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**USACE / NAVFAC / AFCEC / NASA** | **UFGS-23 09 23.02 (November 2015)**

**Preparing Activity: USACE** | **Superseding**
**UFGS-23 09 23 (May 2011)**
**UFGS-23 09 23.13 20 (August 2009)**

**UNIFIED FACILITIES GUIDE SPECIFICATIONS**

**References are in agreement with UMRL dated April 2018**

**********

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

SECTION 23 09 23.02

BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS

**11/15**

-- End of Section Table of Contents --

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|---|---|
| **USACE / NAVFAC / AFCEC / NASA** | **UFGS-23 09 23.02 (November 2015)** |
| | **----------** |
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**UNIFIED FACILITIES GUIDE SPECIFICATIONS**

**References are in agreement with UMRL dated April 2018**

**********

SECTION 23 09 23.02

BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS
**11/15**

**********

**NOTE: This guide specification covers the requirements for protocol-specific requirements for a Direct Digital Control (DDC) building control system based on the ASHRAE 135 protocol, including a tailoring option to require the Niagara Framework.**

**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.**

**Remove information and requirements not required in respective project, whether or not brackets are present.**

**Comments, suggestions and recommended changes for this guide specification are welcome and should be as a Criteria Change Request (CCR).**

**********

**********

**NOTE: The use of this UFGS, and the design of BACnet 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 00 INTRUMENTATION AND CONTROL FOR HVAC in order to specify a complete and functional system.**

**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 without prior approval as specified in UFC 3-410-02.**

**When used with UFGS 23 09 00, this specification covers installation of local (building-level) controls using BACnet-based DDC. It 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 BACnet or Niagara Framework tailoring option).**

**For projects that require the building system to provide UMCS functionality (without connection to a UMCS), the designer must include the necessary requirements from Section 25 10 10 in the project specification.**

**Template drawings in electronic format for use with this section are available in the listing for UFGS 23 09 00 online at:**
http://www.wbdg.org/ccb/NAVGRAPH/graphtoc.pdf
**********

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

**"Manual Tailoring Tags"**
**When printed to PDF there is no easy way to differentiate between different tailoring options. For this reason temporary "tags" have been added to the text to indicate which tailoring options applies to which text. These "tags" take the form of an opening tag and a closing tag. For example, the following text would be shown to be in Army tailoring option tags:**
**{ARMY}Text for specific tailoring{/ARMY}**

**These temporary tags are in turn in the "MANUAL TAILORING TAGS" tailoring option. When selecting tailoring options for this specification REMOVE the "MANUAL TAILORING TAGS" tailoring option to remove these temporary tags.**

**WARNING - YOU HAVE NOT REMOVED THE "MANUAL TAILORING TAGS" TAILORING OPTION. YOU MUST REMOVE (DESELECT) THIS TAILORING OPTION.**

**Niagara Framework or NOT Niagara Framework Tailoring Options**
**This specification includes tailoring options for whether or not the Niagara Framework is required - "Niagara Framework" and "NOT Niagara Framework". Exactly ONE of these tailoring options must be chosen. You have currently selected the following options:**
**----------**
**{NIAGARA FRAMEWORK}Niagara Framework{/NIAGARA**

**FRAMEWORK}**
**{NOT NIAGARA FRAMEWORK}NOT Niagara Framework{/NOT NIAGARA FRAMEWORK}**
**----------**
**If you don't see either the words "Niagara Framework" or "NOT Niagara Framework" between the dashes above, you have not selected a tailoring option and this specification is not valid. Select ONE of the tailoring options.**

**If you see both "Niagara Framework" and "NOT Niagara Framework" you have selected both tailoring options. Remove one of the tailoring options.**

**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. Only ONE of the four tailoring options related to the service should be use. You have currently selected the following options:**
**----------**
**{AIR FORCE}AIR FORCE{/AIR FORCE}**
**{ARMY}ARMY{/ARMY}**
**{NAVY}NAVY{/NAVY}**
**{SERVICE GENERIC}SERVICE GENERIC{/SERVICE GENERIC}**
**----------**
**If more than one item appears between the dashes above you have selected more than one services tailoring option and need to remove all but one of them.**

