnet Network Browser software as indicated. Install the BACnet Network Browser on workstation hardware.

b. Monitoring and Control Software: Install the monitoring and control (M&C)software as shown. Except for M&C Software performing Point Calculations, install M&C Software on server or controller hardware. Install M&C Software performing Point Calculations or Electrical Peak Demand Limiting on either server hardware or Monitoring and Control (M&C) Controller Hardware. Install M&C Software in a manner consistent with its B-AWS listing such that it provides all functionality of a B-AWS.

Install M&C Software to support the number of points required in PART 2 (PRODUCTS), regardless of the number of points integrated under this project specification. Note that meeting this requirement may entail the installation of unused hardware or spare point licenses to accommodate the full number of required points in order to allow for integration of future field control systems.

Where software requires connection to an IP device outside of the EMCS, coordinate with the Contracting Officer to obtain access to a Government-furnished server to provide the needed functionality. Do not connect to any device outside of the EMCS without explicit permission from the Contracting Officer.

3.3 INTEGRATION OF FIELD CONTROL SYSTEMS

Fully integrate the field control systems in accordance with the following three step sequence and as specified and shown.

STEP 1: Install and configure Control Hardware as necessary to connect the field control system to the FPOC, which is part of the EMCS IP network, and to provide control protocol translation and supervisory functionality.

STEP 2: Add Field Control System to M&C Software: Perform system discovery, system database merges, or any other actions necessary to allow M&C Software access to the field control system.

STEP 3: Configure M&C Software to provide monitoring and control of the field control system, including but not limited to the creation of system displays and the configuration of scheduling, alarming, and trending.

3.3.1 Integration Step 1: Install Control Hardware

Install Control Hardware as specified at the FPOC location as shown to connect the field control system to the EMCS IP network via the FPOC and, if necessary, to provide control protocol translation and supervisory functionality. Coordinate all connections and other activities related to an FPOC with the Contracting Officer. Depending on the field control system media and protocol this must be accomplished through one of the following:

a. Connect the existing field control network hardware at the FPOC location to the FPOC.

b. Install a Control Protocol Router connected to both the field control network and the FPOC.

In addition, for integration of field control systems via ASHRAE 135, also install a BACnet Supervisory Controller as needed to implement scheduling, alarming and trending in the field control system. The BACnet supervisory controller may be the same device as the control protocol gateway or router.

3.3.1.1 Installation of Control Protocol Router

If there is not an existing connection between the FPOC and the field control network, install a BACnet/IP Router to connect the field control network to the FPOC. Install additional field control system network media as needed to connect the Router to the field control system.

3.3.1.2 Installation of BACnet Supervisory Controller

If required for implementation of scheduling, alarming and trending, install a BACnet Supervisory Controller connected to the building control system IP network and configure it to provide scheduling, alarming and trending functions for the field control system. When the BACnet Supervisory Controller is the same device as a control protocol router or gateway, install it in accordance with the installation requirements for a router or gateway.

3.3.2 Integration Step 2: Add Field Control System to M&C Software

Perform system discovery, system database merges, or any other actions necessary to allow M&C Software access to points and data in the field control system.

3.3.2.1 Integration of Field Control Systems Via ASHRAE 135

Use the M&C Software to fully discover the field control system. Full discovery of a field control system includes but is not limited to discovery of all ASHRAE 135 devices, all standard ASHRAE 135 Objects and Properties of each device, and all standard ASHRAE 135 services supported by each device.

3.3.2.2 Integration of Field Control Systems Via Other (non-ASHRAE 135) Protocols

Perform all actions necessary to make all points as shown on the Points Schedule from the field control system available in the M&C Software.

3.3.3 Integration Step 3: Configure M&C Software

Configure M&C Software to provide monitoring and control of the field control system, including but not limited to the creation of system displays and the configuration of scheduling, alarming, and trending.

3.3.3.1 Configure M&C Software Communication

Create and configure points and establish network communication between M&C Software and Field Control Systems as specified to support M&C Software functionality:

a. Update points on currently active displays via polling as necessary to meet M&C Software display refresh requirements.

b. Send points used for overrides to the device receiving the override as shown on the Points Schedule. For BACnet systems write operator overrides with a priority of 8 and demand limiting overrides with a priority of 10.

c. For Notification Class Objects used for Alarms, configure the Recipient_List Property to point to the appropriate M&C Software process. Use the ConfirmedEventNotification service for events from ASHRAE 135 field control systems used for alarms.

3.3.3.2 Configure M&C Software Functionality

Fully configure M&C Software functionality using the M&C Software capabilities specified in PART 2 of this Section.

a. Create System Displays including overrides, as shown on the Points Schedule and as specified. Label all points on displays with the point name as shown on the Points Schedule. Configure user permissions for access to and executions of action using graphic pages. Coordinate user permissions with the Controls HVAC shop supervisor.

b. Configure alarm handling as shown on the Points Schedule, as shown on the Alarm Routing Schedule, and as specified. Create and configure Objects in BACnet Supervisory Controllers and in the field control system to support alarming as shown on the Points Schedule and as specified. Alarm events with priority 112 are critical and events with priority 224 are non-critical. For alarm events with other priorities, treat events with priorities of 200 or above as non-critical, and all others as critical. For alarms requiring notification via text message or e-mail, configure the alarm notification to use the specified Government furnished server to send the alarm notification.

c. Configure scheduling as indicated and as shown on the points schedule. Create and configure Schedule Objects in BACnet Supervisory Controllers or in the field control system.

Create and configure displays for configuration of Schedule Objects in the field control system. Label schedules and scheduled points with full English-language descriptors. Provide a separate configuration capability for each schedule. A single configuration display may be used to configured multiple schedules, provided that each schedule is separately configurable from the display.

d. Create and configure Trend Objects in BACnet Supervisory Controllers and in the field control system as shown on the Points Schedule and as specified. Trend points at 15 minute intervals.

   Create and configure displays for creation and configuration of trends and for display of all trended points.

e. Configure Demand Limiting as shown on the Demand Limit Schedule and Points Schedule and as specified.

f. Configure M&C Software standard reports.

3.4 START-UP AND START-UP TESTING

Test all equipment and perform all other tests necessary to ensure the system is installed and functioning as specified. Prepare a Start-Up and Start-Up Testing Report documenting all tests performed and their results and certifying that the system meets the requirements specified in the contract documents.

3.5 PERFORMANCE VERIFICATION TEST (PVT)

3.5.1 PVT Phase I Procedures

Provide PVT Procedures which include:

a. Network bandwidth usage and available bandwidth (throughput) measurements. Network bandwidth usage must reference the normal usage network Bandwidth Calculations.

b. Test System Reaction during PVT: The total system response time from initiation of a control action command from the workstation, to display of the resulting status change on the workstation must not exceed 20 seconds under system normal heavy load conditions assuming a zero response time for operation of the node's control device.

c. Verification of IP Connectivity.

d. Verification of configuration of M&C Software functionality.

3.5.2 PVT Phase I

Demonstrate compliance of the control system with the contract documents. Using test plans and procedures previously approved by the Government, demonstrate all physical and functional requirements of the project. Upon completion of PVT Phase I and as specified, prepare and submit the PVT Phase I Report documenting all tests performed during the PVT and their results. In the PVT report, include all tests in the PVT Procedures and any other testing performed during the PVT. Document failures and repairs with test results.

3.5.3 PVT Phase II

Include Basic Training as part of PVT Phase II. Failures or deficiencies of the EMCS during Basic Training are considered PVT failures. Upon completion of PVT Phase II, and as specified, prepare and submit the PVT Phase II Report documenting any failures which occurred and repairs performed during PVT Phase II.

3.6 MAINTENANCE AND SERVICE

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 EMCS operating as specified, and accepted by the Government, and other services as specified. Perform work in compliance with manufacturer's recommendations and industry standards. Provide technical support via telephone during regular working hours.

3.6.1 Work Coordination

Schedule and arrange work to cause the least interference with the normal Government business and mission. In those cases where some interference may be essentially unavoidable, coordinate with the Government to minimize the impact of the interference, inconvenience, equipment downtime, interrupted service and personnel discomfort.

3.6.2 Work Control

Upon completion of work on a system or piece of equipment, that system or piece of equipment must be free of missing components or defects which would prevent it from functioning as originally intended and designed. Replacements must conform to the same specifications as the original equipment. During and at completion of work, do not allow debris to spread unnecessarily into adjacent areas nor accumulate in the work area itself.

3.6.3 Working Hours

Working hours are from 6:30 A.M. to 4:00 P.M. local time Mondays through Fridays except Federal holidays.

3.6.4 Replacement, Modernization, Renovation

The Government may replace, renovate, or install new equipment as part of the EMCS at Government expense and by means not associated with this contract without voiding the system warranty. Replaced, improved, updated, modernized, or renovated systems and equipment interfaced to the system may be added to the Contractor's maintenance and service effort as a modification.

3.6.5 Access To EMCS Equipment

Access to EMCS equipment must be in accordance with the following:

a. Coordinate access to facilities and arrange that they be opened and closed during and after the accomplishment of the work effort. For access to a controlled facility contact the Government for assistance.

b. The Government may provide keys for access to EMCS equipment where the Government determines such key issuance is appropriate. Establish and implement methods of ensuring that keys issued by the Government are not lost or misplaced, are not used by unauthorized persons, and are not duplicated.

c. The Government may provide passwords or issue Common Access Cards (CAC) for access to EMCS computer equipment where the Government

determines such issuance is appropriate. Establish and implement methods of ensuring that passwords and Common Access Cards issued by the Government are not used by unauthorized persons.

3.6.6 Records, Logs, and Progress Reports

Keep records and logs of each task, and organize cumulative chronological records for each major component, and for the complete system. Maintain a continuous log for the EMCS. Keep complete logs and be available for inspection on site, demonstrating that planned and systematic adjustments and repairs have been accomplished for the EMCS.

3.6.7 Preventive Maintenance Requirements

Prepare a Preventive Maintenance Work Plan as specified.

3.6.7.1 Preventive Maintenance Work Plan

Prepare a Preventive Maintenance Work Plan detailing all required preventive maintenance. Obtain Government approval of the Work Plan as specified in paragraph PROJECT SEQUENCING. Strictly adhere to the approved work plan to facilitate Government verification of work. If it is necessary to reschedule maintenance, make a written request to the Government detailing the reasons for the proposed change at least five days prior to the originally scheduled date. Scheduled dates will be changed only with the prior written approval of the Government.

3.6.7.2 Semiannual Maintenance

Perform the following Semiannual Maintenance as specified:

a. Perform data backups on all Server Hardware.

b. Run system diagnostics and correct diagnosed problems.

c. Perform fan checks and filter changes for EMCS hardware.

d. Perform all necessary adjustments on printers.

e. Resolve all outstanding problems.

f. Install new ribbons, ink cartridges and toner cartridges into printers, and ensure that there is at least one spare ribbon or cartridge located at each printer.

3.6.7.3 Maintenance Procedures

3.6.7.3.1 Maintenance Coordination

Coordinate any scheduled maintenance event that may result in component downtime with the Government as follows, where time periods are measured as actual elapsed time from beginning of equipment off-line period, including working and non-working hours:

a. For non-redundant computer server hardware, provide 14 days notice, components must be off-line for no more than 8 hours.

b. For redundant computer server hardware, provide 7 days notice, components must be off-line for no more than 36 hours.

c. For active (powered) control hardware, provide 14 days notice, components must be off-line for no more than 6 hours.

d. For cabling and other passive network hardware, provide 21 days notice, components must be off-line for no more than 12 hours.

3.6.7.3.2 Software/Firmware

Software/firmware maintenance includes application programs, and files required for the proper operation of the EMCS regardless of storage medium. User (project site) developed software is not covered by this contract, except that the EMCS software/firmware must be maintained to allow user creation, modification, deletion, and proper execution of such user-developed software as specified. Perform diagnostics and corrective reprogramming as required to maintain total EMCS operations as specified. Back up software before performing any computer hardware and software maintenance. Do not modify any parameters without approval from the Government. Properly document any approved changes and additions, and update the appropriate manuals.

3.6.8 Service Call Reception

a. A Government representative will advise the Contractor by phone or in person of all maintenance and service requests, as well as the classification of each based on the definitions specified. A description of the problem or requested work, date and time notified, location, classification, and other appropriate information will be placed on a Service Call Work Authorization Form by the Government.

b. Submit procedures for receiving and responding to service calls 24 hours per day, seven days a week, including weekends and holidays and during regular working hours. Provide a single telephone number for receipt of service calls during regular working hours; service calls are to be considered received at the time and date the telephone call is placed by the authorized Government representative.

c. Separately record each service call request, as received on the Service Call Work Authorization form and complete the Service Call Work Authorization form for each service call. Include the following information in the completed form: 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.

d. Respond to each service call request within two working hours. Provide the status of any item of work within four hours of the inquiry during regular working hours, and within 16 hours after regular working hours or as needed to meet the Equipment Repair requirements as specified.

3.6.9 Service Call Work Warranty

Provide a 1 year unconditional warranty on service call work which includes labor and material necessary to restore the equipment involved in the initial service call to a fully operable condition. In the event that service call work causes damage to additional equipment, restore the

system to full operation without cost to the Government. Provide response times for service call warranty work equivalent to the response times required by the initial service call.

3.6.10 System Modifications

Make recommendations for system modification in writing to the Government. Do not make system modifications without prior approval of the Government. Incorporate any modifications made to the system into the Operations and Maintenance Instructions, and any other documentation affected. Make available to the Government software updates for all software furnished under this specification during the life of this contract. Schedule at least one update near the end of the contract period, at which time make available the latest released version of all software provided under this specification, and install and validate it upon approval by the Government.

3.7 TRAINING

Conduct training courses for designated personnel in the maintenance, service, and operation of the system as specified, including specified hardware and software. The training must be oriented to the specific system provided under this contract. Provide audiovisual equipment and other training material and supplies required for the training. When training is conducted at Government facilities, the Government reserves the right to record the training sessions for later use. A training day is defined as 8 hours of classroom instruction, excluding lunchtime, Monday through Friday, during the daytime shift in effect at the training facility. For guidance in planning the required instruction, the Contractor should assume that attendees will be tradesmen such as electricians or boiler operators. Obtain approval of the training schedule from the Government at least 30 days prior to the first day of training.

3.7.1 Training Documentation

Prepare and submit one set of Training manuals for each of Basic Training Documentation, Advanced Training Documentation, and Refresher Training Documentation, where each set of documentation consists of:

3.7.1.1 Course Attendance List

Course Attendance List developed in coordination with and signed by the Controls HVAC shop supervisor.

3.7.1.2 Training Manuals

Include an agenda, defined objectives for each lesson, and a detailed description of the subject matter for each lesson in the training manuals. Where portions of the course material are presented by audiovisuals, include copies of those audiovisuals as a part of the printed training manuals.

3.7.2 Basic Training

Conduct a Basic Training course at the project site on the installed system for a period of no less than 5 training days during Phase 2 of the PVT. A maximum of ten personnel will attend this course. Design training targeted towards training personnel in the day-to-day operation and basic

maintenance of the system. Upon completion of this course, each student, using appropriate documentation, should be able to start the system, operate the system, recover the system after a failure, perform routine maintenance and describe the specific hardware architecture and operation of the system. Include the following topics at a minimum:

a. General system architecture.

b. Functional operation of the system, including workstations and system navigation.

c. System start-up procedures.

d. Failure recovery procedures.

e. Schedule configuration.

f. Trend configuration.

g. Perform point overrides and override release.

h. Reports generation.

i. Alarm reporting and acknowledgements.

j. Diagnostics.

k. Historical files.

l. Maintenance procedures:

(1) Physical layout of each piece of hardware.

(2) Troubleshooting and diagnostic procedures.

(3) Preventive maintenance procedures and schedules.

3.7.3 Advanced Training

Conduct an Advanced Operator Training course at the project site for a period of not less then five days. A maximum of ten personnel will attend this course. Structure the course to consist of "hands-on" training under the constant monitoring of the instructor. Include training on the M&C Software, and the BACnet Network Browser. Upon completion of this course, the students should be fully proficient in the operation and management of all system operations and must be able to perform all tasks required to integrate a field control system into the EMCS. Report the skill level of each student at the end of this course. Include the following topics at a minimum:

a. A review of all topics in Basic Training.

b. Using the BACnet Network Browser for network discovery.

c. M&C Software configuration, including but not limited to: Creating and editing system displays, alarms, schedules, trends, demand limiting and calculations.

3.7.4 Refresher Training

Conduct a Refresher Training course at the project site for a period of two training days when approved by the Government and as specified in paragraph PROJECT SEQUENCING. A maximum of ten personnel will attend the course. Structure the course to address specific topics that the students need to discuss and to answer questions concerning the operation of the system. Upon completion of the course, the students should be fully proficient in system operation and have no unanswered questions regarding operation of the installed EMCS. Correct any system failures discovered during the Refresher Training at no cost to the Government.

APPENDIX A

QC CHECKLIST		
This checklist is not all-inclusive of the requirements of this specification and should not be interpreted as such.		
This checklist is for (check one:)		
	Pre-Construction QC Checklist Submittal (Items 1-2)	( )
	Post-Construction QC Checklist Submittal (Items 1-6)	( )
	Close-out QC Checklist Submittal (Items 1-14)	( )
Instructions: Initial each item in the space provided (|____|) verifying that the requirement has been met.		
Verify the following items for Pre-Construction, Post-Construction and Closeout QC Checklist Submittals:		
1	Contractor Design Drawing Riser Diagram includes location and types of all Control Hardware and Computer Hardware.	|____|
2	M&C Software supports , and ASHRAE 135 . M&C Software is BTL Listed as a B-AWS.	|____|
Verify the following items for Post-Construction and Closeout QC Checklist Submittal:		
3	Communication between the M&C Software and ASHRAE 135 field control systems uses only ASHRAE 135.	|____|

QC CHECKLIST			
4	Connections to non-ASHRAE 135field control systems are via a Gateway from the field control system to ASHRAE 135 or via a EMCS supported protocol without the use of a hardware Gateway.		|____|
5	Computer workstations and servers are installed as shown on the EMCS Riser Diagram.		|____|
6	Training schedule and course attendee lists have been developed and coordinated with shops and submitted.		|____|
Verify the following items for Closeout QC Checklists Submittal:			
7	All points in field control systems have been discovered and are available at the M&C Software.		|____|
8	All software has been licensed to the Government.		|____|
9	M&C software monitoring displays have been created for all building systems, including all override and display points indicated on Points Schedule drawings.		|____|
10	Final As-built Drawings accurately represent the final installed system.		|____|
11	Default trends have been set up (per Points Schedule drawings).		|____|
12	Scheduling has been configured at the M&C Software (per Occupancy Schedule drawing).		|____|
13	O&M Instructions have been completed and submitted.		|____|

QC CHECKLIST		
14	Basic Operator and Advanced Training courses have been completed.	|____|
_____	_____	
	(QC Representative Signature) (Date)	

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 28 - ELECTRONIC SAFETY AND SECURITY

SECTION 28 31 76

INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, ADDRESSABLE

08/20

ATTACHMENTS:

Fire Alarm and Control Panel J&A

-- End of Section Table of Contents --

SECTION 28 31 76

INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM, ADDRESSABLE
08/20

PART 1 GENERAL

[*Am-1]
Attachment: Fire Alarm and Control Panel J&A [**Am-1]

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACOUSTICAL SOCIETY OF AMERICA (ASA)

ASA S3.2	(2020) American National Standard Method for Measuring the Intelligibility of Speech Over Communication Systems (ASA 85)

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide http://www.approvalguide.com/

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41.1	(2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 4	(2018) Standard for Integrated Fire Protection and Life Safety System Testing
NFPA 70	(2020; TIA 22-1; ERTA 1 2022) National Electrical Code
NFPA 72	(2022) National Fire Alarm and Signaling Code
NFPA 90A	(2021) Standard for the Installation of Air Conditioning and Ventilating Systems
NFPA 170	(2021) Standard for Fire Safety and Emergency Symbols

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-601-02	(2021) Fire Protection Systems Inspection,

	Testing, and Maintenance
UFC 4-010-06	(2016; with Change 1, 2017) Cybersecurity of Facility-Related Control Systems

UNDERWRITERS LABORATORIES (UL)

UL 268	(2016; Reprint Nov 2021) UL Standard for Safety Smoke Detectors for Fire Alarm Systems
UL 268A	(2008; Reprint Oct 2014) Smoke Detectors for Duct Application
UL 464	(2016; Reprint Sep 2017) UL Standard for Safety Audible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories
UL 497A	(2001; Bul. 2019) UL Standard for Safety Secondary Protectors for Communications Circuits
UL 497B	(2004; Reprint Feb 2022) UL Standard for Safety Protectors for Data Communications and Fire Alarm Circuits
UL 864	(2014; Reprint May 2020) UL Standard for Safety Control Units and Accessories for Fire Alarm Systems
UL 1283	(2017) UL Standard for Safety Electromagnetic Interference Filters
UL 1449	(2021) UL Standard for Safety Surge Protective Devices
UL 1480	(2016; Reprint Sep 2017) UL Standard for Safety Speakers for Fire Alarm and Signaling Systems, Including Accessories
UL 1638	(2016; Reprint Sep 2017) UL Standard for Safety Visible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories
UL 1971	(2002; Reprint Oct 2008) Signaling Devices for the Hearing Impaired
UL 2017	(2008; Reprint Dec 2018) UL Standard for Safety General-Purpose Signaling Devices and Systems
UL 2034	(2017; Reprint Apr 2022) UL Standard for Safety Single and Multiple Station Carbon Monoxide Alarms
UL 2075	(2013; Bul. 2019) UL Standard for Safety Gas and Vapor Detectors and Sensors

UL 2572	(2016; Bul. 2018) UL Standard for Safety Mass Notification Systems
UL Fire Prot Dir	(2012) Fire Protection Equipment Directory

1.2 RELATED SECTIONS

Section 25 05 11.21 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS FIRE AND LIFE SAFETY SYSTEMS, applies to this section, with the additions and modifications specified herein. In addition, refer to the following sections for related work and coordination:

Section 21 13 13 WET PIPE SPRINKLER SYSTEM, FIRE PROTECTION
Section 23 30 00 HVAC AIR DISTRIBUTION
Section 08 71 00 DOOR HARDWARE for door release and additional work related to finish hardware.
Section 07 84 00 FIRESTOPPING for additional work related to firestopping.

1.3 SUMMARY

1.3.1 Scope

a. This work includes designing and modifying the existing fire alarm and mass notification (MNS) system as described herein and on the contract drawings for the PRIDE Hangar. Include system wiring, raceways, pull boxes, terminal cabinets, outlet and mounting boxes, control equipment, initiating devices, notification appliances, supervising station fire alarm transmitters/mass notification transceiver, and other accessories and miscellaneous items required for a complete operational system even though each item is not specifically mentioned or described. Provide system complete and ready for operation. Design and installation must comply with UFGS Section 25 05 11.21 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS FIRE AND LIFE SAFETY SYSTEMS, UFC 4-010-06 and AFGM 2019-320-02.

b. Provide equipment, materials, installation, workmanship, inspection, and testing in strict accordance with NFPA 72, except as modified herein. The system layout on the drawings show the intent of coverage and suggested locations. Final quantity, system layout, and coordination are the responsibility of the Contractor.

c. Each remote fire alarm control unit must be powered from a wiring riser specifically for that use or from a local emergency power panel located on the same floor as the remote fire alarm control unit. Where remote fire control units are provided, equipment for notification appliances may be located in the remote fire alarm control units.

d. The fire alarm and mass notification system must be independent of the building security, building management, and energy/utility monitoring systems other than for control functions.

1.3.2 Qualified Fire Protection Engineer (QFPE)

Services of the QFPE must include:

a. Reviewing SD-02, SD-03, and SD-05 submittal packages for completeness

and compliance with the provisions of this specification. Construction (shop) drawings and calculations must be prepared by, or prepared under the immediate supervision of, the QFPE. The QFPE must affix their professional engineering stamp with signature to the shop drawings, calculations, and material data sheets, indicating approval prior to submitting the shop drawings to the DFPE.

b. Providing a letter documenting that the SD-02, SD-03, and SD-05 submittal package has been reviewed and noting any outstanding comments.

c. Performing in-progress construction surveillance prior to installation of ceilings (rough-in inspection).

d. Witnessing pre-Government and final Government functional performance testing and performing a final installation review.

e. Signing applicable certificates under SD-07.

1.4 DEFINITIONS

Wherever mentioned in this specification or on the drawings, the equipment, devices, and functions must be defined as follows:

1.4.1 Interface Device

An addressable device that interconnects hard wired systems or devices to an analog/addressable system.

1.4.2 Fire Alarm and Mass Notification Control Unit (FMCU)

A master control unit having the features of a fire alarm control unit (FACU) and an autonomous control unit (ACU) where these units are interconnected to function as a combined fire alarm/mass notification system. The FACU and ACU functions may be contained in a single cabinet or in independent, interconnected, and co-located cabinets.

1.4.3 Remote Fire Alarm and Mass Notification Control Unit

A control unit, physically remote from the fire alarm and mass notification control unit, that receives inputs from automatic and manual fire alarm devices; may supply power to detection devices and interface devices; may provide transfer of power to the notification appliances; may provide transfer of condition to relays or devices connected to the control unit; and reports to and receives signals from the fire alarm and mass notification control unit.

1.4.4 Local Operating Console (LOC)

A unit designed to allow emergency responders and/or building occupants to operate the MNS including delivery of recorded messages and/or live voice announcements, initiate visual, textual visual, and audible appliance operation and other relayed functions.

1.4.5 Terminal Cabinet

A steel cabinet with locking, hinge-mounted door where terminal strips are securely mounted inside the cabinet.

1.4.6 Control Module and Relay Module

Terms utilized to describe emergency control function interface devices as defined by NFPA 72.

1.4.7 Designated Fire Protection Engineer (DFPE)

The DoD fire protection engineer that oversees that Area of Responsibility for that project. This is sometimes referred to as the "cognizant" fire protection engineer. Interpret reference to "authority having jurisdiction" and/or AHJ in referenced standards to mean the Designated Fire Protection Engineer (DFPE). The DFPE may be responsible for review of the contractor submittals having a "G" designation, and for witnessing final inspection and testing.

1.4.8 Qualified Fire Protection Engineer (QFPE)

A QFPE is an individual who is a licensed professional engineer (P.E.), who has passed the fire protection engineering written examination administered by the National Council of Examiners for Engineering and Surveying (NCEES) and has relevant fire protection engineering experience.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval.

Shop drawings (SD-02), product data (SD-03) and calculations (SD-05) must be prepared by the fire alarm designer and combined and submitted as one complete package. The QFPE must review the SD-02/SD-03/SD-05 submittal package for completeness and compliance with the Contract provisions prior to submission to the Government. The QFPE must provide a Letter of Confirmation that they have reviewed the submittal package for compliance with the contract provisions. This letter must include their registered professional engineer stamp and signature. Partial submittals and submittals not reviewed by the QFPE will be returned by the Government disapproved without review.

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualified Fire Protection Engineer (QFPE); G-AE

Fire alarm system designer; G-AE

Supervisor; G-AE

Technician; G-AE

Installer; G-AE

Test Technician; G-AE

Fire Alarm System Site-Specific Software Acknowledgement; G-AE

SD-02 Shop Drawings

Nameplates

Instructions

Wiring Diagrams

System Layout

Notification Appliances

Initiating devices

Amplifiers

Battery Power

Voltage Drop Calculations

SD-03 Product Data

Fire Alarm and Mass Notification Control Unit (FMCU); G-AE

Local Operating Console (LOC)

Amplifiers

Tone Generators

Digitalized voice generators

Manual Stations

Smoke Detectors

Duct Smoke Detectors

Carbon monoxide detector

Addressable Interface Devices

Addressable Control Modules

Isolation Modules

Notification Appliances

Textual Display Sign Control Panel

Textual Display Signs

Batteries

Battery Chargers

Supplemental Notification Appliance Circuit Panels

Auxiliary Power Supply Panels

Surge Protective Devices

Alarm Wiring

Back Boxes and Conduit

Ceiling Bridges for Ceiling-Mounted Appliances

Terminal Cabinets

Environmental Enclosures or Guards

Document Storage Cabinet

SD-06 Test Reports

Test Procedures; G-AE

SD-07 Certificates

Verification of Compliant Installation; G-AE

Request for Government Final Test; G-AE

SD-10 Operation and Maintenance Data

Operation and Maintenance (O&M) Instructions; G-AE

Instruction of Government Employees; G-AE

SD-11 Closeout Submittals

As-Built Drawings; G-AE

Spare Parts

1.6 SYSTEM OPERATION

Fire alarm system/mass notification system including textual display sign control panel(s), components requiring power, except for the FMCU(s) power supply, must operate on 24 volts DC unless noted otherwise in this section.

The interior fire alarm and mass notification system must be a complete, supervised, noncoded, analog/addressable fire alarm and mass notification system conforming to NFPA 72, UL 864, and UL 2572. Systems meeting UL 2017 only are not acceptable. The system must be activated into the alarm mode by actuation of an alarm initiating device. The system must remain in the alarm mode until the initiating device is reset and the control unit is reset and restored to normal. The system may be placed in the alarm mode by local microphones, LOC, FMCU, or remotely from authorized locations/users.

1.6.1 Alarm Initiating Devices and Notification Appliances (Visual, Voice, Textual)

a. Connect alarm initiating devices to initiating device circuits (IDC) Class "B", or to signaling line circuits (SLC) Class "B" and installed in accordance with NFPA 72.

b. Connect notification appliances to notification appliance circuits (NAC) Class "B".

1.6.2 Functions and Operating Features

The system must provide the following functions and operating features:

a. Power, annunciation, supervision, and control for the system. Addressable systems must be microcomputer (microprocessor or microcontroller) based with a minimum word size of eight bits with sufficient memory to perform as specified.

b. Visual alarm notification appliances must be synchronized as required by NFPA 72.

c. Electrical supervision of the primary power (AC) supply, presence of the battery, battery voltage, and placement of system modules within the control unit.

d. An audible and visual trouble signal to activate upon a single break or open condition, or ground fault. The trouble signal must also operate upon loss of primary power (AC) supply, absence of a battery supply, low battery voltage, or removal of alarm or supervisory control unit modules. After the system returns to normal operating conditions, the trouble signal must again sound until the trouble is acknowledged. A smoke detector in the process of being verified for the actual presence of smoke must not initiate a trouble condition.

e. A trouble signal silence feature that must silence the audible trouble signal, without affecting the visual indicator.

f. Program capability via switches in a locked portion of the FMCU to bypass the automatic notification appliance circuits, fire reporting system air handler shutdown door release features. Operation of this programmed action must indicate on the FMCU display as a supervisory or trouble condition.

g. Alarm functions must override trouble or supervisory functions. Supervisory functions must override trouble functions.

h. The system must be capable of being programmed from the control unit keyboard. Programmed information must be stored in non-volatile memory.

i. The system must be capable of operating, supervising, and/or monitoring non-addressable alarm and supervisory devices.

j. There must be no limit, other than maximum system capacity, as to the number of addressable devices that may be in alarm simultaneously.

k. Where the fire alarm/mass notification system is responsible for initiating an action in another emergency control device or system, such as HVAC, the addressable fire alarm relay must be located in the vicinity of the emergency control device.

l. An alarm signal must automatically initiate the following functions:

(1) Transmission of an alarm signal to the fire department.

(2) Visual indication of the device operated on the FMCU. Indication must be by zone or circuit, and type of device.

(3) Actuation of alarm notification appliances.

(4) Recording of the event electronically in the history log of the FMCU.

(5) Release of doors held open by electromagnetic devices.

m. A supervisory signal must automatically initiate the following functions:

(1) Visual indication of the device operated on the FMCU. Indication must be by zone or circuit, and type of device.

(2) Transmission of a supervisory signal to the fire department.

(3) Operation of a duct smoke detector must shut down the appropriate air handler in accordance with NFPA 90A in addition to other requirements of this paragraph and as allowed by NFPA 72.

(4) Recording of the event electronically in the history log of the FMCU.

n. A trouble condition must automatically initiate the following functions:

(1) Visual indication of the device operated on the FMCU. Indication must be by floor, zone or circuit, and type of device.

(2) Transmission of a trouble signal to the fire department.

(3) Recording of the event electronically in the history log of the FMCU.

o. Activation of a carbon monoxide alarm initiating device must automatically initiate the following functions:

(1) Visual indication of the device operated on the FMCU. Indication must be by room number, device address, and device type.

