**UNIFIED FACILITIES GUIDE SPECIFICATIONS**

**References are in agreement with UMRL dated July 2023**
**********

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**

PART 1 GENERAL

1.1 SUMMARY
1.1.1 Control System Vendor Requirement
1.1.2 Proprietary Systems
1.1.2.1 Proprietary Systems Exempted From Open Protocol Requirements
1.1.2.2 Implementation of Proprietary Systems
1.1.2.3 Proprietary Multi-Split Engineering Tool Software
1.1.3 System Requirements
1.1.4 End to End Accuracy
1.1.5 Verification of Dimensions
1.1.6 Drawings
1.2 RELATED SECTIONS
1.3 REFERENCES
1.4 DEFINITIONS
1.4.1 Alarm Generation (All protocols)
1.4.2 Application Generic Controller (AGC) (LonWorks)
1.4.3 Application Specific Controller (ASC) (LonWorks)
1.4.4 Building Automation and Control Network (BACnet) (BACnet)
1.4.5 BACnet Advanced Application Controller (B-AAC) (BACnet)
1.4.6 BACnet Application Specific Controller (B-ASC) (BACnet)
1.4.7 BACnet Building Controller (B-BC) (BACnet)
1.4.8 BACnet Broadcast Management Device (BBMD) (BACnet)
1.4.9 BACnet/IP (BACnet)
1.4.10 BACnet Internetwork (BACnet)
1.4.11 BACnet Interoperability Building Blocks (BIBBs) (BACnet)
1.4.12 BACnet Network (BACnet)
1.4.13 BACnet Operator Display (B-OD) (BACnet)
1.4.14 BACnet Segment (BACnet)
1.4.15 BACnet Smart Actuator (B-SA) (BACnet)
1.4.16 BACnet Smart Sensor (B-SS) (BACnet)
1.4.17 BACnet Testing Laboratories (BTL) (BACnet)
1.4.18 BACnet Testing Laboratories (BTL) Listed (BACnet)

1.4.19 Binary (All protocols)
1.4.20 Binding (LonWorks)
1.4.21 Broadcast (BACnet)
1.4.22 Building Control Network (BCN) (All protocols)
1.4.23 Building Point of Connection (BPOC) (All protocols)
1.4.24 Channel (LonWorks)
1.4.25 Commandable (All protocols)
1.4.26 Commandable Objects (BACnet)
1.4.27 Configurable (All protocols)
1.4.28 Configuration Property (LonWorks)
1.4.29 Control Logic Diagram (All protocols)
1.4.30 Device (BACnet)
1.4.31 Device Object (BACnet)
1.4.32 Device Profile (BACnet)
1.4.33 Digital Controller (All protocols)
1.4.34 Direct Digital Control (DDC) (All protocols)
1.4.35 Domain (LonWorks)
1.4.36 Explicit Messaging (LonWorks)
1.4.37 External Interface File (XIF) (LonWorks)
1.4.38 Field Point of Connection (FPOC) (All protocols)
1.4.39 Fox Protocol (Niagara Framework)
1.4.40 Functional Profile (LonWorks)
1.4.41 Gateway (All protocols)
1.4.42 General Purpose Programmable Controller (GPPC) (LonWorks)
1.4.43 IEEE 802.3 Ethernet (All protocols)
1.4.44 Internet Protocol (IP, TCP/IP, UDP/IP) (All protocols)
1.4.45 Input/Output (I/O) (All protocols)
1.4.46 I/O Expansion Unit (All protocols)
1.4.47 IP subnet (All protocols)
1.4.48 JACE (Niagara Framework)
1.4.49 Local-Area Network (LAN) (All protocols)
1.4.50 Local Display Panels (LDPs) (All protocols)
1.4.51 LonMark (LonWorks)
1.4.52 LonMark International (LonWorks)
1.4.53 LonMark Interoperability Association (LonWorks)
1.4.54 LonMark Object (LonWorks)
1.4.55 LonWorks (LonWorks)
1.4.56 LonWorks Network Services (LNS) (LonWorks)
1.4.57 LonWorks Network Services (LNS) Plug-in (LonWorks)
1.4.58 MAC Address (All protocols)
1.4.59 Master-Slave/Token-Passing (MS/TP) (BACnet)
1.4.60 Monitoring and Control (M&C) Software (All protocols)
1.4.61 Network Number (BACnet)
1.4.62 Network Variable (LonWorks)
1.4.63 Network Configuration Tool (LonWorks)
1.4.64 Niagara Framework (Niagara Framework)
1.4.65 Niagara Framework Supervisory Gateway (Niagara Framework)
1.4.66 Node (LonWorks)
1.4.67 Node Address (LonWorks)
1.4.68 Node ID (LonWorks)
1.4.69 Object (BACnet)
1.4.70 Object Identifier (BACnet)
1.4.71 Object Instance (BACnet)
1.4.72 Object Properties (BACnet)
1.4.73 Operator Configurable (All protocols)
1.4.74 Override (All protocols)
1.4.75 Packaged Equipment (All protocols)
1.4.76 Packaged Unit (All protocols)
1.4.77 Performance Verification Test (PVT) (All protocols)

1.4.78 Physical Segment (BACnet)
1.4.79 Polling (All protocols)
1.4.80 Points (All protocols)
1.4.81 Program ID (LonWorks)
1.4.82 Proportional, Integral, and Derivative (PID) Control Loop (All protocols)
1.4.83 Proprietary (BACnet)
1.4.84 Protocol Implementation Conformance Statement (PICS) (BACnet)
1.4.85 Repeater (All protocols)
1.4.86 Router (All protocols)
1.4.87 Segment (All protocols)
1.4.88 Service Pin (LonWorks)
1.4.89 Standard BACnet Objects (BACnet)
1.4.90 Standard BACnet Properties (BACnet)
1.4.91 Standard BACnet Services (BACnet)
1.4.92 Standard Configuration Property Type (SCPT) (LonWorks)
1.4.93 Standard Network Variable Type (SNVT) (LonWorks)
1.4.94 Subnet (LonWorks)
1.4.95 TP/FT-10 (LonWorks)
1.4.96 TP/XF-1250 (LonWorks)
1.4.97 User-defined Configuration Property Type (UCPT) (LonWorks)
1.4.98 User-defined Network Variable Type (UNVT) (LonWorks)
1.4.99 UMCS (All protocols)
1.4.100 UMCS Network (All protocols)
1.4.101 Writable Property (BACnet)
1.5 PROJECT SEQUENCING
1.6 SUBMITTALS
1.7 DATA PACKAGE AND SUBMITTAL REQUIREMENTS
1.8 SOFTWARE FOR DDC HARDWARE AND GATEWAYS
1.8.1 Programming Software
1.8.2 Controller Application Programs
1.8.3 Configuration Software
1.8.4 Controller Configuration Settings
1.8.5 Programming Software
1.8.6 Controller Application Programs
1.8.7 LNS Plug-Ins (for LNS-based LonWorks systems)
1.8.8 Niagara Framework Wizards (for Niagara LonWorks systems)
1.8.9 Niagara Framework Supervisory Gateway Backups
1.8.10 Niagara Framework Engineering Tool(for all Niagara Framework system)
1.9 BOILER OR CHILLER PLANT GATEWAY REQUEST
1.10 QUALITY CONTROL CHECKLISTS
1.10.1 Pre-Construction Quality Control (QC) Checklist
1.10.2 Post-Construction Quality Control (QC) Checklist
1.10.3 Closeout Quality Control (QC) Checklist

PART 2 PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENTS
2.2 PRODUCT DATA
2.2.1 XIF Files
2.3 OPERATION ENVIRONMENT
2.4 WIRELESS CAPABILITY
2.5 ENCLOSURES
2.5.1 Outdoors
2.5.2 Mechanical and Electrical Rooms
2.5.3 Other Locations
2.6 WIRE AND CABLE
2.6.1 Terminal Blocks

2.6.2 Control Wiring for Binary Signals
2.6.3 Control Wiring for Analog Signals
2.6.4 Power Wiring for Control Devices
2.6.5 Transformers

PART 3 EXECUTION

3.1 EXISTING CONDITIONS
3.1.1 Existing Conditions Survey
3.1.2 Existing Equipment Downtime
3.1.3 Existing Control System Devices
3.2 INSTALLATION
3.2.1 Dielectric Isolation
3.2.2 Penetrations in Building Exterior
3.2.3 Device Mounting Criteria
3.2.4 Labels and Tags
3.2.5 Surge Protection
3.2.5.1 Power-Line Surge Protection
3.2.5.2 Surge Protection for Transmitter and Control Wiring
3.2.6 Basic Cybersecurity Requirements
3.2.6.1 Passwords
3.2.6.2 Wireless Capability
3.2.6.3 IP Network Physical Security
3.3 DRAWINGS AND CALCULATIONS
3.3.1 Sample Drawings
3.3.2 Drawing Index and Legend
3.3.3 Thermostat and Occupancy Sensor Schedule
3.3.4 Valve Schedule
3.3.5 Damper Schedule
3.3.6 Project Summary Equipment Schedule
3.3.7 Equipment Schedule
3.3.8 Occupancy Schedule
3.3.9 DDC Hardware Schedule
3.3.9.1 DDC Hardware Identifier
3.3.9.2 HVAC System
3.3.9.3 LonWorks Device Information
3.3.9.3.1 Network Address
3.3.9.3.2 Unique Node ID
3.3.9.4 BACnet Device Information
3.3.9.4.1 Device Object Identifier
3.3.9.4.2 Network Number
3.3.9.4.3 MAC Address
3.3.9.4.4 BTL Listing
3.3.9.4.5 Proprietary Services Information
3.3.9.4.6 Alarming Information
3.3.9.4.7 Scheduling Information
3.3.9.4.8 Trending Information
3.3.9.5 Niagara Station ID
3.3.10 Points Schedule
3.3.10.1 Point Name
3.3.10.2 Description
3.3.10.3 DDC Hardware Identifier
3.3.10.4 Settings
3.3.10.5 Range
3.3.10.6 Input or Output (I/O) Type
3.3.10.7 Object and Property Information
3.3.10.8 Primary Point Information: SNVT Name
3.3.10.9 Primary Point Information: SNVT Type
3.3.10.10 Niagara Station ID

3.3.10.11 Network Data Exchange Information (Gets Data From, Sends Data To)
3.3.10.12 Override Information (Object Type and Instance Number)
3.3.10.13 Override Information (SNVT Name and Type)
3.3.10.14 Trend Object Information
3.3.10.15 Alarm Information
3.3.10.16 Configuration Information
3.3.11 Riser Diagram
3.3.12 Control System Schematics
3.3.13 Sequences of Operation[ Including Control Logic Diagrams]
3.3.14 Controller, Motor Starter and Relay Wiring Diagram
3.4 CONTROLLER TUNING
3.5 START-UP
3.5.1 Start-Up Test
3.5.1.1 Systems Check
3.5.1.1.1 Step 1 - System Inspection
3.5.1.1.2 Step 2 - Calibration Accuracy Check
3.5.1.1.3 Step 3 - Actuator Range Check
3.5.1.2 Weather Dependent Test
3.5.2 Start-Up Testing Report
3.5.3 Draft LNS Database
3.6 PERFORMANCE VERIFICATION TEST (PVT)
3.6.1 PVT Procedures
3.6.1.1 Sensor Accuracy Checks
3.6.1.2 Temporary Trending Hardware
3.6.1.3 Endurance Test
3.6.1.4 PVT Equipment List
3.6.2 PVT Execution
3.6.3 PVT Report
3.6.4 Final LNS Database
3.7 PERFORMANCE VERIFICATION TESTING
3.7.1 General
3.7.2 Performance Verification Testing and Commissioning
3.7.3 Performance Verification Testing of Equipment with Packaged Controls
3.7.3.1 Controls Contractor Responsibilities
3.7.3.2 Equipment Supplier Responsibilities
3.7.4 Sequencing of Performance Verification Testing Activities
3.7.4.1 PVT Testing for Multi-Phase Construction
3.7.5 Control Contractor's Performance Verification Testing Plan
3.7.6 Performance Verification Testing Sample Size
3.7.6.1 Selection of Systems to Test
3.7.7 Conducting Performance Verification Testing
3.7.8 Endurance Testing
3.7.8.1 General
3.7.8.2 Hardware
3.7.8.3 Endurance Testing Results Format
3.7.8.4 Endurance Testing Start, Duration, and Frequency
3.7.8.4.1 Points Trended at One Minute Intervals
3.7.8.4.2 Points Trended at 15 Minute Intervals
3.7.8.5 Trended Control Points
3.7.8.5.1 Air-Cooled Chiller Chilled Water System.
3.7.8.5.2 HVAC Heating Hot Water System with Boiler.
3.7.8.5.3 HVAC Heating Hot Water System with Steam-to-Hot Water Heat Exchanger.
3.7.8.5.4 Air Handling Unit with Relief Air Fan
3.7.8.5.5 Dedicated Outside Air System (DOAS)
3.7.8.5.6 Series Fan-Powered Supply Air Terminal Units
3.7.8.6 Endurance Testing Sample Size