**********
{NIAGARA FRAMEWORK AND NOT NIAGARA FRAMEWORK}
**********
**WARNING - Both the Niagara Framework and NOT Niagara Framework Tailoring Options have been selected. This will result in a specification that contains conflicts and cannot be met. DESELECT one of these tailoring options. See UFC 3-410-02.**
**********
{/NIAGARA FRAMEWORK AND NOT NIAGARA FRAMEWORK}
PART 1 GENERAL
{NIAGARA FRAMEWORK}
**********
**NOTE: IMPORTANT: You selected the Niagara Framework Tailoring Option. Ensure that the front end (UMCS) uses the Niagara Framework, otherwise integration will fail.**
**********
{/NIAGARA FRAMEWORK}
1.1 SUMMARY

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

1.1.1 System Requirements

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

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

b. Install and configure control hardware to provide ASHRAE 135 Objects and Properties {NIAGARA FRAMEWORK}or Niagara Framework Objects {/NIAGARA FRAMEWORK}as indicated and as needed to meet the requirements of this specification.

{NIAGARA FRAMEWORK}

**NOTE: Select Web Pages if a local (in the building) web interface is required.**

c. Use Niagara Framework hardware and software exclusively for scheduling, trending, and communication with a front end (UMCS). Use Niagara Framework or standard BACnet Objects and services for alarming. Use the Fox protocol for all communication between Niagara Framework Supervisory Gateways; use the ASHRAE 135 protocol for all other building communication. [Niagara Framework Supervisory Gateway must serve web pages as specified.]

{/NIAGARA FRAMEWORK}

{NIAGARA FRAMEWORK}

**NOTE: Select the required version of the Niagara Framework. This choice must be carefully coordinated with the project site. Niagara Framework is currently (2015) in a transition between two releases: "AX" and "Version 4". A Version 4 UMCS front end (e.g. as specified in Section 25 10 10) UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION will work with either an AX or Version 4 Niagara Framework Supervisory Gateway, but an AX front end will ONLY work with an AX Niagara Framework Supervisory Gateway.**

**If the site has an AX front end, select "AX". If the site has a Version 4 front end, or does not have a front end:**

**1) if there are multiple vendors servicing the**

**project site that support Version 4, select "Version 4"**

**2) otherwise, select "either AX or Version 4"**

**********

e. Use Niagara Framework [AX][Version 4.0 or later][either AX or Version 4.0 or later].

{/NIAGARA FRAMEWORK}

1.1.2 Verification of Specification Requirements

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

1.2 REFERENCES

**********

**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 | (2016) BACnet—A Data Communication Protocol for Building Automation and Control Networks |

BACNET INTERNATIONAL (BTL)

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

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 802.3 | (2015; CORR 2017; AMD 1 2017) Ethernet |

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

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

TRIDIUM, INC (TRIDIUM)

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

U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)

| | |
|---|---|
| FCC Part 15 | Radio Frequency Devices (47 CFR 15) |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 916 | (2007; Reprint Aug 2014) Standard for Energy Management Equipment |

## 1.3 DEFINITIONS

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

## 1.4 SUBMITTALS

**********
**NOTE: Submittals related to this section are specified in UFGS 23 09 00 INTRUMENTATION AND CONTROL FOR HVAC. UFGS 23 09 00 MUST be used with this specification to have a complete specification.**
**********

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

# PART 2 PRODUCTS

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

## 2.1 NETWORK HARDWARE

### 2.1.1 BACnet Router

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

for DDC Hardware, and {NIAGARA FRAMEWORK}except for Niagara Framework Supervisory Gateways, devices used as BACnet routers {/NIAGARA FRAMEWORK} must support the NM-RC-B BIBB.