(2) Transmission of a carbon monoxide alarm signal to the fire department.

(3) Activation of all strobes and the audible carbon monoxide message throughout the building.

(4) Recording of the event electronically in the history log of the FMCU.

p. System control equipment must be programmed to provide a 60-minute to 180-minute delay in transmission of trouble signals resulting from primary power failure.

q. Activation of a LOC pushbutton must activate the audible and visual alarms in the facility. The audible message must be the one associated with the pushbutton activated.

1.7 TECHNICAL DATA AND SITE-SPECIFIC SOFTWARE

Technical data and site-specific software (meaning technical data that relates to computer software) that are specifically identified in this project, and may be required in other specifications, must be delivered, strictly in accordance with the CONTRACT CLAUSES. The fire alarm system manufacturer must submit written confirmation of this contract provision as "Fire Alarm System Site-Specific Software Acknowledgement". Identify data delivered by reference to the specification paragraph against which it is furnished. Data to be submitted must include complete system, equipment, and software descriptions. Descriptions must show how the equipment will operate as a system to meet the performance requirements of this contract. The site-specific software data package must also include the following:

a. Items identified in NFPA 72, titled "Site-Specific Software".

b. Identification of programmable portions of the system equipment and capabilities.

c. Description of system revision and expansion capabilities and methods of implementation detailing both equipment and software requirements.

d. Provision of operational software data on all modes of programmable portions for fire alarm and mass notification.

e. Description of Fire Alarm and Mass Notification Control Unit equipment operation.

f. Description of auxiliary and remote equipment operations.

g. Library of application software.

h. Operation and maintenance manuals.

1.8 EXISTING EQUIPMENT

a. Equipment and devices must be compatible and operable with the existing fire alarm/mass notification system and must not impair reliability or operational functions of existing supervising station fire alarm system.

b. Equipment and devices must be compatible and operable with the existing building fire alarm/mass notification system. Equipment must not impair reliability or operational functions of the existing system.

1.9 QUALITY ASSURANCE

1.9.1 Submittal Documents

1.9.1.1 Preconstruction Submittals

Within 36 days of contract award but not less than 14 days prior to commencing any work on site, the Contractor must submit the following for review and approval. SD-02, SD-03 and SD-05 submittals received prior to the review and approval of the qualifications of the fire alarm subcontractor and QFPE must be returned disapproved without review. All resultant delays must be the sole responsibility of the Contractor.

1.9.1.2 Shop Drawings

Shop drawings must not be smaller than the Contract Drawings. Drawings must comply with the requirements of NFPA 72 and NFPA 170. Minimum scale for floor plans must be 1/8"=1'.

1.9.1.3 Nameplates

Nameplate illustrations and data to obtain approval by the Contracting Officer before installation.

1.9.1.4 Wiring Diagrams

Three copies of point-to-point wiring diagrams showing the points of connection and terminals used for electrical field connections in the system, including interconnections between the equipment or systems that are supervised or controlled by the system. Diagrams must show connections from field devices to the FMCU and remote FMCU, initiating circuits, switches, relays and terminals, including pathway diagrams between the control unit and shared communications equipment within the protected premises. Point-to-point wiring diagrams must be job specific and must not indicate connections or circuits not being utilized. Provide complete riser diagrams indicating the wiring sequence of all devices and their connections to the control equipment. Include a color-code schedule for the wiring.

1.9.1.5 System Layout

Three copies of plan view drawing showing device locations, terminal cabinet locations, junction boxes, other related equipment, conduit routing, conduit sizes, wire counts, conduit fill calculations, wire color-coding, circuit identification in each conduit, and circuit layouts for all floors. Indicate candela rating of each visual notification appliance. Indicate the wattage of each speaker. Clearly identify the locations of isolation modules. Indicate the addresses of all devices, modules, relays, and similar. Show/identify all acoustically similar spaces. Indicate if the environment for the FMCU is within its environmental listing (e.g. temperature/humidity).

Provide a complete description of the system operation in matrix format similar to the "Typical Input/Output Matrix" included in the Annex of NFPA 72.

1.9.1.6 Notification Appliances

Calculations and supporting data on each circuit to indicate that there is at least 25 percent spare capacity for notification appliances. Annotate data for each circuit on the drawings.

1.9.1.7 Initiating Devices

Calculations and supporting data on each circuit to indicate that there is at least 25 percent spare capacity for initiating devices. Annotate data for each circuit on the drawings.

1.9.1.8 Amplifiers

Calculations and supporting data to indicate that amplifiers have sufficient capacity to simultaneously drive all notification speakers at

tapped settings plus 25 percent spare capacity. Annotate data for each circuit on the drawings.

1.9.1.9 Battery Power

Calculations and supporting data as required in paragraph Battery Power Calculations for alarm, alert, and supervisory power requirements. Calculations including ampere-hour requirements for each system component and each control unit component, and the battery recharging period, must be included on the drawings.

1.9.1.10 Voltage Drop Calculations

Voltage drop calculations for each notification circuit indicating that sufficient voltage is available for proper operation of the system and all components, at a minimum rated voltage of the system operating on batteries. Include the calculations on the system layout drawings.

1.9.1.11 Product Data

Three copies of annotated descriptive data to show the specific model, type, and size of each item. Catalog cuts must also indicate the NRTL listing. The data must be highlighted to show model, size, and options that are intended for consideration. Data must be adequate to demonstrate compliance with all contract requirements. Product data for all equipment must be combined into a single submittal.

Provide an equipment list identifying the type, quantity, make, and model number of each piece of equipment to be provided under this submittal. The equipment list must include the type, quantity, make and model of spare equipment. Types and quantities of equipment submitted must coincide with the types and quantities of equipment used in the battery calculations and those shown on the shop drawings.

1.9.1.12 Operation and Maintenance (O&M) Instructions

Six copies of the Operation and Maintenance Instructions. The O&M Instructions must be prepared in a single volume or in multiple volumes, with each volume indexed, and may be submitted as a Technical Data Package. Manuals must be approved prior to training. The Interior Fire Alarm And Mass Notification System Operation and Maintenance Instructions must include the following:

a. "Manufacturer Data Package five" as specified in Section 01 78 23 OPERATION AND MAINTENANCE DATA.

b. Operating manual outlining step-by-step procedures required for system startup, operation, and shutdown. The manual must include the manufacturer's name, model number, service manual, parts list, and preliminary equipment list complete with description of equipment and their basic operating features.

c. Maintenance manual listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The manuals must include conduit layout, equipment layout and simplified wiring, and control diagrams of the system as installed.

d. Complete procedures for system revision and expansion, detailing both equipment and software requirements.

e. Software submitted for this project on CD/DVD media utilized.

f. Printouts of configuration settings for all devices.

g. Routine maintenance checklist. The routine maintenance checklist must be arranged in a columnar format. The first column must list all installed devices, the second column must state the maintenance activity or state no maintenance required, the third column must state the frequency of the maintenance activity, and the fourth column provided for additional comments or reference. All data (devices, testing frequencies, and similar) must comply with UFC 3-601-02.

h. A final Equipment List must be submitted with the Operating and Maintenance (O&M) manual.

1.9.1.13 As-Built Drawings

The drawings must show the system as installed, including deviations from both the project drawings and the approved shop drawings. These drawings must be submitted within two weeks after the final Government test of the system. At least one set of the as-built (marked-up) drawings must be provided at the time of, or prior to the final Government test.

1.9.2 Qualifications

1.9.2.1 Fire Alarm System Designer

The fire alarm system designer must be certified as a Level IV (minimum) Technician by National Institute for Certification in Engineering Technologies (NICET) in the Fire Alarm Systems subfield of Fire Protection Engineering Technology or meet the qualifications for a QFPE.

1.9.2.2 Supervisor

A NICET Level IV fire alarm technician must supervise the installation of the fire alarm/mass notification system. A fire alarm technician with a minimum of eight years of experience must supervise the installation of the fire alarm/mass notification system. The fire alarm technicians supervising the installation of equipment must be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.9.2.3 Technician

Fire alarm technicians with a minimum of four years of experience must be utilized to install and terminate fire alarm/mass notification devices, cabinets and control units. The fire alarm technicians installing the equipment must be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.9.2.4 Installer

NICET Level II technician to assist in the installation of fire alarm/mass notification devices, cabinets and control units. A licensed electrician must be allowed to install wire, cable, conduit and backboxes for the fire alarm system/mass notification system. The fire alarm installer must be factory trained in the installation, adjustment, testing, and operation of

the equipment specified herein and on the drawings.

1.9.2.5 Test Technician

Fire alarm technicians with a minimum of eight years of experience and NICET Level IV utilized in testing and certification of the installation of the fire alarm/mass notification devices, cabinets and control units. The fire alarm technicians testing the equipment must be factory trained in the installation, adjustment, testing, and operation of the equipment installed as part of this project.

1.9.2.6 Manufacturer

Components must be of current design and must be in regular and recurrent production at the time of installation. Provide design, materials, and devices for a protected premises fire alarm system, complete, conforming to NFPA 72, except as specified herein.

1.9.3 Regulatory Requirements

Equipment and material must be listed or approved. Listed or approved, as used in this section, means listed, labeled or approved by a Nationally Recognized Testing Laboratory (NRTL) such as UL Fire Prot Dir or FM APP GUIDE. The omission of these terms under the description of any item of equipment described must not be construed as waiving this requirement. All listings or approvals by testing laboratories must be from an existing ANSI or UL published standard. The recommended practices stated in the manufacturer's literature or documentation must be considered as mandatory requirements.

1.10 DELIVERY, STORAGE, AND HANDLING

Protect equipment delivered and placed in storage from the weather, humidity, and temperature variation, dirt and dust, and other contaminants.

1.11 MAINTENANCE

1.11.1 Spare Parts

Furnish the following spare parts in the manufacturers original unopened containers:

a. Five complete sets of system keys.

b. Two of each type of fuse required by the system.

c. One manual stations.

d. Two of each type of detector installed.

e. Two of each type of detector base and head installed.

f. One electromagnetic door holders.

g. Two of each type of audible and visual alarm device installed.

h. One textual visual notification appliance.

i. Two of each type of addressable monitor module installed.

j. Two of each type of addressable control module installed.

k. One 120 VAC surge protective device.

1.11.2 Special Tools

Software, connecting cables and proprietary equipment, necessary for the maintenance, testing, and reprogramming of the equipment must be furnished to the Contracting Officer, prior to the instruction of Government employees.

PART 2 PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENT

All fire alarm and mass notification equipment must be listed for use under the applicable reference standards. Interfacing of UL 864 or similar approved industry listing with Mass Notification equipment listed to UL 2572 must be done in a laboratory listed configuration, if the software programming features cannot provide a listed interface control.

2.2 MATERIALS AND EQUIPMENT

2.2.1 Standard Products

Provide materials, equipment, and devices that have been tested by a nationally recognized testing laboratory and listed for fire protection service when so required by NFPA 72 or this specification. Select material from one manufacturer, where possible, and not a combination of manufacturers, for any particular classification of materials. Material and equipment must be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 2 years prior to bid opening.

2.2.2 Nameplates

Major components of equipment must have the manufacturer's name, address, type or style, model or serial number, catalog number, date of installation, installing Contractor's name and address, and the contract number provided on a new name plate permanently affixed to the item or equipment. Major components include, but are not limited to, the following:

a. FMCU

Nameplates must be etched metal or plastic, permanently attached by screws to control units or adjacent walls.

2.2.3 Keys

Keys and locks for equipment, control units and devices must be identical. Master all keys and locks to a single key as required by the Installation Fire Department.

2.2.4 Instructions

Provide a typeset printed or typewritten instruction card mounted behind a Lexan plastic or glass cover in a stainless steel or aluminum frame.

Install the instructions on the interior of the FMCU. The card must show those steps to be taken by an operator when a signal is received as well as the functional operation of the system under all conditions, normal, alarm, supervisory, and trouble. The instructions must also include procedures for operating live voice microphones. The instructions and their mounting location must be approved by the Contracting Officer before being posted.

2.3 FIRE ALARM AND MASS NOTIFICATION CONTROL UNIT

Provide a complete fire alarm and mass notification control unit (FMCU) fully enclosed in a lockable steel cabinet as specified herein. Operations required for testing or for normal care, maintenance, and use of the system must be performed from the front of the enclosure. If more than a single unit is required at a location to form a complete control unit, the unit cabinets must match exactly. The system must be capable of defining any module as an alarm module and report alarm trouble, loss of polling, or as a supervisory module, and reporting supervisory short, supervisory open or loss of polling such as waterflow switches, valve supervisory switches, fire pump monitoring, independent smoke detection systems, relays for output function actuation.

a. Each control unit must provide power, supervision, control, and logic for the entire system, utilizing solid state, modular components, internally mounted and arranged for easy access. Each control unit must be suitable for operation on a 120 volt, 60 hertz, normal building power supply. Provide each control unit with supervisory functions for power failure, internal component placement, and operation.

b. Visual indication of alarm, supervisory, or trouble initiation on the FMCU must be by liquid crystal display or similar means with a minimum of 80 characters. The mass notification control unit must have the capability of temporarily deactivate the fire alarm audible notification appliances while delivering voice messages.

c. Provide secure operator console for initiating recorded messages, strobes and displays; and for delivering live voice messages. Provide capacity for at least eight prerecorded messages. Provide the ability to automatically repeat prerecorded messages. Provide a secure microphone for delivering live messages. Provide adequate discrete outputs to temporarily deactivate fire alarm audible notification, initiate/synchronize strobes and initiate textual visual notification appliances. Provide a complete set of self-diagnostics for controller and appliance network. Provide local diagnostic information display and local diagnostic information and system event log file. [*Am-1]

d. Fire alarm and Mass Notification Control Units shall be a Monaco MAAP X control panel. [**Am-1]

2.3.1 Cabinet

Install control unit components in cabinets large enough to accommodate all components and also to allow ample gutter space for interconnection of control units as well as field wiring. The cabinet must be a sturdy steel housing, complete with back box, hinged steel door with cylinder lock, and semi-recessed mounting provisions. The enclosure must be identified by an engraved phenolic resin nameplate. Lettering on the nameplate must say "Fire Alarm and Mass Notification control unit" and must not be less than

1-inch high. Provide prominent rigid plastic or metal identification plates for lamps, circuits, meters, fuses, and switches.

2.3.2 Silencing Switches

2.3.2.1 Alarm Silencing Switch

Provide an alarm silencing switch at the FMCU that must silence the audible and visual notification appliances. Subsequent activation of initiating devices must cause the notification appliances to re-activate.

2.3.2.2 Supervisory/Trouble Silencing Switch

Provide supervisory and trouble silencing switch(es) that must silence the audible trouble and supervisory signal(s), but not extinguish the visual indicator. This switch must be overridden upon activation of a subsequent supervisory or trouble condition. Audible trouble indication must resound automatically every 24 hours after the silencing feature has been operated if the supervisory or trouble condition still exists.

2.3.3 Non-Interfering

Power and supervise each circuit such that a signal from one device does not prevent the receipt of signals from any other device. Initiating devices must be manually reset by switch from the FMCU after the initiating device or devices have been restored to normal.

2.3.4 Audible Notification System

The Audible Notification System must comply with the requirements of NFPA 72 for Emergency Voice/Alarm Communications System requirements, except as specified herein. The system must be a one-way, multi-channel voice notification system incorporating user selectability of a minimum eight distinct sounds for tone signaling, and the incorporation of a voice module for delivery of recorded messages. Audible appliances must produce a three-pulse temporal pattern for three cycles followed by a voice message that is repeated until the control unit is reset or silenced. For carbon monoxide detector activation, audible appliances must produce a four-pulse temporal pattern for three cycles followed by a voice message that is repeated until the control unit is reset or silenced. Automatic messages must be broadcast through speakers throughout the building/facility but not in stairs or elevator cabs. A live voice message must override the automatic audible output through use of a microphone input at the control unit or the LOC.

a. When using the microphone, live messages must be broadcast selectable by zone, or all call. The system must be capable of operating all speakers at the same time.

b. The microprocessor must actively interrogate circuitry, field wiring, and digital coding necessary for the immediate and accurate rebroadcasting of the stored voice data into the appropriate amplifier input. Loss of operating power, supervisory power, or any other malfunction that could render the digitalized voice module inoperative must automatically cause the three-pulse temporal pattern to take over all functions assigned to the failed unit in the event an alarm is activated.

2.3.4.1 Outputs and Operational Modules

All outputs and operational modules must be fully supervised with on-board diagnostics and trouble reporting circuits. Provide form "C" contacts for system alarm and trouble conditions. Provide circuits for operation of auxiliary appliance during trouble conditions. During a Mass Notification event, the control unit must not generate nor cause any trouble alarms to be generated with the Fire Alarm system.

2.3.4.2 Mass Notification

a. The system must have the capability of utilizing an LOC with redundant controls of the FMCU. Notification Appliance Circuits (NAC) must be provided for the activation of strobe appliances. Audio output must be selectable for line level. A hand-held microphone must be provided and, upon activation, must take priority over any tone signal, recorded message or PA microphone operation in progress, while maintaining the strobe NAC circuit activation.

b. The Mass Notification functions must override the manual or automatic fire alarm notification. Other fire alarm functions including transmission of a signal(s) to the fire department must remain operational. When a mass notification announcement is disengaged and a fire alarm condition still exists, the audible and visual notification appliances must resume activation for alarm conditions. The fire alarm message must be of lower priority that all other messages (except any "test" messages) and must not override any other messages.

c. Messages must be recorded professionally utilizing standard industry methods, in a professional female voice. Message and tone volumes must both be at the same decibel level. Messages recorded from the system microphone must not be accepted. A 1000 Hz tone (as required by NFPA 72) must precede messages and be similar to the existing mass notification messages within the PRIDE Hangar.

d. Auxiliary Input Module must be designed to be an outboard expansion module to either expand the number of optional LOC's, or allow a telephone interface.

2.3.5 Memory

Provide each control unit with non-volatile memory and logic for all functions. The use of long life batteries, capacitors, or other age-dependent devices must not be considered as equal to non-volatile processors, PROMS, or EPROMS.

2.3.6 Field Programmability

Provide control units and control units that are fully field programmable for both input and output of control, initiation, notification, supervisory, and trouble functions. The system program configuration must be menu driven. System changes must be password protected. Any proprietary equipment and proprietary software needed by qualified technicians to implement future changes to the fire alarm system must be provided as part of this contract.

2.3.7 Input/Output Modifications

The FMCU must contain features that allow the bypassing of input devices from the system or the modification of system outputs. These control features must consist of a control unit mounted keypad. Any bypass or modification to the system must indicate a trouble condition on the FMCU.

2.3.8 Resetting

Provide the necessary controls to prevent the resetting of any alarm, supervisory, or trouble signal while the alarm, supervisory or trouble condition on the system still exists.

2.3.9 Walk Test

The FMCU must have a walk test feature. When using this feature, operation of initiating devices must result in limited system outputs, so that the notification appliances operate for only a few seconds and the event is indicated in the history log, but no other outputs occur.

2.3.10 History Logging

The control unit must have the ability to store a minimum of 400 events in a log. These events must be stored in a battery-protected memory and must remain in the memory until the memory is downloaded or cleared manually. Resetting of the control unit must not clear the memory.

2.3.11 Manual Access

An operator at the control unit, having a proper access level, must have the capability to manually access the following information for each initiating device.

a. Primary status.

b. Device type.

c. Present average value.

d. Present sensitivity selected.

e. Detector range (normal, dirty).

2.4 LOCAL OPERATING CONSOLES (LOC)

2.4.1 General

The LOC must consist of a remote microphone station incorporating a push-to-talk (PTT) hand-held microphone and system status indicators. The LOC must have the capability of being utilized to activate prerecorded messages. The unit must incorporate microphone override of any tone generation or recorded messages. The unit must be fully supervised from the FMCU. The housing for the LOC must not be lockable.

2.4.2 Multiple LOCs

When an installation has more than one LOC, the LOCs must be programmed to allow only one LOC to be available for paging or messaging at a time. Once one LOC becomes active, all other LOC's will have an indication that

the system is busy (Amber Busy Light) and cannot be used at that time. This is to avoid two messages being given at the same time. It must be possible to override or lockout the LOC's from the FMCU.

2.5 AMPLIFIERS, PREAMPLIFIERS, TONE GENERATORS

Any amplifiers, preamplifiers, tone generators, digitalized voice generators, and other hardware necessary for a complete, operational, textual audible circuit conforming to NFPA 72 must be housed in a remote FMCU, terminal cabinet, or in the FMCU. Individual amplifiers must be 100 watts maximum.

2.5.1 Operation

The system must automatically operate and control all building speakers.

2.5.2 Construction

Amplifiers must utilize computer grade solid state components and must be provided with output protection devices sufficient to protect the amplifier against any transient up to 10 times the highest rated voltage in the system.

2.5.3 Inputs

Equip each system with separate inputs for the tone generator, digitalized voice driver and control unit mounted microphone. Microphone inputs must be of the low impedance, balanced line type. Both microphone and tone generator input must be operational on any amplifier.

2.5.4 Tone Generator

The tone generator must produce a three-pulse temporal pattern and must be constantly repeated until interrupted by either the digitalized voice message, the microphone input, or the alarm silence mode as specified. The tone generator must be single channel with an automatic backup generator per channel such that failure of the primary tone generator causes the backup generator to automatically take over the functions of the failed unit and also causes transfer of the common trouble relay. The tone generator must be provided with securely attached labels to identify the component as a tone generator and to identify the specific tone it produces.

2.5.5 Protection Circuits

Each amplifier must be constantly supervised for any condition that could render the amplifier inoperable at its maximum output. Failure of any component must cause illumination of a visual "amplifier trouble" indicator on the control unit, appropriate logging of the condition in the history log, and other actions for trouble conditions as specified.

2.6 MANUAL STATIONS

Provide metal or plastic, semi-flush or surface mounted, double-action, addressable manual stations, that are not subject to operation by jarring or vibration. Stations must be equipped with screw terminals for each conductor. Stations that require the replacement of any portion of the device after activation are not permitted. Stations must be finished in red with molded raised lettering operating instructions of contrasting

color. The use of a key must be required to reset the station.

2.7 SMOKE DETECTORS

2.7.1 Spot Type Detectors

Provide addressable photoelectric smoke detectors as follows:

a. Provide analog/addressable photoelectric smoke detectors utilizing the photoelectric light scattering principle for operation in accordance with UL 268. Smoke detectors must be listed for use with the FMCU.

b. Provide self-restoring type detectors that do not require any readjustment after actuation at the FMCU to restore them to normal operation. The detector must have a visual indicator to show actuation.

c. Vibration must have no effect on the detector's operation. Protect the detection chamber with a fine mesh metallic screen that prevents the entrance of insects or airborne materials. The screen must not inhibit the movement of smoke particles into the chamber.

d. Provide twist lock bases with screw terminals for each conductor. The detectors must maintain contact with their bases without the use of springs.

e. The detector address must identify the particular unit, its location within the system. Detectors must be of the low voltage type rated for use on a 24 VDC system.

f. Laser smoke detector must provide point identification of the fire location through addressability, must experience no delay in response time due to smoke dilution or smoke transportation time, and must offer complete supervision of wiring and detector.

2.7.2 Duct Smoke Detectors

Duct-mounted addressable photoelectric smoke detectors must consist of a smoke detector, as specified in paragraph Spot Type Detectors, mounted in a special housing fitted with duct sampling tubes. Detector circuitry must be mounted in a metallic or plastic enclosure exterior to the duct. It is not permitted to cut the duct insulation to install the duct detector directly on the duct. Detectors must be listed for operation over the complete range of air velocities, temperature and humidity expected at the detector when the air-handling system is operating. Detectors must be powered from the FMCU.

a. Sampling tubes must run the full width of the duct. The duct detector package must conform to the requirements of NFPA 90A, UL 268A, and must be listed for use in air-handling systems. The control functions, operation, reset, and bypass must be controlled from the FMCU.

b. Lights to indicate the operation and alarm condition must be visible and accessible with the unit installed and the cover in place. Remote indicators must be provided where required by NFPA 72. Remote indicators as well as the affected fan units must be properly identified in etched plastic placards.

c. Detectors must provide for control of auxiliary contacts that provide control, interlock, and shutdown functions specified in Section 23 09 00 to INSTRUMENTATION AND CONTROL FOR HVAC. Auxiliary contacts provide for this function must be located within 3 feet of the controlled circuit or appliance. The auxiliary contacts must be supplied by the fire alarm system manufacturer to ensure complete system compatibility.

2.8 CARBON MONOXIDE DETECTOR

Analog/addressable carbon monoxide (CO) detectors must be listed to UL 2075 and set to respond to the sensitivity limits of UL 2034. Carbon monoxide detectors must be listed for use with fire alarm control units. Detectors must be surface mounted in the horizontal orientation and supported independently of wiring connections. Detectors must be self-restoring. For FMCU with no listed compatible addressable CO detectors, provide listed 4-wire detectors. Do not provide CO detectors with local alarms. Detector must be provided with an LED status indicator.

a. Where 4-wire CO detectors are necessary, each 4-wire CO detector must be individually monitored via addressable interface modules for alarm and off normal/trouble conditions (including loss of power to the individual detector). Power circuits for 4-wire CO detectors must be dedicated to powering the CO detectors only. Battery powered and 120 VAC powered detectors are prohibited.

b. Wiring connections must be made by means of screw terminals and detectors must be equipped with trouble relays. Detectors must be able to mount a single-gang electrical box.

c. A trouble condition at an individual CO detector must not affect any other CO detectors. CO detectors must be powered by the FMCU.

d. Detectors must be provided with a means to test CO gas entry into the CO sensing cell.

2.9 ADDRESSABLE INTERFACE DEVICES

The initiating device being monitored must be configured as a Class "B" initiating device circuits. The module must be listed as compatible with the control unit. The module must provide address setting means compatible with the control unit's SLC supervision and store an internal identifying code. Monitor module must contain an integral LED that flashes each time the monitor module is polled and is visible through the device cover plate. Pull stations with a monitor module in a common backbox are not required to have an LED. Modules must be listed for the environmental conditions in which they will be installed.

2.10 ADDRESSABLE CONTROL MODULES

The control module must be capable of operating as a relay (dry contact form C) for interfacing the control unit with other systems, and to control door holders or initiate elevator fire service. The module must be listed as compatible with the control unit. The indicating device or the external load being controlled must be configured as Class B notification appliance circuits. The system must be capable of supervising, audible, visual and dry contact circuits. The control module must have both an input and output address. The supervision must detect a short on the supervised circuit and must prevent power from being applied

to the circuit. The control module must provide address setting means compatible with the control unit's SLC supervision and store an internal identifying code. The control module must contain an integral LED that flashes each time the control module is polled and is visible through the device cover plate. Control Modules must be listed for the environmental conditions in which they will be installed.

2.11 ISOLATION MODULES

a. Provide isolation modules to subdivide each signaling line circuit in accordance with NFPA 72 between adjacent isolation modules.

b. Isolation modules must provide short circuit isolation for signaling line circuit wiring.

c. Power and communications must be supplied by the SLC and must report faults to the FMCU.

d. After the wiring fault is repaired, the fault isolation modules must test the lines and automatically restore the connection.

2.12 NOTIFICATION APPLIANCES

2.12.1 Audible Notification Appliances

Audible appliances must conform to the applicable requirements of UL 464. Appliances must be connected into notification appliance circuits. Surface mounted audible appliances must be painted white. Recessed audible appliances must be installed with a grill that is painted white.

2.12.1.1 Speakers

a. Speakers must conform to the applicable requirements of UL 1480. Speakers must have six different sound output levels and operate with audio line input levels of 70.7 VRMs and 25 VRMs, by means of selectable tap settings. Interior speaker tap settings must include taps of 1/4, 1/2, 1, and 2 watt, at a minimum. Exterior speakers must also be multi-tapped with no more than 15 watt maximum setting. Speakers must incorporate a high efficiency speaker for maximum output at minimum power across a frequency range of 400 Hz to 4,000 Hz, and must have a sealed back construction. Speakers must be capable of installation on standard 4-inch square electrical boxes. Where speakers and strobes are provided in the same location, they may be combined into a single unit. All inputs must be polarized for compatibility with standard reverse polarity supervision of circuit wiring via the FMCU.

b. Provide speaker mounting plates constructed of cold rolled steel having a minimum thickness of 16 gage or molded high impact plastic and equipped with mounting holes and other openings as needed for a complete installation. Fabrication marks and holes must be ground and finished to provide a smooth and neat appearance for each plate. Each plate must be primed and painted.

c. Speakers must utilize screw terminals for termination of all field wiring.

2.12.2 Visual Notification Appliances

Visual notification appliances must conform to the applicable requirements of UL 1638, UL 1971 and conform to the Architectural Barriers Act (ABA). Visual Notification Appliances must have clear high intensity optic lens, xenon flash tubes, or light emitting diode (LED) and be marked "Alert" in letters of contrasting color. The light pattern must be dispersed so that it is visible above and below the strobe and from a 90 degree angle on both sides of the strobe. Strobe flash rate must be 1 flash per second and a minimum of 15 30 75 177 candela based on the UL 1971 test. Strobe must be surface or semi-flush mounted.

2.12.3 Textual Display Signs

Textual display signs must be of the same type as those existing in the facility and must not exceed 16 inches long by 6 inches high by 3 inches deep with a height necessary to meet the requirements of NFPA 72. The text display must spell out the word "EVACUATE" or "ANNOUNCEMENT" as appropriate. The design of text display must be such that it cannot be read when not illuminated.

LCD or LED scrolling text displays must meet the following requirements at a minimum:

a. Two lines of information for high priority messaging.

b. Minimum of 20 characters per line (40 total) displayed.

c. Text must be no less than height requirements and color/contrast requirements of NFPA 72.

d. 32K character memory.

e. Display must be wall or ceiling mounted.

f. Mounting brackets for a convenient wall/cubicle mount.

g. The system must interface with the textual display sign control panel to activate the proper message.

2.13 ELECTRIC POWER

2.13.1 Primary Power

Power must be 120 VAC 60 Hz service for the FMCU from the AC service to the building in accordance with NFPA 72.

2.14 SECONDARY POWER SUPPLY

Provide for system operation in the event of primary power source failure. Transfer from normal to auxiliary (secondary) power or restoration from auxiliary to normal power must be automatic and must not cause transmission of a false alarm.

2.14.1 Batteries

Provide sealed, maintenance-free, sealed lead acid batteries as the source for emergency power to the FMCU. Batteries must contain suspended electrolyte. The battery system must be maintained in a fully charged

condition by means of a solid state battery charger. Provide an automatic transfer switch to transfer the load to the batteries in the event of the failure of primary power.

2.14.1.1 Capacity

Battery size must be the greater of the following two capacities. This capacity applies to every control unit associated with this system, including supplemental notification appliance circuit panels, auxiliary power supply panels, fire alarm transmitters, and Base-wide mass notification transceivers. When determining the required capacity under alarm condition, visual notification appliances must include both textual and non-textual type appliances.

a. Sufficient capacity to operate the fire alarm system under supervisory and trouble conditions, including audible trouble signal devices for 48 hours and audible and visual signal devices under alarm conditions for an additional 15 minutes.

b. Sufficient capacity to operate the mass notification for 60 minutes after loss of AC power.

2.14.1.2 Battery Power Calculations

a. Verify that battery capacity exceeds supervisory and alarm power requirements for the criteria noted in the paragraph "Capacity" above.

    (1) Substantiate the battery calculations for alarm and supervisory power requirements. Include ampere-hour requirements for each system component and each control unit component, and compliance with UL 864.

    (2) Provide complete battery calculations for both the alarm and supervisory power requirements. Submit ampere-hour requirements for each system component with the calculations.

    (3) Provide voltage drop calculations to indicate that sufficient voltage is available for proper operation of the system and all components. Calculations must be performed using the minimum rated voltage of each component.

b. For battery calculations assume a starting voltage of 24 VDC for starting the calculations to size the batteries. Calculate the required Amp-Hours for the specified standby time, and then calculate the required Amp-Hours for the specified alarm time. Using 20.4 VDC as starting voltage, perform a voltage drop calculation for circuits containing device and/or appliances remote from the power sources.