3.7.8.6.1 Selection of Systems to Test
3.7.9 Performance Verification Test Report
3.8 FINAL LNS DATABASE
3.9 OPERATION AND MAINTENANCE (O&M) INSTRUCTIONS
3.10 MAINTENANCE AND SERVICE
3.10.1 Description of Work
3.10.2 Personnel
3.10.3 Scheduled Inspections
3.10.4 Scheduled Work
3.10.5 Emergency Service
3.10.6 Operation
3.10.7 Records and Logs
3.10.8 Work Requests
3.10.9 System Modifications
3.11 TRAINING
3.11.1 Training Documentation
3.11.2 Training Course Content
3.11.3 Training Documentation Submittal Requirements

ATTACHMENTS:

QC Checklist for LNS-Based LonWorks Systems

QC Checklist for Niagara Framework Based LonWorks Systems

QC Checklist for BACnet Systems

QC Checklist for Niagara Framework Based BACnet Systems

QC CHECKLIST FOR LNS-BASED LONWORKS SYSTEMS

QC CHECKLIST FOR NIAGARA FRAMEWORK BASED LONWORKS SYSTEMS

QC CHECKLIST FOR BACNET SYSTEMS

QC CHECKLIST FOR NIAGARA FRAMEWORK BASED BACNET SYSTEMS

-- End of Section Table of Contents --

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|---|---|
| **USACE / NAVFAC / AFCEC / NASA** | **UFGS-23 09 00 (February 2019)** |
| | **Change 3 - 05/21** |
| | **----------** |
| **Preparing Activity: USACE** | **Superseding** |
| | **UFGS-23 09 00 (November 2015)** |

**UNIFIED FACILITIES GUIDE SPECIFICATIONS**

**References are in agreement with UMRL dated July 2023**

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SECTION 23 09 00

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

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**NOTE: This guide specification covers the requirements for HVAC control systems, including tailoring options for LNS-Based LonWorks, Niagara Framework-Based LonWorks, BACnet and Niagara Framework-Based BACnet systems.**

**Adhere to** UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

**Comments, suggestions and recommended changes for this guide specification are welcome and should be as a** Criteria Change Request (CCR)**. CCRs for this specification can be submitted through the Whole Building Design Guide page for this section:** http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufg

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**NOTE: The use of this UFGS, and the design of control systems, must be in accordance with UFC 3-410-02, DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. This specification MUST be used in conjunction with UFGS 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS or UFGS 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS as well as UFGS 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC and UFGS 23 09 93 SEQUENCES OF OPERATION FOR HVAC CONTROL in order to specify a complete and functional system.**

Except as otherwise indicated, edit this guide specification for project specific requirements ONLY by selecting appropriate tailoring options, choosing applicable items(s), or inserting appropriate information in bracketed items. Do not make edits outside of bracketed items except as noted without prior approval as indicated in UFC 3-410-02 DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING SYSTEMS.

When used with UFGS 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS, this specification covers installation of local (building-level) controls using LonWorks-based DDC using either LNS or the Niagara Framework.

When used with UFGS 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS, this specification covers installation of local (building-level) controls using BACnet-based DDC, and may include the Niagara Framework.

This specification is primarily intended for building level control systems which are to be integrated into a Utility Monitoring and Control System (UMCS) as specified in Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION (where Section 25 10 10 has also used the matching protocol tailoring option).

For projects that require the building system to provide UMCS functionality (without connection to a UMCS), include the necessary requirements from Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION in the project specifications.

Template drawings in electronic format for use with this section are available online at the Whole Building Design Guide page for this section: http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufg

**********

**********

NOTE: This specification makes use of SpecsIntact Tailoring Options. This note describes these options and how to use them.

"TAILORING OPTION NOTES" Tailoring Option
Each time tailoring options are used there is an accompanying designer note describing the text that is tailored. As this Section makes heavy use of tailoring options there are many of these notes and they can distract from designer notes describing other decisions. The designer notes describing tailoring options are all in a "TAILORING OPTION NOTES" tailoring option which can be hidden (in SpecsIntact select View-Tailoring Options and then deselect "TAILORING OPTION NOTES") once this section is tailored and the tailoring option notes are no

longer needed.

Protocol Tailoring Options
This specification includes tailoring options for selection of protocol, and whether the Niagara Framework is required. There are four tailoring options, of which EXACTLY ONE must be used (the remaining three must be DESELECTED when managing tailoring options):

1) BACNET: A (non-Niagara Framework) BACnet system: When this tailoring option is included this Section will reference Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Use UFGS 23 09 23.02 with the "NOT Niagara Framework" tailoring option selected (DESELECT the "Niagara Framework" tailoring option in UFGS 23 09 23.02).

2) LNS: A LonWorks system using LNS. When this tailoring option is included this Section will reference Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Use UFGS 23 09 23.01 with the "LNS" tailoring option selected (and DESELECT the "Niagara Framework" tailoring option in UFGS 23 09 23.01).

3) NIAGARA BACNET: A Niagara Framework system using BACnet controllers. When this tailoring option is included this Section will reference Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Use UFGS 23 09 23.02 with the "Niagara Framework" tailoring option selected (DESELECT the "NOT Niagara Framework" tailoring option in UFGS 23 09 23.02).

4) NIAGARA LONWORKS: A Niagara Framework system using LonWorks controllers. When this tailoring option is included this Section will reference Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Use UFGS 23 09 23.01 with the "Niagara Framework" tailoring option selected (DESELECT the "LNS" tailoring option in UFGS 23 09 23.01).

You have currently included the following options:
---
NIAGARA BACNET
NIAGARA LONWORKS
BACNET
LNS
---

**If you don't see any text between dashes above, you have DESELECTED all protocol tailoring option and this specification is not valid. SELECT ONE of the tailoring options.**

**If you see more than one line of text between the dashes above you have left multiple tailoring options related to protocol selected. DESELECT one or more tailoring options until a SINGLE protocol tailoring option is selected.**

**Service Tailoring Option**
**This specification also includes tailoring options for the Service (Air Force, Army, Navy) the specification is used for. There is a "Service Generic" tailoring option that can also be used when none of the other services tailoring options apply. Only ONE of the five tailoring options related to the services should be used. You have currently included the following options:**
**----------**
**AIR FORCE**
**ARMY**
**NAVY**
**SERVICE GENERIC**
**----------**
**If more than one item appears between the dashes above you have included more than one services tailoring option and need to DESELECT all but one of them. If there is no text between the dashes above you have not included any services tailoring options. Select ONE of the services tailoring options for inclusion.**
**********

PART 1 GENERAL

1.1 SUMMARY

**********
**NOTE: If sequences of operation are provided in Section 23 09 93 SEQUENCES OF OPERATION FOR HVAC CONTROL, keep the bracketed text referring to that section. If Section 23 09 93 is not provided remove the bracketed text.**
**********

**********
**NOTE: This subpart uses tailoring options:**

**1) Text referring to UFGS 23 09 23.01 will be included if the LNS or NIAGARA LONWORKS tailoring options are selected.**

**2) Text referring to UFGS 23 09 23.02 will be included if the BACNET or NIAGARA BACNET tailoring options are selected.**
**********

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 indicated and shown and in accordance with Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC,[ Section 23 09 93 SEQUENCES OF OPERATION FOR HVAC CONTROL,] Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for LNS LonWorks systems or Niagara LonWorks systems, 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 Control System Vendor Requirement

**********
**NOTE: This subpart is within tailoring options and is included ONLY when the NAVY tailoring optionis selected**
**********

**********
**NOTE: Keep this bracketed subpart ONLY for Navy projects where the installation has obtained a J&A to downselect a particular vendor.**

**When keeping this subpart text:**

**1) fill in the control system manufacturer and product line information. For example: "ControlCo, BestSystem version 5".**

**2) Include the configuration setting requirements so the equipment can be programmed in accordance with the existing Risk Management Framework Authority to Operate. Obtain the equipment configuration settings from Public Works, the system owner, or local CIO office. Include these requirements as an attachment to this specification, as part of the contract drawings, or in some other manner and select the appropriate bracketed text indicating where the settings are provided.**
**********

The control system provided under this Section must be [_____]. Configure the equipment as indicated in [attached configuration setting requirements][the configuration settings drawings][_____].

]1.1.2 Proprietary Systems

1.1.2.1 Proprietary Systems Exempted From Open Protocol Requirements

**********
**NOTE: UFC 3-410-02 defines specific circumstances in which a specific HVAC system can be excepted from the open protocol requirements and a proprietary**

**network may be used instead.**

**When including/allowing proprietary networks in a design per UFC 3-410-02, the systems specifically permitted to use proprietary networks must be indicated in Table 1 below.**

**Review UFC 3-410-02 for the requirements related to this exception before permitting proprietary networks to ensure the exception is permitted, approved, and properly documented.**
**********

The following systems are specifically exempted from the open protocol requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS:

a. A simple split (DX) system consisting of a single indoor unit and a single outdoor unit from the same manufacturer.

b. Systems in Table I (previously approved by the designer in accordance with UFC 3-410-02).

| TABLE I: Systems Approved to Use Proprietary Communications | | |
|---|---|---|
| System | Type (Multi-Split/VRF or Chiller/Boiler Plant) | Proprietary Multi-Split Engineering Tool Software Required (for Multi-Split/VRF only) |
| | | |
| | | |

c. A system (not already shown Table I) of multiple boilers or multiple chillers communicating with a proprietary network for which an approved request has been obtained and for which: all units are from the same manufacturer, they are all co-located in the same room, the network connecting them is fully contained in that room, and the units are operating using a common "plant" sequence of operation which stages the units in a manner that requires operational parameters be shared between them and which cannot be accomplished with a single lead-lag command from a third-party controller.

1.1.2.2 Implementation of Proprietary Systems

For proprietary systems exempted from open protocol requirements, a proprietary network and DDC hardware communicating via proprietary protocol are permitted. For these systems a building control network meeting the requirements of Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS must also be provided, along with a gateway or interface to connect the proprietary system to the open building control network.

The proprietary system gateway or interface must provide the required functionaliality as shown on the points schedule. Scheduling, alarming, trending, overrides, network inputs, network outputs and other protocol

related requirements must be met on the open protocol control system as specified in Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

1.1.2.3 Proprietary Multi-Split Engineering Tool Software

**********
**NOTE: Indicate in Table I for each permitted system whether the engineering tool software is required. Coordinate with the project site to determine if this software is needed.**
**********

For each permitted proprietary systems in Table 1 shown as requiring Proprietary Multi-Split Engineering Tool Software, provide the software needed to replace a unit and configure the replacement. Submit hard copies of the software user manuals with the software submittal.