2.1.2 BACnet Gateways

**********
**Gateways should be used only for the integration of a single piece of equipment. Gateways should not be used to permit the installation of new, non-ASHRAE 135 networks.**
**********

In addition to the requirements for DDC Hardware, the BACnet Gateway must {NIAGARA FRAMEWORK}be a Niagara Framework Supervisory Gateway or must {/NIAGARA FRAMEWORK}meet the following requirements:

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

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

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

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

Although Gateways must meet DDC Hardware requirements{NIAGARA FRAMEWORK} , except for Niagara Framework Supervisory Gateways,{/NIAGARA FRAMEWORK} they are not DDC Hardware and must not be used when DDC Hardware is required. {NIAGARA FRAMEWORK}(Niagara Framework Supervisory Gateways are both Gateways and DDC Hardware.){/NIAGARA FRAMEWORK}

2.1.3 Ethernet Switch

**********
**NOTE: Select whether Ethernet Switches must be managed. In general, do NOT require managed switches unless there is a specific project requirement for managed switches. Managed switches add cost to the system, and require that they be managed by the project site following installation. Some sites are equipped to handle such management, but for some {Army}(many){/Army} sites this will be an uacceptable O&M burden.**
**********

Ethernet Switches [must be managed switches and ]must autoconfigure between 10,100 and 1000 megabits per second (MBPS).

2.2 CONTROL NETWORK WIRING

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

**********

**NOTE: Although the controls contractor installs the building control system backbone, which is an IP network, this system will later be integrated into the basewide network via the FPOC. To ensure no issues arise during this later integration, obtain additional Ethernet media requirements (if any) from the project site {ARMY} NEC{/ARMY}.**

**********

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

2.3 DIRECT DIGITAL CONTROL (DDC) HARDWARE

2.3.1 General Requirements

All DDC Hardware must meet the following requirements:

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

b. It must conform to the BTL Guide

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

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

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

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

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

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

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

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

(3) Communication information, including but not limited to COV

subscriptions, event reporting destinations, Notification Class Object settings, and internal communication settings, must persist for any loss of power less than 2,500 hours.

i. Internal Clocks:

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

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

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

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

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

m. {NIAGARA FRAMEWORK}Except for Niagara Framework Supervisory Gateways, {/NIAGARA FRAMEWORK}Device must support Commandable Objects to support Override requirements as detailed in PART 3 EXECUTION

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

**********

**NOTE: Select whether to allow devices using 2-wire (twisted pair with shield) media.**

**The use of devices using 3-wire (twisted pair with reference and shield) MS/TP media is generally preferable, particularly where long MS/TP runs are required, or in electrically noisy environments. However, many vendors do not offer devices supporting 3-wire media, and requiring use of 3 wire media will overly limit competition.**

**Unless the use of 3-wire devices is specifically required for the project, keep the bracketed text to allow the use of 2-wire devices.**

**********

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

(1) Must have a configurable Max_Master Property.

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

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

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

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

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

r. {NIAGARA FRAMEWORK}Except for Niagara Framework Supervisory Gateways, {/NIAGARA FRAMEWORK}DDC Hardware controlling a single terminal unit must have:

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

(2) A configurable Device Object Name.

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

s. Except for Objects in {NIAGARA FRAMEWORK}either Niagara Framework Supervisory Gateways or {/NIAGARA FRAMEWORK}DDC Hardware controlling a single terminal unit, all Objects (including Device Objects) must:

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

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

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

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

2.3.2 Hardware Input-Output (I/O) Functions

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

2.3.2.1 Analog Inputs

DC Hardware analog inputs (AIs) must be implemented using ASHRAE 135 Analog Input Objects and perform analog to digital (A-to-D) conversion with a minimum resolution of 8 bits plus sign or better as needed to meet the accuracy requirements specified in Section 23 09 00. Signal conditioning

including transient rejection must be provided for each analog input. Analog inputs must be capable of being individually calibrated for zero and span. Calibration via software scaling performed as part of point configuration is acceptable. The AI must incorporate common mode noise rejection of at least 50 dB from 0 to 100 Hz for differential inputs, and normal mode noise rejection of at least 20 dB at 60 Hz from a source impedance of 10,000 ohms.