2.14.2 Battery Chargers

Provide a solid state, fully automatic, variable charging rate battery charger. The charger must be capable of providing 120 percent of the connected system load and must maintain the batteries at full charge. In the event the batteries are fully discharged (20.4 Volts dc), the charger must recharge the batteries back to 95 percent of full charge within 48 hours after a single discharge cycle as described in paragraph CAPACITY above. Provide pilot light to indicate when batteries are manually placed on a high rate of charge as part of the unit assembly if a high rate switch is provided.

2.15 SURGE PROTECTIVE DEVICES

Surge protective devices must be provided to suppress all voltage transients which might damage fire alarm control unit components. Systems having circuits located outdoors, communications equipment must be protected against surges induced on any signaling line circuit. Cables and conductors, that serve as communications links, must have surge protection circuits installed at each end. The surge protective device must wire in series to the power supply of the protected equipment with screw terminations. Line voltage surge arrestor must be installed directly adjacent to the power panel where the FMCU breaker is located.

a. Surge protective devices for nominal 120 VAC must be UL 1449 listed with a maximum 500 volt suppression level and have a maximum response time of 5 nanoseconds. The surge protective device must also meet IEEE C62.41.1 and IEEE C62.41.2 category B tests for surge capacity. The surge protective device must feature multi-stage construction and be provided with a long-life indicator lamp (either light emitting diode or neon) which extinguishes upon failure of protected components. Any unit fusing must be externally accessible.

b. Surge protective devices for nominal 24 VAC, fire alarm telephone dialer, or ethernet connection must be UL 497B listed, meet IEEE C62.41.1 and have a maximum response time of 1-nanosecond. The surge protective device must feature multi-stage construction and be self-resetting. The surge protective device must be a base and plug style. The base assembly must have screw terminals for fire alarm wiring. The base assembly must accept "plug-in" surge protective module.

c. All surge protective devices (SPD) must be the standard product of a single manufacturer and be equal or better than the following:

    (1) For 120 VAC nominal line voltage: UL 1449 and UL 1283 listed, series connected 120 VAC, 20A rated, surge protective device in a NEMA 4x enclosure. Minimum 50,000 amp surge current rating with EMI/RFI filtering and a dry contact circuit for remote monitoring of surge protection status.

    (2) For 24-volt nominal line voltage: UL 497B listed, series connected low voltage, 24-volt, 5A rated, loop circuit protector, base and replaceable module.

    (3) For alarm telephone dialers: UL 497A listed, series connected, 130-volt, 150 mA rated with self-resetting fuse, dialer circuit protector with modular plug and play.

    (4) For IP-DACTS: UL 497B listed, series connected, 6.4-volt, 1.5A rated with 20 kA/pair surge current, data network protector with modular plug and play.

2.16 WIRING

Provide wiring materials under this section as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM with the additions and modifications specified herein.

2.16.1 Alarm Wiring

IDC and SLC wiring must be solid copper cable in accordance with the manufacturers requirements. Copper signaling line circuits and initiating device circuit field wiring must be No. 18 AWG size conductors at a minimum. Visual notification appliance circuit conductors, that contain audible alarm appliances, must be copper No. 16 AWG size conductors at a minimum. Speaker circuits must be copper No. 16 AWG size twisted and shielded conductors at a minimum. Wiring for textual notification appliance circuits must be in accordance with manufacturer's requirements but must be supervised by the FMCU. Wire size must be sufficient to prevent voltage drop problems. Circuits operating at 24 VDC must not operate at less than the listed voltages for the detectors and/or appliances. Power wiring, operating at 120 VAC minimum, must be a minimum No. 12 AWG solid copper having similar insulation. Acceptable power-limited cables are FPL, FPLR or FPLP as appropriate with red colored covering. Nonpower-limited cables must comply with NFPA 70.

2.17 SYSTEM MONITORING

2.17.1 Valves

Each valve affecting the proper operation of a fire protection system, including automatic sprinkler control valves, sprinkler service entrance valve, isolating valves for pressure type waterflow or supervision switches, and valves at backflow preventers, whether supplied under this contract or existing, must be electrically monitored to ensure its proper position. Provide each tamper switch with a separate address, unless they are within the same room, then a maximum of five can use the same address.

2.18 ENVIRONMENTAL ENCLOSURES OR GUARDS

Environmental enclosures must be provided to permit fire alarm/mass notification components to be used in areas that exceed the environmental limits of the listing. The enclosure must be listed for the device or appliance as either a manufactured part number or as a listed compatible accessory for the component is currently listed. Guards required to deter mechanical damage must be either a listed manufactured part or a listed accessory for the category of the initiating device or notification appliance.

PART 3 EXECUTION

3.1 VERIFYING ACTUAL FIELD CONDITIONS

Before commencing work, examine all adjoining work on which the contractor's work is in any way dependent for perfect workmanship according to the intent of this specification section, and report to the Contracting Officer's Representative any condition which prevents performance of first class work. No "waiver of responsibility" for incomplete, inadequate or defective adjoining work will be considered unless notice has been filed before submittal of a proposal.

3.2 INSTALLATION

3.2.1 Fire Alarm and Mass Notification Control Unit (FMCU)

Locate the FMCU where indicated on the drawings. Semi-recess the enclosure with the top of the cabinet 6 feet above the finished floor or

center the cabinet at 5 feet, whichever is lower. Conductor terminations must be labeled and a drawing containing conductors, their labels, their circuits, and their interconnection must be permanently mounted in the FMCU. Locate the document storage cabinet adjacent to the FMCU unless the Contracting Officer directs otherwise.

3.2.2 Battery Cabinets

When batteries will not fit in the FMCU, locate battery cabinets below or adjacent to the FMCU. Battery cabinets must be installed at an accessible location when standing at floor level. Battery cabinets must not be installed lower than 12 inches above finished floor, measured to the bottom of the cabinet, nor higher than 36 inches above the floor, measured to the top of the cabinet. Installing batteries above drop ceilings or in inaccessible locations is prohibited. Battery cabinets must be large enough to accommodate batteries and also to allow ample gutter space for interconnection of control units as well as field wiring. The cabinet must be provided in a sturdy steel housing, complete with back box, hinged steel door with cylinder lock, and surface mounting provisions.The cabinet must be identified by an engraved phenolic resin nameplate. Lettering on the nameplate must indicate the control unit(s) the batteries power and must not be less than 1-inch high.

3.2.3 Manual Stations

Locate manual stations as required by NFPA 72 and as indicated on the drawings. Mount stations so they are located no farther than 5 feet from the exit door they serve, measured horizontally. Manual stations must be mounted at 44 inches measured to the operating handle.

3.2.4 Notification Appliances

a. Locate notification appliance devices as required by NFPA 72 and to meet the intelligibility requirements. Where two or more visual notification appliances are located in the same room or corridor or field of view, provide synchronized operation. Devices must use screw terminals for all field wiring. Audible and visual notification appliances mounted in acoustical ceiling tiles must be centered in the tiles plus or minus 2 inches.

b. Audible and visual notification appliances mounted on the exterior of the building, within unconditioned spaces, or in the vicinity of showers must be listed weatherproof appliances installed on weatherproof backboxes.

c. Speakers must not be located in close proximity to the FMCU or LOC so as to cause feedback when the microphone is in use.

3.2.5 Smoke and Heat Detectors

Locate detectors as required by NFPA 72 and their listing on a 4-inch mounting box. Install heat detectors not less than 4 inches from a side wall to the near edge. Heat detectors located on the wall must have the top of the detector at least 4 inches below the ceiling, but not more than 12 inches below the ceiling. Smoke detectors are permitted to be on the wall no lower than 12 inches from the ceiling with no minimum distance from the ceiling.

3.2.6 Carbon Monoxide Detectors

Locate detectors as required by NFPA 72 and their listings on a 4-inch mounting box. Carbon monoxide detectors must be installed separate from smoke and/or heat detectors.

3.2.7 Electromagnetic Door Holder Release

Doors must be held open at a minimum of 90 degrees so as not to impede egress from the space. Mount the armature portion on the door and have an adjusting screw for seating the angle of the contact plate. Wall-mount the electromagnetic release, with a total horizontal projection not exceeding 4 inches. Ensure all doors release to close upon first stage (pre-discharge) alarm. Electrical supervision of wiring external of control unit for magnetic door holding circuits is not required.

3.2.8 Local Operating Console (LOC)

Locate the LOC(s) as required by NFPA 72 and as indicated. Mount the console so that the top message button and microphone is no higher than 4 feet above the floor and the bottom (lowest) message button and microphone is at least 3 feet above the finished floor.

3.2.9 Ceiling Bridges

Provide ceiling bridges for ceiling-mounted appliances. Ceiling bridges must be as recommended/required by the manufacturer of the ceiling-mounted notification appliance.

3.3 SYSTEM FIELD WIRING

3.3.1 Wiring within Cabinets, Enclosures, and Boxes

Provide wiring installed in a neat and workmanlike manner and installed parallel with or at right angles to the sides and back of any box, enclosure, or cabinet. Conductors that are terminated, spliced, or otherwise interrupted in any enclosure, cabinet, mounting, or junction box must be connected to screw-type terminal blocks. Mark each terminal in accordance with the wiring diagrams of the system. The use of wire nuts or similar devices is prohibited. Wiring to conform with NFPA 70.

Indicate the following in the wiring diagrams:

a. Point-to-point wiring diagrams showing the points of connection and terminals used for electrical field connections in the system, including interconnections between the equipment or systems that are supervised or controlled by the system. Diagrams must show connections from field devices to the FMCU and remote fire alarm/mass notification control units, initiating circuits, switches, relays and terminals.

b. Complete riser diagrams indicating the wiring sequence of devices and their connections to the control equipment. Include a color code schedule for the wiring. Include floor plans showing the locations of devices and equipment.

3.3.2 Terminal Cabinets

Provide a terminal cabinet at the base of any circuit riser, on each floor

at each riser, and where indicated on the drawings. Terminal size must be appropriate for the size of the wiring to be connected. Conductor terminations must be labeled and a drawing containing conductors, their labels, their circuits, and their interconnection must be permanently mounted in the terminal cabinet. Minimum size is 8 inches by 8 inches. Only screw-type terminals are permitted. Provide an identification label, that displays "FIRE ALARM TERMINAL CABINET" with 2-inch lettering, on the front of the terminal cabinet.

3.3.3 Alarm Wiring

a. Voltages must not be mixed in any junction box, housing or device, except those containing power supplies and control relays.

b. Utilize shielded wiring where recommended by the manufacturer. For shielded wiring, ground the shield at only one point, in or adjacent to the FMCU.

c. Pigtail or T-tap connections to signal line circuits, initiating device circuits, supervisory alarm circuits, and notification appliance circuits are prohibited. T-tapping using screw terminal blocks is allowed for Class "B" signaling line circuits.

d. Color coding is required for circuits and must be maintained throughout the circuit. Conductors used for the same functions must be similarly color coded. Conform wiring to NFPA 70.

e. Pull all conductors splice free. The use of wire nuts, crimped connectors, or twisting of conductors is prohibited. Where splices are unavoidable, the location of the junction box or pull box where they occur must be identified on the as-built drawings. The number and location of splices must be subject to approval by the Designated Fire Protection Engineer (DFPE).

3.3.4 Back Boxes and Conduit

In addition to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, provide all wiring in rigid metal conduit or intermediate metal conduit unless specifically indicated otherwise. Minimum conduit size must be 3/4-inch in diameter. Do not use electrical non-metallic tubing (ENT) or flexible non-metallic tubing and associated fittings.

a. Galvanized rigid steel (GRS) conduit must be utilized where exposed to weather, where subject to physical damage, and where exposed on exterior of buildings. Intermediate metal conduit (IMC) may be used in lieu of GRS as allowed by NFPA 70.

b. Electrical metallic tubing (EMT) is permitted above suspended ceilings or exposed where not subject to physical damage. Do not use EMT underground, encased in concrete, mortar, or grout, in hazardous locations, where exposed to physical damage, outdoors or in fire pump rooms. Use die-cast compression connectors.

c. For rigid metallic conduit (RMC), only threaded type fitting are permitted for wet or damp locations.

d. Flexible metal conduit is permitted for initiating device circuits 6 feet in length or less. Flexible metal conduit is prohibited for notification appliance circuits and signaling line circuits. Use

liquid tight flexible metal conduit in damp and wet locations.

e. Schedule 40 (minimum) polyvinyl chloride (PVC) is permitted where conduit is routed underground or underground below floor slabs. Convert non-metallic conduit, other than PVC Schedule 40 or 80, to plastic-coated rigid, or IMC, steel conduit before turning up through floor slab.

f. Exterior wall penetrations must be weathertight. Conduit must be sealed to prevent the infiltration of moisture.

3.3.5 Conductor Terminations

Labeling of conductors at terminal blocks in terminal cabinets, FMCU, and remote FMCU and the LOC must be provided at each conductor connection. Each conductor or cable must have a shrink-wrap label to provide a unique and specific designation. Each terminal cabinet, FMCU, and remote FMCU must contain a laminated drawing that indicates each conductor, its label, circuit, and terminal. The laminated drawing must be neat, using 12 point lettering minimum size, and mounted within each cabinet, control unit, or unit so that it does not interfere with the wiring or terminals. Maintain existing color code scheme where connecting to existing equipment.

3.4 FIRESTOPPING

Provide firestopping for holes at conduit penetrations through floor slabs, fire-rated walls, partitions with fire-rated doors, corridor walls, and vertical service shafts in accordance with Section 07 84 00 FIRESTOPPING.

3.5 PAINTING

a. In unfinished areas (including areas above drop ceilings), paint all exposed electrical conduit (serving fire alarm equipment), fire alarm conduit, surface metal raceway, junction boxes and covers red. In lieu of painting conduit, the contractor may utilize red conduit with a factory applied finish.

b. In finished areas, paint exposed electrical conduit (serving fire alarm equipment), fire alarm conduit, surface metal raceways, junction boxes, and electrical boxes to match adjacent finishes. The inside cover of the junction box must be identified as "Fire Alarm" and the conduit must have painted red bands 3/4-inch wide at 10-foot centers and at each side of a floor, wall, or ceiling penetration.

c. Painting must comply with Section 09 90 00 PAINTS AND COATINGS.

3.6 FIELD QUALITY CONTROL

3.6.1 Test Procedures

Submit detailed test procedures, prepared and signed by the NICET Level IV Fire Alarm Technician, and the representative of the installing company, and reviewed by the QFPE 60 days prior to performing system tests. Detailed test procedures must list all components of the installed system such as initiating devices and circuits, notification appliances and circuits, signaling line devices and circuits, control devices/equipment, batteries, transmitting and receiving equipment, power sources/supply, annunciators, special hazard equipment, emergency communication equipment,

interface equipment, and surge protective devices. Test procedures must include sequence of testing, time estimate for each test, and sample test data forms. The test data forms must be in a check-off format (pass/fail with space to add applicable test data; similar to the forms in NFPA 72 and NFPA 4.) The test procedures and accompanying test data forms must be used for the pre-Government testing and the Government testing. The test data forms must record the test results and must:

a. Identify the NFPA Class of all Initiating Device Circuits (IDC), and Notification Appliance Circuits (NAC), Voice Notification System Circuits (NAC Audio), and Signaling Line Circuits (SLC).

b. Identify each test required by NFPA 72 Test Methods and required test herein to be performed on each component, and describe how these tests must be performed.

c. Identify each component and circuit as to type, location within the facility, and unique identity within the installed system. Provide necessary floor plan sheets showing each component location, test location, and alphanumeric identity.

d. Identify all test equipment and personnel required to perform each test (including equipment necessary for smoke detector testing. The use of magnets is not permitted.

e. Provide space to identify the date and time of each test. Provide space to identify the names and signatures of the individuals conducting and witnessing each test.

3.6.2 Pre-Government Testing

3.6.2.1 Verification of Compliant Installation

Conduct inspections and tests to ensure that devices and circuits are functioning properly. Tests must meet the requirements of paragraph entitled "Minimum System Tests" as required by NFPA 72. The contractor and an authorized representative from each supplier of equipment must be in attendance at the pre-Government testing to make necessary adjustments. After inspection and testing is complete, provide a signed Verification of Compliant Installation letter by the QFPE that the installation is complete, compliant with the specification and fully operable. The letter must include the names and titles of the witnesses to the pre-Government tests. Provide all completion documentation as required by NFPA 72 including all referenced annex sections and the test reports noted below.

a. NFPA 72 Record of Completion.

b. NFPA 72 Record of Inspection and Testing.

c. Fire Alarm and Emergency Communication System Inspection and Testing Form.

d. Audibility test results with marked-up test floor plans.

e. Intelligibility test results with marked-up floor plans.

f. Documentation that all tests identified in the paragraph "Minimum System Tests" are complete.

3.6.2.2 Request for Government Final Test

When the verification of compliant installation has been completed, submit a formal request for Government final test to the Designated Fire Protection Engineer (DFPE). Government final testing will not be scheduled until the DFPE has received copies of the request for Government final testing and Verification of Compliant Installation letter with all required reports. Government final testing will not be performed until after the connections to the installation-wide fire reporting system been completed and tested to confirm communications are fully functional. Submit request for test at least 15 calendar days prior to the requested test date.

3.6.3 Correction of Deficiencies

If equipment was found to be defective or non-compliant with contract requirements, perform corrective actions and repeat the tests. Tests must be conducted and repeated if necessary until the system has been demonstrated to comply with all contract requirements.

3.6.4 Government Final Tests

The tests must be performed in accordance with the approved test procedures in the presence of the DFPE. Furnish instruments and personnel required for the tests. The following must be provided at the job site for Government Final Testing:

a. The manufacturer's technical representative.

b. The contractor's Qualified Fire Protection Engineer (QFPE).

c. Marked-up red line drawings of the system as actually installed.

d. Loop resistance test results.

e. Complete program printout including input/output addresses.

f. Copy of pre-Government Test Certificate, test procedures and completed test data forms.

g. Audibility test results with marked-up floor plans.

h. Intelligibility test results with marked-up floor plans.

Government Final Tests will be witnessed by the Designated Fire Protection Engineer Contracting Officer's Representative (COR), Qualified Fire Protection Engineer (QFPE). At this time, any and all required tests noted in the paragraph "Minimum System Tests" must be repeated at their discretion.

3.7 MINIMUM SYSTEM TESTS

3.7.1 System Tests

Test the system in accordance with the procedures outlined in NFPA 72. The required tests are as follows:

a. Loop Resistance Tests: Measure and record the resistance of each

circuit with each pair of conductors in the circuit short-circuited at the farthest point from the circuit origin. The tests must be witnessed by the Contracting Officer and test results recorded for use at the final Government test.

b. Verify the absence of unwanted voltages between circuit conductors and ground. The tests must be accomplished at the pre-Government test with results available at the final system test.

c. Verify that the control unit is in the normal condition as detailed in the manufacturer's O&M manual.

d. Test each initiating device and notification appliance and circuit for proper operation and response at the control unit. Smoke detectors must be tested in accordance with manufacturer's recommended calibrated test method. Use of magnets is prohibited. Testing of duct smoke detectors must comply with the requirements of NFPA 72 except disconnect at least 20 percent of devices. If there is a failure at these devices, then supervision must be tested at each device.

e. Carbon Monoxide Detector Tests: Carbon monoxide detectors must be tested in accordance with NFPA 72 and the manufacturer's recommended calibrated test method.

f. Test the system for specified functions in accordance with the contract drawings and specifications and the manufacturer's O&M manual.

g. Test both primary power and secondary power. Verify, by test, the secondary power system is capable of operating the system for the time period and in the manner specified.

h. Determine that the system is operable under trouble conditions as specified.

i. Visually inspect wiring.

j. Test the battery charger and batteries.

k. Verify that software control and data files have been entered or programmed into the FMCU. Hard copy records of the software must be provided to the Contracting Officer.

l. Verify that red-line drawings are accurate.

m. Measure the current in circuits to ensure there is the calculated spare capacity for the circuits.

n. Measure voltage readings for circuits to ensure that voltage drop is not excessive.

o. Disconnect the verification feature for smoke detectors during tests to minimize the amount of smoke needed to activate the sensor. Testing of smoke detectors must be conducted using real smoke or the use of canned smoke which is permitted.

p. Measure the voltage drop at the most remote appliance (based on wire length) on each notification appliance circuit.

q. Verify the documentation cabinet is installed and contains all

as-built shop drawings, product data sheets, design calculations, site-specific software data package, and all documentation required by paragraph titled "Test Reports".

3.7.2 Audibility Tests

Sound pressure levels from audible notification appliances must be a minimum of 15 dBa over ambient with a maximum of 110 dBa in any occupiable area. The provisions for audible notification (audibility and intelligibility) must be met with doors, fire shutters, movable partitions, and similar devices closed.

3.7.3 Intelligibility Tests

Intelligibility testing of the System must be accomplished in accordance with NFPA 72 for Voice Evacuation Systems, and ASA S3.2. Following are the specific requirements for intelligibility tests:

a. Intelligibility Requirements: Verify intelligibility by measurement after installation.

b. Ensure that a CIS value greater than the required minimum value is provided in each area where building occupants typically could be found. The minimum required value for CIS is .8. Rounding of values is permitted.

c. Areas of the building provided with hard wall and ceiling surfaces (such as metal or concrete) that are found to cause excessive sound reflections may be permitted to have a CIS score less than the minimum required value if approved by the DFPE, and if building occupants in these areas can determine that a voice signal is being broadcast and they must walk no more than 33 feet to find a location with at least the minimum required CIS value within the same area.

d. Areas of the building where occupants are not expected to be normally present are permitted to have a CIS score less than the minimum required value if personnel can determine that a voice signal is being broadcast and they must walk no more than 50 feet to a location with at least the minimum required CIS value within the same area.

e. Take measurements near the head level applicable for most personnel in the space under normal conditions (e.g., standing, sitting, sleeping, as appropriate).

f. The distance the occupant must walk to the location meeting the minimum required CIS value must be measured on the floor or other walking surface as follows:

(1) Along the centerline of the natural path of travel, starting from any point subject to occupancy with less than the minimum required CIS value.

(2) Curving around any corners or obstructions, with a 12 inches clearance there from.

(3) Terminating directly below the location where the minimum required CIS value has been obtained.

Use commercially available test instrumentation to measure intelligibility

as specified by NFPA 72 as applicable. Use the mean value of at least three readings to compute the intelligibility score at each test location.

3.8 SYSTEM ACCEPTANCE

Following acceptance of the system, as-built drawings and O&M manuals must be delivered to the Contracting Officer for review and acceptance. The drawings must show the system as installed, including deviations from both the project drawings and the approved shop drawings. These drawings must be submitted within two weeks after the final Government test of the system. At least one set of as-built (marked-up) drawings must be provided at the time of, or prior to the Final Government Test.

a. The drawings must be prepared electronically and sized no less than the contract drawings. Furnish one set of CDs or DVDs containing software back-up and CAD based drawings in latest version of AutoCAD, and portable document formats of as-built drawings and schematics.

b. Include complete wiring diagrams showing connections between devices and equipment, both factory and field wired.

c. Include a riser diagram and drawings showing the as-built location of devices and equipment.

d. Provide Operation and Maintenance (O&M) Instructions.

3.9 INSTRUCTION OF GOVERNMENT EMPLOYEES

3.9.1 Instructor

Provide the services of an instructor, who has received specific training from the manufacturer for the training of other persons regarding the operation, inspection, testing, and maintenance of the system provided. The instructor must train the Government employees designated by the Contracting Officer, in the care, adjustment, maintenance, and operation of the fire alarm system. The instructor must be thoroughly familiar with all parts of this installation. The instructor must be trained in operating theory as well as in practical O&M work. Submit the instructors information and qualifications including the training history.

3.9.2 Required Instruction Time

Provide 8 hours of instruction after final acceptance of the system. The instruction must be given during regular working hours on such dates and times selected by the Contracting Officer. The instruction may be divided into two or more periods at the discretion of the Contracting Officer. The training must allow for rescheduling for unforeseen maintenance and/or fire department responses.

3.9.2.1 Technical Training

Equipment manufacturer or a factory representative must provide 1 days of on site. Training must allow for classroom instruction as well as individual hands on programming, troubleshooting and diagnostics exercises.

3.9.3 Technical Training Manual

Provide, in manual format, lesson plans, operating instructions, maintenance procedures, and training data for the training courses. The

operations training must familiarize designated government personnel with proper operation of the installed system. The maintenance training course must provide the designated government personnel adequate knowledge required to diagnose, repair, maintain, and expand functions inherent to the system.

3.10 EXTRA MATERIALS

3.10.1 Repair Service/Replacement Parts

Repair services and replacement parts for the system must be available for a period of 10 years after the date of final acceptance of this work by the Contracting Officer. During the warranty period, the service technician must be on-site within 24 hours after notification. All repairs must be completed within 24 hours of arrival on-site.

During the warranty period, the installing fire alarm contractor is responsible for conducting all required testing and maintenance in accordance with the requirements and recommended practices of NFPA 72 and the system manufacturer. Installing fire alarm contractor is NOT responsible for any damage resulting from abuse, misuse, or neglect of equipment by the end user.

3.10.2 Spare Parts

Spare parts furnished must be directly interchangeable with the corresponding components of the installed system. Spare parts must be suitably packaged and identified by nameplate, tagging, or stamping. Spare parts must be delivered to the Contracting Officer at the time of the Government testing and must be accompanied by an inventory list.

3.10.3 Document Storage Cabinet

Upon completion of the project, but prior to project close-out, place in the document storage cabinet copies of the following record documentation:

a. As-built shop drawings

b. Product data sheets

c. Design calculations

d. Site-specific software data package

e. All documentation required by SD-06.

-- End of Section --

Control No. CECT-NWO-23-10

JUSTIFICATION REVIEW DOCUMENT
FULL AND OPEN COMPETITION

PROJECT/EQUIPMENT:
Sole Source contract for brand name "Monaco" fire alarm panel equipment through construction award of the B-21 Weapons Loader Trainer Facility (WLT) at Ellsworth Air Force Base, South Dakota.

AUTHORITY: 10 U.S.C. 2304(a)(1) as implemented by FAR 6.302-1, gives DoD the authority to set aside requirements when there is only one responsible source, and no other supplies or services will satisfy agency requirements. FAR 6.302-1(a)(2)(iii) states: "For DoD, services may be deemed to be available only from the original source in the case of follow-on contracts for the continued provision of highly specialized services when it is likely that award to any other source would result in— (A) Substantial duplication of cost to the Government that is not expected to be recovered through competition."

AMOUNT: $36,602.00

PREPARED BY:	NAME: Michele Renkema PHONE: [redacted]	DATE:
CONTRACTING OFFICER	NAME: Amanda E. Eaton PHONE: [redacted]	DATE:
TECHNICAL	NAME: Trevor J. Weihing PHONE: [redacted]	DATE:
REQUIREMENTS	NAME: Trevor J. Weihing PHONE: [redacted]	DATE:

SIGNATURES ARE REQUIRED BELOW

I have reviewed this J&A and find the justification adequate to support other than full and open competition.

DEPUTY FOR SMALL BUSINESS	SIGNATURE: GLYNN.JAMES.R.1163086235 Digitally signed by GLYNN.JAMES.R.1163086235 Date: 2023.05.22 07:44:32 -07'00' NAME: James Glynn	DATE: PHONE: [redacted]
DISTRICT COUNSEL	SIGNATURE: TRACY.THOMAS.J.1231350582 Digitally signed by TRACY.THOMAS.J.1231350582 Date: 2023.05.22 10:31:19 -05'00' NAME: Thomas J. Tracy	DATE: PHONE: [redacted]

FAR Part 6 Justification and Approval for
Other than Full and Open Competition

1. Contracting Activity: U.S. Army Corps of Engineers (USACE), Omaha District, 1616 Capitol Ave, Omaha, NE 68102.

2. Description of Action: This Justification and Approval (J&A) is requested to specify a brand name fire alarm panel in the contract specifications for the construction of a B-21 Weapon Loader Trainer Facility (WLT) that will be executed at Ellsworth AFB, Rapid City, South Dakota. In FY23 USACE Omaha District will compete and award the B-21 WLT project as a Firm-Fixed-Price (FFP), Design-Bid-Build construction contract utilizing Operations and Maintenance (Air Force) (OMAF) funding.

An Air Force J&A was approved 17 December 2021 to allow the purchase of fire alarm panels from a limited number of fire alarm manufacturers to reduce training, operations, and maintenance costs. This J&A was not developed for a specific acquisition but rather allows each installation to perform analyses to document and justify acquisitions from select manufacturer(s) based upon pre-planning efforts conducted at each location.

The 28th Civil Engineering Squadron (CES) memorandum dated 28 June 2022 summarizes the analyses performed at Ellsworth AFB. As noted, almost half of all fire alarm panels are Monaco brand, including the centralized fire dispatch system. In addition, Ellsworth AFB is going to a full point-to-point reporting system to assist with fire detection across the installation.

3. Description of Supplies/Services: USACE received the mission to renovate existing building 7504 at 124,694 SF from Pride Hangar into the Weapons Loader Trainer Facility (WLT) in support of the new B-21 mission. Congress approved the project and USACE received the DD Form 1391 from Air Force Civil Engineering Center (AFCEC). This facility will have administrative/support areas, secure enclosures that will house the weapon loader trainers, small training devices, and training for the emerging B-21 aircraft. As part of the design and construction effort, new fire alarm panels are needed with the modification/renovation of the facilities.

The Government will not purchase these items directly, but will require the construction contractor to provide and install the following:

ITEM	PROPOSED MAKE	ESTIMATED AMOUNT
Fire Alarm Panels	Monaco	[redacted]

The material cost estimate of [redacted] was based on the 100% Cost Estimate prepared by the A-E designer, Jacobs, and validated through Engineering Division at Omaha District.

4. Authority Cited: The statutory authority permitting acquisition of the requirement by other than full and open competition is 10 United States Code (U.S.C) 2304(a)(1), as

implemented by Federal Acquisition Regulation (FAR) 6.302-1(a)(2), only one responsible source and no other supplies or services will satisfy agency requirements.

5. Reason for Authority Cited: As set forth in FAR 6.302-1(a)(2), when the supplies or services required by the agency are available only from one responsible source, or for DoD, NASA, and the Coast Guard, from only one or a limited number of responsible sources, and no other types of supplies or services will satisfy agency requirements, full and open competition need not be provided for. This J&A applies the Only One Responsible Source authority using the application of FAR 6.302-1(b)(4), which indicates that use of FAR 6.302-1 is appropriate "When the agency head has determined in accordance with the agency's standardization program that only specified makes and models of technical equipment and parts will satisfy the agency's needs for additional units or replacement items, and only one source is available."

a. Background:

(1) USACE will be the servicing agency for the construction of the B-21 WLT facility at Ellsworth AFB. The Air Force is establishing standardization requirements for facility fire alarm panel manufacturers across all Air Force installations. The Air Force Installation Contracting Center Contracting Authority (AFICC/CA) approved a Class J&A on 17 December 2021 to limit the number of fire alarm panel manufacturers. The J&A states “in order to implement this acquisition strategy, the Air Force must pre-plan the brand name facility fire alarm panels per installation”. Analyses were performed and summarized within the 28th CES memorandum and it was recommended to utilize Monaco brand name fire alarm panels.

(2) FAR 17.503(d)(1) states that if a J&A or a D&F is required by law or regulation, the servicing agency shall execute and issue the J&A or D&F, though the requesting agency shall furnish the servicing agency any information needed to make the J&A or D&F. Therefore, USACE, as the servicing agency concluded that J&As in support of Ellsworth AFB work and other Air Force projects must be executed by Army.

b. Justification:

(1) FAR 6.302-1(b)(4) permits use of the Only One Responsible Source authority when the agency head has determined in accordance with the agency's standardization program that only specified makes and models of technical equipment and parts will satisfy the agency's needs for additional units or replacement items, and only one source is available.

(2) The 17 December 2021 Air Force J&A provides authority to limit the number of fire alarm panel manufacturers on the basis that each installation performs the necessary analyses and justification before implementation. A Notice of Proposed Contract Action/Special Notice, 772_Fire_Alarm_Panel_Brand_Name was posted on SAM.gov 01 June 2021 and remained open for 15 days with no vendors expressing interest. A separate survey of small businesses from the General Services Administration listings was conducted in March 2021. This action satisfied the requirements of FAR 5.201.