Submit Proprietary Multi-Split Engineering Tool Software on CD-ROM as a Technical Data Package. Submit [_____] hard copies of the software user manual for each piece of software.

1.1.3 System Requirements

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

**********
**NOTE: Select where sequences of operation are specified. UFGS 23 09 93 SEQUENCES OF OPERATION FOR HVAC CONTROL contains template sequences of operation.**
**********

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.

**********
**NOTE: The requirement ", unless otherwise pre-approved by the Contracting Officer" in the following paragraph is required only for Air Force projects and is in AIR FORCE tailoring tags. (Deselect the AIR FORCE tailoring option if not specifying an Air Force owned 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.

**********
**NOTE: The following list paragraph is included only when the NIAGARA BACNET or NIAGARA LONWORKS tailoring options are selected.**
**********

h. All Niagara Framework components have an unrestricted interoperability license with a Niagara Compatibility Statement (NiCS) following the Tridium Open NiCS Specification and have a value of "ALL" for "Station Compatibility In", "Station Compatibility Out", "Tool Compatibility In" and "Tool Compatibility Out". Note that this will result in the following entries in the license file:

```
accept.station.in="*"
accept.station.out="*"
accept.wb.in="*"
accept.wb.out="*"
```

### 1.1.4 End to End Accuracy

**********
**NOTE: This paragraph is referenced (by subpart title) elsewhere in the specification. If this paragraph is edited, removed, renamed, etc. make sure to verify that all references to it are updated as needed.**
**********

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.

### 1.1.5 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.

1.1.6 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

**********
**NOTE: Select whether Section 01 91 00.15 or , BUILDING COMMISSIONING, is used for commissioning or provide appropriate reference to the Commissioning specification.**
**********

**********
**NOTE: This subpart used tailoring options:**
**1) Text referring to UFGS 23 09 23.01 is included only when the LNS or NIAGARA LONWORKS tailoring option is selected.**

**2) Text referring to UFGS 23 09 23.02 is included only when the BACNET or NIAGARA BACNET tailoring option is selected.**
**********

Related work specified elsewhere:

a. Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for LonWorks Systems using LNS or Niagara Framework or 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

c. Section 23 09 93 SEQUENCES OF OPERATIONS FOR HVAC CONTROLS

d. Section 25 08 10 UTILITY MONITORING AND CONTROL SYSTEMS TESTING

e. Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEMS (UMCS) FRONT END AND INTEGRATION

f. Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS

g. [Section 01 91 00.15 BUILDING COMMISSIONING][_____]

1.3 REFERENCES

**********
**NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date,**

**and title.**

**Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.**

**References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.**

**********

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; Interpretation 1-8 2021; Errata 1-2 2021; Addenda CD 2021; Addenda BV-CE 2022; Interpretation 9-12 2022; Interpretation 13-17 2023; Addenda BV-CF 2023; Errata 3 2023) BACnet—A Data Communication Protocol for Building Automation and Control Networks |
| ASHRAE FUN IP | (2021) Fundamentals Handbook, I-P Edition |
| ASHRAE FUN SI | (2021) Fundamentals Handbook, SI Edition |

CONSUMER ELECTRONICS ASSOCIATION (CEA)

| | |
|---|---|
| CEA-709.1-D | (2014) Control Network Protocol Specification |
| CEA-709.3 | (1999; R 2015) Free-Topology Twisted-Pair Channel Specification |

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 | (2023) National Electrical Code |
| NFPA 90A | (2024) Standard for the Installation of Air Conditioning and Ventilating Systems |

TRIDIUM, INC (TRIDIUM)

| | |
|---|---|
| Niagara Framework | (2012) NiagaraAX User's Guide |
| Tridium Open NiCS | (2005) Understanding the NiagaraAX Compatibility Statement (NiCS) |

U.S. DEPARTMENT OF DEFENSE (DOD)

| | |
|---|---|
| UFC 3-410-02 | (2018; with Change 2, 2021) Direct Digital Control for HVAC and Other Building Control 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

**********
**NOTE: Other sections (UFGS 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS, UFGS 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS, UFGS 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC, UFGS 23 09 93 SEQUENCES OF OPERATION FOR HVAC CONTROL) reference this section for relevant 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.

**********
**NOTE: The following subparts use tailoring options to include or exclude terms based on the which tailoring options are selected. Each individual term does not have a designer note associated with it as this makes the list of definitions very difficult to read. The parenthesis after the subpart title will also indicate when the term is in tailoring option tags:**

**1) Subparts including "(LonWorks)" in the title are included when the LNS or NIAGARA LONWORKS tailoring options are selected.**

**2) Subparts including "(BACnet)" in the title are included when the BACNET or NIAGARA BACNET tailoring**

**options are selected.**

**3) Subparts including "(Niagara Framework)" in the title are included when the NIAGARA BACNET or NIAGARA LONWORKS tailoring options are selected.**

**4) Subparts including "(All protocols)" are not in any tailoring options and are always included.**

**********

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. Note that this does NOT include delivery of the alarm to the final destination (such as a user interface) - see paragraph ALARM ROUTING in Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION.

1.4.2 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).

1.4.3 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.

1.4.4 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.

1.4.5 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.

1.4.6 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.

1.4.7 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.

### 1.4.8 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.

### 1.4.9 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.

### 1.4.10 BACnet Internetwork (BACnet)

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

### 1.4.11 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) |
| 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) |

| The following is a list of some BIBBs used by this or referenced Sections: | |
|---|---|
| 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) |

1.4.12 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.

1.4.13 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.

1.4.14 BACnet Segment (BACnet)

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

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

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

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

A simple sensing device with limited resources.

1.4.17 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.

1.4.18 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".

1.4.19 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'.

1.4.20 Binding (LonWorks)

The act of establishing communications between CEA-709.1-D devices by associating the output of a device to the input of another so that information is automatically (and regularly) sent.

1.4.21 Broadcast (BACnet)

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

1.4.22 Building Control Network (BCN) (All protocols)

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

1.4.23 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.)

1.4.24 Channel (LonWorks)

A portion of the control network consisting of one or more segments connected by repeaters. Channels are separated by routers. The device quantity limitation is dependent on the topology/media and device type. For example, a TP/FT-10 network with locally powered devices is limited to 128 devices per channel.

1.4.25 Commandable (All protocols)

See Overridable.

1.4.26 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.

1.4.27 Configurable (All protocols)

**********
**NOTE: This subpart uses tailoring options:**

**1) Text referring to "Non-Niagara Framework BACnet system" is included only when the NIAGARA BACNET tailoring options is selected.**

**2) Text referring to "Niagara Framework BACnet system" is included only when the BACNET tailoring options is selected.**
**********

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 non-Niagara Framework 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

In a Niagara Framework 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
3) via the Niagara Framework

Note this is more stringent than the ASHRAE 135 definition.

1.4.28 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 paragraph STANDARD CONFIGURATION PROPERTY TYPE (SCPT).

1.4.29 Control Logic Diagram (All protocols)

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

1.4.30 Device (BACnet)

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

1.4.31 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.

1.4.32 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).

1.4.33 Digital Controller (All protocols)

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

1.4.34 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.

1.4.35 Domain (LonWorks)

A grouping of up to 32,385 nodes that can communicate directly with each other. (Devices in different domains cannot communicate directly with each other.) See also Node Address.

1.4.36 Explicit Messaging (LonWorks)

A non-standard and often vendor (application) specific method of communication between devices where each message contains a message code that identifies the type of message and the devices use these codes to determine the action to take when the message is received.

1.4.37 External Interface File (XIF) (LonWorks)

A file which documents a device's external interface, specifically the number and types of LonMark objects, the number, types, directions, and connection attributes of network variables, and the number of message tags.

1.4.38 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.

1.4.39 Fox Protocol (Niagara Framework)

The protocol used for communication between components in the Niagara Framework. By default, Fox uses TCP port 1911.

1.4.40 Functional Profile (LonWorks)

A standard description, defined by LonMark, of one or more LonMark

Objects used to classify and certify devices.

1.4.41 Gateway (All protocols)

**********
**NOTE: This subpart uses tailoring options: Text referring to Niagara Framework is included only when the NIAGARA LONWORKS or NIAGARA BACNET tailoring options are selected.**
**********

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.

A Niagara Framework Supervisory Gateway is one type of Gateway.

1.4.42 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.

1.4.43 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.

1.4.44 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.

1.4.45 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".

1.4.46 I/O Expansion Unit (All protocols)

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

1.4.47 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.

1.4.48 JACE (Niagara Framework)

Java Application Control Engine. See paragraph NIAGARA FRAMEWORK SUPERVISORY GATEWAY

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

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

1.4.50 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.

1.4.51 LonMark (LonWorks)

See paragraph LONMARK INTERNATIONAL. Also, a certification issued by LonMark International to CEA-709.1-D devices.

1.4.52 LonMark International (LonWorks)

Standards committee consisting of numerous independent product developers, system integrators and end users dedicated to determining and maintaining the interoperability guidelines for LonWorks. Maintains guidelines for the interoperability of CEA-709.1-D devices and issues the LonMark Certification for CEA-709.1-D devices.

1.4.53 LonMark Interoperability Association (LonWorks)

See paragraph LONMARK INTERNATIONAL.

1.4.54 LonMark Object (LonWorks)

A collection of network variables, configuration properties, and associated behavior defined by LonMark International and described by a Functional Profile. It defines how information is exchanged between devices on a network (inputs from and outputs to the network).

1.4.55 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.

1.4.56 LonWorks Network Services (LNS) (LonWorks)

A network management and database standard for CEA-709.1-D devices.

1.4.57 LonWorks Network Services (LNS) Plug-in (LonWorks)

Software which runs in an LNS compatible software tool, typically a network configuration tool. Device configuration plug-ins provide a user friendly method to edit a device's configuration properties.

1.4.58 MAC Address (All protocols)

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

1.4.59 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.

1.4.60 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.

1.4.61 Network Number (BACnet)

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

1.4.62 Network Variable (LonWorks)

See paragraph STANDARD NETWORK VARIABLE TYPE (SNVT).

1.4.63 Network Configuration Tool (LonWorks)

**********

**NOTE: This subpart uses tailoring options: The parenthetical referring to LNS is included only when the LNS tailoring option is selected.**

**********

The software used to configure the control network and set device configuration properties. This software creates and modifies the control network database (LNS Database).

1.4.64 Niagara Framework (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.

1.4.65 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-based user interface.

Note that different vendors refer to this component by different names.

The most common name is "JACE"; other names include (but are not limited to)"EC-BOS", "FX-40", "TMN", "SLX" and "UNC".

1.4.66 Node (LonWorks)

A device that communicates using the CEA-709.1-D protocol and is connected to a CEA-709.1-D network.

1.4.67 Node Address (LonWorks)

The logical address of a node on the network, consisting of a Domain number, Subnet number and Node number. Note that the "Node number" portion of the address is the number assigned to the device during installation and is unique within a subnet. This is not the factory-set unique Node ID (see Node ID).

1.4.68 Node ID (LonWorks)

A unique 48-bit identifier assigned (at the factory) to each CEA-709.1-D device. Sometimes called the Neuron ID.

1.4.69 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.

1.4.70 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.

1.4.71 Object Instance (BACnet)

See paragraph OBJECT IDENTIFIER

1.4.72 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.