2.3.2.2 Analog Outputs

**********

**NOTE: PART 3 of this section and the Points Schedules may require that points have an H-O-A switch. For analog outputs these switches may be "full on, full off" overrides or may have a knob allowing for override to any value (0-100 percent). Unless the project site specifically requires that analog outputs be fully adjustable through the range 0-100 percent, keep the bracketed text allowing either option (i.e. keep "to 0 percent and to 100 percent"). Requiring fully adjustable overrides (i.e. "through the range of 0 percent to 100 percent") will likely raise the cost of the system.**

**********

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

2.3.2.3 Binary Inputs

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

2.3.2.4 Binary Outputs

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

2.3.2.4.1 Relay Contact Closures

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

2.3.2.4.2 Triac Outputs

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

2.3.2.5 Pulse Accumulator

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

2.3.2.6 ASHRAE 135 Objects for Hardware Inputs and Outputs

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

[2.3.2.7 Integrated H-O-A Switches

**********

**NOTE: Even if H-O-A switches are implemented, Requiring feedback of H-O-A status may seriously limit competition and raise project costs. Unless there is a specific project requirement for H-O-A feedback, remove the bracketed text.**

**********

Where integrated H-O-A switches are provided on hardware outputs, controller must provide means of monitoring position or status of H-O-A switch. This feedback may be provided via {NIAGARA FRAMEWORK}the Niagara Framework or via {/NIAGARA FRAMEWORK}any valid BACnet method, including the use of proprietary Objects, Properties, or Services.

]2.3.3 Local Display Panel (LDP)

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

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

2.3.4 Expansion Modules and Tethered Hardware

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

a. An unlimited number of hardware expansion modules, where the individual hardware expansion modules are designed to directly connect, both mechanically and electrically, to the base unit hardware. The

expansion modules must be commercially available as an optional add-on to the base unit.

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

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

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

2.3.5 Supervisory Control Requirements

{NOT NIAGARA FRAMEWORK}2.3.5.1 Scheduling Hardware

DDC Hardware used for scheduling must meet the following requirements:

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

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

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

d. The Present_Value Property of Schedule must support the following values: 1, 2, 3, 4. {/NOT NIAGARA FRAMEWORK}

2.3.5.2 Alarm Generation Hardware

{NIAGARA FRAMEWORK}Non-Niagara Framework {/NIAGARA FRAMEWORK}DDC Hardware used for alarm generation must meet the following requirements:

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

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

{NOT NIAGARA FRAMEWORK}c. For Event Enrollement Objects used for alarm generation, the following Properties must be Writeable:

(1) Event_Parameters
(2) Event_Enable
(3) If the issue date of this project specification is after 1 January 2016, Time_Delay_Normal must be writeable.
{/NOT NIAGARA FRAMEWORK}

{NOT NIAGARA FRAMEWORK}d{/NOT NIAGARA FRAMEWORK}{NIAGARA FRAMEWORK}c{/NIAGARA FRAMEWORK}. For all Objects implementing Intrinsic Alarming, the following Properties must be Writeable:

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

{NOT NIAGARA FRAMEWORK}e{/NOT NIAGARA FRAMEWORK}{NIAGARA FRAMEWORK}d{/NIAGARA FRAMEWORK}. It is preferred, but not required, that devices support the DM-OCD-B BIBB on all Notification Class Objects{NOT NIAGARA FRAMEWORK} and Event Enrollment Objects, such that a front end BTL listed as a B-AWS may create or delete Notification Class Objects and Event Enrollment Objects{/NOT NIAGARA FRAMEWORK}. It is also preferred, but not required that devices supporting the DM-OCD-B BIBB accept any valid value as an initial value for properties of Notification Class Objects {NOT NIAGARA FRAMEWORK}and Event Enrollment Objects. Note that there are additional requirements in the EXECUTION Part of this Section for devices which do not support the DM-OCD-B BIBB as specified {/NOT NIAGARA FRAMEWORK}.