(3) On 28 June 2022, the 28th CES Commander signed a memorandum containing the installation analyses performed thereby justifying use of a sole source manufacturer for fire alarm panels at Ellsworth AFB. Monaco Enterprises was identified historically as the proven local and regional support with better responsiveness and capabilities than other manufacturers.

c. Alternatives: The J&A and 28th CES memorandum executed by the Air Force compels USACE to include the requirement for Monaco fire alarm panels in solicitations for construction work at Ellsworth AFB. There are other manufactured fire alarm systems on the installation, however, almost half are Monaco brand including the centralized dispatch. There is no alternative product that meets the Air Force's need to meet the goal of point-to-point immediate notification if fire occurs in a building for appropriate response. Alternatives considered that would differ from the terms of this J&A were to purchase fire alarm panels separately and provide them to the construction contractor(s) as government furnished equipment (GFE). This alternative would still involve the purchase of Monaco brand equipment on a sole source basis. Further, the effort associated with purchasing, storing, conveying, and managing the GFE was determined to be both inefficient and uneconomical. No other feasible alternatives were identified.

d. Impact: If this J&A is not approved, USACE's construction contracts will not be executed in accordance with the Air Force's J&A and 28th CES memorandum to limit fire alarm manufacturers at each relative installation. USACE will be unable to implement the Air Force's standardization efforts of limited fire alarm manufacturers in the mission at Ellsworth AFB. If the fire alarm panel manufacturers are not limited at each installation, the Air Force will not be able to realize the efficiencies and reduction of costs that have been targeted in the category management analysis. Anticipated advantages include reduced training costs for Air Force maintenance personnel, eliminating proprietary rights of maintenance, and improving point-to-point communications to centralize notifications to the fire department to determine and provide the appropriate response.

6. Efforts to Obtain Competition: The Contracting Officer published the notices required by FAR 5.201, as described below, and any bids or proposals received shall be considered.

a. *Effective competition.* The B-21 WLT solicitation for construction at Ellsworth AFB will be issued competitively. Though the brand name requirement for fire alarm panel equipment will be stipulated in the solicitations, this is a small component of the larger construction project. The majority of construction requirement for B-21 WLT, in both effort and total dollars, will be unrestricted stand-alone solicitation. This J&A will be posted with the solicitation. Potential Contractors will be made aware that specifications for this project will require the installation of Monaco fire alarm panels. This coordination alerts them to engage subcontractors that are certified in installing this item.

b. *Subcontracting competition.* Though the use of specified makes of items cannot be considered competitive regardless of the number of suppliers available, it is anticipated that multiple vendors will be available to provide and install Monaco fire alarm panels at the subcontracting level and this sole source will not affect the overall

competition for the construction requirements.

7. Actions to Increase Competition: The only barriers to competition under this class J&A have been generated by historical purchases. This class J&A action only recognizes that past competitive awards have established the number and mix of fire alarm panels on each base. The Category Management analysis and action only recognizes these facts and maximizes efficiencies based on what the Air Force has in its current inventory across the enterprise and at local levels. The Air Force will continue to perform data driven analysis over time to look for market changes that may increase competition amongst fire alarm panel manufacturers. Additionally, as standard industry practice involves manufacturers, selling through vendors, competition will be maintained at the Dealer/ Distributor level.

A Sources Sought was posted 4 April 2023, under NAICS 334290, Other Communications Equipment Manufacturing with a Small Business Standard of 800 employees for a period of 15 days with no responses.

IAW FAR Part 5.2, Synopses of Proposed Contract Action, a Notice of Intent (NOI) under NAICS 334290, Communications Equipment Manufacturing, Commercial and Institutional Building Construction, to include the brand name for Monaco Brand Name Fire Alarm Panels was posted to beta.SAM.gov on 18 April 2023.

Based upon the responses received and the information above it is apparent there are adequate numbers of suppliers available to provide the required items and no alternative sources were identified for fire alarm control panel equipment that would meet the government's requirements.

8. Market Research: Market research indicated that competition among authorized suppliers for the brand name product, Monaco fire alarm panels, will exist since they are readily available in the commercial marketplace and there are multiple companies that are licensed to sell the products. Because there are multiple sources, it is reasonable to expect that a fair and reasonable price will result from adequate competition at the subcontracting level.

IAW with FAR 5.201, the Air Force posted a Notice of Proposed Contract Action/Special Notice, 772_Fire_Alarm_Panel_Brand_Name on SAM.gov 01 June 2021 when efforts were underway to prepare their J&A. This AF Class J&A included limiting fire alarm panel manufacturers based upon further analyses conducted at each installation, including Ellsworth AFB. The posting remained open for 15 days. A description of the requirement was included in the SAM.gov notice and advised any interested responsible party that believed it was equally or otherwise uniquely capable of meeting the requirements to submit a capability statement. Zero vendors expressed interest in the published notice.

Additionally, a Sources Sought was posted 4 April 2023, under NAICS 334290, Other Communications Equipment Manufacturing, for a period of 15 days with no responses.

9. Interested Sources: As described above no interested parties to responded to any of the notifications listed above. The J&A will be posed with the issuance of the B-21

WLT solicitation in accordance with FAR 5.102(a)(6).

10. Other Facts: Reasonable efforts were made to retrieve other facts from computer records, contract files, and other sources to support the use of other than full and open competition. Prior to the recent standardization efforts launched by the Air Force, there is no known history of sole source procurement of fire alarm panel equipment on an Air Force installation-wide basis.

a. Prior to the recent standardization efforts launched by the Air Force, there is no known history of sole source procurement of fire alarm control panel equipment on an Air Force installation-wide basis.

b. As previously stated, The Air Force Installation Contracting Center Contracting Authority (AFICC/CA) approved a Class J&A on 17 December 2021 to limit the number of fire alarm panel manufacturers based upon follow-on analyses conducted at each installation. This is summarized in the 28th CES memorandum and it was recommended to utilize Monaco brand name fire alarm panels. This Class J&A implements the Air Force standardization determination for construction of the B-21 WLT at Ellsworth AFB.

c. The J&A will be posted with the issuance of the B-21 WLT solicitation in accordance with FAR 5.102(a)(6).

11. Technical Certification: I certify that the supporting data under my cognizance which are included in the justification are accurate and complete to the best of my knowledge and belief.

Typed Name: Trevor Weihing Date: 5/10/23

Title: Project Manager Signature: Digitally signed by WEIHING.TREVOR.1275487640 Date: 2023.05.10 16:28:33 -05'00'

12. Requirements Certification: I certify that the supporting data under my cognizance which are included in the justification are accurate and complete to the best of my knowledge and belief.

Typed Name: Trevor Weihing Date: 5/10/23

Title: Project Manager Signature: Digitally signed by WEIHING.TREVOR.1275487640 Date: 2023.05.10 16:28:55 -05'00'

13. Fair and Reasonable Cost Determination: I hereby determine that the anticipated cost or price to the Government for this contract action will be fair, reasonable, and realistic based on an analysis that includes comparison with the Independent Government Estimate. In accordance with FAR 15.403(b)(1), Certified Cost & Pricing Data will not be required for this action as competition is expected.

Typed Name: Amanda E. Eaton Date: _____

Title: Contracting Officer Signature: Amanda E. Eaton Digitally signed by EATON.AMANDA.ELIZABETH.1 395793418 Date: 2023.05.12 10:26:04 -04'00'

14. Contracting Officer Certification: I certify that this justification is accurate and complete to the best of my knowledge and belief.

Typed Name: Amanda E. Eaton Date: _____

Title: Contracting Officer Signature Amanda E. Eaton Digitally signed by EATON.AMANDA.ELIZABETH.1 395793418 Date: 2023.05.22 14:04:43 -04'00'

:

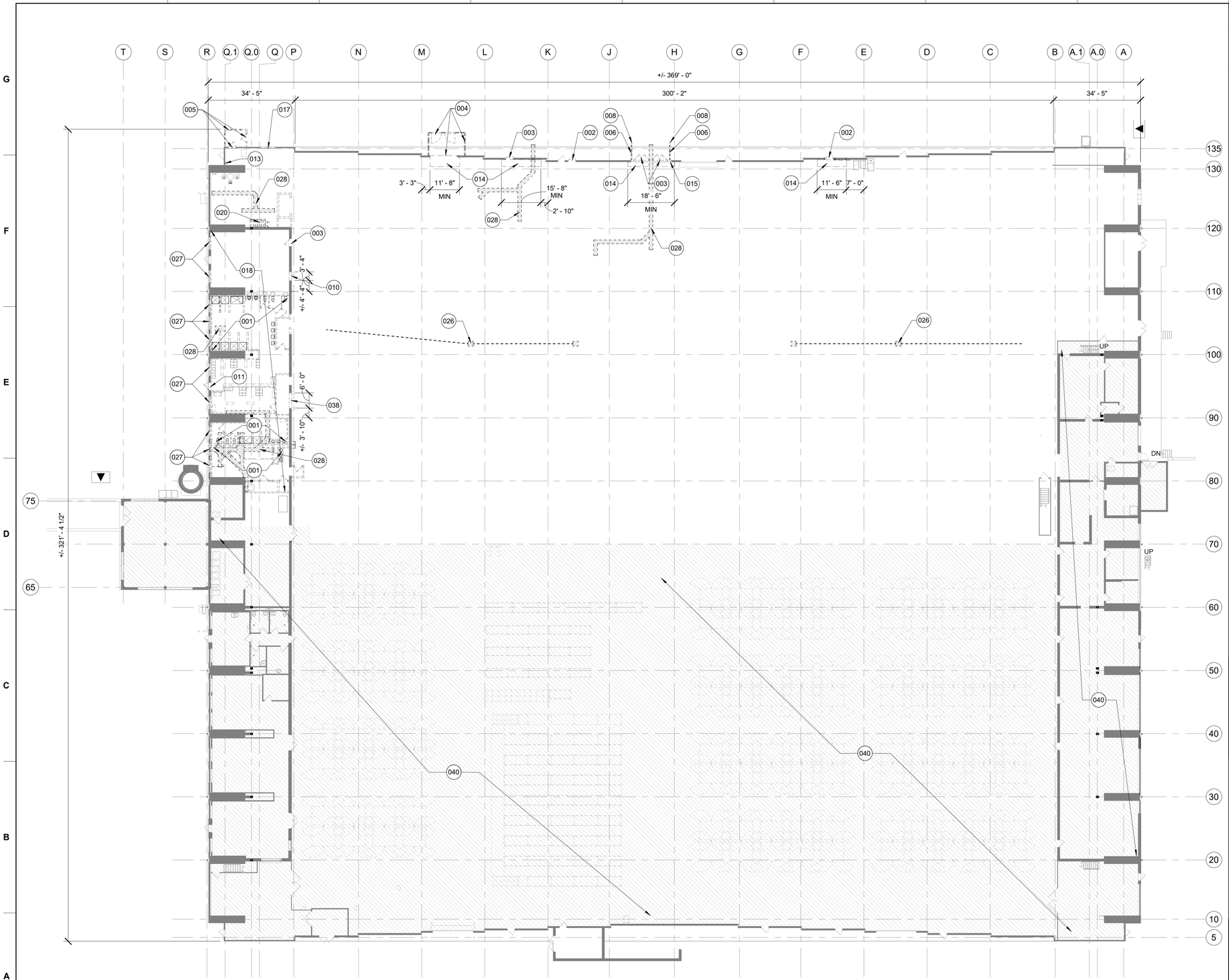
Approval

Based on the foregoing justification, I hereby approve the procurement of *Monaco* fire alarm panels for the estimated amount of [redacted] for the B-21 WLT on an other than full and open competition basis pursuant to the authority of 10 U.S.C.2304(c)(1) Only One Responsible Source and No Other Supplies or Services Will Satisfy Agency Requirements subject to availability of funds, and provided that the services or property herein described have otherwise been authorized for acquisition.

Amanda E. Eaton

Digitally signed by EATON.AMANDA.ELIZABETH.1395793418
Date: 2023.05.22 14:05:20 -04'00'

Amanda E. Eaton
Contracting Officer



A1 OVERALL DEMOLITION FLOOR PLAN - LEVEL 01
SCALE 1" = 20'-0"

GENERAL SHEET NOTES

1. REFER TO G-003 FOR GENERAL NOTES.

SHEET KEYNOTES

001 REMOVE ALL PLUMBING FIXTURES, ACCESSORIES, AND TOILET PARTITIONS FROM THIS AREA

002 REMOVE DOOR, FRAME, AND ASSOCIATED HARDWARE. INFILL OPENING WITH PARTITION TO MATCH EXISTING ADJACENT WALL

003 REMOVE DOOR, FRAME, AND ASSOCIATED HARDWARE. PREPARE OPENING IN HANGAR DOOR FOR NEW OVERHEAD DOOR ASSEMBLY AND INFILL REMAINING OPENING TO MATCH EXISTING ADJACENT WALL

004 REMOVE ALUMINUM STOREFRONT WEATHER ENCLOSURE VESTIBULE, ASSOCIATED DOORS, STRUCTURE, AND ROOF ASSEMBLIES . PREPARE OPENING FOR NEW OVERHEAD DOOR ASSEMBLY

005 REMOVE METAL WEATHER ENCLOSURE VESTIBULE, ASSOCIATED DOORS, WINDOWS, STRUCTURE, AND ROOF ASSEMBLIES. INFILL OPENING WITH WALL ASSEMBLY TO MATCH EXISTING ADJACENT WALL

006 REMOVE GLAZED WIND SCREEN AND SALVAGE FOR REINSTALLATION SHOWN ON FLOOR PLANS

008 REMOVE BOLLARD. PATCH AND REPAIR CONCRETE. REFER TO CIVIL

010 REMOVE PORTION OF WALL / PARTITION TO UNDERSIDE OF STRUCTURE FOR NEW OPENING

011 REMOVE DOOR, FRAME, AND ASSOCIATED HARDWARE. PREPARE OPENING FOR NEW DOOR ASSEMBLY

013 STEEL LADDER TO INTERNAL OVERHEAD METAL ACCESS STAIR TO REMAIN. PROTECT DURING CONSTRUCTION

014 CUT AND REMOVE HANGAR DOOR TRACK, AND PREPARE AREA FOR CONCRETE TOPPING

015 REMOVE PORTION OF HANGAR DOOR LEAF AND EXISTING OVERHEAD DOOR AND ASSOCIATED FRAMING. MODIFY HANGAR DOOR LEAF STRUCTURE FOR NEW OVERHEAD DOOR INSTALLATION. REFER TO PLANS AND STRUCTURAL.

017 REMOVE PORTION OF METAL PANEL FOR NEW DOOR OPENING

018 REMOVE CEILING, LIGHTING, DIFFUSERS, AND ASSOCIATED CEILING MOUNTED EQUIPMENT IN THIS AREA. REFER TO MECHANICAL, ELECTRICAL, AND FIRE PROTECTION.

020 REMOVE STAIRS AND STEEL HANDRAILS

026 SAWCUT EXISTING CONCRETE SLAB FOR ELECTRICAL GROUNDING. REFER TO ELECTRICAL. COORDINATE LOCATION WITH CONTRACTING OFFICER

027 REMOVE ALUMINUM WINDOW AND PREP OPENING FOR PREFINISHED ALUMINUM WINDOW SYSTEM, REFER TO PLANS AND EXTERIOR ELEVATIONS.

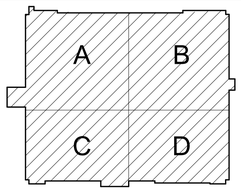
028 APPROXIMATE LOCATION AND SIZE OF EXISTING CONCRETE FLOOR SLAB TO BE REMOVED FOR NEW WORK. REFER TO MECHANICAL, ELECTRICAL, AND PLUMBING FOR NEW WORK AND STRUCTURAL FOR BACK-FILL AND PATCHING. FINISH FACE TO ALIGN WITH EXISTING FACE OF SLAB

038 SAW-CUT AND REMOVE PORTION OF CMU WALL FOR NEW OPENING / DOOR. REFER TO FLOOR PLANS AND STRUCTURAL FOR LINTEL DETAIL

040 EXISTING AREA TO BE REMAIN AS-IS (NOT IN SCOPE). PROTECT FROM DUST, DEBRIS, AND ASSOCIATED CONSTRUCTION ACTIVITIES.

LEGEND

- EXISTING WALL TO REMAIN
- WALL TO BE DEMOLISHED
- AREA NOT IN SCOPE
- EXISTING DOOR
- DOOR TO BE DEMOLISHED



OVERALL
KEY PLAN

GRAPHIC SCALE

0 10' 20' 40' 60'
SCALE: 1"=20'

PLAN NORTH
TRUE N

R 001

US Army Corps of Engineers
Omaha District ®

MARK	DESCRIPTION	DATE
1	AMENDMENT 0001	18 MAY 2023

DESIGNED BY: M. HEIMMER
DRAWN BY: N. BOYER
CHECKED BY: R. YAW
SUBMITTED BY: B. DYSON
ISSUE DATE: 28 APRIL 2023
SOLICITATION NO.: W9128F23R0012
CONTRACT NO.:
DRAWING CODE:
SIZE: ANSI D 22x34
FILE NAME: FXBM231802AD101

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
OMAHA, NEBRASKA

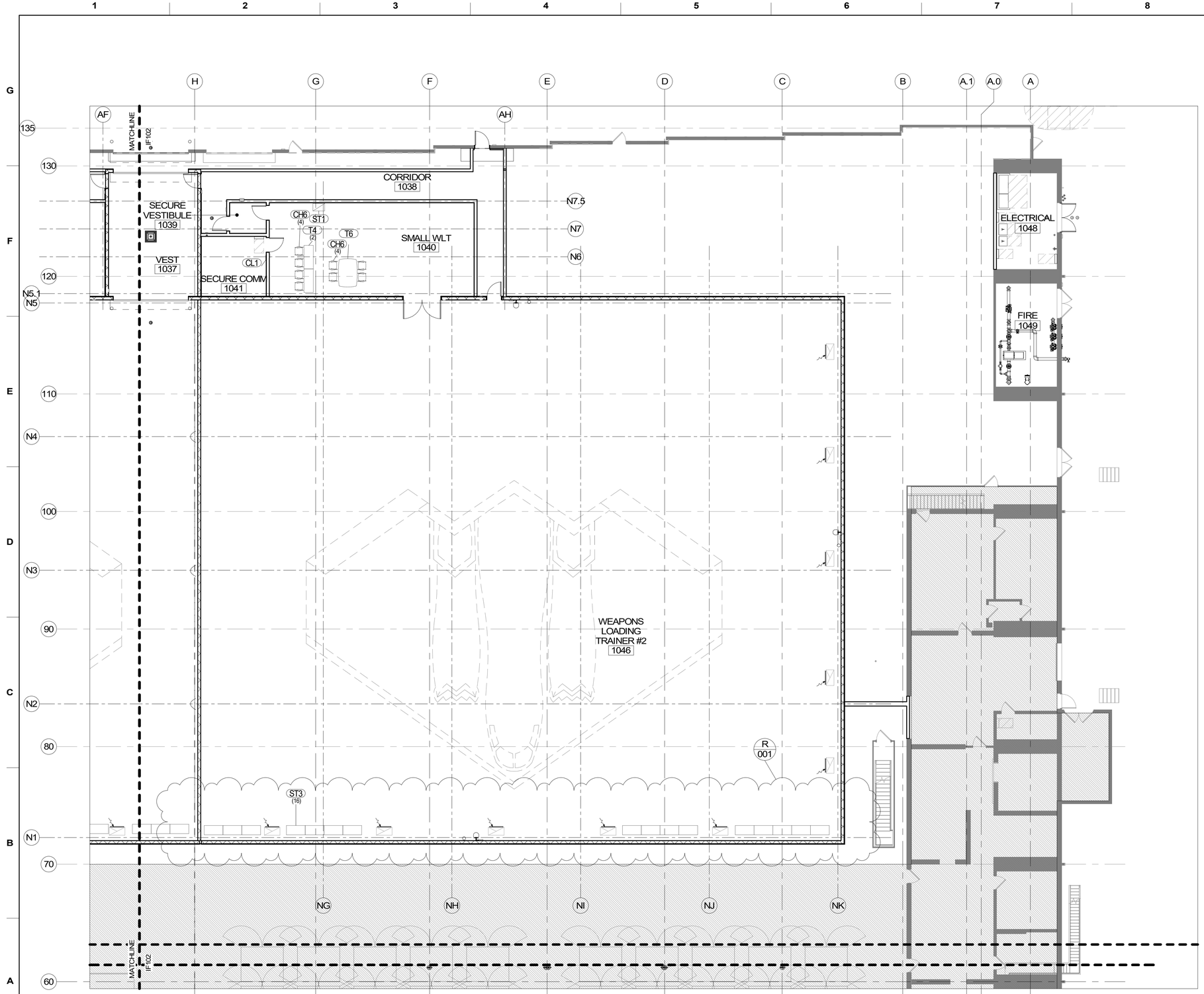
Jacobs
1001 HIGHLANDS PLAZA DR. WEST, SUITE 400
ST. LOUIS, MISSOURI 63110

ELLSWORTH AIR FORCE BASE, SD
DESIGN B-21: WEAPONS LOADER TRAINING FACILITY
PROJECT NUMBER: FXBM231802
OVERALL DEMOLITION FLOOR PLAN - LEVEL 01

SHEET ID
AD101

File Path: C:\Users\Public_Revit_Local_Models\2021\FXBM231802_ARCH_v21_natalie.boyer.rvt
Plot Date: 5/15/2023 10:37:15 AM

ADVERTISEMENT - 100% DESIGN



A1 PARTIAL FURNITURE PLAN - LEVEL 01 - AREA B - BID OPTION

SCALE 3/32" = 1'-0"

GENERAL NOTES - FF&E PLANS

A	ITEMS SHOWN IN THE FF&E LEGEND INDICATE ITEMS PROVIDED AND INSTALLED BY THE CONTRACTOR. ITEMS SHOWN IN THE GFGI LEGEND INDICATE ITEMS INTENDED FOR INFORMATIONAL / COORDINATION PURPOSED ONLY AND ARE NOT IN CONTRACT.
B	FF&E PACKAGE IS PROVIDED AS A BASIS OF DESIGN. FINAL FF&E ITEMS ARE TO BE APPROVED BY THE USERS PRIOR TO PROCUREMENT AND INSTALLATION.
C	FURNITURE CONTRACTOR TO FIELD VERIFY ROOM DIMENSIONS AND COORDINATE FURNITURE SIZES PRIOR TO PROCUREMENT AND INSTALLATION.
D	EACH DESK TO RECEIVE ONE (1) DESK SIDE WASTE BIN AND ONE (1) DESK SIDE RECYCLE BIN AS SPECIFIED
E	ALL INDUSTRIAL (B1 PARTS AREA) STORAGE UNITS & EQUIPMENT BY USER, TYP

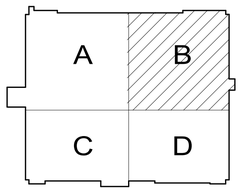
151 OUTLINE OF SMALL WEAPONS LOADER TRAINER

FF&E LEGEND - BID OPTION (CFCI)

TAG	DESCRIPTION
AP1	UNDERCOUNTER FRIDGE
AP2	MICROWAVE
AP3	REFRIGERATOR, SINGLE DOOR
AP4	COFFEE POT
CH1	CHAIR, TASK
CH2	CHAIR, DINING
CH3	CHAIR, GUEST
CH4	CHAIR, RECLINER
CH5	CHAIR, WAITING
CH6	CHAIR, TRAINING
CH7	CHAIR, CONFERENCE
CL1	WALL CLOCK
D1	DESK, L-SHAPED
DB1	DISPLAY BOARD, GLASS FRONT
L1	LECTERN
MA1	TRASH/RECYCLING RECEPTACLE
MA4	TELEVISION
MB1	MARKERBOARD
MB2	MARKERBOARD, 96"
ST1	STORAGE, 2-DOOR CABINET
ST2	LATERAL FILE, 4 DRAWER LATERAL FILE
ST3	
T1	TABLE, DINING
T2	TABLE, OCCASIONAL
T3	TABLE, SIDE
T4	TABLE, TRAINING
T5	TABLE, CONFERENCE
T6	TABLE, CONFERENCE SMALL
WS1	WORKSTATION 6 X 6
WS2	WORKSTATION 8 X 8
WS3	WORKSTATION 5 X 6

GFGI EQUIP LEGEND (BY USER)

TAG	DESCRIPTION
EQ1	STAND UP PRINTER / COPIER



AREA B
KEY PLAN

GRAPHIC SCALE

0 4' 8' 16' 32'

SCALE: 3/32"=1'-0"

PLAN NORTH

TRUE N

US Army Corps of Engineers
Omaha District ®

MARK	DESCRIPTION	DATE
1	AMENDMENT 0001	18 MAY 2023

ISSUE DATE: 28 APRIL 2023
SOLICITATION NO.: W912BP23R0012
CONTRACT NO.:
DRAWING CODE:
FILE NAME: FXBM231802IF103b

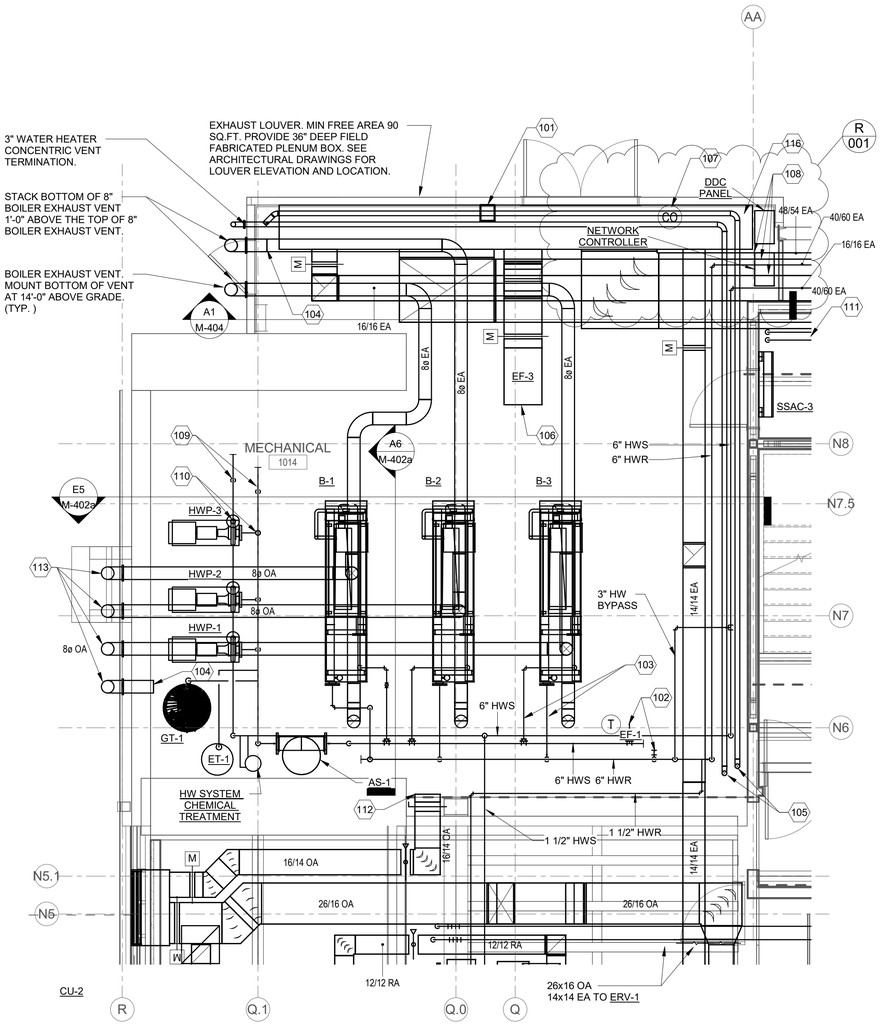
DESIGNED BY: M. ABOVE
DRAWN BY: M. ABOVE
CHECKED BY: T. SIGUR
SUBMITTED BY: B. DYSON
SIZE: ANSI D 22x34

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
OMAHA, NEBRASKA

Jacobs
1001 HIGHLANDS PLAZA DR. WEST, SUITE 400
ST. LOUIS, MISSOURI 63110

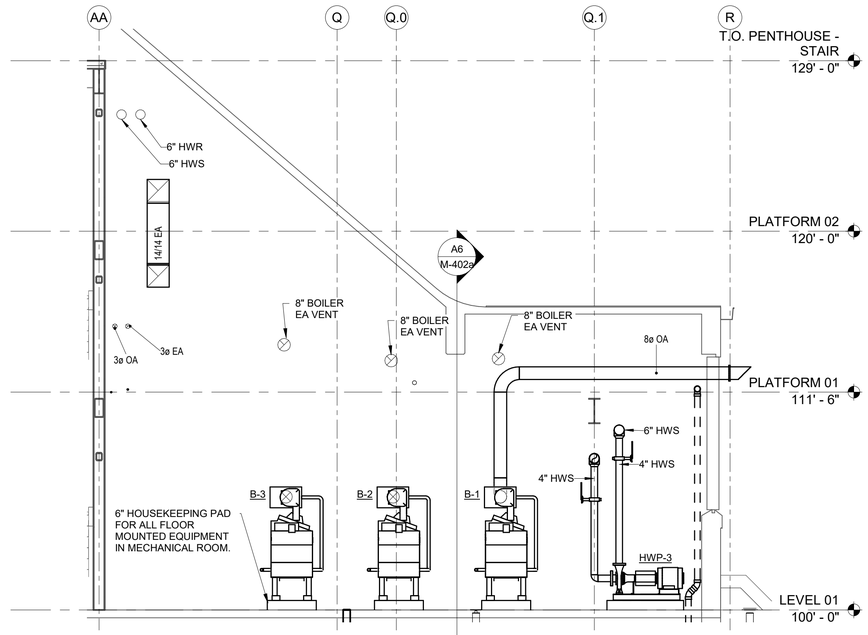
ELLSWORTH AIR FORCE BASE, SD
DESIGN B-21: WEAPONS LOADER TRAINING FACILITY
PROJECT NUMBER: FXBM231802
PARTIAL FURNITURE PLAN - LEVEL 01 - AREA B BID OPTION

SHEET ID
IF103b



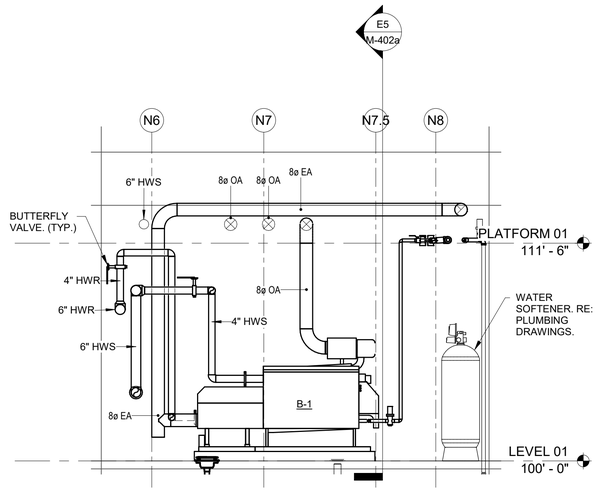
A1 ENLARGED HVAC PLAN - MECHANICAL ROOM 1014 - BASE BID

SCALE 1/4" = 1'-0"



E5 MECHANICAL ROOM BOILER SECTION

SCALE 1/4" = 1'-0"



A6 MECHANICAL ROOM BOILER PIPING SECTION

SCALE 1/4" = 1'-0"

GENERAL SHEET NOTES

1. REFER TO SHEET M-001 FOR ADDITIONAL GENERAL NOTES, LEGEND, AND ABBREVIATIONS.
2. MAINTAIN MANUFACTURER'S RECOMMENDED CLEARANCES ON ALL EQUIPMENT.
3. PROVIDE CLEARANCES FOR ALL ELECTRICAL AND CONTROL PANELS PER NEC.
4. PROVIDE BRACING FOR EQUIPMENT WEIGHING MORE THAN 31 LBS PER UFC 4-010-01.
5. PROVIDE U.L. RATED THROUGH-PENETRATION FIRE STOP SYSTEMS AT ALL PENETRATIONS BETWEEN THE HANGAR/SHOP DEMISING WALL.
6. PROVIDE REMOTE DAMPER ACTUATORS OR ACCESS PANEL FOR ALL DAMPERS LOCATED ABOVE HARD CEILINGS.
7. PROVIDE BALANCING DAMPER AT EACH LOW PRESSURE TAKEOFF.
8. PROVIDE SECURITY BARS AT ALL SECURED WALL DUCT PENETRATIONS, AND SOUND RATED DAMPERS AT ALL RATED PENETRATIONS.
9. DUCT TAP DIAMETERS TO VAV'S ARE EQUAL TO VAV INLET UNLESS OTHERWISE NOTED.