1.4.73 Operator Configurable (All protocols)

**********

**NOTE: This subpart uses tailoring options:**

**1) Text referring to Niagara Framework is included only when the NIAGARA LONWORKS or NIAGARA BACNET tailoring options are selected.**

**2) Text referring to LNS is included only when the LNS tailoring option is included.**

**3) Text referring to non Niagara-based BACnet is only included when the BACNET tailoring option is selected.**

**********

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

For Niagara Framework Systems, a property, setting, or value is Operator Configurable when it is configurable from a Niagara Framework Front End.

For LNS LonWorks systems, Operator Configurable is defined the same as Configurable. See paragraph CONFIGURABLE.

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.

1.4.74 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).

1.4.75 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.

1.4.76 Packaged Unit (All protocols)

See packaged equipment.

1.4.77 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.

1.4.78 Physical Segment (BACnet)

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

1.4.79 Polling (All protocols)

A device periodically requesting data from another device.

1.4.80 Points (All protocols)

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

1.4.81 Program ID (LonWorks)

An identifier (number) stored in the device that identifies the node manufacturer, functionality of device (application & sequence), transceiver used, and the intended device usage.

1.4.82 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).

1.4.83 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.

1.4.84 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.

1.4.85 Repeater (All protocols)

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

1.4.86 Router (All protocols)

**********

**NOTE: This subpart uses tailoring options:**

**1) Text referring to LonWorks is included if the LNS or NIAGARA LONWORKS tailoring options are selected.**

**2) Text referring to BACnet is included if the BACNET or NIAGARA BACNET tailoring options are selected.**

**********

A device that connects two CEA-709.1-D channels (in a LonWorks system) or two 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 LonWorks control network or a BACnet internetwork and to limit network traffic.

1.4.87 Segment (All protocols)

**********

**NOTE: This subpart uses tailoring options: The TP/FT-10 example is included only if the LNS or NIAGARA LONWORKS tailoring option is selected.**

**********

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, in a LonWorks system a TP/FT-10 network with locally powered devices is limited to 64 devices per segment.

1.4.88 Service Pin (LonWorks)

A hardware push-button on a device which causes the device to broadcast a message (over the control network) containing its Node ID and Program ID.

1.4.89 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.

1.4.90 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.

1.4.91 Standard BACnet Services (BACnet)

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

1.4.92 Standard Configuration Property Type (SCPT) (LonWorks)

Pronounced skip-it. A standard format type (maintained by LonMark International) for Configuration Properties.

1.4.93 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.

1.4.94 Subnet (LonWorks)

Consists of a logical grouping of up to 127 nodes, where the logical grouping is defined by node addressing. Each subnet is assigned a number which is unique within the Domain. See also paragraph NODE ADDRESS.

1.4.95 TP/FT-10 (LonWorks)

A Free Topology Twisted Pair network defined by CEA-709.3. This is the most common media type for a CEA-709.1-D control network.

1.4.96 TP/XF-1250 (LonWorks)

A high speed (1.25 Mbps) twisted pair, doubly-terminated bus network defined by the LonMark Interoperability Guidelines. This media is typically used only as a backbone media to connect multiple TP/FT-10 networks.

1.4.97 User-defined Configuration Property Type (UCPT) (LonWorks)

Pronounced u-keep-it. A Configuration Property format type that is defined by the device manufacturer.

1.4.98 User-defined Network Variable Type (UNVT) (LonWorks)

A network variable format defined by the device manufacturer. Note that UNVTs create non-standard communications (other vendor's devices may not correctly interpret it) and may close the system and therefore are not permitted by this specification.

1.4.99 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.

1.4.100 UMCS Network (All protocols)

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

1.4.101 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

**********

**NOTE: Table II provides bracketed text in which the number of days between items may be specified. In many cases this information will be specified elsewhere. When project schedule is specified elsewhere remove bracketed text and Table II will provide sequencing but not specific intervals. If time intervals are to be specified here keep the bracketed text and enter the number of days in the space provided.**

**********

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'.

**********

**NOTE: The following table uses tailoring options:**
**1) Items referring to LNS are included only when the LNS tailoring option is selected.**

**2) XIF Files is included only when the LNS or NIAGARA FRAMEWORK tailoring option is selected**

**3) Items referring to Niagara Framework are included only when the NIAGARA LONWORKS or NIAGARA BACNET tailoring option is selected.**

**********

| 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 |
| 6 | E | Start-Up and Start-Up Testing | ACO #5 |
| 7 | S | Post-Construction QC Checklist | [[_____] days ]ACO #6 |
| 8 | S | Programming Software<br>Configuration Software<br><br>Niagara Framework Engineering Tool<br>Niagara Framework Wizards<br><br>XIF Files<br><br>LNS Plug-Ins | [[_____] days ]ACO #6 |
| 9 | S | Draft As-Built Drawings<br>Draft LNS Database | [[_____] days ]ACO #6 |
| 10 | S | Start-Up Testing Report | [[_____] days ]ACO #6 |
| 11 | S | PVT Procedures | [[_____] days ]before schedule start of #12 and AAO #10 |
| 12 | S,E | Execute PVT PVT Testing Activities | AAO #9 and #11As indicated in PART 3 of this Section |
| 13 | S | PVT Report | [[_____] days ]ACO #12 As indicated in PART 3 of this Section |

| TABLE II. PROJECT SEQUENCING | | | |
|---|---|---|---|
| ITEM # | TYPE | DESCRIPTION | SEQUENCING (START OF ACTIVITY OR DEADLINE FOR SUBMITTAL) |
| 14 | S | Controller Application Programs<br>Controller Configuration Settings<br><br>Niagara Framework Supervisory Gateway Backups<br><br>Final LNS Database | [[_____] days ]AAO #13 |
| 15 | S | Final As-Built Drawings | [[_____] days ]AAO #13 |
| 16 | S | O&M Instructions | AAO #15 |
| 17 | S | Training Documentation | AAO #10 and [[_____] days ]before scheduled start of #18 |
| 18 | E | Training | AAO #16 and #17 |
| 19 | S | Closeout QC Checklist | ACO #18 |

## 1.6 SUBMITTALS

**********

**NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.**

**For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.**

**The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.**

**Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.**

**********

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.][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-02 Shop Drawings

DDC Contractor Design Drawings; G[, [_____]]

Draft As-Built Drawings; G[, [_____]]

Final As-Built Drawings; G[, [_____]]

SD-03 Product Data

Programming Software; G[, [_____]]

Controller Application Programs; G[, [_____]]

Configuration Software; G[, [_____]]

**********

**NOTE: Controller Configuration Settings is only required for BACnet and is included only when BACNET or NIAGARA BACNET tailoring options are selected.**

**********

Controller Configuration Settings; G[, [_____]]

Proprietary Multi-Split Engineering Tool Software; G[, [_____]]

Manufacturer's Product Data; G[, [_____]]

**********

**NOTE: XIF files and the three LNS-related submittals are only required for LNS-based LonWorks systems and are included when the LNS tailoring option is selected.**

**********

XIF files; G[, [_____]]

Draft LNS Database; G[, [_____]]

Final LNS Database; G[, [_____]]

LNS Plug-ins; G[, [_____]]

**********

**NOTE: Niagara Framework Supervisory Gateway Backups, Niagara Framework Engineering Tool and Niagara Framework Wizards are only required for Niagara Framework systems and are included when the NIAGARA LONWORKS or NIAGARA BACNET**

**********

Niagara Framework Supervisory Gateway Backups; G[, [_____]]

**********

**NOTE: The Niagara Framework Engineering Tool is specified in Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS and Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS, but is a designer option in these Sections. If the Niagara Framework Engineering Tool is not required for the project, remove the submittal requirements in this Section.**

**********

[ Niagara Framework Engineering Tool; G[, [_____]]]

Niagara Framework Wizards; G[, [_____]]

SD-05 Design Data

Boiler Or Chiller Plant Gateway Request

SD-06 Test Reports

Existing Conditions Report

Pre-Construction Quality Control (QC) Checklist; G[, [_____]]

Post-Construction Quality Control (QC) Checklist; G[, [_____]]

Start-Up Testing Report; G[, [_____]]

**********

**NOTE: The following two submittals do not apply to Navy projects and are includeed only when the ARMY, AIR FORCE or SERVICE GENERIC tailoring option is selected..**

**********

PVT Procedures; G[, [_____]]

PVT Report; G[, [_____]]

**********

**NOTE: The following four submittals apply only to**

**Navy projects and are included only when the NAVY tailoring option is selected.**
**********

Control Contractor's Performance Verification Testing Plan; G

Equipment Supplier's Performance Verification Testing Plan; G

Endurance Testing Results; G

Performance Verification Test Report; G

SD-10 Operation and Maintenance Data

Operation and Maintenance (O&M) Instructions; G[, [_____]]

Training Documentation; G[, [_____]]

SD-11 Closeout Submittals

**********
**NOTE: The Enclosure Keys are needed by the project site DPW.**
**********

Enclosure Keys; G[, [_____]]

**********
**NOTE: The Password Summary Report is needed by the project site DPW.**
**********

Password Summary Report; G[, [_____]]

Closeout Quality Control (QC) Checklist; G[, [_____]]

## 1.7 DATA PACKAGE AND SUBMITTAL REQUIREMENTS

**********
**NOTE: The acquisition of all technical data, data bases and computer software items that are identified herein will be accomplished strictly in accordance with the Federal Acquisition Regulation (FAR) and the Defense Acquisition Regulation Supplement (DFARS). Those regulations as well as the Services implementation thereof should also be consulted to ensure that a delivery of critical items of technical data is not inadvertently lost. Specifically, DFARS 252.227-7013 Rights in Technical Data - Noncommercial Items, as well as any requisite software licensing agreements will be made a part of the CONTRACT CLAUSES or SPECIAL CONTRACT REQUIREMENTS.**

**In addition, the appropriate DD Form 1423 Contract Data Requirements List, will be filled out for each distinct deliverable data item and made a part of the contract. Where necessary, a DD Form 1664, Data Item Description, will be used to explain and more**

**fully identify the data items listed on the DD Form 1423. It is to be noted that all of these clauses and forms are required to ensure the delivery of the data in question and that such data is obtained with the requisite rights to use by the Government.**

**Include with the request for proposals a completed DD Form 1423, Contract Data Requirements List. This form is essential to obtain delivery of all documentation. Each deliverable will be clearly specified with both description and quantity being required.**

**Coordinate the review of all submittals with the project site. The site may have a System Integrator or other individual/office that should review all submittals before acceptance of the system.**

**Most of the submittals included in this Section are critical and require Government review. Any added submittals, normally, should be for information only and reviewed through the Contractor Quality Control system.**

**********

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 Programming Software

**********

**NOTE: This subpart only applies to LonWorks systems and is only included when the LNS or NIAGARA LONWORKS tailoring option is selected.**

**In addition, the sentence referring to Application Generic Controllers and Wizards is included only when the NIAGARA LONWORKS tailoring option is selected.**

**********

For each type of General Purpose Programmable Controller (GPPC), provide the programming software in accordance with Section 23 09 23.01 LONWORKS

DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. For each type of Application Generic Controller (AGC) provided as part of without a configuration and programming Wizard, provide the programming and configuration software in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Submit hard copies of user manuals for each software with the software submittal.

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

### 1.8.2 Controller Application Programs

**********

**NOTE: This subpart only applies to LonWorks systems and is only included with the LNS and NIAGARA LONWORKS tailoring options.**

**In addition, "(LNS plug-in)" is only included when the LNS tailoring options is selected.**

**********

For each General Purpose Programmable Controller (GPPC), provide copies of the application program as source code compatible with the programming software for that GPPC in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. For each Application Generic Controller (AGC), provide copies of the application program as source code compatible with the programming and configuration tool (LNS plug-in) for that AGC in accordance with Section 23 09 23.01 LONWORKS 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.

### 1.8.3 Configuration Software

**********

**NOTE: This subpart only applies to BACnet systems and is only included with the BACNET and NIAGARA BACNET tailoring options.**

**********

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 [_____] hard copies of the software user manual for each piece of software.