SHEET KEYNOTES

101. EMERGENCY POWER OFF SWITCH (PUSH BUTTON TYPE WITH HINGED CLEAR COVER) FOR BOILER AND WATER HEATER GAS CUT OFF. UPON ACTIVATION OF SWITCH THE NATURAL GAS TO THE BOILERS AND WATER HEATER SHALL BE CUT OFF AND SHALL GENERATE AN ALARM TO THE BAS.
102. PROVIDE AND INSTALL 4" SHUT-OFF VALVE AND CAP AT LOCATION SHOWN IN HWS&R PIPING FOR CONNECTION TO BID OPTION WORK. REFERENCE M-402b FOR MORE INFORMATION.
103. 4" HWS&R CONNECTION WITH ISOLATION VALVE. (TYP. FOR EACH BOILER).
104. PROVIDE AND INSTALL BOILER EXHAUST VENT AND CAP AT LOCATION SHOWN FOR CONNECTION TO BID OPTION WORK. REFERENCE SHEET M-402b FOR MORE INFORMATION.
105. 3" STAINLESS STEEL VENT CONNECTIONS FROM WATER HEATER. ROUTE VENT THROUGH BOILER ROOM AND TERMINATE AT EXTERIOR WALL WITH CONCENTRIC VENT FITTING.
106. PROVIDE WIRE MESH SCREEN AT INLET OF INLINE EXHAUST FAN.
107. CARBON MONOXIDE AND NO2 SENSOR MOUNTED ON WALL. IF SENSOR REGISTERS A CO CONCENTRATION HIGHER THAN 50 PPM (ADJUSTABLE) OR NO2 CONCENTRATION HIGHER THAN 1 PPM (ADJUSTABLE), AUDIBLE AND VISUAL ALARMS SHALL BE INITIATED BOTH LOCALLY AND AT THE B.A.S.
108. THREE EXHAUST DUCTS STACKED ABOVE EACH OTHER.
109. PROVIDE AND INSTALL 4" SHUT-OFF VALVE AND CAP AT LOCATION SHOWN IN 6" HEADER FOR CONNECTION TO BID OPTION WORK. REFERENCE M-402b FOR MORE INFORMATION.
110. 4" HWP CONNECTIONS WITH ISOLATION VALVES IN RISER. (TYP. FOR ALL HWP CONNECTIONS.)
111. REFRIGERANT PIPING UP TO MECHANICAL PLATFORM 02 ABOVE. ROUTE AND SIZE REFRIGERANT PIPING PER MANUFACTURER'S GUIDELINES. REFERENCE SHEET MP-212 FOR CONTINUATION.
112. PROVIDE WIRE MESH SCREEN AT OUTLET OF OA DUCTWORK.
113. CATEGORY 4 STAINLESS STEEL BOILER INTAKE VENT. MOUNT BOTTOM OF VENT AT 11'-0" ABOVE GRADE. (TYP. 4)
114. INTAKE LOUVER. MIN. FREE AREA = 10 SQ.FT. BOTTOM OF LOUVER SHALL BE AT MIN. 10'-0" ABOVE FINISHED GRADE. COORDINATE HEIGHT AND LOCATION WITH ARCHITECTURAL DRAWINGS. PROVIDE 18" INSULATED SHEET METAL PLENUM BOX FOR LOUVER.
115. CATEGORY 4 STAINLESS STEEL BOILER EXHAUST VENT. SLOPE TOWARD BOILER AT MINIMUM 1/4" PER FOOT. MOUNT BOTTOM OF VENT AT 14'-0" ABOVE GRADE. (TYP.)
116. LOCATE OPERATOR WORKSTATION AT THIS LOCATION.

GRAPHIC SCALE

4 3 2 1 0 4 8

SCALE: 1/4"=1'-0"

PLAN NORTH

TRUE N

US Army Corps of Engineers
Omaha District ®

MARK	DESCRIPTION	DATE
1	AMENDMENT 0001	18 MAY 2023

DESIGNED BY: A. RAMOS
DRAWN BY: A. RAMOS
CHECKED BY: J. STAMPER
SUBMITTED BY: B. DYSON
ISSUE DATE: 28 APRIL 2023
SOLICITATION NO.: W9128F23R0012
CONTRACT NO.:
DRAWING CODE:
FILE NAME: FXBM231802M-402a
SIZE: ANSI D 22x34

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
OMAHA, NEBRASKA

Jacobs
1001 HIGHLANDS PLAZA DR. WEST, SUITE 400
ST. LOUIS, MISSOURI 63110

ELLSWORTH AIR FORCE BASE, SD
DESIGN B-21: WEAPONS LOADER TRAINING FACILITY
PROJECT NUMBER: FXBM231802
HVAC ENLARGED PLANS - BASE BID

SHEET ID

M-402a

ADVERTISEMENT - 100% DESIGN

CONTROL VALVE SCHEDULE

EQUIPMENT SERVED	FUNCTION	TYPE	PIPE SIZE (IN)	VALVE SIZE (IN)	FLOW RATE (GPM)	PD (FT.HD)	MIN. VALVE Cv	POWER REQUIREMENT (VOLT/PHASE)	NORMAL OPERATING POSITION	FAIL POSITION
B-1	HW ISOLATION	2-WAY/2-POSITION	4	4	215	5	96.15	24V	NORMALLY OPEN	FAIL OPEN
B-2	HW ISOLATION	2-WAY/2-POSITION	4	4	215	5	96.15	24V	NORMALLY OPEN	FAIL OPEN
B-3	HW ISOLATION	2-WAY/2-POSITION	4	4	215	5	96.15	24V	NORMALLY OPEN	FAIL OPEN
B-4(BO)	HW ISOLATION	2-WAY/2-POSITION	4	4	215	5	96.15	24V	NORMALLY OPEN	FAIL OPEN
HW-BYPASS	HW BYPASS	2-WAY/MODULATING	3	2	60	5	26.83	24V	NORMALLY CLOSED	FAIL CLOSED
VAV-1-1	HW CONTROL / ISOLATION	2-WAY/MODULATING	3/4	1/2	0.5	5	0.22	24V	NORMALLY OPEN	FAIL OPEN
VAV-1-2	HW CONTROL / ISOLATION	2-WAY/MODULATING	3/4	1/2	0.5	5	0.22	24V	NORMALLY OPEN	FAIL OPEN
VAV-1-3	HW CONTROL / ISOLATION	2-WAY/MODULATING	3/4	1/2	0.5	5	0.22	24V	NORMALLY OPEN	FAIL OPEN
VAV-1-4	HW CONTROL / ISOLATION	2-WAY/MODULATING	3/4	1/2	0.5	5	0.22	24V	NORMALLY OPEN	FAIL OPEN
VAV-1-5	HW CONTROL / ISOLATION	2-WAY/MODULATING	3/4	1/2	0.5	5	0.22	24V	NORMALLY OPEN	FAIL OPEN
VAV-1-6	HW CONTROL / ISOLATION	2-WAY/MODULATING	3/4	1/2	0.5	5	0.22	24V	NORMALLY OPEN	FAIL OPEN
VAV-1-7	HW CONTROL / ISOLATION	2-WAY/MODULATING	3/4	1/2	0.5	5	0.22	24V	NORMALLY OPEN	FAIL OPEN
VAV-2-1	HW CONTROL / ISOLATION	2-WAY/MODULATING	3/4	1/2	0.5	5	0.22	24V	NORMALLY OPEN	FAIL OPEN
VAV-2-2	HW CONTROL / ISOLATION	2-WAY/MODULATING	3/4	1/2	1	5	0.45	24V	NORMALLY OPEN	FAIL OPEN
VAV-2-3	HW CONTROL / ISOLATION	2-WAY/MODULATING	3/4	1/2	0.5	5	0.22	24V	NORMALLY OPEN	FAIL OPEN
VAV-2-4	HW CONTROL / ISOLATION	2-WAY/MODULATING	3/4	1/2	0.5	5	0.22	24V	NORMALLY OPEN	FAIL OPEN
VAV-2-5	HW CONTROL / ISOLATION	2-WAY/MODULATING	3/4	1/2	0.5	5	0.22	24V	NORMALLY OPEN	FAIL OPEN
VAV-2-6	HW CONTROL / ISOLATION	2-WAY/MODULATING	3/4	1/2	0.5	5	0.22	24V	NORMALLY OPEN	FAIL OPEN
VAV-2-7	HW CONTROL / ISOLATION	2-WAY/MODULATING	3/4	1/2	0.5	5	0.22	24V	NORMALLY OPEN	FAIL OPEN
VAV-2-8	HW CONTROL / ISOLATION	2-WAY/MODULATING	3/4	1/2	0.5	5	0.22	24V	NORMALLY OPEN	FAIL OPEN
UH-1	HW ISOLATION	2-WAY/2-POSITION	3/4	3/4	2	5	0.89	24V	NORMALLY OPEN	FAIL OPEN
UH-2	HW ISOLATION	2-WAY/2-POSITION	1 1/4	1 1/4	10.7	5	4.79	24V	NORMALLY OPEN	FAIL OPEN
UH-3	HW ISOLATION	2-WAY/2-POSITION	1 1/4	1 1/4	10.7	5	4.79	24V	NORMALLY OPEN	FAIL OPEN
UH-4	HW ISOLATION	2-WAY/2-POSITION	1 1/4	1 1/4	10.7	5	4.79	24V	NORMALLY OPEN	FAIL OPEN
UH-5	HW ISOLATION	2-WAY/2-POSITION	1 1/4	1 1/4	10.7	5	4.79	24V	NORMALLY OPEN	FAIL OPEN
UH-6 (BO)	HW ISOLATION	2-WAY/2-POSITION	1 1/4	1 1/4	10.7	5	4.79	24V	NORMALLY OPEN	FAIL OPEN
UH-7 (BO)	HW ISOLATION	2-WAY/2-POSITION	1 1/4	1 1/4	10.7	5	4.79	24V	NORMALLY OPEN	FAIL OPEN
UH-8 (BO)	HW ISOLATION	2-WAY/2-POSITION	1 1/4	1 1/4	10.7	5	4.79	24V	NORMALLY OPEN	FAIL OPEN
UH-9 (BO)	HW ISOLATION	2-WAY/2-POSITION	1 1/4	1 1/4	10.7	5	4.79	24V	NORMALLY OPEN	FAIL OPEN
AHU-1	HW CONTROL / ISOLATION	2-WAY/MODULATING	3/4	1/2	6	5	2.68	24V	NORMALLY OPEN	FAIL OPEN
AHU-2	HW CONTROL / ISOLATION	2-WAY/MODULATING	3/4	1/2	9	5	4.02	24V	NORMALLY OPEN	FAIL OPEN
MAU-1	HW CONTROL / ISOLATION	2-WAY/MODULATING	4	3	135	5	60.37	24V	NORMALLY OPEN	FAIL OPEN
MAU-2	HW CONTROL / ISOLATION	2-WAY/MODULATING	4	3	135	5	60.37	24V	NORMALLY OPEN	FAIL OPEN
MAU-3 (BO)	HW CONTROL / ISOLATION	2-WAY/MODULATING	4	3	135	5	60.37	24V	NORMALLY OPEN	FAIL OPEN
MAU-4 (BO)	HW CONTROL / ISOLATION	2-WAY/MODULATING	4	3	135	5	60.37	24V	NORMALLY OPEN	FAIL OPEN

NOTES:
(BO) DESIGNATES EQUIPMENT TO BE INCLUDED AS PART OF A BID OPTION.
1. COORDINATE POWER CONNECTION TO EACH CONTROL VALVE WITH ELECTRICAL CONTRACTOR.

R
001

US Army Corps of Engineers
Omaha District ®

MARK	DESCRIPTION	DATE
1	AMENDMENT 0001	18 MAY 2023

DESIGNED BY: A. RAMOS
DRAWN BY: A. RAMOS
CHECKED BY: J. STAMPER
SUBMITTED BY: B. DYSON
SIZE: ANSI D 22x34
ISSUE DATE: 28 APRIL 2023
SOLICITATION NO.: W9128F23R0012
CONTRACT NO.:
DRAWING CODE::
FILE NAME: FXBM231802M-603

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
OMAHA, NEBRASKA

Jacobs
1001 HIGHLANDS PLAZA DR. WEST, SUITE 400
ST. LOUIS, MISSOURI 63110

ELLSWORTH AIR FORCE BASE, SD
DESIGN B-21: WEAPONS LOADER
TRAINING FACILITY
PROJECT NUMBER: FXBM231802

SCHEDULES

SHEET ID

M-603

ADVERTISEMENT - 100% DESIGN

GENERAL ABBREVIATIONS

(ALL SYMBOLS SHOWN ARE NOT NECESSARILY USED ON THE DRAWINGS)

CONTROLS SYMBOLS

- CENTRIFUGAL FAN
- PLENUM FAN
- PUMP
- HYDRONIC COIL
- GAS COIL
- DX COIL
- ELECTRIC COIL
- EVAPORATIVE COOLING COIL
- DIFFERENTIAL PRESSURE SWITCH
- DIFFERENTIAL PRESSURE TRANSMITTER
- LOUVER
- DAMPER
- DAMPER OPPOSED BLADE
- FILTER
- WALL THERMOSTAT
- TEMPERATURE SENSOR
- PIPE WELL TEMPERATURE SENSOR
- AIRFLOW SENSOR
- AIRFLOW MEASURING STATION
- SMOKE DETECTOR
- FREEZE STAT
- HUMIDIFIER
- DX WITH CONDENSER REHEAT

- ROOM THERMOSTAT
- ROOM HUMIDISTAT
- TEMPERATURE SENSOR
- HUMIDITY SENSOR
- DUCT SMOKE DETECTOR
- FLOW SENSOR
- FREEZESTAT
- FLOW SWITCH
- RELAY
- ELECTRIC MOTOR
- LEVEL TRANSMITTER
- VIBRATION SWITCH
- DUCT HUMIDITY SENSOR/TRANSMITTER
- PRESSURE TRANSMITTER
- MOTOR STARTER (LOCAL OR MCC)
- STATIC PRESSURE SENSOR/TRANSMITTER
- DIFFERENTIAL PRESSURE SENSOR/TRANSMITTER
- DIFFERENTIAL PRESSURE SWITCH (DIGITAL)
- AQUASTAT
- DUCT AVERAGING TEMPERATURE ELEMENT
- LIQUID FLOW METER
- VENTURI FLOW METER
- RECEIVER PRESSURE GAUGE (PANEL MTD.)
- CURRENT SENSING RELAY
- ELECTRIC DAMPER ACTUATOR
- CARBON DIOXIDE (CO2) SENSOR
- CARBON MONOXIDE (CO) SENSOR
- FIRESTAT
- REFRIGERANT DETECTOR/SENSOR
- MANUALLY ACTIVATED SWITCH (PULL STAT., PUSH STAT., ETC)
- ANALOG ELEMENT
- DIGITAL ELEMENT
- VARIABLE FREQUENCY DRIVE
- SILICON CONTROLLED RECTIFIER HEAT CONTROL

NORMAL OPEN	NORMAL CLOSED	
		GATE VALVE
		VALVE W/ REDUCERS (GATE VALVE SHOWN)
		GLOBE VALVE
		BUTTERFLY VALVE
		NEEDLE VALVE/INSTRUMENT VALVE
		3-WAY VALVE
		BALL VALVE
		PLUG VALVE
		ANGLE VALVE

CONTROL VALVE SYMBOLS:

- ELECTRIC ACTUATOR
- PNEUMATIC ACTUATOR
- SOLENOID ACTUATOR

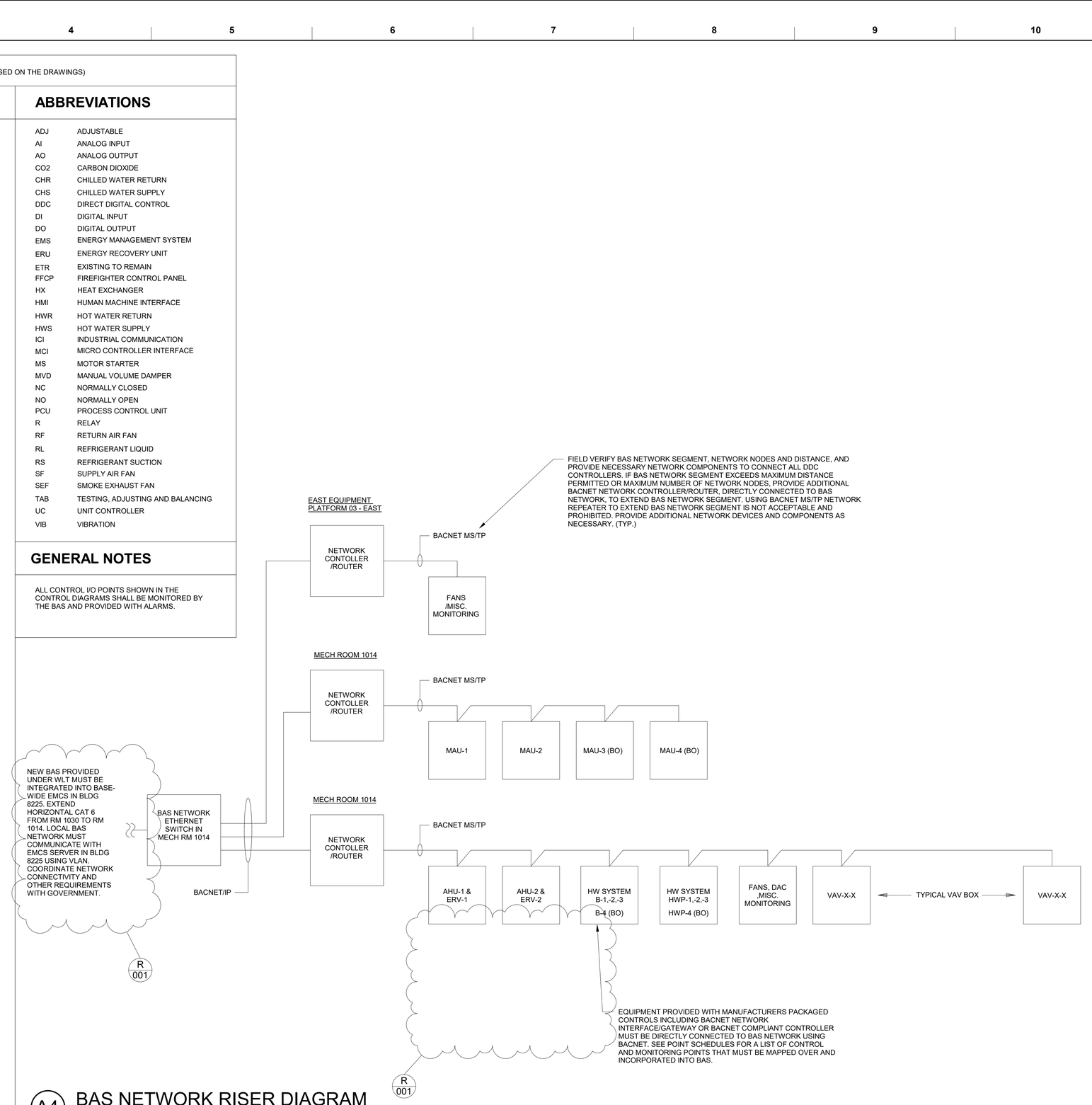
αα-## DO/DI — FEEDBACK; CONTROL POINT TYPE IDENTIFIER

ABBREVIATIONS

ADJ	ADJUSTABLE
AI	ANALOG INPUT
AO	ANALOG OUTPUT
CO2	CARBON DIOXIDE
CHR	CHILLED WATER RETURN
CHS	CHILLED WATER SUPPLY
DDC	DIRECT DIGITAL CONTROL
DI	DIGITAL INPUT
DO	DIGITAL OUTPUT
EMS	ENERGY MANAGEMENT SYSTEM
ERU	ENERGY RECOVERY UNIT
ETR	EXISTING TO REMAIN
FFCP	FIREFIGHTER CONTROL PANEL
HX	HEAT EXCHANGER
HMI	HUMAN MACHINE INTERFACE
HWR	HOT WATER RETURN
HWS	HOT WATER SUPPLY
ICI	INDUSTRIAL COMMUNICATION
MCI	MICRO CONTROLLER INTERFACE
MS	MOTOR STARTER
MVD	MANUAL VOLUME DAMPER
NC	NORMALLY CLOSED
NO	NORMALLY OPEN
PCU	PROCESS CONTROL UNIT
R	RELAY
RF	RETURN AIR FAN
RL	REFRIGERANT LIQUID
RS	REFRIGERANT SUCTION
SF	SUPPLY AIR FAN
SEF	SMOKE EXHAUST FAN
TAB	TESTING, ADJUSTING AND BALANCING
UC	UNIT CONTROLLER
VIB	VIBRATION

GENERAL NOTES

ALL CONTROL I/O POINTS SHOWN IN THE CONTROL DIAGRAMS SHALL BE MONITORED BY THE BAS AND PROVIDED WITH ALARMS.



A4 BAS NETWORK RISER DIAGRAM
SCALE NOT TO SCALE

US Army Corps of Engineers
Omaha District ®

MARK	DESCRIPTION	DATE
1	AMENDMENT 0001	18 MAY 2023

DESIGNED BY: A. RAMOS
DRAWN BY: A. RAMOS
CHECKED BY: J. STAMPER
SUBMITTED BY: B. DYSON
ISSUE DATE: 28 APRIL 2023
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DRAWING CODE:
SIZE: ANSI D 22x34
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US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
OMAHA, NEBRASKA

Jacobs
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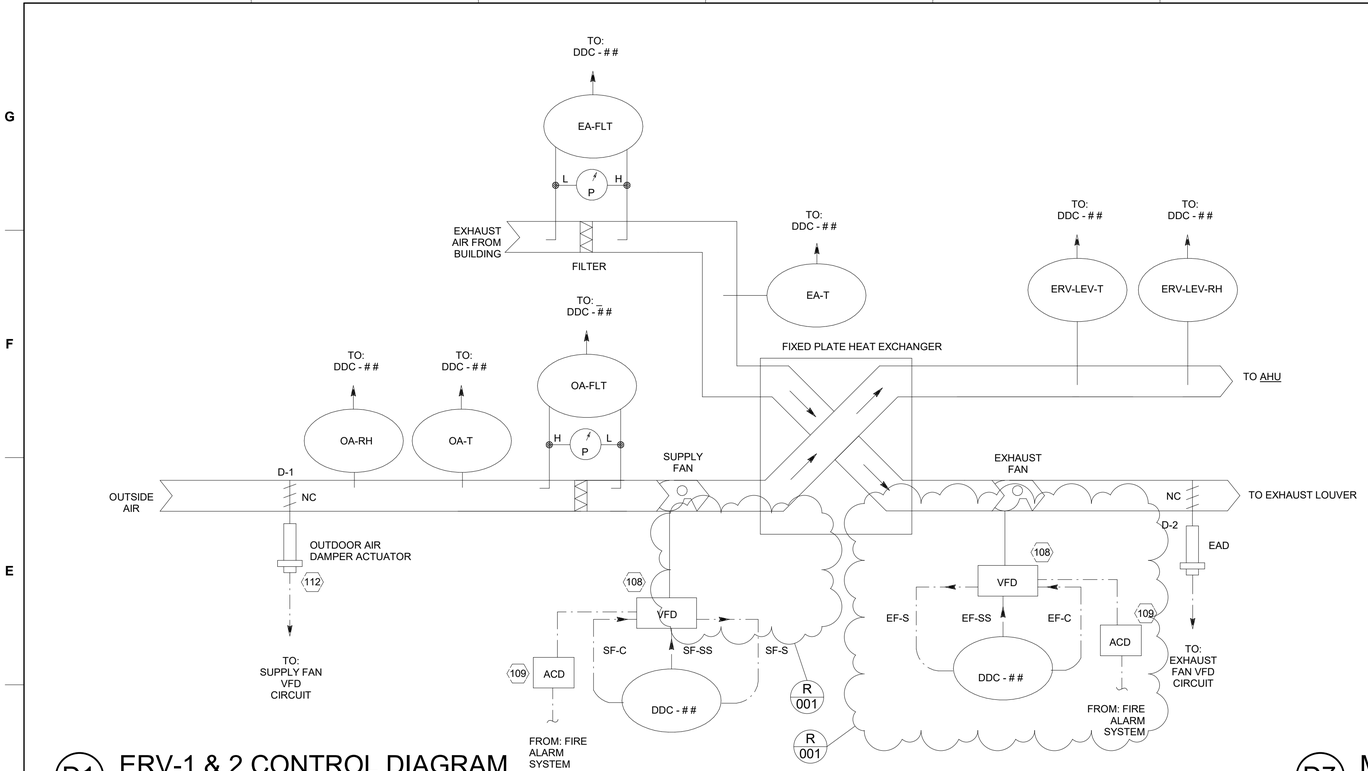
ST. LOUIS, MISSOURI 63110

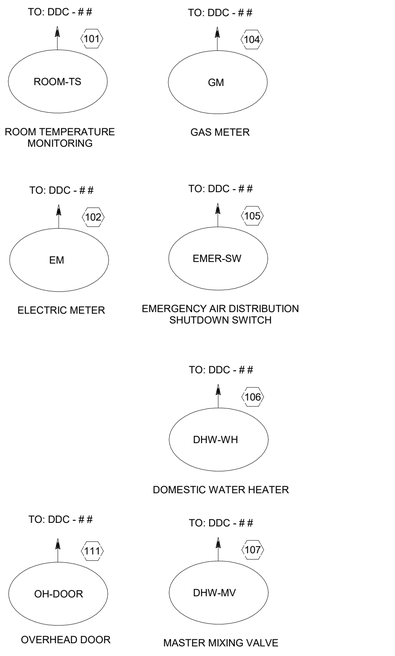
ELLSWORTH AIR FORCE BASE, SD
DESIGN B-21; WEAPONS LOADER TRAINING FACILITY
PROJECT NUMBER: FXBM231802
CONTROL SYSTEMS SYMBOLS, ABBREVIATIONS, & NOTES

SHEET ID
M-801



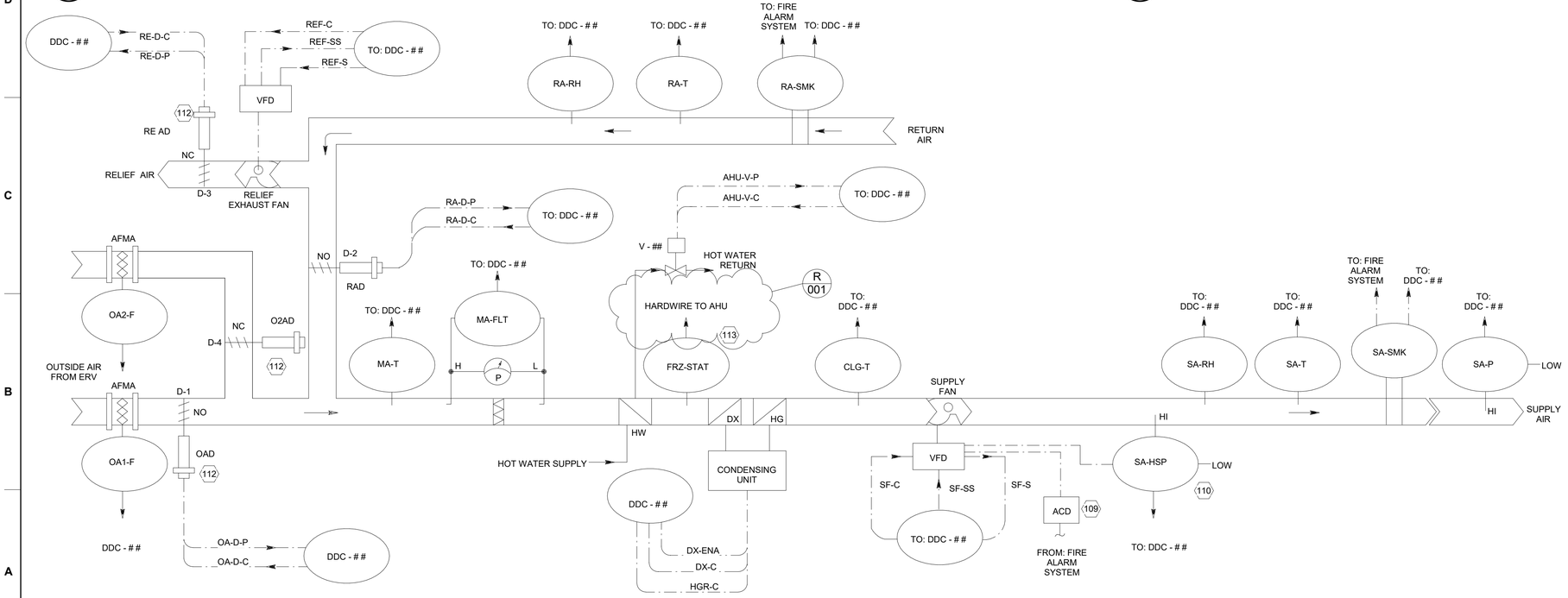
D1 ERV-1 & 2 CONTROL DIAGRAM

SCALE NOT TO SCALE



D7 MISC. POINTS CONTROL DIAGRAM

SCALE NTS



A1 AIR HANDLING UNIT (AHU-1 & 2)

SCALE NOT TO SCALE

GENERAL SHEET NOTES

1. REFER TO SHEET M-001 AND M-801 FOR ADDITIONAL GENERAL NOTES, LEGEND, AND ABBREVIATIONS.

SHEET KEYNOTES

101. PROVIDE SPACE TEMPERATURE SENSORS IN COMM ROOMS AND ELECTRICAL ROOMS, AND CONNECT TO BAS FOR SPACE TEMPERATURE MONITORING AND ALARM.

102. CONNECT ELECTRIC METER PULSE OUTPUT TO BAS FOR METERING.

103. RESERVED.

104. CONNECT NATURAL GAS METER PULSE OUTPUT TO BAS FOR METERING.

105. TYPICAL EMERGENCY AIR DISTRIBUTION SHUT DOWN SWITCH. WHEN SWITCH IS ACTIVATED, AIR HANDLING UNITS, OUTSIDE AIR INTAKE MOTORIZED DAMPERS AND EXHAUST FANS CONTROLLED BY BAS MUST BE SHUT DOWN. ONCE EMERGENCY CONDITION IS CLEARED AND SWITCH IS RESET, ALL EQUIPMENT MUST RETURN TO NORMAL OPERATION.

106. DOMESTIC HOT WATER SYSTEM MUST BE PROVIDED WITH AND CONTROLLED BY SELF-CONTAINED, PACKAGED CONTROLS. FIELD COORDINATE AND CONNECT RELAY OUTPUTS/CONTACTS FOR DOMESTIC WATER HIGH AND LOW TEMPERATURE ALARM TO BAS FOR ALARM MONITORING.

107. CONNECT TEMPERATURE SENSOR AT DOMESTIC WATER MASTER MIXING VALVE OUTLET FOR HIGH AND LOW TEMPERATURE ALARM. CONNECT TO BAS FOR MONITORING.

108. VARIABLE FREQUENCY DRIVE.

109. INTERLOCK FAN WITH FIRE ALARM SYSTEM THROUGH CONTROL MODULE (CM) TO STOP AHU WHEN ANY DUCT SMOKE DETECTOR ASSOCIATED WITH FAN SENSES PARTICLES OF COMBUSTION. THIS INTERLOCK SHALL BE HARD WIRED AND NOT PERFORMED THROUGH BAS. CM AND DUCT SMOKE DETECTOR FURNISHED AND INSTALLED UNDER DIVISION 28.

110. INTERLOCK FAN WITH HIGH DUCT PRESSURE SWITCH TO STOP FAN WHEN SWITCH IS ACTIVATED.

111. CONNECT OVERHEAD DOOR SWITCH TO BAS FOR MONITORING OPEN/CLOSED POSITION OF DOOR.

112. PROVIDE INTERLOCK WIRING BETWEEN FAN AND ASSOCIATED DAMPERS. WHEN FAN IS COMMANDED TO START IN EITHER HAND OR AUTO MODE, DAMPER SHALL OPEN. ONCE DAMPER IS PROVEN OPEN BY ASSOCIATED END SWITCH, FAN SHALL START. DAMPER SHALL CLOSE WHEN THE FAN STOPS.

113. HARDWIRE FREEZE STAT TO UNIT TO SHUT DOWN UNIT UPON SENSING AIRFLOW TEMPERATURES BELOW 35F. (ADJ.)

R 001

US Army Corps of Engineers
Omaha District ®

MARK	DESCRIPTION	DATE
1	AMENDMENT 0001	18 MAY 2023

ISSUE DATE: 28 APRIL 2023
SOLICITATION NO.: W9128F23R0012
CONTRACT NO.:
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FILE NAME: FXBM231802M-803

DESIGNED BY: A. RAMOS
DRAWN BY: A. RAMOS
CHECKED BY: J. STAMPER
SUBMITTED BY: B. DYSON
SIZE: ANSI D 22x34

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
OMAHA, NEBRASKA

Jacobs
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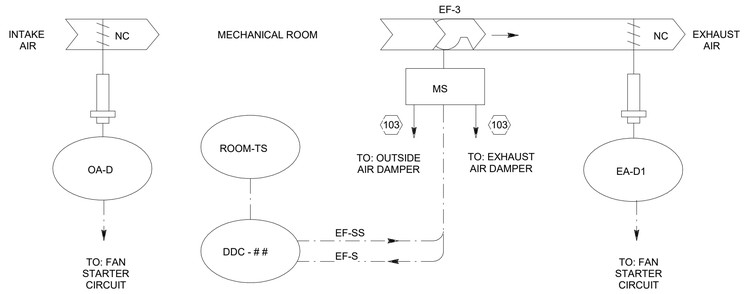
ST. LOUIS, MISSOURI 63110

ELLSWORTH AIR FORCE BASE, SD
DESIGN B-21: WEAPONS LOADER
TRAINING FACILITY
PROJECT NUMBER: FXBM231802

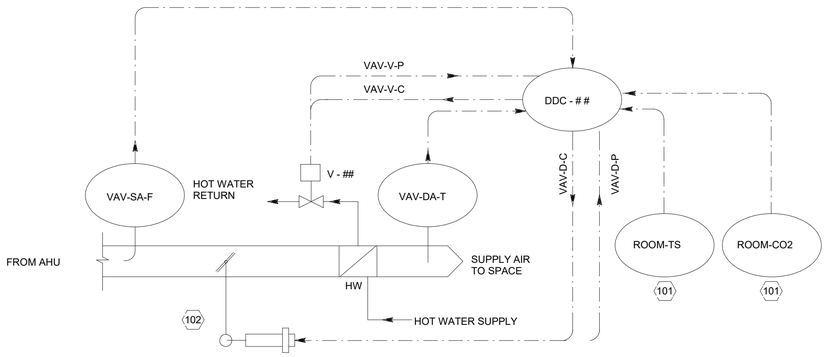
CONTROLS DIAGRAMS

SHEET ID

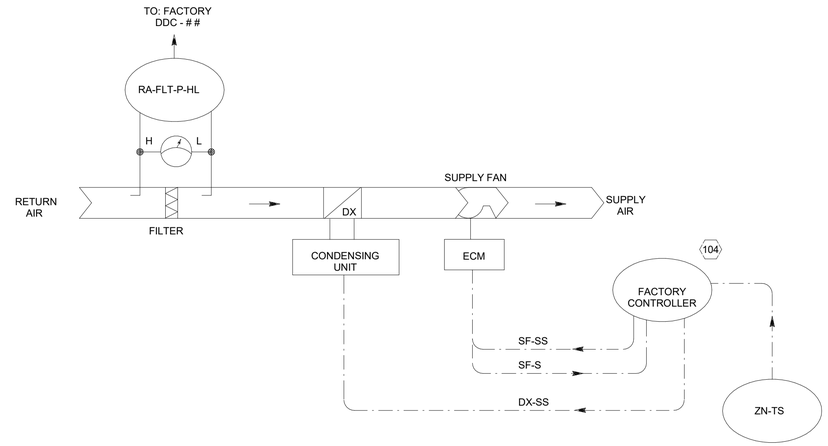
M-803



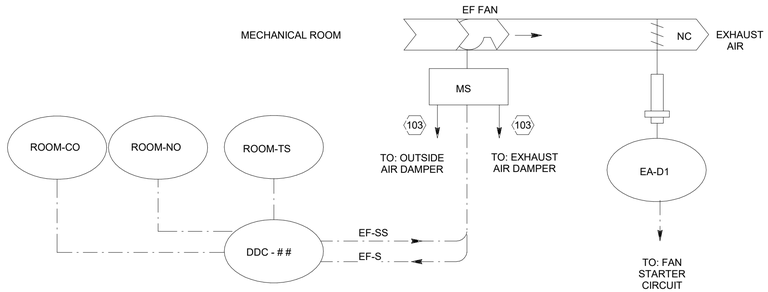
F1 EXHAUST FAN CONTROL DIAGRAM (EF-3 MECHANICAL ROOM)
SCALE NOT TO SCALE



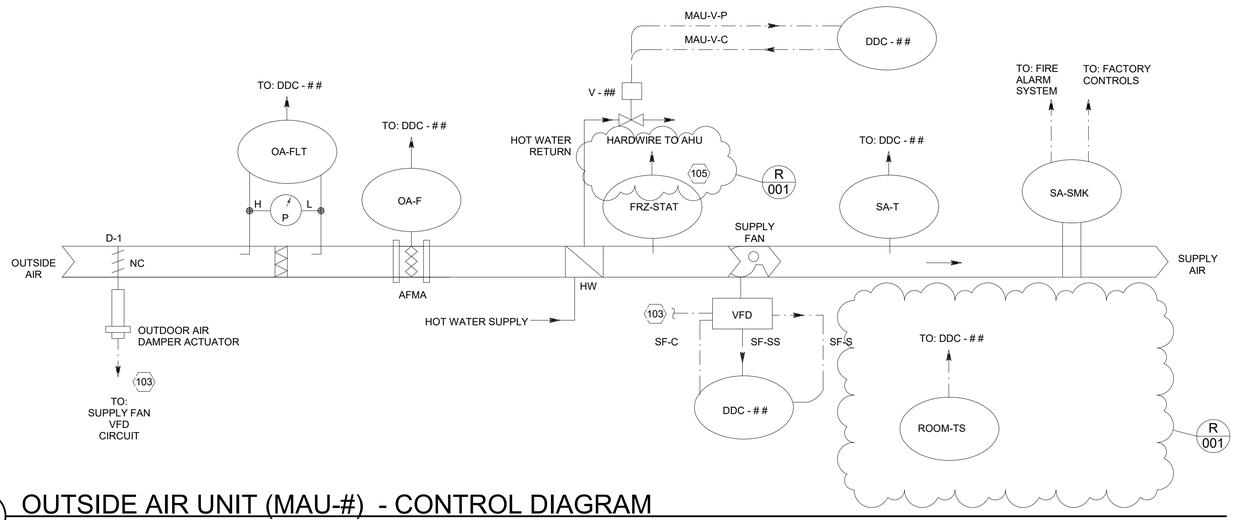
D1 VAV BOX WITH HW REHEAT CONTROL DIAGRAM
SCALE NOT TO SCALE



E5 SPLIT AC UNIT CONTROL DIAGRAM (SSAC)
SCALE NOT TO SCALE



D5 EXHAUST FAN CONTROL DIAGRAM EF-1, EF-2, EF-4(BO), EF-5(BO)
SCALE NOT TO SCALE



A1 OUTSIDE AIR UNIT (MAU-#) - CONTROL DIAGRAM
SCALE NTS

GENERAL SHEET NOTES

1. REFER TO SHEET M-001 AND M-801 FOR ADDITIONAL GENERAL NOTES, LEGEND, AND ABBREVIATIONS.

SHEET KEYNOTES

101. TYPICAL SPACE TEMPERATURE AND CO2 SENSORS FOR VAV BOX. SEE FLOOR PLANS FOR LOCATIONS OF SENSORS.

102. TYPICAL SINGLE DUCT VAV BOXES. SEE MECHANICAL EQUIPMENT SCHEDULE AND FLOOR PLANS.

103. PROVIDE INTERLOCK WIRING BETWEEN FAN AND ASSOCIATED DAMPERS. WHEN FAN IS COMMANDED TO START IN EITHER HAND OR AUTO MODE, DAMPER SHALL OPEN. ONCE DAMPER IS PROVEN OPEN BY ASSOCIATED END SWITCH, FAN SHALL START. DAMPER SHALL CLOSE WHEN THE FAN STOPS.

104. SPLIT SYSTEM AC UNIT MUST BE CONTROLLED BY PACKAGED CONTROLS INCLUDING WALL MOUNTED THERMOSTAT AS REQUIRED, NOT BY BAS.

105. HARDWIRE FREEZE STAT TO UNIT TO SHUT DOWN UNIT UPON SENSING AIRFLOW TEMPERATURES BELOW 35F. (ADJ.)

US Army Corps of Engineers
Omaha District ®

MARK	DESCRIPTION	DATE
1	AMENDMENT 0001	18 MAY 2023

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DRAWN BY: A. RAMOS
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US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
OMAHA, NEBRASKA

Jacobs
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ST. LOUIS, MISSOURI 63110

ELLSWORTH AIR FORCE BASE, SD
DESIGN B-21: WEAPONS LOADER
TRAINING FACILITY
PROJECT NUMBER: FXBM231802
CONTROLS DIAGRAMS

SHEET ID
M-804

SEQUENCE OF OPERATION:

HEATING HOT WATER SYSTEM:

GENERAL:
THE HEATING WATER SYSTEM SHALL SERVE HOT WATER TO THE HYDRONIC HEATING COILS FROM AHUS, MAUS, UNIT HEATERS, AND VAV TERMINAL UNITS. FOR THE BASE BID, THE SYSTEM CONSISTS OF THREE CONDENSING BOILERS OPERATING IN A LEAD-LAG CONFIGURATION (B-1, B-2 & B-3). THE SYSTEM EMPLOYS A VARIABLE PRIMARY PUMPING SCHEME.

SHARED POINTS
1. OUTSIDE AIR TEMPERATURE FROM THE WEATHER STATION.
2. HOT WATER TEMPERATURE CONTROL VALVE POSITIONS

RUN CONDITIONS:
THE HEATING WATER SYSTEM SHALL BE ENABLED TO RUN WHEN ANY OF THE FOLLOWING CONDITIONS ARE MET:
1. VALVE FOR AHU OR MAU CALLS FOR HEATING AND ITS RESPECTIVE CONTROL VALVE IS GREATER THAN 20% (ADJUSTABLE) OPEN FOR GREATER THAN 3 MINUTES (ADJUSTABLE).
2. ANY 3 (ADJUSTABLE) VALVES FOR UNIT HEATERS OR TERMINAL UNITS, CALL FOR HEATING AND ITS RESPECTIVE CONTROL VALVE IS GREATER THAN 20% (ADJUSTABLE) OPEN FOR GREATER THAN 3 MINUTES (ADJUSTABLE).
3. ACTIVATED BY DDC SYSTEM SCHEDULING.
4. INITIATION OF BOILER START SEQUENCE AT THE BAS WORKSTATION OR THE NETWORK CONTROLLER OR THE LOCAL BOILER CONTROL PANEL.

THE HEATING WATER SYSTEM SHALL BE DISABLED BY THE DDC SYSTEM WHEN ONE OF THE FOLLOWING CONDITIONS ARE MET:
1. NO HOT WATER CONTROLLERS ARE CALLING FOR HEATING.
2. DEACTIVATED BY DDC SYSTEM SCHEDULING.
3. MANUALLY COMMANDED BY THE OPERATOR.
4. UPON ACTIVATION OF THE BOILER/WATER HEATER EMERGENCY SHUTDOWN SWITCH. THE EMERGENCY SHUTDOWN SWITCH SHALL COMMAND THE NATURAL GAS SUPPLY CONTROL VALVE TO CLOSE.

TO PREVENT SHORT CYCLING, THE BUILDING HEATING WATER SYSTEM SHALL RUN FOR AND BE OFF FOR A MINIMUM TIME OF 30 MINUTES (ADJUSTABLE) UNLESS SHUT DOWN ON SAFETIES. THE BUILDING HEATING WATER SYSTEM SHALL BE AUTOMATICALLY ACTIVATED FOR FREEZE PROTECTION WHENEVER THE OUTSIDE AIR TEMPERATURE IS LESS THAN 35°F (ADJUSTABLE).

BOILER OPERATION:
WHEN THE HEATING WATER SYSTEM IS ENABLED TO OPERATE, THE LEAD BOILER SHALL BE COMMANDED TO START AND SHALL ACTIVATE USING ITS OWN INTERNAL STARTUP CONTROL SEQUENCE. UPON ACTIVATION OF THE BOILER, THE ASSOCIATED CONTROL VALVE (B#-V-C) SHALL BE COMMANDED OPEN. AS PART OF THE STARTUP SEQUENCE FOR ANY BOILER, FLOW THROUGH THE BOILER MUST BE VERIFIED (DETECTED AT THE FLOW SWITCH AT THE BOILER, B#-HWR-FS) TO BE ABOVE THE MINIMUM BOILER FLOW REQUIREMENT (AS PROVIDED BY THE BOILER MANUFACTURER).

THE BOILERS SHALL RUN SUBJECT TO THEIR OWN INTERNAL SAFETIES AND CONTROLS. THE BOILERS SHALL VARY THEIR LEVEL OF FIRE AS REQUIRED TO MAINTAIN THE LEAVING WATER TEMPERATURE AS INDICATED IN THE BOILER SUPPLY WATER TEMPERATURE (RESETABLE AS NOTED BELOW).

THE BOILERS SHALL BE CONTROLLED IN A LEAD-LAG OPERATION. ONE BOILER SHALL BE DESIGNATED AS THE LEAD UNIT. THE BAS SHALL DESIGNATE WHICH LAG BOILER SHALL BE ENABLED FIRST. THE BAS SHALL HAVE THE CAPABILITY TO DESIGNATE ANY BOILER AS LEAD OR LAG AS DESIRED AND TO ROTATE THE SEQUENCE AUTOMATICALLY BASED ON THE FOLLOWING:
1. MANUALLY THROUGH A SOFTWARE SWITCH.
2. BOILER RUNTIME.
3. SCHEDULING, SUCH AS ROTATING THE SEQUENCE ONCE PER DAY, WEEK, MONTH, SEASON, ETC.

THE MANUFACTURER SUPPLIED BOILER SEQUENCER SHALL ENABLE, MODULATE, AND DISABLE THE BOILERS TO OPERATE THEM BY THE MOST EFFICIENT MEANS POSSIBLE BY MONITORING BOILER FIRE RATE, SYSTEM FLOW RATE, AND WATER TEMPERATURES.

THE BAS SHALL ENABLE/DISABLE THE BOILERS AND MONITOR AVAILABLE BOILER CONTROL POINTS THROUGH A BAS INTERFACE CARD FURNISHED BY THE BOILER MANUFACTURER.

WHEN THE HEATING WATER SYSTEM IS DISABLED, BOILERS SHALL BE COMMANDED TO STOP IN SEQUENCE AND SHALL DEACTIVATE USING THEIR OWN INTERNAL SHUTDOWN CONTROL SEQUENCE. IF ALL BOILERS ARE RUNNING WHEN THE HEATING WATER SYSTEM IS DISABLED, THE LAG BOILERS SHALL BE SHUTDOWN IN ORDER FIRST, THEN THE LEAD BOILER SHALL BE SHUTDOWN.

THE BOILER MANUFACTURER REPRESENTATIVE SHALL PROVIDE INFORMATION TO THE BAS PROVIDER TO ASSURE THAT THE SEQUENCE OF OPERATION IS COMPLETELY DEFINED SO THAT ACTIVATION OR DEACTIVATION OF A LAG BOILER DOES NOT SUFFICIENTLY IMBALANCE FLOW THROUGH THE LEAD BOILER SO AS TO CAUSE THE LEAD BOILER TO TRIP OFFLINE. IN ADDITION TO THE SEQUENCE OF OPERATION ABOVE, EMPLOY ADDITIONAL STRATEGIES SUCH AS:
1. REDUCE LEAD BOILER LOAD SLOWLY BEFORE ACTIVATING THE LAG BOILER.
2. ANY OTHER STRATEGIES ACCEPTABLE TO THE BOILER MANUFACTURER. THE INTENT IS FOR LAG BOILERS ACTIVATION AND DEACTIVATION TO BE DONE IN A STABLE MANNER.

BOILER SAFETIES:
THE FOLLOWING SAFETIES SHALL BE MONITORED THROUGH THE BAS:
1. BOILER ALARM.
2. LOW WATER LEVEL.

ALARMS SHALL BE PROVIDED TO THE BAS OPERATOR INTERFACE AS FOLLOWS:
1. BOILER ALARM.
2. LOW WATER LEVEL ALARM.
3. NO FLOW SIGNAL.
4. HIGH DIFFERENTIAL PRESSURE ACROSS BOILER.
5. ACTIVATION OF THE BOILER/WATER HEATER EMERGENCY SHUTDOWN SWITCH.

BUILDING HEATING WATER TEMPERATURE CONTROL:
THE BUILDING HEATING WATER TEMPERATURE SETPOINT SHALL BE MAINTAINED BY THE BOILER'S OWN INTERNAL CONTROLS.

ALARMS SHALL BE PROVIDED AS FOLLOWS:
1. BUILDING HIGH HEATING WATER SUPPLY TEMP: IF GREATER THAN 5°F (ADJUSTABLE) ABOVE SETPOINT.
2. BUILDING LOW HEATING WATER SUPPLY TEMP: IF GREATER THAN 10°F (ADJUSTABLE) BELOW SETPOINT.

BOILER SUPPLY WATER TEMPERATURE (HWS-T) RESET:
BOILER LEAVING WATER TEMPERATURE SHALL BE RESET BASED ON OUTDOOR TEMPERATURE. LEAVING WATER TEMPERATURE SETPOINT SHALL BE LINEARLY DERIVED BETWEEN THE FOLLOWING LIMITS:
1. AT AN OUTSIDE TEMPERATURE OF 35ºF OR BELOW (ADJUSTABLE), LEAVING WATER TEMPERATURE SHALL BE 140ºF (ADJUSTABLE).
2. AT AN OUTSIDE TEMPERATURE OF 55ºF OR ABOVE (ADJUSTABLE), LEAVING WATER TEMPERATURE SHALL BE 110ºF (ADJUSTABLE).

HOT WATER PUMP OPERATION:
THE HOT WATER PUMPS SHALL OPERATE IN A LEAD/LAG FASHION. ONE PUMP SHALL BE DESIGNATED AS THE LEAD UNIT. THE BAS SHALL DESIGNATE WHICH LAG PUMP SHALL BE ENABLED FIRST. THE BAS SHALL HAVE THE CAPABILITY TO DESIGNATE ANY PUMP AS LEAD OR LAG AS DESIRED AND TO ROTATE THE SEQUENCE AUTOMATICALLY BASED ON THE FOLLOWINGS:
1. MANUALLY THROUGH A SOFTWARE SWITCH.
2. PUMP RUNTIME.
3. SCHEDULING, SUCH AS ROTATING THE SEQUENCE ONCE PER DAY, WEEK, MONTH, SEASON, ETC.

WHEN THE HYDRONIC HEATING SYSTEM IS ENABLED THE LEAD PUMP SHALL BE STARTED IMMEDIATELY.
WHEN THE HEATING WATER SYSTEM IS DEACTIVATED, THE PUMPS SHALL BE STOPPED AFTER A SUITABLE TIME DELAY (INITIAL SETTING: 5 MINUTES, ADJUSTABLE).
UPON FAILURE OF THE LEAD PUMP THE LAG PUMP SHALL BE STARTED AND THE LEAD PUMP SHALL BE COMMANDED OFF. PUMP FAILURE SHALL BE DETERMINED BY THAT DESCRIBED IN THE PUMP FAILURE ALARM SECTION.

WHEN A PUMP IS COMMANDED TO START IT SHALL BE ENERGIZED AT MINIMUM VFD SPEED THEN RAMP AS REQUIRED BY THE DIFFERENTIAL PRESSURE CONTROL SYSTEM. WHEN A PUMP IS COMMANDED TO STOP IT SHALL FIRST CONTINUE TO RUN FOR A SUITABLE TIME DELAY PERIOD (INITIAL SETTING: 5 MINUTES, ADJUSTABLE), THEN SHALL RAMP TO MINIMUM VFD SPEED THEN BE DEENERGIZED.

THE CONTROLLER SHALL MONITOR THE SYSTEM DIFFERENTIAL PRESSURE SENSORS (HW-SYS-DP) AND VARY THE PUMP'S VFD SPEED TO MAINTAIN THE DIFFERENTIAL PRESSURE SETPOINTS AT EACH SENSOR (INITIAL SETPOINTS OF 10 FT W.C. (ADJUSTABLE), FINAL SETPOINTS TO BE DETERMINED DURING TEST AND BALANCE). ON A DROP IN SYSTEM DIFFERENTIAL PRESSURE, THE PUMP SPEED SHALL BE APPROPRIATELY INCREASED. ON A RISE IN SYSTEM DIFFERENTIAL PRESSURE, THE PUMP SPEED SHALL BE APPROPRIATELY DECREASED. THE PUMP VFD WILL BE CONTROLLED BETWEEN MINIMUM VFD SPEED SETTING PLUS 2 HZ AND MAXIMUM SPEED SETTING.

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WHEN THE LEAD OR LAG PUMP'S VFD IS AT 95% MAXIMUM SPEED, A LAG PUMP SHALL BE ENABLED AND RAMPED TO MINIMUM SPEED. THE LEAD PUMP & LAG PUMPS VFD'S SHALL BE RAMPED TO MEET AT THE SAME OPERATING SPEED THEN OPERATE IN UNISON TO MAINTAIN THE SYSTEM DIFFERENTIAL PRESSURE. IF THE PUMPS ARE OPERATING AT MINIMUM SPEED FOR 5 MINUTES (ADJUSTABLE), THE LAG PUMP(S) SHALL BE DISABLED AND ITS VFD SLOWLY RAMPED DOWN. WHILE THE LAG PUMP RUNS THROUGH ITS SHUT DOWN, THE OTHER OPERATING PUMP VFD SHALL MODULATE TO MAINTAIN SYSTEM DIFFERENTIAL PRESSURE.

FAILURE ALARMS: PUMPS SHALL BE COMMANDED OFF. AN ALARM SHALL BE PROVIDED TO THE BAS OPERATOR INTERFACE AS FOLLOWS:
1. SYSTEM FAILURE: IF ALL PUMPS FAIL TO START, THE BAS SHALL REMOVE THE HYDRONIC HEATING SYSTEM START COMMAND.
2. FAILURE: COMMANDED ON, BUT THE STATUS IS OFF.
3. RUNNING IN HAND: COMMANDED OFF, BUT THE STATUS IS ON.
4. VFD FAULT.

NON-FAILURE ALARMS: PUMPS SHALL NOT BE COMMANDED OFF. AN ALARM SHALL BE PROVIDED TO THE BAS OPERATOR INTERFACE AS FOLLOWS:
1. RUNTIME EXCEEDED: STATUS RUNTIME EXCEEDS A USER DEFINABLE LIMIT.

DIFFERENTIAL PRESSURE RESET:
THE DIFFERENTIAL PRESSURE SETPOINTS SHALL BE RESET DOWN TO MAINTAIN A MAXIMUM OF 1 (ADJUSTABLE) HOT WATER TEMPERATURE CONTROL VALVE FROM ANY MECHANICAL SYSTEM/UNIT AT A MAXIMUM OF 90% (ADJUSTABLE) OPEN. AS MORE CONTROL VALVES OPEN THE DIFFERENTIAL PRESSURE SETPOINTS SHALL RESET UP TO THE PRESSURE SETPOINTS ESTABLISHED DURING BALANCING.

MINIMUM FLOW BYPASS:
THE MINIMUM FLOW BYPASS CONTROL VALVE (HW-BP-C) SHALL MODULATE OPEN UPON A DROP IN FLOW THROUGH THE FLOW SENSOR (HWR-F) BELOW THE SUM OF MINIMUM FLOWS OF OPERATING BOILERS. THE MINIMUM FLOW BYPASS CONTROL VALVE SHALL REMAIN CLOSED WHEN THE FLOW IS ABOVE THE SUM OF OPERATION BOILERS' MINIMUM FLOW.

THE DESIGNED MINIMUM FLOW FOR EACH BOILER IS SCHEDULED (FINAL VALUE TO BE VERIFIED WITH BOILER MANUFACTURER).

BOILER/WATER HEATER EMERGENCY SHUTDOWN SWITCH:
UPON ACTIVATION OF BOILER/WATER HEATER EMERGENCY SHUTDOWN SWITCH THE BOILER/WATER HEATER SHALL SHUT DOWN, AND ASSOCIATED NATURAL GAS SUPPLY SHALL AUTOMATICALLY SHUT OFF AND AN ALARM SIGNAL SHALL BE SENT TO THE BAS.

SEQUENCE OF OPERATION - AIR HANDLING UNITS:

GENERAL:
COOLING CONTROL IS PROVIDED BY THE AHU. THE UNITS ARE VARIABLE AIR VOLUME TO MEET DESIGN AIRFLOW REQUIREMENTS.

SHARED POINTS:
1. OA DB TEMPERATURE FROM WEATHER STATION
2. OA ENTHALPY FROM THE WEATHER STATION
3. OUTSIDE AIR LOUVER DAMPER.

SYSTEM OPERATION:
THE BAS SHALL ALLOW THE AHU TO BE PROGRAMMED FOR START AND STOP BASED ON A USER DEFINABLE SCHEDULE UNIQUE TO EACH DAY OF THE WEEK (SUNDAY THROUGH SATURDAY PLUS HOLIDAYS). THE SUPPLY FAN SHALL RUN ANYTIME THE UNIT IS COMMANDED TO RUN, UNLESS SHUTDOWN ON SAFETIES. TO PREVENT SHORT CYCLING, THE FAN SHALL HAVE A USER DEFINABLE MINIMUM RUNTIME OF 30 MINUTES (ADJUSTABLE). UPON RECEIVING A START COMMAND, THE RETURN AIR DAMPER SHALL OPEN AND THE STATUS SHALL BE CONFIRMED. IF DAMPER STATUS IS NOT CONFIRMED OPEN AFTER 1 MINUTE (ADJUSTABLE) AN ALARM SHALL BE GENERATED AT THE BAS AND THE AHU SHALL BE DISABLED.

SYSTEM START:
THE UNIT SHALL EMPLOY AN OPTIMAL START STRATEGY AND SHALL START PRIOR TO SCHEDULED OCCUPANCY BASED ON THE TIME NECESSARY FOR THE ZONES TO REACH THEIR OCCUPIED SETPOINT. THE START TIME SHALL AUTOMATICALLY ADJUST BASED ON CHANGES IN OUTSIDE AIR TEMPERATURE AND ZONE TEMPERATURES. WHEN THE BAS CALLS FOR THE UNIT TO START, THE FOLLOWING SEQUENCES SHALL BE ACTIVATED:
1. SUPPLY FAN COMMANDED ON.
2. OUTSIDE AIR LOUVER DAMPER OPEN
3. OUTSIDE AIR ECONOMIZER DAMPER CLOSED.
4. RETURN AIR DAMPER (RA-D) OPEN.
5. DX COOLING COIL ENABLED.

SUPPLY FAN OPERATION:
WHEN THE AHU IS ENABLED:
THE OUTSIDE AIR DAMPER SHALL BE OPENED. THE RETURN AIR DAMPER SHALL BE OPENED, AND THE SUPPLY FAN SHALL BE ENERGIZED AT THE MINIMUM VFD SPEED. THE BAS SHALL MEASURE SUPPLY DUCT STATIC PRESSURE AT A DUCT MOUNTED STATIC PRESSURE SENSOR (SA-P) AND MODULATE THE SUPPLY FAN VFD SPEED TO MINIMIZE THE DUCT STATIC PRESSURE SETPOINT NECESSARY TO MAINTAIN ONE VAV TERMINAL UNIT INLET CONTROL DAMPER AT THE FULL OPEN (MAXIMUM COOLING DEMAND) WITH A TIME-OUT FEATURE (CRITICAL ZONE RESET STRATEGY). THE BAS SHALL ALSO HAVE THE CAPABILITY OF MANUAL STATIC PRESSURE SETPOINT ADJUSTMENT AS A USER OVERRIDE FUNCTION.

WHEN THE AHU IS DISABLED:
THE SUPPLY FAN SHALL SHALL RAMP DOWN TO ITS MINIMUM VFD SPEED AND THEN DEENERGIZE. THE OUTSIDE AIR DAMPER SHALL BE CLOSED.

ALARMS SHALL BE PROVIDED AS FOLLOWS:
1. IF THE RETURN AIR DAMPER STATUS IS NOT CONFIRMED AFTER 1 MINUTE (ADJUSTABLE).
2. HIGH SUPPLY AIR STATIC PRESSURE: IF THE SUPPLY AIR STATIC PRESSURE IS 25% (ADJUSTABLE) GREATER THAN THE SETPOINT.
3. LOW SUPPLY AIR STATIC PRESSURE: IF THE SUPPLY AIR STATIC PRESSURE IS 25% (ADJUSTABLE) LESS THAN THE SETPOINT.
4. SUPPLY FAN FAILURE: COMMANDED ON, BUT STATUS IS OFF.
5. SUPPLY FAN IN HAND: COMMANDED OFF, BUT STATUS IS ON.
6. VFD FAULT.

ECONOMIZER OPERATION:
THE AHU ECONOMIZER SHALL BE ENABLED WHENEVER ALL OF THE FOLLOWINGS ARE MET:
1. OUTSIDE AIR ENTHALPY IS LESS THAN THE RETURN AIR ENTHALPY.
2. THE AHU STATUS IS ON.
3. A MINIMUM OUTSIDE AIR REQUIREMENT OF THE TOTAL AIRFLOW IS DEMANDED UP TO A MAXIMUM OF 100% OF THE AIR IS OUTSIDE AIR.
4. ASSOCIATED ERV MOTORIZED DAMPER IS CLOSED AND ASSOCIATED ERV IS NOT ENERGIZED.

THE AHU ECONOMIZER SHALL BE DISABLED WHENEVER ONE OF THE FOLLOWINGS IS MET:
1. OUTSIDE AIR ENTHALPY IS GREATER THAN THE RETURN AIR ENTHALPY.
2. THE MIXED AIR TEMPERATURE (MA-T) IS LESS THAN 50°F (ADJUSTABLE) AND THE ECONOMIZER OUTSIDE AIR DAMPER (ECO-D) IS CLOSED FOR 30 MINUTES (ADJUSTABLE).
3. LOSS OF SUPPLY FAN STATUS.

WHEN CONDITIONS ARE MET TO DISABLE THE ECONOMIZER, THE ECONOMIZER MOTORIZED DAMPER SHALL CLOSE AND THE ASSOCIATED ERV MOTORIZED DAMPER SHALL OPEN AND INITIATE THE ERV SEQUENCE.

WHEN THE ECONOMIZER IS ENABLED, THE CONTROLLER SHALL MEASURE THE MIXED AIR TEMPERATURE (T-03) AND MODULATE THE OUTSIDE AIR ECONOMIZER DAMPER, AND THE RETURN AIR DAMPER (OUTSIDE AIR DAMPERS SHALL BE FULLY OPEN BEFORE THE RETURN AIR DAMPER IS CLOSED) TO MAINTAIN THE UNIT SUPPLY AIR TEMPERATURE (SA-T) AT 55°F (ADJUSTABLE). WHEN THE OUTSIDE AIR AND RETURN AIR DAMPER ARE NOT ABLE TO MAINTAIN THE SUPPLY AIR TEMPERATURE, THE DX COOLING COIL IS TO MAINTAIN THE SUPPLY AIR TEMPERATURE AS A SECOND STAGE OF COOLING. THE OUTSIDE AIR DAMPER SHALL BE OPEN.

WHEN ALL VAV BOXES ARE AT THE MINIMUM DAMPER POSITION, THE UNIT SUPPLY AIR TEMPERATURE SETPOINT (SA-T) SHALL BE RESET BETWEEN 55°F AND 65°F TO MINIMIZE VAV HEATING, WHILE MAINTAINING ALL BOXES AT MINIMUM FLOW.