### 1.8.4 Controller Configuration Settings

**********

**NOTE: This subpart only applies to BACnet systems and is only included with the BACNET and NIAGARA BACNET tailoring options.**

**********

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.

### 1.8.5 Programming Software

**********

**NOTE: This subpart only applies to BACnet systems and is only included with the BACNET and NIAGARA BACNET tailoring options.**

**********

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 [_____] hard copies of the software user manual for each piece of software.

### 1.8.6 Controller Application Programs

**********

**NOTE: This subpart only applies to BACnet systems and is only included with the BACNET and NIAGARA BACNET tailoring options.**

**********

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.

### 1.8.7 LNS Plug-Ins (for LNS-based LonWorks systems)

**********

**NOTE: This subpart only applies to LNS-based LonWorks systems and and is only included with the LNS tailoring option.**

**********

Provide LNS Plug-ins in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for each Application Specific Controller and each Application Generic Controller. For LNS Plug-ins distributed under a license, license the Plug-In to the project site. Submit hard copy manuals, if available, for each plug-in provided as part of the LNS- Plug-Ins submittal.

Submit LNS Plug-ins 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.

### 1.8.8 Niagara Framework Wizards (for Niagara LonWorks systems)

**********

**NOTE: This subpart only applies to Niagara Framework Based LonWorks systems and is only**

**included with the NIAGARA LONWORKS tailoring option.**
**********

For each Application Generic Controller with a Niagara Framework Wizard and for each Application Specific Controller provide Niagara Framework Wizards in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Submit hard copy manuals, if available, for each Wizard provided as part of the Niagara Framework Wizards submittal.

Submit Niagara Framework Wizards 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 [_____] hard copies of the software user manual, if available, for each Wizard.

1.8.9 Niagara Framework Supervisory Gateway Backups
**********

**NOTE: This subpart only applies to Niagara Framework systems and is only included with the NIAGARA LONWORKS and NIAGARA BACNET tailoring options.**
**********

For each Niagara Framework Supervisory Gateway, provide a backup of all software within the Niagara Framework Supervisory Gateway, including configuration settings. This backup must be sufficient to allow the restoration of the Niagara Framework Supervisory Gateway or the replacement of the Niagara Framework Supervisory Gateway.

Submit backups for each Niagara Framework Supervisory Gateway on CD-ROM as a Technical Data Package. Mark each backup indicating clearly the source Niagara Framework Supervisory Gateway.

[1.8.10 Niagara Framework Engineering Tool(for all Niagara Framework system)
**********

**NOTE: This subpart only applies to Niagara Framework systems and is only included with the NIAGARA LONWORKS and NIAGARA BACNET tailoring options.**

**In addition, this subpart uses tailoring options:**

**1) Text referring to UFGS 23 09 23.01 will be included if the NIAGARA LONWORKS tailoring option is selected.**

**2) Text referring to UFGS 23 09 23.02 will be included if the NIAGARA BACNET tailoring option is selected.**
**********

**********

**NOTE: The Niagara Framework Engineering Tool is specified in Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS and Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS, but is a designer option in these Sections. If the Niagara Framework Engineering Tool is not required for the project, remove the**

**submittal requirements in this Section.**
**********

Provide a Niagara Framework Engineering Tool in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS and Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Submit software user manuals with the Niagara Framework Engineering Tool submittal.

Submit the Niagara Framework Engineering Tool on CD-ROM as a Technical Data Package. Submit [_____] hard copies of the software user manual for the Niagara Framework Engineering Tool.

]1.9 BOILER OR CHILLER PLANT GATEWAY REQUEST

**********
**NOTE: Before approving the use of a gateway to multiple chillers or boilers ensure that the sequence of operation for the units requires information be shared between them and cannot be readily performed by a third-party controller.**
**********

**********
**NOTE: This subpart uses tailoring options:**

**1) Text referring to UFGS 23 09 23.01 and LonWorks will be included if the LNS or NIAGARA LONWORKS tailoring options are selected.**

**2) Text referring to UFGS 23 09 23.02 and BACnet will be included if the BACNET or NIAGARA BACNET tailoring options are selected.**
**********

If requesting the use of a gateway to a boiler or chiller plant as indicated in paragraph Proprietary Systems Exempted From Open Protocol Requirements, submit a Boiler or Chiller Plant Gateway Request describing the configuration of the boilers or chillers including model numbers for equipment and controllers, the sequence of operation for the units, and a justification for the need to operate the units on a shared non-LonWorks non-BACnet network.

1.10 QUALITY CONTROL CHECKLISTS

**********
**NOTE: This subpart uses tailoring options. Each checklist is included only when appropriate tailoring option is selected.**
**********

The QC Checklist for LNS-Based LonWorks 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 LonWorks 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 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.

### 1.10.1 Pre-Construction Quality Control (QC) Checklist

**********
**NOTE: Indicate the required number of Pre-Construction QC Checklists.**
**********

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

### 1.10.2 Post-Construction Quality Control (QC) Checklist

**********
**NOTE: Indicate the required number of Post-Construction QC Checklists.**
**********

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

### 1.10.3 Closeout Quality Control (QC) Checklist

**********
**NOTE: Indicate the required number of Closeout QC Checklists.**
**********

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

## PART 2 PRODUCTS

**********
**NOTE: This subpart uses tailoring options:**

**1) Text referring to UFGS 23 09 23.01 will be included if the LNS or NIAGARA LONWORKS tailoring options are selected.**

**2) Text referring to UFGS 23 09 23.02 will be included if the BACNET or NIAGARA BACNET tailoring options are selected.**
**********

Provide products meeting the requirements of Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC, Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for LNS LonWorks systems or Niagara LonWorks systems, 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

**********

**NOTE: This subpart uses tailoring options:**

**1) Text referring to UFGS 23 09 23.01 will be included if the LNS or NIAGARA LONWORKS tailoring options are selected.**

**2) Text referring to UFGS 23 09 23.02 will be included if the BACNET or NIAGARA BACNET tailoring options are selected.**

**********

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 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS, 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 LonWorks hardware: for each manufacturer, model and version (revision) of DDC Hardware indicate the type or types of DDC Hardware the product is being provided as in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS

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.

2.2.1 XIF Files

**********

**NOTE: This subpart only applies to LonWorks systems and is only included when the LNS or NIAGARA LONWORKS tailoring option is selected.**

**********

Provide External Interface Files (XIF Files) for DDC Hardware in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Submit external interface files (XIF files) as a technical data package for each model of DDC Hardware provided under this specification. Submit XIF files 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:

**********

**NOTE: Designer must decide if suggested outside air temperature range is sufficient, and provide a range if it's not.**

**********

(1) Products installed indoors: Ambient temperatures in the range of 0 to 50 degrees C 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 [-37 to +66 degrees C -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

**********

**NOTE: In outdoor applications specify Type 3 unless hosedown of the enclosure is anticipated, in which case specify Type 4.**

**For retrofit projects in older mechanical rooms or where hosedown of the enclosure is anticipated specify Type 4 enclosures. Type 4 provides a greater degree of protection in dirty and wet environments than does Type 2.**
**********

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][Type 4] requirements.

2.5.2 Mechanical and Electrical Rooms

For enclosures located in mechanical or electrical rooms, provide enclosures meeting NEMA 250 [Type 2][Type 4] 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 (1.02 mm diameter) 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 (1.02 mm diameter) 18 AWG or thicker, copper, single- or multiple-twisted wire meeting the following requirements:

a. minimum 50 mm (2 inch) 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

**********

**NOTE: For renovation or retrofits keep this paragraph dealing with existing conditions. For new constructions existing conditions generally does not apply and this paragraph can be removed.**

**Indicate the required number of copies of the Existing Conditions Report.**

**********

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

**********
**NOTE: This subpart uses tailoring options:**

**1) Text referring to UFGS 23 09 23.01 will be included if the LNS or NIAGARA LONWORKS tailoring options are selected.**

**2) Text referring to UFGS 23 09 23.02 will be included if the BACNET or NIAGARA BACNET tailoring options are selected.**
**********

Fully install and test the control system in accordance Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC, Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for LNS LonWorks systems or Niagara LonWorks systems, 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

**********

**NOTE: Determine if any additional inputs or outputs require surge protection and show the requirement for them on the drawings.**

**********

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

**********

**NOTE: Provide a POC for password coordination. This will generally be a supervisor or other senior member of the project site maintenance organization.**

**This report is required to be delivered as hardcopy in a sealed envelope to keep passwords more confidential.**

**********

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 [_____]. 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

**********

**NOTE: Most contractor drawings are updated Contract Drawings. Therefore, it is important that the contract drawing package is complete.**

**Drawing package content is discussed in UFC 3-410-02 and UFC 3-410-07. Template drawings are available online at Whole Building Design Guide page for this section:** http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufg

**Many requirements in this specification refer to the Points Schedules so it is critical that complete Points Schedules are part of the Contract Drawings.**

**A Riser Diagram is not a required part of the Contract Drawings but you may wish to include a Riser Diagram in the contract drawings to show project specific requirements such as DDC Hardware locations etc.**

**Select a drawing size, (approx 279x432 mm 11x17 inch or 557x860 mm 22x34 inch) or to leave to leave it up to the Contractor.**

**Select an electronic submittal format in coordination with the project site. Be sure to require drawings in a format that is usable by the site maintenance staff. This may require including multiple format requirements here.**

**********

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 841 by 594 mm 34 by 22 inches][or][A3 420 by 297 mm 17 by 11 inches] sheets, and electronic drawings in PDF and in [AutoCAD][Microstation][Bentley BIM V8][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: [_____] hard copies and [_____] copies on CD-ROM.

b. Submit Draft As-Built Drawings consisting of each drawing indicated updated with as-built data for the system prior to PVT. Submit Draft As-Built Drawings as a single complete package: [_____] hard copies and [_____] copies on CD-ROM.

c. 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: [_____] hard copies and [_____] 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 LonWorks Device Information

**********
**NOTE: This subpart and its subparts are required only for LonWorks systems and are included only when the LNS or NIAGARA LONWORKS tailoring options are selected.**
**********

3.3.9.3.1 Network Address

The LonWorks Domain, Subnet and Node address for the device.

3.3.9.3.2 Unique Node ID

The Unique 48-bit Node ID associated with the device. (Also referred to as the Neuron ID for some devices)

3.3.9.4 BACnet Device Information

**********
**NOTE: This subpart and its subparts are required only for BACnet systems and are included only when the BACNET or NIAGARA BACNET tailoring options are selected.**
**********

3.3.9.4.1 Device Object Identifier

The Device Object Identifier: The Object_Identifier of the Device Object

3.3.9.4.2 Network Number

The Network Number for the device.

3.3.9.4.3 MAC Address

The MAC Address for the device

3.3.9.4.4 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.

3.3.9.4.5 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.

3.3.9.4.6 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.

3.3.9.4.7 Scheduling Information

Indicate whether the device is used for scheduling.

3.3.9.4.8 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.

3.3.9.5 Niagara Station ID

**********
**NOTE: This subpart is required only for Niagara Framework systems and is included only when the NIAGARA LONWORKS or NIAGARA BACNET tailoring options are selected.**
**********

The Niagara Station ID for each Niagara Framework Supervisory Gateway

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

**********

**NOTE: This subpart is required only for BACnet systems and is included only when the BACNET or NIAGARA BACNET tailoring options are selected.**

**********

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 Primary Point Information: SNVT Name

**********

**NOTE: This subpart is required only for LonWorks systems and is included only when the LNS or NIAGARA LONWORKS tailoring options are selected.**

**********

The name of the SNVT used for 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.

3.3.10.9 Primary Point Information: SNVT Type

**********

**NOTE: This subpart is required only for LonWorks systems and is included only when the LNS or NIAGARA LONWORKS tailoring options are selected.**

**********

The SNVT type used by the point. Provide this information whenever SNVT Name is required.

3.3.10.10 Niagara Station ID

**********

**NOTE: This subpart is required only for Niagara Framework systems and is included only when the NIAGARA LONWORKS or NIAGARA BACNET tailoring options are selected.**

**********

The Niagara Station ID of the Niagara Framework Supervisory Gateway the point is mapped into.

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

**********

**NOTE: This subpart is required only for BACnet systems and is included only when the BACNET or NIAGARA BACNET tailoring options are selected.**

**********

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

3.3.10.12 Override Information (Object Type and Instance Number)

**********

**NOTE: This subpart is required only for BACnet systems and is included only when the BACNET or NIAGARA BACNET tailoring options are selected.**

**In addition this subpart uses tailoring options: The text referring to Niagara Framework is only included when the NIAGARA BACNET tailoring option is selected.**

**********

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.

3.3.10.13 Override Information (SNVT Name and Type)

**********

**NOTE: This subpart is required only for LonWorks systems and is included only when the LNS or NIAGARA LONWORKS tailoring options are selected.**

**In addition this subpart uses tailoring options: The text referring to Niagara Framework is only included when the NIAGARA LONWORKS tailoring option is selected.**

**********

For each point requiring an Override and not residing in a Niagara Framework Supervisory Gateway, indicate the SNVT Name and SNVT Type of the network variable used for the override.

3.3.10.14 Trend Object Information

**********
**NOTE: This subpart is required only for non Niagara Framework based BACnet systems and is included only when the NIAGARA BACNET tailoring option is selected.**
**********

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.

3.3.10.15 Alarm Information

**********
**NOTE: This subpart is required only for BACnet systems and is included only when the BACNET or NIAGARA BACNET tailoring options are selected.**
**********

**********
**NOTE: The following paragraph is included only when the BACNET tailoring option is selected.**
**********

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.)

**********
**NOTE: The following paragraph is included only when the NIAGARA BACNET tailoring option is selects.**
**********

For Niagara BACnet systems: Indicate the Alarm Generation Type and Notification Class Object Instance Number for each point requiring an alarm. (Note that not all alarms will have a Notification Class Object.)

3.3.10.16 Configuration Information

**********
**NOTE: The next paragraph uses tailoring options. Text after the first sentence is included only when**

**the NIAGARA BACNET or NIAGARA LONWORKS tailoring option is selected.**
**********

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:

**********
**NOTE: The following TWO list paragraphs are included only when the BACNET or NIAGARA BACNET tailoring option is selected.**
**********

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.

**********
**NOTE: The following TWO list paragraphs are included only when the LNS or NIAGARA LONWORKS tailoring option is selected. In addition:**
**1) References to LNS plug-ins are included only when the LNS tailoring option is selected.**
**2) References to Niagara Framework Wizards are included only when the NIAGARA LONWORKS tailoring option is selected.**
**********

a. Indicate "Plug-In" if the point is configurable via an LNS plug-in. Indicate "Niagara Framework Wizard" if the point is configurable via a Niagara Framework Wizard.

b. If the point is not configurable through an LNS plug-ina Niagara Framework Wizard, indicate the network variable or configuration property used to configure the value.

### 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[ Including Control Logic Diagrams]

**********

**NOTE: Require Control Logic Diagrams if they have been included in the contract drawing or if the intent is to require the contractor to develop them. If requiring contractor to develop control logic diagrams provide at least one sample to establish format. If not requiring control logic diagrams remove bracketed text.**

**********

Provide HVAC control system sequence of operation and [control logic diagrams] in the same format as the Contract Drawings. Within these drawings, refer to devices by their unique identifiers. Submit sequences of operation[ and control logic diagrams] 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 SI 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

**********
**NOTE: If the specification has been edited to include M&C Software (from Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION), include the requirement to inspect M&C Clients to make sure they display shutdown conditions. Otherwise, remove the bracketed text referring to M&C Client**
**********

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 [and each M&C Client] 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).

### 3.5.3 Draft LNS Database

**********

**NOTE: This subpart is required only for LNS-based LonWorks systems and is included only when the LNS tailoring options is selected.**

**********

Upon completion of the Start-Up Test, submit the Draft LNS Database reflecting the system as installed and configured at the completion of the Start-Up and Start-Up-Testing. The Draft LNS Database must be a complete, fully commissioned LNS database for the complete control network provided under this specification. The Draft LNS database submittal must consist of the entire folder structure of the LNS database (e.g. c:\Lm\DB\{database name}. For versions of LNS which use credits, the provided LNS Database must include all device credits.

Submit two copies of the fully commissioned, valid draft LNS Database (including all LNS credits) as a Technical Data Package. Submit each copy on a CD-ROM and clearly mark the CD-ROM identifying it as the LNS Database for the work covered under this specification and with the date of the most recent database modification.

## 3.6 PERFORMANCE VERIFICATION TEST (PVT)

**********

**NOTE: This subpart does not apply to Navy projects, and is included only when the ARMY, AIR FORCE or SERVICE GENERIC tailoring option is selected.**

**********

### 3.6.1 PVT Procedures

**********

**NOTE: The designer must decide whether to require a one-point accuracy check and/or inlet and outlet air temperature measurements. Project specific requirements should be added, particularly for problematic controls based on designer and user experience.**

**********

Prepare PVT Procedures based on Section 25 08 10 UTILITY MONITORING AND CONTROL SYSTEM TESTING 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

**********
**NOTE: This subpart is required only for LNS-based LonWorks systems and is included only when the LNS tailoring options is selected.**
**********

**********
**NOTE: For LNS-based LonWorks, trending is accomplished at the UMCS Front End, and the building control system will generally not be integrated into the UMCS during PVT. In this case additional hardware to perform trending will be required.**
**********

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

**********
**NOTE: Select the duration of the endurance test.**
**********

**********
**NOTE: This subpart uses tailoring options:**
**1) The paragraph requiring the use of BACnet Trend Log Objects is included only when the BACNET tailoring option is selected.**

**2) The paragraph requiring the use of a Niagara Trend Log Object is included only when the NIAGARA LONWORKS or NIAGARA BACNET tailoring option is selected. The last sentence of the paragraph (which requires measuring TP/FT-10 bandwidth) is only included when the NIAGARA LONWORKS tailoring option is selected.**

**3) The paragraph referring to existing trend capabilities and temporary trending hardware is included only when the LNS tailoring option is selected.**

**4) The sentence requiring the measurement of bandwidth on TP/FT-10 is included only when the LNS or NIAGARA LONWORKS tailoring option is selected**

**********

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.

Use the building control system Niagara Trend Log 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. The PVT must include a methodology to measure and record the network bandwidth usage on each TP/FT-10 channel during the endurance test.

Use the existing trending capabilities or the Temporary Trending Hardware as indicated to trend all points shown as requiring a trend on the Point Schedule for the entire endurance test. The PVT must include a methodology to measure and record the network bandwidth usage on each TP/FT-10 channel during the endurance test.

#### 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

**********

**NOTE: Indicate the required number of copies for the 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.

### 3.6.4 Final LNS Database

**********

**NOTE: This subpart is required only for LNS-based LonWorks systems and is included only when the LNS tailoring options is selected.**

**********

Submit a Final LNS Database consisting of the complete, fully commissioned LNS database for the complete control network provided under this specification. Provide the the entire folder structure of the LNS database (e.g. c:\Lm\DB\{database name}. For versions of LNS which use credits, include all device credits in the provided LNS Database.

Submit two copies of the fully commissioned, valid as-built LNS Database (including all LNS credits) for the complete control network provided under this specification as a Technical Data Package. Submit each copy on CD-ROM and clearly mark the CD-ROM identifying it as the LNS Database for the work covered under this specification and with the date of the most recent database modification.

## 3.7 PERFORMANCE VERIFICATION TESTING

**********

**NOTE: This subpart and its subparts are the PVT requirements for Navy projects and are included only when the NAVY tailoring option is selected.**

**********

### 3.7.1 General

**********

**NOTE: Indicate the number of days before installation for the pre-PVT meeting, and the meeting attendees.**

**********

PVT testing must demonstrate compliance of controls work with contract document requirements and must be performed by the Controls Contractor and Equipment Suppliers. No less than [14][__] calendar days prior to start of controls system installation, meet with the Contracting Office's technical representative (COTR) [and the designing engineer of the HVAC systems], the Contractor's QA representative, the Contractor's Controls Contractor representative,[ and the control system Owner] to develop a mutual understanding relate to the details of the PVT work requirements, including required submittals, work schedule, and field quality control.

### 3.7.2 Performance Verification Testing and Commissioning

PVT testing is a Government quality assurance function that includes systems trending and field tests. Commissioning is a quality control function that is the Commissioning Team's responsibility to the extent required by this contract.

### 3.7.3 Performance Verification Testing of Equipment with Packaged Controls

Controls Contractor and Equipment Supplier(s) must share and coordinate PVT testing responsibilities for equipment provided with on-board factory packaged controls such as boiler controllers, dedicated outside air systems (DOAS's), and packaged pumping systems.

#### 3.7.3.1 Controls Contractor Responsibilities

The Controls Contractor must provide a PVT Plan separate from Equipment Supplier's performance verification testing plan, perform endurance testing, and perform PVT testing concurrent with Equipment Suppliers' testing for equipment provided with on-board factory packaged controls to demonstrate the following:

a. Equipment enabling and disabling.

b. Equipment standard and optional control points necessary to accomplish functionality regardless if specified in contract documents or not.

c. Equipment standard and optional alarms critical to safe operation regardless if specified in contract documents or not.

d. All control points added by Controls Contractor in addition to onboard factory packaged controls regardless if specified in contract documents or not.

Refer to paragraphs titled "Performance Verification Test Plan" and "Endurance Testing" for additional information.

#### 3.7.3.2 Equipment Supplier Responsibilities

Each Equipment Supplier must provide PVT Plans separate from Controls Contractor's plans and perform PVT testing concurrent with Controls Contractor's testing for their equipment provided with on-board factory packaged controls to demonstrate the following:

a. Equipment standard and optional control features necessary to accomplish functionality regardless if specified in contract documents or not.

b. Equipment standard and optional operation modes necessary to accomplish functionality regardless if specified in contract documents or not.

c. Equipment standard and optional alarm conditions for safe operation regardless if specified in contract documents or not.

Refer to all paragraphs under paragraph titled "Performance Verification Testing" except for section titled "Endurance Testing" for additional information.

### 3.7.4 Sequencing of Performance Verification Testing Activities

PVT activities must be sequenced with major activities listed below for Test and Balance (TAB) Contractor, Equipment Suppliers, Commissioning Specialists, and others to demonstrate fully functioning systems. Refer to Section 01 32 17.00 20 COST-LOADED NETWORK ANALYSIS SCHEDULES (NAS). Complete the items in TABLE III: SEQUENCING OF PVT TESTING ACTIVITIES as schedule activities or milestones.

| TABLE III: SEQUENCING OF PVT TESTING ACTIVITIES | |
|---|---|
| SEQUENCE | ITEM |
| 1 | Submission, review, and approval of Control Contractors PVT Plans. |
| 2 | Submission, review, and approval of Equipment Suppliers PVT Plans. |
| 3 | Submission, review, and approval of certified final Test and Balance Report. |
| 4 | Conduct commissioning functional performance tests. |
| 5 | Submission, review, and approval of all of the Commissioning Specialists completed functional performance tests. |
| 6 | Request Contracting Officer to allow beginning of Government-witnessed PVT testing. |
| 7 | Contracting Officers approval to begin PVT testing. |
| 8 | Conduct PVT field work. |
| 9 | Governments verbal approval of PVT field work for all systems. |
| 10 | Conduct Test and Balance verification field work. |
| 11 | Governments written approval of Test and Balance verification field work. |
| 12 | Submission, review, and approval of endurance testing. |
| 13 | Governments written approval of PVT field work for all systems. |
| 14 | Facility acceptance recommendation. |
| 15 | Submission, review, and approval of Control Contractors PVT Report. |
| 16 | Submission, review, and approval of Equipment Suppliers PVT Report. |
| 17 | Conduct applicable re-testing and seasonal testing within 10 months of beneficial occupancy. |

#### 3.7.4.1 PVT Testing for Multi-Phase Construction

For air moving systems except outside air systems serving multiple phases, all major activities listed in TABLE III through Government’s verbal approval of Test and Balance verification field work can be completed by

phase if all ductwork construction is completed for that phase.