DX COOLING COIL OPERATION:
THE BAS SHALL ENABLE THE DX COOLING COIL WHENEVER THE MIXED AIR TEMPERATURE (MA-T) RISES ABOVE 55ºF (ADJUSTABLE). THE DX COOLING COIL SHALL OPERATE UNDER MANUFACTURER SUPPLIED SAFETIES AND CONTROLS TO MAINTAIN THE UNIT SUPPLY AIR TEMPERATURE (SA-T) AT 55ºF (ADJUSTABLE) (SENSIBLE COOLING CONTROL).

AN ALARM SHALL BE PROVIDED FOR HIGH SUPPLY AIR TEMPERATURE IF THE UNIT SUPPLY AIR TEMPERATURE IS 5ºF (ADJUSTABLE) GREATER THAN SUPPLY AIR TEMPERATURE SETPOINT.

FREEZE PROTECTION: IF THE MIXED AIR DROPS BELOW 35°F (ADJUSTABLE), OR THE FREEZE STAT IS ON, THE DX COOLING COIL WILL BE DISABLED.

ALARMS SHALL BE PROVIDED AS FOLLOWS:
1. HIGH SUPPLY AIR TEMPERATURE: IF THE SUPPLY AIR IS 5°F (ADJUSTABLE) GREATER THAN THE COIL DISCHARGE SETPOINT.
2. COOLING COIL FREEZE STAT: IF THE FREEZE STAT HAS SENSED FREEZING CONDITIONS.

SUPPLY AIR TEMPERATURE SET POINT RESET CONTROL: THE BAS MUST MONITOR THE VAV BOX CONTROLLERS AND SEND A SUPPLY AIR TEMPERATURE SET POINT RESET SIGNAL TO THE UNIT CONTROLLER TO RESET THE SUPPLY AIR TEMPERATURE BASED ON THE VAV BOX WITH THE HIGHEST DEMAND FOR COOLING. THE SUPPLY AIR TEMPERATURE SET POINT MUST BE RESET BETWEEN 53 °F AND 60°F, TO THE HIGHEST POSSIBLE VALUE WHILE MAINTAINING ALL VAV ZONE TEMPERATURES AT THE REQUIRED SET POINT.

HOT WATER HEATING COIL OPERATION:
HEATING MODE CONTROL SHALL BE ENABLED WHENEVER:
1. MIXED OUTSIDE AIR TEMPERATURE (MA-T) IS BELOW 55°F (ADJUSTABLE) MINUS 2°F (ADJUSTABLE);
2. SUPPLY FAN STATUS IS ON.

THE BAS SHALL MODULATE THE HOT WATER CONTROL VALVE (AHU-V-C) TO MAINTAIN THE UNIT SUPPLY AIR TEMPERATURE SETPOINT (SA-T) AT 55°F (ADJUSTABLE).

THE BAS SHALL MODULATE THE HOT WATER CONTROL VALVE CLOSED WHEN OUTSIDE AIR TEMPERATURE (OA-T) IS ABOVE 55°F (ADJUSTABLE).

ALARMS SHALL BE PROVIDED AS FOLLOWS:
1. LOW SUPPLY AIR TEMPERATURE: IF THE SUPPLY AIR IS 5°F (ADJUSTABLE) LOWER THAN THE COIL DISCHARGE SETPOINT.

FREEZE PROTECTION: IF THE MIXED AIR DROPS BELOW 38°F (ADJUSTABLE), OR THE FREEZE STAT IS ON, THE HEATING WATER COIL TEMPERATURE SPRING RETURN CONTROL VALVE SHALL OPEN FULLY.

FREEZE PROTECTION:
THE BAS SHALL MONITOR THE MIXED AIR TEMP (MA-T) TO ENSURE COILS DO NOT FREEZE. A HARD-WIRED FREEZESTAT LOCATED AFTER THE HEATING COIL WILL SIGNAL AN AUTOMATIC SHUTDOWN OF THE UNIT AND GENERATE ALARM AT THE BAS IF THE MIXED AIR TEMPERATURE IS LESS THAN 35°F (ADJUSTABLE).

OUTSIDE AIR FLOW:
THE BAS SHALL MONITOR THE OUTSIDE AIR VOLUME THROUGH THE AIR FLOW MEASURING STATION (OA-F) TO ENSURE ADEQUATE VENTILATION SUPPLY AIR FLOW. ALARMS SHALL BE PROVIDED PER THE FOLLOWINGS:
1. HIGH OUTSIDE AIR FLOW: OUTSIDE AIR VOLUME IS 15% (ADJUSTABLE) GREATER THAN THE MAXIMUM DESIGN AIR FLOW SETPOINT.
2. LOW OUTSIDE AIR FLOW: OUTSIDE AIR VOLUME IS 15% (ADJUSTABLE) LESS THAN THE MINIMUM DESIGN AIR FLOW SETPOINT.

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FILTER DIFFERENTIAL PRESSURE MONITOR:
THE BAS SHALL MONITOR THE DIFFERENTIAL PRESSURE ACROSS THE FILTER BANK (MA-FLT). ALARM SHALL BE PROVIDED WHEN FILTER DIFFERENTIAL PRESSURE EXCEEDS SETPOINT (ADJUSTABLE).

UNIT FAULT AND SHUTDOWN:
THE UNIT SHALL SHUT DOWN AND GENERATE ALARM AT THE BAS IF ONE OF THE FOLLOWING CONDITIONS OCCURS:
1. SUPPLY AIR SMOKE DETECTION: SA DUCT DETECTOR SHALL BE HARD WIRED TO SHUTDOWN THE UNIT. SA SMOKE ALARM UPON DETECTION OF SMOKE IN THE SUPPLY AIR DISCHARGE. THE SA SMOKE DETECTOR SHALL ALSO ADDRESS THE FIRE ALARM CONTROL PANEL, RE: FIRE PROTECTION.
2. RETURN AIR SMOKE DETECTION: RA DUCT DETECTOR SHALL BE HARD WIRED TO SHUTDOWN THE UNIT. RA SMOKE ALARM UPON DETECTION OF SMOKE IN THE RETURN AIR. THE RA SMOKE DETECTOR SHALL ALSO ADDRESS THE FIRE ALARM CONTROL PANEL, RE: FIRE PROTECTION.
3. SUPPLY FAN FAILURE: COMMANDED ON, BUT STATUS IS OFF.
4. SUPPLY FAN IN HAND: COMMANDED OFF, BUT STATUS IS ON.
5. HIGH STATIC: THE SUPPLY FAN DIFFERENTIAL PRESSURE SWITCH (SA-P) SHALL BE HARDWIRED TO SHUT DOWN THE UNIT WHEN THE FAN STATIC PRESSURE REACHES THE HIGH LIMIT SETPOINT (ADJUSTABLE).
6. AT/FP EMERGENCY SHUTDOWN: AN EMERGENCY SHUTDOWN SIGNAL FROM A PUSH BUTTON SWITCH WHERE INDICATED ON PLANS.
7. COMMANDED OFF BY BAS.

UNIT SHUTDOWN SHALL ALIGN THE UNIT COMPONENTS TO THE FOLLOWINGS:
1. SUPPLY FAN OFF.
2. DX COOLING COIL DE-ENERGIZED.
3. OUTSIDE AIR DAMPER CLOSED.
4. RETURN AIR DAMPER OPEN.

ERV-# SEQUENCE OF OPERATIONS:

1. OUTSIDE AIR/ EXHAUST FAN HAND-OFF-AUTO OPERATION: HAND-OFF-AUTO OPERATION SWITCH ON EACH VFD SHALL CONTROL THE FAN.

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IN THE OFF MODE, THE FAN SHALL BE STOPPED AND THE ASSOCIATED OUTDOOR AND EXHAUST AIR DAMPERS SHALL BE CLOSED.

IN THE HAND MODE THE ASSOCIATED OUTDOOR AND EXHAUST AIR DAMPERS SHALL OPEN, AND THE ASSOCIATED DAMPER POSITION SWITCHES SHALL START THE RESPECTIVE FAN WHEN THE DAMPERS ARE FULLY OPEN.

IN THE AUTO POSITION THE BAS WILL START/STOP THE UNIT THROUGH THE UNIT CONTROLLER AS DESCRIBED BELOW. PROVIDE AN ADJUSTABLE DELAY-ON-MAKE RELAY, WIRED IN BOTH THE HAND AND AUTO MODES TO STAGGER THE RESTART OF THE UNIT, AFTER A POWER FAILURE, TO PREVENT CREATING A SPIKE IN THE FACILITY ELECTRICAL DEMAND. SAFETIES SHALL BE HARD WIRED TO STOP THE SUPPLY FAN.

2. AUTOMATIC MODE START/STOP CONTROL:

THE BAS SHALL START AND STOP THE UNIT. TO START THE UNIT, THE BAS SHALL SEND A START SIGNAL TO THE OUTSIDE AIR FAN MOTOR STARTER AND THE EXHAUST FAN MOTOR STARTER, WHICH WILL OPEN THE OUTDOOR AND EXHAUST AIR DAMPERS. WHEN THE DAMPERS ARE FULLY OPEN, AS SENSED BY THE DAMPER POSITION SWITCHES, THE RESPECTIVE OUTSIDE AIR AND EXHAUST FANS SHALL START. IF THE FAN DOES NOT START AFTER 60 SECOND (ADJUSTABLE) TIME DELAY, A FAILURE ALARM SHALL BE ISSUED AND THE START COMMAND SHALL BE CANCELED. TO STOP A UNIT, THE BAS SHALL SEND A STOP SIGNAL TO EACH MOTOR STARTER, WHICH WILL CLOSE THE RESPECTIVE ISOLATION DAMPERS AND DE-ENERGIZE THE RESPECTIVE SUPPLY AND EXHAUST FANS. THE UNIT SHALL BE SOFTWARE INTERLOCKED WITH AHU-1 AND THE UNIT SHALL BE STARTED WHEN AHU-1 IS IN THE OCCUPIED MODE. THE UNIT SHALL BE DISABLED WHEN AHU-1 IS STARTED IN THE UNOCCUPIED MODE.

3. DIRTY FILTER ALARM: DIFFERENTIAL PRESSURE SWITCH SHALL MONITOR THE PRESSURE DROP AT THE FILTERS. WHEN THE PRESSURE EXCEEDS AND ADJUSTABLE LIMIT, AN ALARM SIGNAL WILL BE SENT TO THE UNIT CONTROLLER AND THE BAS. A PRESSURE DIFFERENCE INDICATOR LOCATED AT THE FILTERS SHALL INDICATE THE DIFFERENTIAL PRESSURE ACROSS THE FILTERS.

4. FAN STATUS: CURRENT SWITCHES SHALL BE USED TO MONITOR THE STATUS OF THE UNIT OUTSIDE AIR AND EXHAUST FAN. IF THE STATUS INDICATED DOES NOT MATCH THE COMMANDED OUTPUT FOR THE FAN AN ALARM SHALL BE GENERATED AT THE UNIT CONTROLLER AND THE BAS.

5. FAILURE MODE: UPOS LOSS OF CONTROL SIGNAL OR ELECTRICAL POWER THE CONTROL DEVICES SHALL FAIL IN THE MANNER INDICATED IN THE "ERV POINT SCHEDULE" ON THE MECHANICAL SHEETS.

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6. ADDITIONAL MONITORING: IN ADDITION TO THE POINTS MENTIONED IN THE SEQUENCES PROVIDE THE ADDITIONAL MONITORING POINTS LISTED IN THE "ERV POINT SCHEDULE".

SEQUENCE OF OPERATION - MAKE-UP AIR UNIT (MAU-#):

NORMAL OPERATION: FANS SHALL OPERATE AT 50% CAPACITY DURING NORMAL OPERATION AND SHALL RAMP UP TO 100% IF THE WLT BAY REACHES NO2 OR CO LIMIT AS SENSED BY ANY OF THE NO2 OR CO SENSORS LOCATED IN THE WLT BAY(S). THE ASSOCIATED WLT BAY EXHAUST FANS MUST BE SOFTWARE INTERLOCKED WITH THE MAKE UP AIR UNITS TO RAMP DOWN TO 50% AIRFLOW WHEN THE ASSOCIATED MAU RAMPS DOWN TO 50%, AND MUST RAMP UP TO 100% AIRFLOW WHEN THE ASSOCIATED MAU RAMPS UP TO 100% AIRFLOW.

HEATING CONTROL: WHEN THE SUPPLY AIR TEMPERATURE DROPS BELOW THE HEATING SET POINT, INITIALLY SET AT 55°F (ADJUSTABLE) WHILE THE SUPPLY FAN IS RUNNING, THE BAS MUST ENABLE AND MODULATE THE HOT WATER VALVE TO MAINTAIN THE SUPPLY AIR TEMPERATURE AT THE SET POINT. WHEN THE SUPPLY FAN IS OFF, THE HEATING MUST BE OFF.

DIRTY FILTER ALARM: WHEN THE PRESSURE AT THE FILTER EXCEEDS A LIMIT SET BY THE UNIT MANUFACTURER, A FILTER ALARM SIGNAL MUST BE SENT TO THE BAS.

GAS UNIT HEATERS (TYPICAL):

WHEN THE TEMPERATURE DROPS BELOW THE SET POINT, INITIALLY SET AT 55°F (ADJUSTABLE), THE UNIT HEATER MUST BE ENABLED. WHEN THE TEMPERATURE RISES ABOVE THE SET POINT, THE UNIT HEATER MUST BE DISABLED AND THE FAN MUST STOP. THE UNIT HEATER MUST BE CONTROLLED BY A WALL MOUNTED THERMOSTAT, NOT THROUGH THE BAS.

HW UNIT HEATERS (TYPICAL):

WHEN THE TEMPERATURE DROPS BELOW THE SET POINT, INITIALLY SET AT 55°F (ADJUSTABLE), THE UNIT HEATER HW CONTROL VALVE SHALL OPEN TO THE SET DESIGN FLOWRATE. WHEN THE TEMPERATURE RISES ABOVE THE SET POINT, THE UNIT HEATER HW CONTROL VALVE MUST CLOSE AND THE FAN MUST STOP. THE UNIT HEATER MUST BE CONTROLLED BY A WALL MOUNTED THERMOSTAT, NOT THROUGH THE BAS.

SPLIT SYSTEM AC/HP UNITS (TYPICAL):

EACH SPLIT SYSTEM AC UNIT MUST BE CONTROLLED BY A UNIT CONTROLLER PROVIDED BY THE UNIT MANUFACTURER, NOT THROUGH THE BAS.

THE BAS MUST MONITOR THE SPACE TEMPERATURE IN THE COMM AND ELEC ROOMS. WHEN THE SPACE TEMPERATURE RISES ABOVE THE SET POINT, INITIALLY SET AT 80°F, THE BAS MUST GENERATE THE HIGH TEMPERATURE ALARM TO THE BAS.

US Army Corps of Engineers
Omaha District ®

MARK	DESCRIPTION	DATE
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DRAWN BY: A. RAMOS
CHECKED BY: J. STAMPER
SUBMITTED BY: B. DYSON
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US ARMY CORPS OF ENGINEERS
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ELLSWORTH AIR FORCE BASE, SD
DESIGN B-21: WEAPONS LOADER TRAINING FACILITY
PROJECT NUMBER: FXBM231802

SEQUENCES OF OPERATION

SHEET ID

M-811

ADVERTISEMENT - 100% DESIGN

SEQUENCE OF OPERATION - VARIABLE AIR VOLUME UNITS:

GENERAL:

VAV BOX DAMPER CONTROL: THE VAV BOX CONTROLLER MUST MODULATE THE VAV BOX DAMPER TO MAINTAIN THE AMOUNT OF AIR SUPPLIED TO THE SPACE AT THE SPACE AIRFLOW SET POINT. THE SPACE AIRFLOW SET POINT MUST BE RESET BY THE SPACE TEMPERATURE BETWEEN THE BOX MINIMUM AIRFLOW AND BOX MAXIMUM AIRFLOW. AS THE SPACE TEMPERATURE INCREASES ABOVE THE SPACE TEMPERATURE SET POINT, THE VAV BOX MUST INCREASE AIRFLOW SET POINT. AS THE SPACE TEMPERATURE DECREASES BELOW THE SPACE TEMPERATURE SET POINT, THE VAV BOX MUST DECREASE AIRFLOW SET POINT. SEE VAV TERMINAL SCHEDULE ON THE MECHANICAL SHEETS FOR VAV BOX MINIMUM AND MAXIMUM AIR FLOW SET POINTS.

VAV BOX HOT WATER RE-HEAT COIL CONTROL: UPON A FURTHER DROP IN SPACE TEMPERATURE, AS SENSED BY THE LOCAL SPACE TEMPERATURE SENSOR, AFTER THE VAV BOX IS DELIVERING THE MINIMUM AIR FLOW, THE VAV BOX ASC MUST MODULATE OPEN THE VAV BOX HOT WATER VALVE. UPON AN INCREASE IN TEMPERATURE, THE REVERSE MUST OCCUR. WHEN THE AIR HANDLING UNIT IS OFF, THE HOT WATER VALVE MUST CLOSE.

VAV BOX SET POINT CONTROL: THE BAS MUST AUTOMATICALLY SWITCH THE VAV BOX TEMPERATURE SET POINT ACCORDING TO THE FOLLOWING (ALL SET POINT MUST BE ADJUSTABLE):

OCCUPIED HEATING SET POINT - 68 F.
OCCUPIED COOLING SET POINT - 78 F.
UNOCCUPIED HEATING SET POINT - 60 F.
UNOCCUPIED COOLING SET POINT - 80 F.

UNOCCUPIED MODE OVERRIDE: DURING THE UNOCCUPIED MODE, IT MUST BE POSSIBLE TO RETURN THE VAV BOX AND THE ASSOCIATED AIR HANDLING UNIT TO THE OCCUPIED MODE BY ACTIVATING A SWITCH ON THE SPACE TEMPERATURE SENSOR. ONCE THE AFTER-HOUR OVERRIDE SWITCH IS ACTIVATED, THE SYSTEM MUST RUN FOR A PREDETERMINED TIME PERIOD (ADJUSTABLE) AND AUTOMATICALLY RETURN TO THE UNOCCUPIED MODE.

ADDITIONAL MONITORING: IN ADDITION TO THE POINTS MENTIONED IN THESE SEQUENCES PROVIDE THE ADDITIONAL MONITORING POINTS LISTED IN THE POINT SCHEDULE.

WLY BAY EXHAUST FANS (EF-1,EF-2,EF-4,EF-5):

EXHAUST FAN HAND-OFF-AUTO OPERATION: A HAND-OFF-AUTO SWITCH MUST BE PROVIDED AS PART OF THE MOTOR STARTER FOR THE EXHAUST FAN. IN THE OFF MODE, THE ISOLATION DAMPER MUST BE CLOSED AND THE EXHAUST FAN MUST BE STOPPED. IN THE HAND MODE, THE ISOLATION DAMPER MUST BE OPENED AND THE EXHAUST FAN MUST START. IN THE AUTO MODE, THE EXHAUST FAN AND ISOLATION DAMPER MUST BE CONTROLLED BY THE BAS AS DESCRIBED BELOW.

AUTOMATIC MODE START/STOP CONTROL:

FAN OPERATION: THE BAS MUST START AND STOP THE FAN BASED ON THE OCCUPANACY SCHEDULE. TO START THE FAN, THE BAS MUST SEND A START SIGNAL TO THE FAN VFD. THIS MUST ENABLE THE HARD WIRE INTERLOCK THAT OPENS THE ISOLATION DAMPERS. TO STOP A FAN, THE BAS MUST SEND A STOP COMMAND TO THE FAN VFD WHICH WILL DE-ENERGIZE THE FAN AND CLOSE THE ISOLATION DAMPERS.

NORMAL AND SPACE CO/NO2 OPERATION: THE EXHAUST FANS MUST BE SOFTWARE INTERLOCKED TO OPERATE CONTINUOUSLY WHEN THE ASSOCIATED MAKEUP AIR UNIT IS IN OPERATION, AND SHALL SHUT DOWN WHEN THE ASSOCIATED MAKEUP AIR UNIT SHUTS DOWN. UNDER NORMAL OPERATION THE EXHAUST FANS WILL OPERATE AT 100% AIRFLOW. IF THE LEVELS OF CARBON MONOXIDE HAVE BEEN MAINTAINED BELOW THE 15PPM (ADJ.) AND NITROGEN DIOXIDE LEVEL 3PPM (ADJ.) FOR 60 MINUTES (ADJ.) THEN THE EXHAUST FAN SHALL RAMP DOWN TO 50% AIRFLOW CAPACITY. THE ASSOCIATED INTERLOCKED MAKEUP AIR UNIT SHALL ALSO RAMP DOWN TO 50% AIRFLOW CAPACITY. IF THE SPACE CARBON MONOXIDE LEVEL RISES ABOVE THE SET POINT, INITIALLY SET AT 15 PPM (ADJUSTABLE), OR SPACE NITROGEN DIOXIDE LEVEL RISES ABOVE THE SET POINT, INITIALLY SET AT 3 PPM (ADJUSTABLE). THE EXHAUST FANS AND MAKEUP AIR UNITS SHALL RAMP UP TO 100% AIRFLOW UNTIL THE CARBON MONOXIDE AND NITROGEN DIOXIDE LEVELS FALL BELOW THE SETPOINTS AND MAINTANED FOR 60 MINUTES (ADJ.). WHEN THE UNITS ARE OPERATING AT 100% AIRFLOW AND IF THE LEVELS OF CARBON MONOXIDE OR NITROGEN DIOXIDE DO FALL BELOW THEIR RESPECTIVE PPM LIMITS IN 2 MINS (ADJ.) THEN AN AUDIBLE AND VISUAL ALARM MUST TURN ON IN THE WLT BAY AND AN ALARM SHALL BE GENERATED AND SENT TO THE BAS.

MANUAL OVERRIDE: UPON ACTIVATION OF THE MANUAL SWITCH IN THE ROOM, OR THE BAS, THE EXHAUST FANS AND ASSOCIATED MAKEUP AIR UNITS SHALL RAMP UP TO 100% AIRFLOW AND FOLLOW THE SPACE CO/NO2 OPERATION SEQUENCE.

FAN STATUS: A CURRENT SWITCH MUST BE USED TO MONITOR THE STATUS OF THE FAN. IF THE STATUS INDICATED DOES NOT MATCH THE COMMANDED OUTPUT FOR THE FAN AN ALARM MUST BE GENERATED AND SENT TO THE BAS AND THE FAN START COMMAND MUST BE CANCELED.

MECHANICAL ROOM EXHAUST FAN (EF-3):

EXHAUST FAN HAND-OFF-AUTO OPERATION: A HAND-OFF-AUTO SWITCH MUST BE PROVIDED AS PART OF THE MOTOR STARTER FOR THE EXHAUST FAN. IN THE OFF MODE, THE ISOLATION DAMPER MUST BE CLOSED AND THE EXHAUST FAN MUST BE STOPPED. IN THE HAND MODE, THE ISOLATION DAMPER MUST BE OPENED AND THE EXHAUST FAN MUST START. IN THE AUTO MODE, THE EXHAUST FAN AND ISOLATION DAMPER MUST BE CONTROLLED BY THE BAS AS DESCRIBED BELOW.

AUTOMATIC MODE START/STOP CONTROL:

SPACE TEMPERATURE OPERATION: THE BAS MUST START AND STOP THE FAN BASED ON THE SPACE TEMPERATURE. WHEN THE SPACE TEMPERATURE RISES ABOVE THE SET POINT, INITIALLY SET AT 85°F (ADJUSTABLE), THE BAS MUST START THE FAN. TO START THE FAN, THE BAS MUST SEND A START SIGNAL TO THE FAN MOTOR STARTER. THIS MUST ENABLE THE HARD WIRE INTERLOCK THAT OPENS THE OUTDOOR AIR INTAKE AND ISOLATION DAMPERS. TO STOP A FAN, THE BAS MUST SEND A STOP COMMAND TO THE FAN MOTOR STARTER WHICH WILL DE-ENERGIZES THE FAN AND CLOSE THE OUTDOOR AIR INTAKE AND ISOLATION DAMPERS.

FAN STATUS: A CURRENT SWITCH MUST BE USED TO MONITOR THE STATUS OF THE FAN. IF THE STATUS INDICATED DOES NOT MATCH THE COMMANDED OUTPUT FOR THE FAN AN ALARM MUST BE GENERATED AND SENT TO THE BAS AND THE FAN START COMMAND MUST BE CANCELED.

SEQUENCE OF OPERATIONS - DESTRATIFICATION FANS:

AUTOMATIC MODE START/STOP CONTROL:
THE BAS SHALL START AND STOP THE FANS. TO START THE FANS, THE BAS CONTROLLER SHALL SEND A START SIGNAL, WHICH WILL START THE FANS IN THE MAIN HANGAR BAY. TO STOP THE FANS, THE BAS CONTROLLER SHALL SEND A STOP COMMAND, WHICH WILL DE-ENERGIZE THE FANS. THE BAS SHALL CYCLCE THE FANS ON AND OFF TO MAINTAIN THE DIFFERENTIAL TEMPERATURE BETWEEN FLOOR LEVEL AND CEILING LEVEL, AS SENSED BY TEMPERATURE SENSORS, ROOM-H-TS AND ROOM-L-TS, AT SET POINT, INITIALLY SET AT 5 DEGREES F (ADJUSTABLE). IF THE DIFFERENTIAL TEMPERATURE RISES ABOVE THE SET POINT, THE FAN SHALL BE ENERGIZED. IF THE DIFFERENTIAL TEMPERATURE DROPS BELOW THE SET POINT MINUS 2F (ADJUSTABLE), THE FAN SHALL BE DE-ENERGIZED. THE FAN SHALL CYCLE ON AND OFF TO MAINTAIN THE DIFFERENTIAL TEMPERATURE YEAR ROUND, REGARDLESS OF THE SEASON.

EMERGENCY AIR DISTRIBUTION SHUT DOWN SWITCH (TYPICAL):

EMERGENCY AIR DISTRIBUTION SHUT DOWN SWITCH: PROVIDE EMERGENCY AIR DISTRIBUTION SHUT DOWN SWITCHES WHERE INDICATED. WHEN THE SWITCH IS ACTIVATED, THE BAS MUST SEND A SIGNAL TO FIRE ALARM SYSTEM, WHICH WILL SHUT DOWN THE AIR HANDLING UNITS AND MAKEUP AIR UNITS AND ASSOCIATED EXHAUST FANS VIA A RESPECTIVE CONTROL MODULE. WHEN THE EMERGENCY CONDITION HAS BEEN CLEARED AND THE MANUAL SWITCH HAS BEEN RESET, THE MECHANICAL EQUIPMENT MUST RETURN TO NORMAL OPERATION.

R 001

US Army Corps of Engineers
Omaha District ®

MARK	DESCRIPTION	DATE
1	AMENDMENT 0001	18 MAY 2023

DESIGNED BY: A. RAMOS
DRAWN BY: A. RAMOS
CHECKED BY: J. STAMPER
SUBMITTED BY: B. DYSON
SIZE: ANSI D 22x34
ISSUE DATE: 28 APRIL 2023
SOLICITATION NO.: W9128F23R0012
CONTRACT NO.:
DRAWING CODE:
FILE NAME: FXBM231802M-812

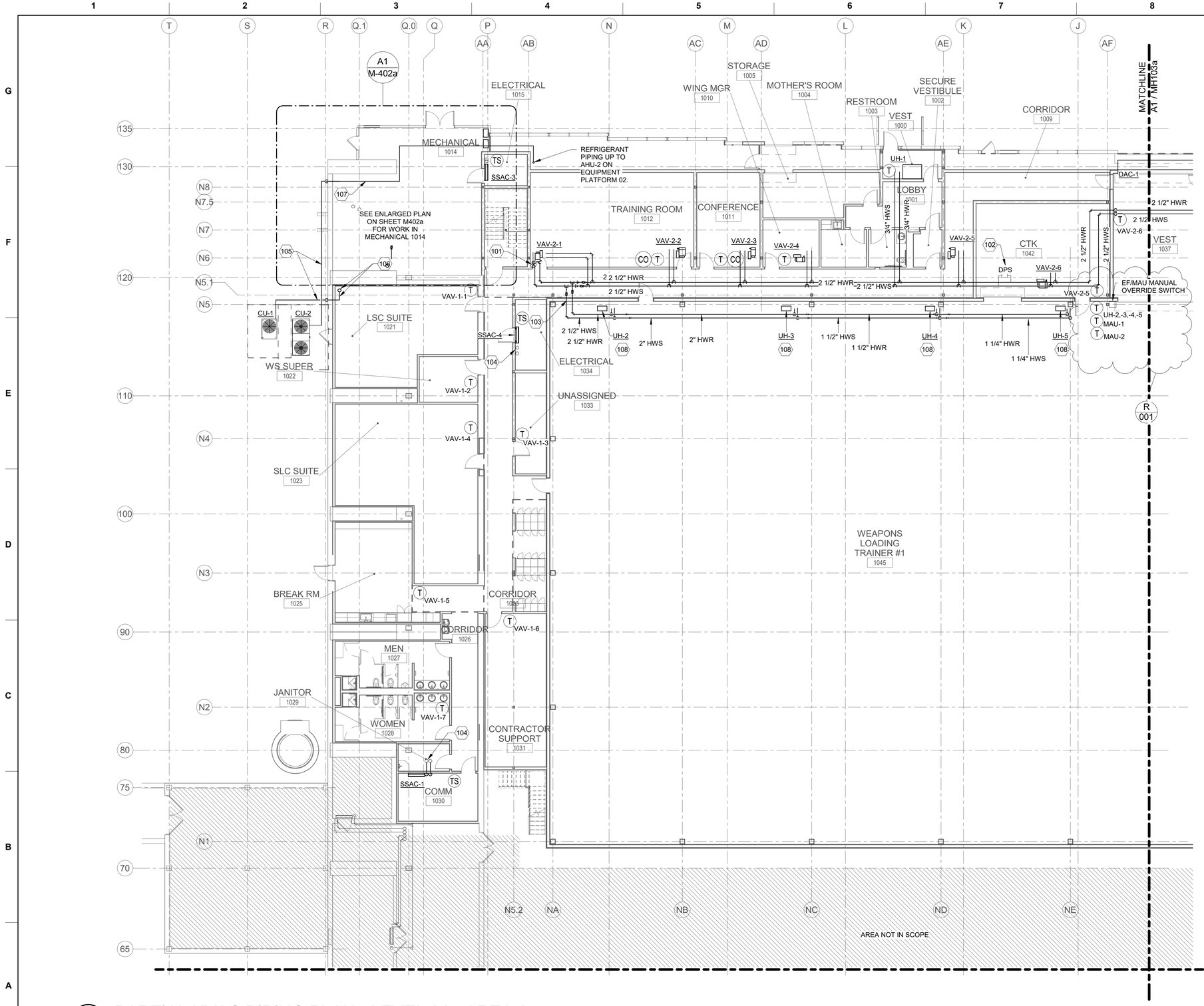
US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
OMAHA, NEBRASKA

Jacobs
1001 HIGHLANDS PLAZA DR. WEST, SUITE 400
ST. LOUIS, MISSOURI 63110

ELLSWORTH AIR FORCE BASE, SD
DESIGN B-21: WEAPONS LOADER TRAINING FACILITY
PROJECT NUMBER: FXBM231802
SEQUENCES OF OPERATION

SHEET ID
M-812

ADVERTISEMENT - 100% DESIGN



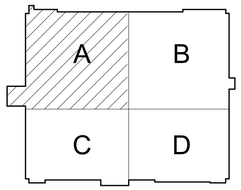
A1 PARTIAL HVAC PIPING PLAN - LEVEL 01 - AREA A
SCALE 3/32" = 1'-0"

GENERAL SHEET NOTES

1. REFER TO SHEET M-001 FOR ADDITIONAL GENERAL NOTES, LEGEND, AND ABBREVIATIONS.
2. MAINTAIN MANUFACTURER'S RECOMMENDED CLEARANCES ON ALL EQUIPMENT.
3. PROVIDE CLEARANCES FOR ALL ELECTRICAL AND CONTROL PANELS PER NEC.
4. PROVIDE BRACING FOR EQUIPMENT WEIGHING MORE THAN 31 LBS PER UFC 4-010-01.
5. COORDINATE THERMOSTATS WITH FURNISHINGS. LOCATE THERMOSTATS 6" ON CENTER FROM LIGHT SWITCH. MOUNT TOP OF THERMOSTAT AS SHOWN AT ADA APPROVED MOUNTING HEIGHT.
6. PROVIDE U.L. RATED THROUGH-PENETRATION FIRE STOP SYSTEMS AT ALL PENETRATIONS BETWEEN THE HANGAR/SHOP DEMISING WALL.
7. ALL BRANCH TAPS TO VAV TERMINAL UNITS SHALL BE 3/4" UNLESS OTHERWISE NOTED.

SHEET KEYNOTES

101. 4" HWS&R PIPING UP TO EQUIPMENT PLATFORM 02 ABOVE.
102. DIFFERENTIAL PRESSURE SENSOR FOR HW SYSTEM.
103. BOTTOM OF PIPING MOUNTED AT 14'-10" A.F.F. PROVIDE DI-ELECTRIC PIPE FITTINGS AT WLT BAY WALL PENETRATION IN ACCORDANCE WITH ICD 705. REFER TO E4/P-501 FOR MORE INFORMATION.
104. REFRIGERANT PIPING UP TO MECHANICAL PLATFORM ABOVE. ROUTE AND SIZE REFRIGERANT PIPING PER MANUFACTURER'S GUIDELINES.
105. TWO LINE SET GENERAL ROUTING ABOVE GRADE AND ROUTED ALONG EXTERIOR WALL. ROUTE AND SIZE REFRIGERANT PIPING PER MANUFACTURER'S GUIDELINES. (TYP.)
106. ROUTE REFRIGERANT PIPING ABOVE CEILING IN LSC SUITE. ROUTE REFRIGERANT PIPING UP TO AHU-1 ON EQUIPMENT PLATFORM 01.
107. FIELD ROUTE REFRIGERANT PIPING THROUGH MECHANICAL ROOM AS ABOVE OTHER UTILITIES OVER TO EQUIPMENT PLATFORM 02.
108. WALL MOUNTED UNIT HEATER. SEE HW UNIT HEATER SCHEDULE ON SHEET M-601 FOR MOUNTING HEIGHTS AND ADDITIONAL INFORMATION.



AREA A
KEY PLAN

GRAPHIC SCALE

0 4' 8' 16' 32'

SCALE: 3/32"=1'-0"

PLAN NORTH

TRUE N

US Army Corps of Engineers
Omaha District ®

MARK	DESCRIPTION	DATE
1	AMENDMENT 0001	18 MAY 2023

ISSUE DATE: 28 APRIL 2023
SOLICITATION NO.: W9128F23R0012
CONTRACT NO.:
DRAWING CODE::

DESIGNED BY: A. RAMOS
DRAWN BY: A. RAMOS
CHECKED BY: J. STAMPFER
SUBMITTED BY: B. DYSON
ANSI D 22x34

FILE NAME: FXBM231802MP102

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
OMAHA, NEBRASKA

Jacobs
1001 HIGHLANDS PLAZA DR. WEST, SUITE 400
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ELLSWORTH AIR FORCE BASE, SD
DESIGN B-21: WEAPONS LOADER TRAINING FACILITY
PROJECT NUMBER: FXBM231802
PARTIAL PIPING PLAN - LEVEL 01 - AREA A

SHEET ID
MP102

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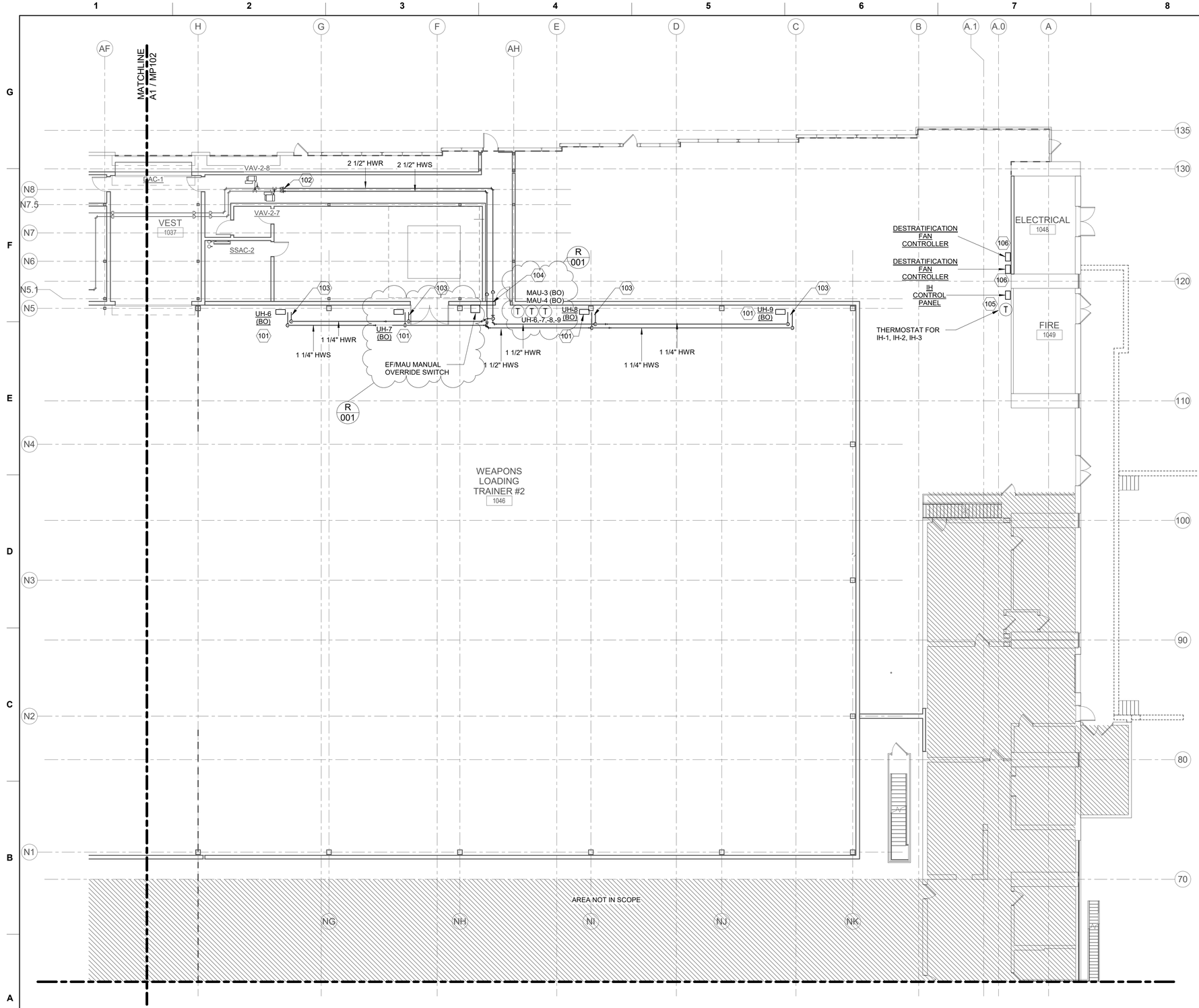


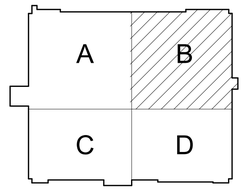
A1 PARTIAL HVAC PIPING PLAN - LEVEL 01 - AREA B - BID OPTION
SCALE 3/32" = 1'-0"

GENERAL SHEET NOTES

1. REFER TO SHEET M-001 FOR ADDITIONAL GENERAL NOTES, LEGEND, AND ABBREVIATIONS.
2. MAINTAIN MANUFACTURER'S RECOMMENDED CLEARANCES ON ALL EQUIPMENT.
3. PROVIDE CLEARANCES FOR ALL ELECTRICAL AND CONTROL PANELS PER NEC.
4. PROVIDE BRACING FOR EQUIPMENT WEIGHING MORE THAN 31 LBS PER UFC 4-010-01.
5. COORDINATE THERMOSTATS WITH FURNISHINGS. LOCATE THERMOSTATS 6" ON CENTER FROM LIGHT SWITCH. MOUNT TOP OF THERMOSTAT AS SHOWN AT ADA APPROVED MOUNTING HEIGHT.
6. PROVIDE U.L. RATED THROUGH-PENETRATION FIRE STOP SYSTEMS AT ALL PENETRATIONS BETWEEN THE HANGAR/SHOP DEMISING WALL.
7. ALL BRANCH TAPS TO VAV TERMINAL UNITS SHALL BE 3/4" UNLESS OTHERWISE NOTED.

SHEET KEYNOTES

101. HOT WATER UNIT HEATER. REFER TO SCHEDULE ON SHEET M602 FOR MOUNTING HEIGHT.
102. EXTEND 2-1/2" HWS&R AT THIS LOCATION TO SERVE UNIT HEATERS IN WLT BAY #2.
103. 1-1/4" HWS&R CONNECTION TO UNIT HEATER. COORDINATE INLET/OUTLET CONNECTION LOCATIONS WITH MANUFCACTURER'S DRAWINGS.
104. BOTTOM OF PIPING MOUNTED AT 14'-10" A.F.F. PROVIDE DI-ELECTRIC PIPE FITTINGS AT WLT BAY WALL PENETRATION IN ACCORDANCE WITH ICD 705. REFER TO E4/P-501 FOR MORE INFORMATION.
105. CONTROL PANEL AND THERMOSTAT LOCATION FOR INFRARED HEATERS.
106. PROVIDE AND INSTALL NEW DESTRATIFICATION FAN CONTROLLER ON WALL AT LOCATION SHOWN.



AREA B
KEY PLAN

GRAPHIC SCALE
0 4' 8' 16' 32'
SCALE: 3/32"=1'-0"

PLAN NORTH
TRUE N

US Army Corps of Engineers
Omaha District ®

MARK	DESCRIPTION	DATE
1	AMENDMENT 0001	18 MAY 2023

DESIGNED BY: A. RAMOS
DRAWN BY: A. RAMOS
CHECKED BY: J. STAMPER
SUBMITTED BY: B. DYSON
ISSUE DATE: 28 APRIL 2023
SOLICITATION NO.: W9128F23R0012
CONTRACT NO.:
DRAWING CODE:
FILE NAME: FXBM231802MP103b
SIZE: ANSI D 22x34

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
OMAHA, NEBRASKA

Jacobs
1001 HIGHLANDS PLAZA DR. WEST, SUITE 400
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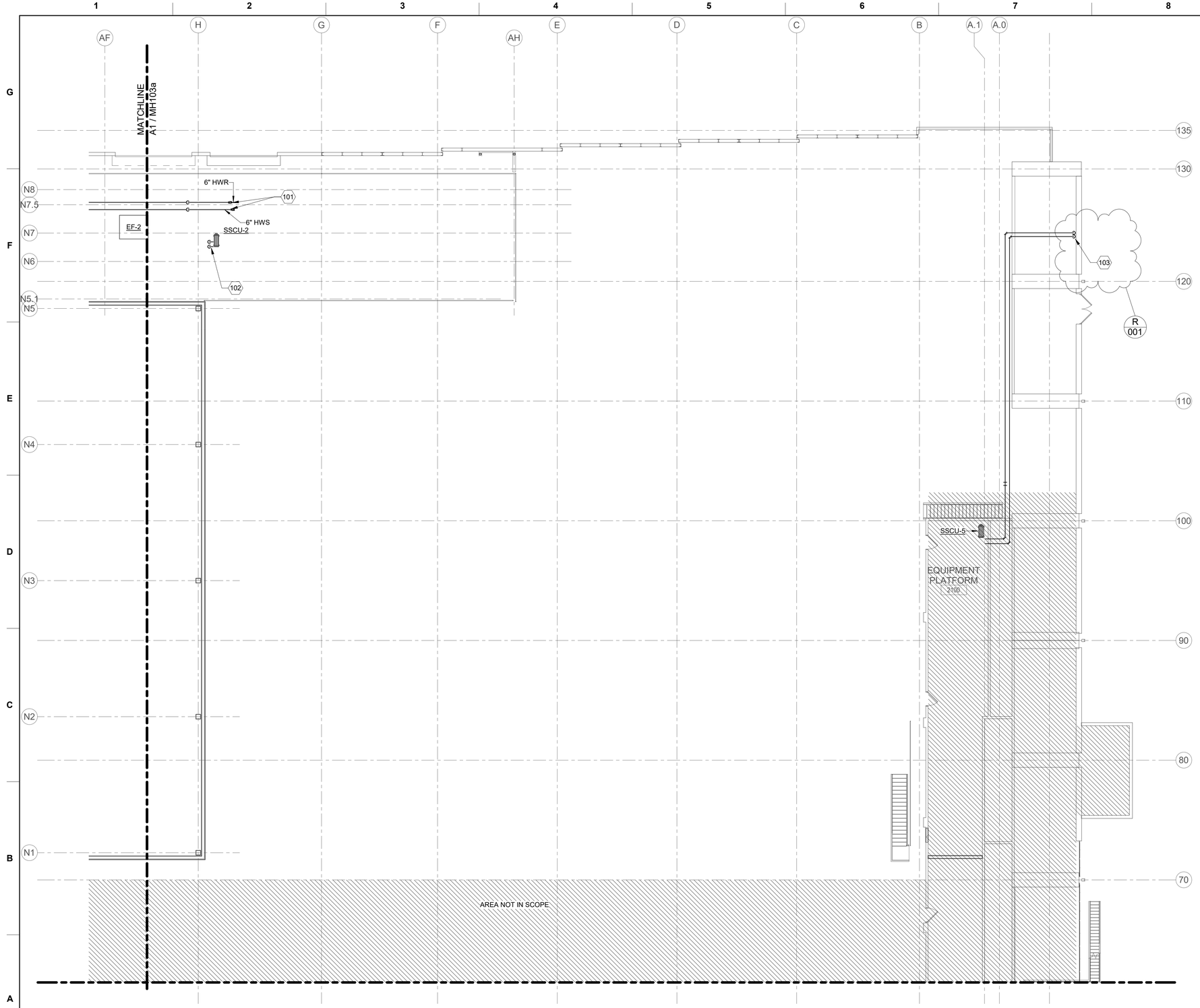
ELLSWORTH AIR FORCE BASE, SD
DESIGN B-21: WEAPONS LOADER
TRAINING FACILITY
PROJECT NUMBER: FXBM231802
PARTIAL PIPING PLAN - LEVEL 01 - AREA
B - BID OPTION

SHEET ID
MP103b

ADVERTISEMENT - 100% DESIGN



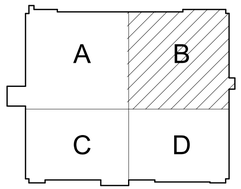
A1 PARTIAL PIPING PLAN - EQUIPMENT PLATFORMS - AREA B - BASE BID
SCALE 3/32" = 1'-0"

GENERAL SHEET NOTES

1. REFER TO SHEET M-001 FOR ADDITIONAL GENERAL NOTES, LEGEND, AND ABBREVIATIONS.
2. MAINTAIN MANUFACTURER'S RECOMMENDED CLEARANCES ON ALL EQUIPMENT.
3. PROVIDE CLEARANCES FOR ALL ELECTRICAL AND CONTROL PANELS PER NEC.
4. PROVIDE BRACING FOR EQUIPMENT WEIGHING MORE THAN 31 LBS PER UFC 4-010-01.
5. COORDINATE THERMOSTATS WITH FURNISHINGS. LOCATE THERMOSTATS 6" ON CENTER FROM LIGHT SWITCH. MOUNT TOP OF THERMOSTAT AS SHOWN AT ADA APPROVED MOUNTING HEIGHT.
6. PROVIDE U.L. RATED THROUGH-PENETRATION FIRE STOP SYSTEMS AT ALL PENETRATIONS BETWEEN THE HANGAR/SHOP DEMISING WALL.
7. ALL BRANCH TAPS TO VAV TERMINAL UNITS SHALL BE 3/4" UNLESS OTHERWISE NOTED.

SHEET KEYNOTES

101. PROVIDE AND INSTALL 6" SHUT-OFF VALVE AND CAP AT LOCATION SHOWN IN HWS&R PIPING FOR CONNECTION TO BID OPTION WORK. REFERENCE MP-113b FOR MORE INFORMATION.
102. REFRIGERANT PIPING DOWN TO SSAC-2 IN SECURE COMM ROOM BELOW. PROVIDE DI-ELECTRIC FITTINGS AT PENETRATION. ROUTE AND SIZE REFRIGERANT PIPING PER MANUFACTURER'S GUIDELINES.
103. REFRIGERANT PIPING DOWN TO SSAC-5 IN ELECTRICAL ROOM BELOW. PROVIDE DI-ELECTRIC FITTINGS AT PENETRATION. ROUTE AND SIZE REFRIGERANT PIPING PER MANUFACTURER'S GUIDELINES.



AREA B
KEY PLAN

GRAPHIC SCALE
0 4' 8' 16' 32'
SCALE: 3/32"=1'-0"

PLAN NORTH
TRUE N

US Army Corps of Engineers
Omaha District ®

MARK	DESCRIPTION	DATE
1	AMENDMENT 0001	18 MAY 2023

ISSUE DATE: 28 APRIL 2023
SOLICITATION NO.: W9128F23R0012
CONTRACT NO.:
DRAWING CODE:
FILE NAME: FXBM231802MP113a

DESIGNED BY: A. RAMOS
DRAWN BY: A. RAMOS
CHECKED BY: J. STAMPER
SUBMITTED BY: B. DYSON
SIZE: ANSI D 22x34

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
OMAHA, NEBRASKA

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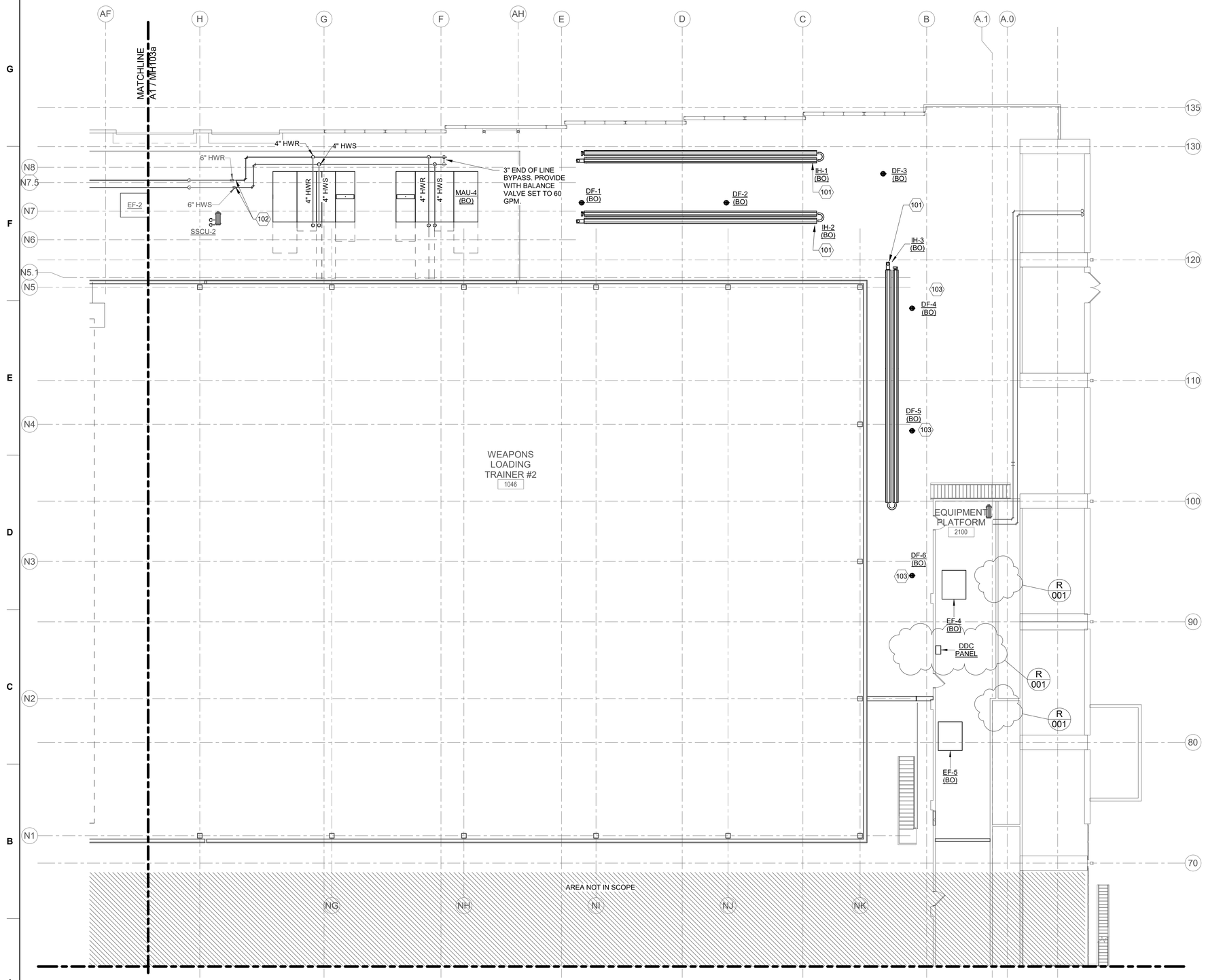
ELLSWORTH AIR FORCE BASE, SD
DESIGN B-21: WEAPONS LOADER TRAINING FACILITY
PROJECT NUMBER: FXBM231802
PARTIAL PIPING PLAN - EQUIPMENT PLATFORMS - AREA B - BASE BID

SHEET ID
MP113a

ADVERTISEMENT - 100% DESIGN



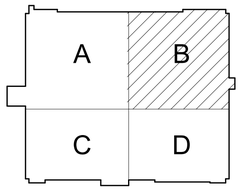
A1 PARTIAL PIPING PLAN - EQUIPMENT PLATFORMS - AREA B - BID OPTION
SCALE 3/32" = 1'-0"

GENERAL SHEET NOTES

1. REFER TO SHEET M-001 FOR ADDITIONAL GENERAL NOTES, LEGEND, AND ABBREVIATIONS.
2. MAINTAIN MANUFACTURER'S RECOMMENDED CLEARANCES ON ALL EQUIPMENT.
3. PROVIDE CLEARANCES FOR ALL ELECTRICAL AND CONTROL PANELS PER NEC.
4. PROVIDE BRACING FOR EQUIPMENT WEIGHING MORE THAN 31 LBS PER UFC 4-010-01.
5. COORDINATE THERMOSTATS WITH FURNISHINGS. LOCATE THERMOSTATS 6" ON CENTER FROM LIGHT SWITCH. MOUNT TOP OF THERMOSTAT AS SHOWN AT ADA APPROVED MOUNTING HEIGHT.
6. PROVIDE U.L. RATED THROUGH-PENETRATION FIRE STOP SYSTEMS AT ALL PENETRATIONS BETWEEN THE HANGAR/SHOP DEMISING WALL.
7. ALL BRANCH TAPS TO VAV TERMINAL UNITS SHALL BE 3/4" UNLESS OTHERWISE NOTED.

SHEET KEYNOTES

101. INFRARED HEATER MOUNTED AT 40'-10" A.F.F. CONTRACTOR TO FIELD VERIFY DIMENSION IN FIELD AS TO NOT CONFLICT WITH EXISTING CONDITIONS.
102. EXTEND 6" HWS&R PIPING AT POINT INDICATED FOR CONNECTION TO EQUIPMENT PROVIDED AS PART OF THE BID OPTION WORK.
103. MOUNT DESTRATIFICATION FAN AT 35'-4" A.F.F.



AREA B
KEY PLAN

GRAPHIC SCALE
0 4' 8' 16' 32'
SCALE: 3/32"=1'-0"

PLAN NORTH
TRUE N

US Army Corps of Engineers
Omaha District ®

MARK	DESCRIPTION	DATE
1	AMENDMENT 0001	18 MAY 2023

DESIGNED BY: A. RAMOS
DRAWN BY: A. RAMOS
CHECKED BY: J. STAMPER
SUBMITTED BY: B. DYSON
SIZE: ANSI D 22x34
ISSUE DATE: 28 APRIL 2023
SOLICITATION NO.: W9128F23R0012
CONTRACT NO.:
DRAWING CODE::
FILE NAME: FXBM231802MP113b

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
OMAHA, NEBRASKA

Jacobs
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ST. LOUIS, MISSOURI 63110

ELLSWORTH AIR FORCE BASE, SD
DESIGN B-21: WEAPONS LOADER TRAINING FACILITY
PROJECT NUMBER: FXBM231802

PARTIAL PIPING PLAN - EQUIPMENT PLATFORMS - AREA B - BID OPTION

SHEET ID
MP113b

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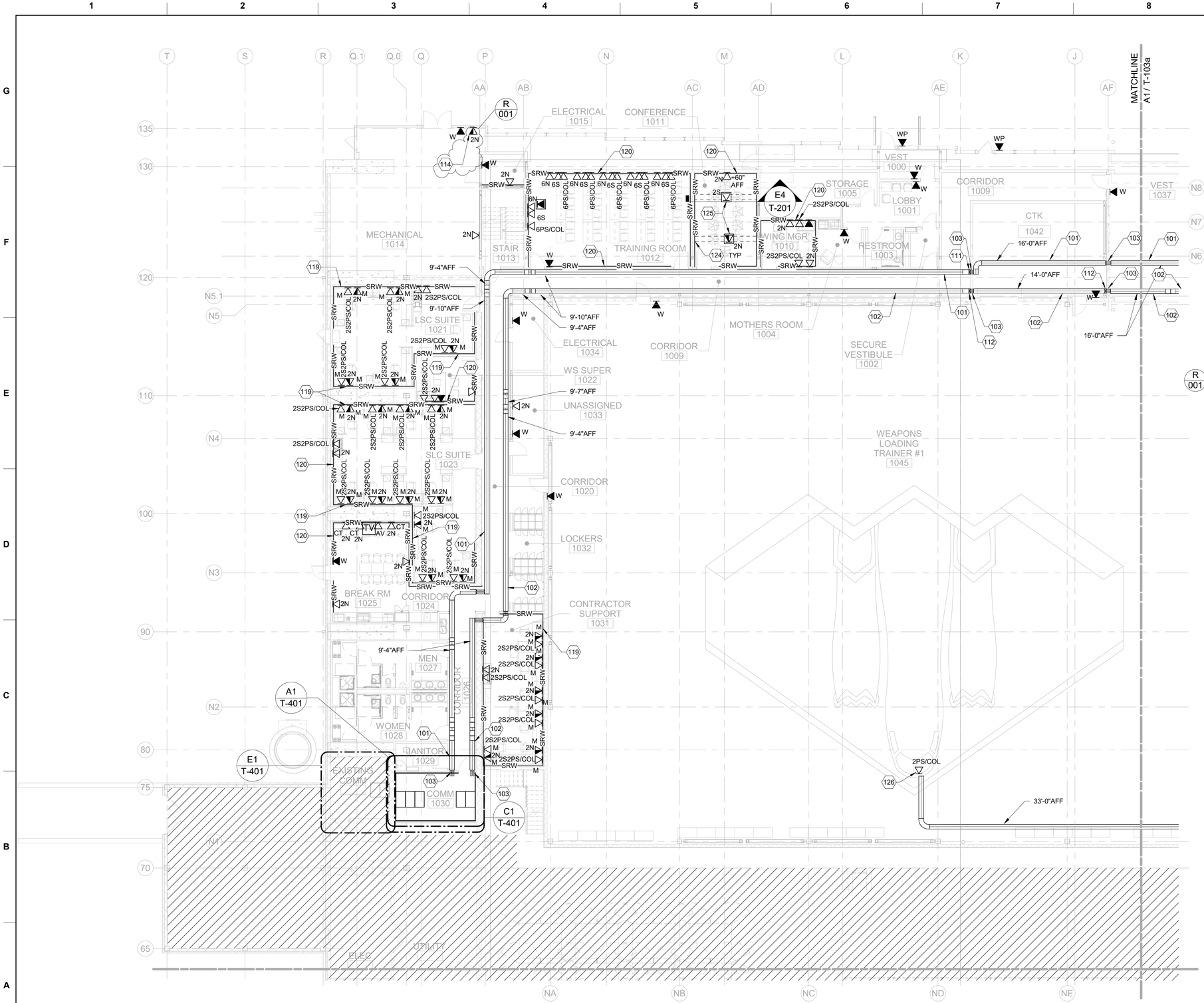


A1 PARTIAL TELECOMMUNICATION PLAN- LEVEL 01 - AREA A

3/32" = 1'-0"

GENERAL SHEET NOTES

1. FOR LEGEND, ABBREVIATIONS AND GENERAL NOTES REFER TO SHEET T-001.
2. REFER TO SHEET T-601 FOR PATHWAY ROUTING DETAILS.

SHEET KEYNOTES

101 PROVIDE 12-INCH WIDE x 4-INCH DEEP UNCLASSIFIED BASKET TRAY.

102 PROVIDE 12-INCH WIDE x 4-INCH DEEP CLASSIFIED BASKET TRAY.

103 PROVIDE (2) 4-INCH SLEEVED CORES AND FIRESTOP UPON COMPLETION OF CONSTRUCTION TO MATCH FIRE RATING.

111 PROVIDE 12-INCH WIDE X 4-INCH DEEP VERTICAL UNCLASSIFIED BASKET TRAY.

112 PROVIDE 12-INCH WIDE X 4-INCH DEEP VERTICAL CLASSIFIED BASKET TRAY.

114 PLACE DEVICE AT THIS LOCATION FOR BAS, MOUNT AT SAME HEIGHT AS PHONE. DEVICE HAS (2) GREEN MMF DUPLEX LC NIPR PORTS AND (1) BLUE CAT 6A PORT. THIS DEVICE WILL PROVIDE A CONNECTION FOR THE BAS VLAN WITH OPTIONS FOR MMF OR COPPER CONNECTIONS, DEPENDING ON CONNECTION REQUIREMENTS.

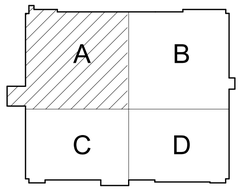
119 PROVIDE SURFACE RACEWAY WITH VENTED SIDEWALLS OF COVER PLATES FOR VIEWING SECURE CABLE ALONG THE ENTIRE RUN, (TRAY TO WORKSTATION) MOUNT 6-INCHES ABOVE THE MODULAR FURNITURE. THE CABLE WILL FEED DOWN INTO THE POWERED FURNITURE WHIP AT THE WALL-BASE. COORDINATE PATHWAY WITH MONITORS AND WHITEBOARD LOCATIONS.

120 PROVIDE SURFACE RACEWAY WITH VENTED SIDEWALLS OF COVER PLATES FOR VIEWING SECURE CABLE ALONG THE ENTIRE RUN, (TRAY TO OUTLETS) 18-INCHES ABOVE FINISHED FLOOR. THE CABLE WILL FEED INTO THE OUTLETS. COORDINATE PATHWAY WITH MONITORS AND WHITEBOARD LOCATIONS.

124 POWER WILL FEED FROM THE TROUGH FROM PLAN WEST; COMMUNICATIONS WILL FEED FROM THE PLANS EAST WALL TO SURFACE RACEWAY. REFER TO DETAIL ON T-503 FOR ADDITIONAL INFORMATION.

125 FLOOR MOUNTED BOXES REFER TO DETAILS ON T-502.

126 TERMINATE AND TEST PROGRAM SECURE COLLATERAL CABLE WITH THE NOSE CONE AREA. ALLOW 15-FEET OF CABLE SLACK AT THIS LOCATION FOR FUTURE MOUNTING TO THE WLT TRAINING MODULE (MOUNTING TO MODULE BY OTHERS).



AREA A
KEY PLAN

GRAPHIC SCALE

0 4' 8' 16' 32'

SCALE: 3/32"=1'-0"

PLAN NORTH

TRUE N

US Army Corps of Engineers
Omaha District ®

MARK	DESCRIPTION	DATE
1	AMENDMENT 0001	18 MAY 2023

DESIGNED BY: R. FAUVELLE
DRAWN BY: C. TINKER
CHECKED BY: M. ADKISON
SUBMITTED BY: B. DITSON
DATE: ISSUE DATE: 28 APRIL 2023
SOLICITATION NO.: W9126F23R0012
CONTRACT NO.:
DRAWING CODE:
FILE NAME: FXBM231802T-102
ANSI D 22x34

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
OMAHA, NEBRASKA

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ELLSWORTH AIR FORCE BASE, SD
DESIGN B-21: WEAPONS LOADER TRAINING FACILITY
PROJECT NUMBER: FXBM231802
PARTIAL TELECOMMUNICATIONS PLAN - LEVEL 01 - AREA A

SHEET ID

T-102

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