For primary systems such as chilled water systems, HVAC heating hot water systems, and outside air systems serving multiple phases, all major activities listed listed in TABLE III through Government’s verbal approval of Test and Balance verification field work for all air moving systems served by that primary system for that phase must be completed prior to conducting PVT field work for that primary system.

### 3.7.5 Control Contractor's Performance Verification Testing Plan

Submit a detailed PVT Plan of the proposed control systems testing in this contract for approval prior to its use. Develop and use a single PVT Plan for each system with a unique control sequence. Systems sharing an identical control sequence can be tested using copies of the PVT Plan intended for these systems.

PVT Plans must include system-based, step-by-step test methods demonstrating system performs in accordance with contract document requirements. The Government may provide sample PVT Plans upon request. PVT Plans must include the following:

a. Control sequences from contract documents segmented such that each control algorithm, operation mode, and alarm condition is immediately followed by numbered test methods required to initiate a response, expected response, space for comments, and “pass" or "fail” indication for each expected response.

b. PVT Plans with control sequences from contract documents that are not segmented into parts will not be accepted.

c. Indication where assisting personnel are required such as Mechanical Contractor.

d. Signature and date lines for the Contractor's PVT administrator, Contractor's quality assurance representative, and Contracting Officer's representative acknowledging completion of testing.

### 3.7.6 Performance Verification Testing Sample Size

PVT testing sample sizes will be as follows:

a. 100-Percent of the following systems:

(1) primary systems including, but not limited to, chilled water and HVAC heating hot water systems

(2) air handling unit systems including all associated fans except for remote exhaust air fans

(3) DOAS’s including all associated fans except for remote exhaust air fans

b. 20-Percent of each set of systems with a shared identical control sequence for systems such as:

(1) air terminal units

(2) exhaust air fans

(3) terminal equipment such as fan coil units and unit heaters

3.7.6.1 Selection of Systems to Test

For sample sets less than 100-percent, the Government will choose which systems will be tested. The Government may require additional testing if previous testing results are inconsistent or demonstrate improper system control as follows:

a. An additional 25-percent after five-percent failure rate of first sample set.

b. 100-percent after any failures occurring in additional sample set.

3.7.7 Conducting Performance Verification Testing

At least 15 days prior to preferred test date, request the Contracting Officer to allow the beginning of Government-witnessed PVT testing. Provide an estimated time table required to perform testing of each system. Furnish personnel, equipment, instrumentation, and supplies necessary to perform all aspects of testing. Testing personnel must be regularly employed in the testing and calibration of control systems. After receipt of Contracting Officer’s approval to begin testing, perform PVT testing using project's as-built (shop) control system drawings, project's design drawings, and approved PVT Plans.

During testing, identify deficiencies that do not meet contract document requirements. Deficiencies must be investigated, corrected with corrections documented, and re-tested at a later date following procedures for the initial PVT testing. The Government may require re-testing of any control system components affected by the original failed test.

3.7.8 Endurance Testing

3.7.8.1 General

Conduct endurance testing in conjunction with the PVT to demonstrate control loop stability and accuracy. For all control loops tested, record trend data of the control variables over time, demonstrating that the control loop responds to a sudden change of the control variable set point without excessive overshoot or undershoot. Conduct endurance testing for each system subject to PVT testing. Systems must be operating as normally anticipated during occupancy throughout endurance testing.

Endurance testing results must clearly demonstrate control loop stability and accuracy. Controlled loop outputs must be stable and accurately maintain each setpoint.

3.7.8.2 Hardware

**********

**NOTE: Select “Use hardware provided in this contract for testing.” only when a workstation is provided in this scope of work.**

**********

[Use hardware provided in this contract for testing.] [Use Government

furnished hardware for testing if available when endurance testing begins. If unavailable, the Contractor must provide suitable hardware for required testing.]

If insufficient buffer capacity exists to trend the entire endurance test, upload trend data during the course of endurance testing to ensure all trend data is retained. Lost trend data will require retesting of all control points for affected system(s).

3.7.8.3 Endurance Testing Results Format

Submit endurance testing results for each tested system in a graphical format complete with clear indication of value(s) for y-axis, value for x-axis, and legend identifying each trended control point. The number of control points contained on a single graph must be such that all control points can be clearly visible. Control points must be logically grouped such that related points appear on a single graph. In addition, submit a separate comma separated value (CSV) file of raw trend data for each trended system. Each trended control point in CSV file must be clearly identified.

For control points recorded based on change of value, change of value for recording data must be clearly identified for each control point.

3.7.8.4 Endurance Testing Start, Duration, and Frequency

**********
**NOTE: Select duration and frequency of data collection.**
**********

Trending of all control points for a given system must start at an identical date and time regardless of the basis of data collection. Duration of all endurance tests must be at least [one-week][_____].

Unless specified otherwise for control points recorded based on time, frequency of data collection must be [15-minutes] [_____]. Frequency of data collection for specific types of control points is as follows:

3.7.8.4.1 Points Trended at One Minute Intervals

a. Temperature for supply air, return air, mixed air, supply water, and return water

b. Temperature for outside air, supply air, return air and exhaust air entering and leaving energy recovery device

c. Flow for supply air, return air, outside air, chilled water, and HVAC heating hot water

d. Flow for exhaust air associated with energy recovery

e. Relative humidity for outside air and return air

f. Relative humidity for outside air, supply air, return air and exhaust air entering and leaving energy recovery device

g. Command and status for control dampers and control valves

h. Speed for fans and pumps

i. Pressure for fans and pumps

3.7.8.4.2 Points Trended at 15 Minute Intervals

a. Temperature and relative humidity for zones

b. Temperature and relative humidity for outside air not associated with energy recovery

c. Command and status for equipment

d. Pressure relative to the outside for facility

3.7.8.5 Trended Control Points

Trended control points for each system must demonstrate each system performs in accordance with contract document requirements. Trended control points must include, but not be limited to, control points listed in contract document points list.

Minimum control points that are required to be trended for selected systems are listed below. These control points must be trended as applicable to this contract in addition to control points necessary to demonstrate systems perform in accordance with contract document requirements and those listed in contract document's points list.

**********
**NOTE: Delete systems below if certain they are not in this project. If uncertain, then keep.**
**********

[3.7.8.5.1 Air-Cooled Chiller Chilled Water System.

a. Chiller(s) command and status

b. Chiller isolation valve(s) command and status

c. Chilled water pump(s) actual speed

d. Chilled water pump(s) setpoint and actual differential pressure

e. Minimum flow bypass control valve command

f. Minimum system flow setpoint and actual flow

g. Chilled water supply setpoint and actual temperature

h. Chilled water return actual temperature

i. Chilled water actual flow

j. Outside air actual dry-bulb temperature

][3.7.8.5.2 HVAC Heating Hot Water System with Boiler.

a. Boiler(s) command and status

b. Boiler(s) isolation valve command and status

c. HVAC heating hot water pump(s) actual speed

d. HVAC heating hot water pump(s) setpoint and actual differential pressure

e. Minimum flow bypass control valve command

f. Minimum system setpoint and actual flow

g. HVAC heating hot water supply setpoint and actual temperature

h. HVAC heating hot water return actual temperature

i. HVAC heating hot water actual flow

j. Outside air actual dry-bulb temperature

][3.7.8.5.3 HVAC Heating Hot Water System with Steam-to-Hot Water Heat Exchanger.

a. Steam control valve(s) command

b. Heat exchanger isolation valve(s) command and status

c. HVAC heating hot water pump(s) actual speed

d. HVAC heating hot water pump(s) setpoint and actual differential pressure

e. Minimum flow bypass control valve command

f. Minimum system setpoint and actual flow

g. HVAC heating hot water supply setpoint and actual temperature

h. HVAC heating hot water return actual temperature

i. HVAC heating hot water actual flow

j. Outside air actual dry-bulb temperature

][3.7.8.5.4 Air Handling Unit with Relief Air Fan

a. Outside air actual dry-bulb temperature

b. Outside air actual relative humidity

c. Outside air setpoint and actual airflow

d. Minimum outside air control damper command

e. Economizer outside air control damper command

f. Facility setpoint and actual relative pressure

g. Return air actual dry-bulb temperature

h. Return air actual relative humidity

i. Return air control damper command

j. Relief air control damper command

h. Relief air fan actual speed

i. Mixed air setpoint and setpoint and actual temperature

j. Preheat coil leaving air setpoint and actual temperature

k. Preheat coil control actuator command

l. Cooling coil leaving air setpoint and actual temperature

m. Cooling coil control valve command

n. Supply air fan actual speed

o. Discharge air actual temperature

p. Supply air fan setpoint and actual static pressure

][3.7.8.5.5 Dedicated Outside Air System (DOAS)

a. Outside air actual dry-bulb temperature

b. Outside air actual relative humidity

c. Outside air isolation damper command and status

d. Outside air setpoint and actual airflow

e. Energy recovery wheel command, status, and actual speed

f. Energy recovery wheel’s OA bypass control damper command and status

g. Energy recovery wheel’s defrost cycle command and status

h. Energy recovery wheel’s OA discharge air actual dry-bulb temperature

i. Energy recovery wheel’s OA discharge air actual relative humidity

j. Preheat coil leaving air setpoint and actual temperature

h. Preheat coil control actuator command

i. Cooling coil leaving air setpoint and actual temperature

j. Cooling coil control valve command

k. Supply air fan actual speed

l. Reheat coil control valve command

m. Discharge air setpoint and actual temperature

n. Supply air fan setpoint and actual static pressure

o. Facility setpoint and actual relative pressure

p. Return air actual dry-bulb temperature

q. Return air actual relative humidity

r. Energy recovery wheel’s EA bypass control damper command and status

s. Energy recovery wheel’s EA discharge air actual dry-bulb temperature

t. Energy recovery wheel’s EA discharge air actual relative humidity

u. Exhaust air fan actual speed

v. Exhaust air isolation damper command and status

][3.7.8.5.6 Series Fan-Powered Supply Air Terminal Units

a. Zone setpoint and actual dry-bulb temperature

b. Zone actual relative humidity

c. Control damper command

d. Fan command and status

e. Heating coil valve command

f. Airflow actual value

g. Leaving air actual temperature

]3.7.8.6 Endurance Testing Sample Size

Endurance Testing sample sizes ware as follows:

a. 100-Percent of the following systems:

(1) primary systems including, but not limited to, chilled water and HVAC heating hot water systems

(2) air handling unit systems including all associated fans except for remote exhaust air fans

(3) DOAS’s including all associated fans except for remote exhaust air fans

b. 20-Percent of each set of systems with a shared identical control sequence for systems such as:

(1) air terminal units

(2) exhaust air fans

(3) terminal equipment such as fan coil units and unit heaters

3.7.8.6.1 Selection of Systems to Test

For sample sets less than 100-percent, the Government will choose which systems will be tested. The Government may require additional testing if previous testing results are inconsistent or demonstrate improper system control as follows:

a. An additional 25-percent after five-percent failure rate of first sample set.

b. 100-percent after any failures occurring in additional sample set.

3.7.9 Performance Verification Test Report

Submit a PVT Report after receiving Government's written approval of PVT field work that is intended to document test results and final control system sequences and settings prior to turnover. The PVT Report must contain the following:

a. Executive summary that briefly discusses results of each system's endurance testing and PVT testing and conclusions for each system.

b. Endurance testing for each system.

c. Completed PVT Plan for each system used during testing that includes hand written field notes and participant signatures.

d. Blank PVT Plan for each system approved prior to testing that is edited to reflect changes occurring during testing. Edits must be typed and must reflect changes to control sequences from contract documents, must reflect changes to numbered test methods required to initiate a response, and must reflect changes to expected response. Only one blank PVT Plan is required for each set of systems sharing an identical control sequence, such as air terminal units, exhaust air fans, fan coil units and unit heaters.

e. Written certification that the installation and testing of all systems are complete and meet all contract document requirements.

3.8 FINAL LNS DATABASE

**********

**NOTE: This subpart is required only for LNS-based LonWorks systems and is included only when the LNS tailoring option is selected.**

**********

Submit a Final LNS Database consisting of the complete, fully commissioned LNS database for the complete control network provided under this specification. Provide the the entire folder structure of the LNS database (e.g. c:\Lm\DB\{database name}. For versions of LNS which use credits, include all device credits in the provided LNS Database.

Submit two copies of the fully commissioned, valid as-built LNS Database (including all LNS credits) for the complete control network provided under this specification as a Technical Data Package. Submit each copy on

CD-ROM and clearly mark the CD-ROM identifying it as the LNS Database for the work covered under this specification and with the date of the most recent database modification.

## 3.9 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.

## [3.10 MAINTENANCE AND SERVICE

**********

**NOTE: The maintenance and service to be provided by the Contractor for the duration of the maintenance contract is specified in this paragraph. The Maintenance and Service may need to be a separate bid item funded by O&M funds.**

**Requirements should be coordinated with "WARRANTY MANAGEMENT" in Section 01 78 00 CLOSEOUT SUBMITTALS**

**If not requiring 1 year maintenance and service, delete this subpart. Most Navy projects will not use this requirement.**

**********

Provide services, materials and equipment as necessary to maintain the

entire system in an operational state as indicated for a period of one year from the date of final acceptance of the project. Minimize impacts on facility operations.

a. The integration of the system specified in this section into a Utility Monitoring and Control System must not, of itself, void the warranty or otherwise alter the requirement for the one year maintenance and service period. Integration into a UMCS includes but is not limited to establishing communication between devices in the control system and the front end or devices in another system.

b. The changing of configuration properties must not, of itself, void the warranty or otherwise alter the requirement for the one year maintenance and service period.

3.10.1 Description of Work

Provide adjustment and repair of the system including the manufacturer's required sensor and actuator (including transducer) calibration, span and range adjustment.

3.10.2 Personnel

Use only service personnel qualified to accomplish work promptly and satisfactorily. Advise the Government in writing of the name of the designated service representative, and of any changes in personnel.

3.10.3 Scheduled Inspections

**********
**NOTE: Indicate when inspections are to be scheduled.**
**********

Perform two inspections at six-month intervals and provide work required. Perform inspections in [June and December][_____]. During each inspection perform the indicated tasks:

a. Perform visual checks and operational tests of equipment.

b. Clean control system equipment including interior and exterior surfaces.

c. Check and calibrate each field device. Check and calibrate 50 percent of the total analog inputs and outputs during the first inspection. Check and calibrate the remaining 50 percent of the analog inputs and outputs during the second major inspection. Certify analog test instrumentation accuracy to be twice the specified accuracy of the device being calibrated. Randomly check at least 25 percent of all binary inputs and outputs for proper operation during the first inspection. Randomly check at least 25 percent of the remaining binary inputs and outputs during the second inspection. If more than 20 percent of checked inputs or outputs failed the calibration check during any inspection, check and recalibrate all inputs and outputs during that inspection.

d. Run system software diagnostics and correct diagnosed problems.

e. Resolve any previous outstanding problems.

3.10.4 Scheduled Work

**********
**NOTE: Include bracketed text to accept default work times or indicate permissible work times in the space provided.**
**********

This work must be performed [during regular working hours, Monday through Friday, excluding Federal holidays][_____].

3.10.5 Emergency Service

The Government will initiate service calls when the system is not functioning properly. Qualified personnel must be available to provide service to the system. A telephone number where the service supervisor can be reached at all times must be provided. Service personnel must be at the site within 24 hours after receiving a request for service. The control system must be restored to proper operating condition as required per Section 01 78 00 CLOSEOUT SUBMITTALS.

3.10.6 Operation

After performing scheduled adjustments and repairs, verify control system operation as demonstrated by the applicable tests of the performance verification test.

3.10.7 Records and Logs

Keep dated records and logs of each task, with cumulative records for each major component, and for the complete system chronologically. Maintain a continuous log for all devices, including initial analog span and zero calibration values and digital points. Keep complete logs and provide logs for inspection onsite, demonstrating that planned and systematic adjustments and repairs have been accomplished for the control system.

3.10.8 Work Requests

Record each service call request as received and include 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. Submit a record of the work performed within 5 days after work is accomplished.

3.10.9 System Modifications

Submit recommendations for system modification in writing. Do not make system modifications, including operating parameters and control settings, without prior approval of the Government.

]3.11 TRAINING

**********
**NOTE: Training requirements should be coordinated with the relevant shop organization at the project site. Extent of training should be based on the needs of the installation personnel.**
**********

Conduct a training course for [_____] 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.

### 3.11.1 Training Documentation

**********

**NOTE: Designer must choose appropriate shop supervisor(s) to coordinate training attendance.**

**********

Prepare training documentation consisting of:

a. Course Attendee List: Develop the list of course attendees in coordination with and signed by the [Controls][HVAC][Electrical] 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.

### 3.11.2 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.

### 3.11.3 Training Documentation Submittal Requirements

**********

**NOTE: Indicate number of additional copies of training material required.**

**********

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 LNS-BASED LONWORKS 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. | |____| |
| 6 | All DDC Hardware is installed on a TP/FT-10 Channel. | |____| |
| 7 | All Application Specific Controllers (ASCs) are LonMark certified. | |____| |
| 8 | Communication between DDC Hardware is only via CEA-709.1-D using SNVTs. Other protocols have not been used. Network variables other than SNVTs have not been used. | |____| |
| 9 | Explicit messaging has not been used. | |____| |
| 10 | Scheduling is performed in DDC Hardware meeting the Simple Schedule Functional Profile | |____| |

Items verified for Closeout QC Checklist Submittal:

| QC CHECKLIST FOR LNS-BASED LONWORKS SYSTEMS | | |
|---|---|---|
| 11 | Final As-built Drawings, including all Points Schedule drawings, accurately represent the final installed system. | \|____\| |
| 12 | Programming software has been submitted for all programmable controllers. | \|____\| |
| 13 | All software has been licensed to the Government. | |
| 14 | O&M Instructions have been completed and submitted. | \|____\| |
| 15 | Training course has been completed. | \|____\| |
| 16 | LonWorks Network Services (LNS) Database is up-to-date and accurately represents the final installed system. | \|____\| |
| 17 | LNS Plug-ins have been submitted for all Application Specific Controllers (ASCs). | \|____\| |
| 18 | Programming software has been submitted for all General Purpose Programmable Controllers (GPPCs) and all Application Generic Controllers (AGCs). | \|____\| |
| | _____ _____ | |
| | (QC Representative Signature) (Date) | |

| QC CHECKLIST FOR NIAGARA FRAMEWORK BASED LONWORKS SYSTEMS |
|---|
| This checklist is not all-inclusive of the requirements of this specification and should not be interpreted as such.<br><br>Instructions: Initial each item in the space provided (\|____\|) verifying that the requirement has been met. |
| This checklist is for (circle one:)<br><br>Pre-Construction QC Checklist Submittal<br><br>Post-Construction QC Checklist Submittal<br><br>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. | \|____\| |

| QC CHECKLIST FOR NIAGARA FRAMEWORK BASED LONWORKS SYSTEMS | | |
|---|---|---|
| 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. | \|_____\| |
| 6 | All DDC Hardware except Niagara Framework Supervisory Gateways is installed on a TP/FT-10 Channel. | \|_____\| |
| 7 | All Application Specific Controllers (ASCs) are LonMark certified. | \|_____\| |
| 8 | Except for communication between two Niagara Framework Supervisory Gateways, Communication between DDC Hardware is only via CEA-709.1-D using SNVTs. Other protocols have not been used. Network variables other than SNVTs have not been used. Communication between Niagara Framework Supervisory Gateways is via Fox Protocol. | \|_____\| |
| 9 | Explicit messaging has not been used. | \|_____\| |
| 10 | Scheduling, Alarming, and Trending have been implemented using Niagara Framework objects and services. | \|_____\| |
| Items verified for Closeout QC Checklist Submittal: | | |
| 11 | Final As-built Drawings, including all Points Schedule drawings, accurately represent the final installed system. | \|_____\| |
| 12 | Programming software has been submitted for all programmable controllers. | \|_____\| |
| 13 | All software has been licensed to the Government. | |
| 14 | O&M Instructions have been completed and submitted. | \|_____\| |
| 15 | Training course has been completed. | \|_____\| |
| 16 | The database in each Niagara Framework Supervisory Gateway is up-to-date and accurately represents the building control network beneath that Niagara Framework Supervisory Gateway. | \|_____\| |
| 17 | Niagara Wizards have been submitted for all Application Specific Controllers (ASCs) for which a Wizard is available and for all Application Generic Controllers (AGCs). | \|_____\| |

| QC CHECKLIST FOR NIAGARA FRAMEWORK BASED LONWORKS SYSTEMS | | |
|---|---|---|
| 18 | Programming software has been submitted for all General Purpose Programmable Controllers (GPPCs) and all Application Generic Controllers (AGCs). | \|_____\| |

_____ _____

(QC Representative Signature) (Date)

| QC CHECKLIST FOR BACNET SYSTEMS | | |
|---|---|---|
| This checklist is not all-inclusive of the requirements of this specification and should not be interpreted as such.<br><br>Instructions: Initial each item in the space provided (\|_____\|) verifying that the requirement has been met. | | |
| This checklist is for (circle one:)<br><br>Pre-Construction QC Checklist Submittal<br><br>Post-Construction QC Checklist Submittal<br><br>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: | | |

| QC CHECKLIST FOR BACNET SYSTEMS | | |
|---|---|---|
| 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. | \|_____\| |
| 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) | |

| QC CHECKLIST FOR NIAGARA FRAMEWORK BASED BACNET SYSTEMS |
|---|
| This checklist is not all-inclusive of the requirements of this specification and should not be interpreted as such.<br><br>Instructions: Initial each item in the space provided (\|_____\|) verifying that the requirement has been met. |
| This checklist is for (circle one:)<br><br>Pre-Construction QC Checklist Submittal<br><br>Post-Construction QC Checklist Submittal<br><br>Close-out QC Checklist Submittal |

| QC CHECKLIST FOR NIAGARA FRAMEWORK BASED BACNET SYSTEMS | | |
|---|---|---|
| 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. | \|_____\| |
| 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 Niagara Framework objects and services, and BACnet Instrinsic Alarming as indicated. | \|_____\| |
| 15 | All Properties indicated as required to be Writable are Writable and Overrides have been provided as indicated | \|_____\| |
| _____ _____ | | |

| QC CHECKLIST FOR NIAGARA FRAMEWORK BASED BACNET SYSTEMS | | |
|---|---|---|
| | (QC Representative Signature) | (Date) |

-- End of Section --