{NOT NIAGARA FRAMEWORK}
e. Devices provided to meet the the requirements indicated under "Support for Future Alarm Generation" in the EXECUTION part of this specification must support the AE-N-E-B BIBB.
{/NOT NIAGARA FRAMEWORK}

{NOT NIAGARA FRAMEWORK}2.3.5.3 Trending Hardware

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

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

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

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

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

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

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

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

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

{/NOT NIAGARA FRAMEWORK}

{NIAGARA FRAMEWORK}2.3.6 Niagara Framework Supervisory Gateway

**********

**NOTE: FYI - The Niagara Framework Supervisory Gateway is known by many names within industry, and this specification uses the name "Niagara Framework Supervisory Gateway" in order to remain vendor neutral. Probably the most common term used for this device in industry is a "Java Application Control Engine", or JACE.**

**********

Any device implementing the Niagara Framework is a Niagara Framework Supervisory Gateway and must meet these requirements. In addition to the general requirements for all DDC Hardware, Niagara Framework Supervisory Gateway Hardware must:

a. Be direct digital control hardware.

b. Have an unrestricted interoperability license and its Niagara Compatability Statement (NiCS) must follow the Tridium Open NiCS Specification.

c. Manage communications between a field control network and the Niagara Framework Monitoring and Control Software, and between itself and other Niagara Framework Supervisory Gateways. Niagara Framework Supervisory Gateway Hardware must use Fox protocol for communication with other Niagara Framework Components, regardless of the manufacturer of the other components.

d. Be fully programmable using the Niagara Framework Engineering Tool and must support the following:

(1) Time synchronization, Calendar, and Scheduling using Niagara Scheduling Objects

(2) Alarm generation and routing using the Niagara Alarm Service

(3) Trending using the Niagara History Service and Niagara Trend Log Objects

(4) Integration of field control networks using the Niagara Framework Engineering Tool

(5) Configuration of integrated field control system using the Niagara Framework Engineering Tool when supported by the field control system

e. Meet the following minimum hardware requirements:

(1) [One]{NAVY}[Two]{/NAVY} 10/100{NAVY}/1000{/NAVY} Mbps Ethernet Port (s)

(2) One or more MS/TP ports.{NAVY}[

(3) Central Processing Unit of 600 Mhz or higher.][

(4) Embedded operating system.]{/NAVY}

f. Provide access to field control network data and supervisory functions via web interface and support a minimum of 16 simultaneous users. Note: implementation of this capability may not be required on all projects.

g. Submit a backup of each Niagara Framework Supervisory Gateway as specified in Section 23 09 00 INTRUMENTATION AND CONTROL FOR HVAC. The backup must be sufficient to restore a Niagara Framework Supervisory Gateway to the final as-built condition such that a new Niagara Framework Supervisory Gateway loaded with the backup is indistringuishable in functionality from the original.
{/NIAGARA FRAMEWORK}

{NIAGARA FRAMEWORK}2.4 Niagara Framework Engineering Tool

The Niagara Framework Engineering Tool must be Niagara Workbench or an equivalent Niagara Framework engineering tool software and must:

a. Have an unrestricted interoperability license and its Niagara Compatability Statement (NiCS) must follow the Tridium Open NiCS Specification.

b. Be capable of performing network configuration for Niagara Framework Supervisory Gateways and Niagara Framework Monitoring and Control Software.

c. Be capable of programming and configuring of Niagara Framework Supervisory Gateways and Niagara Framework Monitoring and Control Software.

d. Be capable of discovery of Niagara Framework Supervisory Gateways and all points mapped into each Niagara Framework Supervisory Gateway and making these points accessible to Niagara Framework Monitoring and Control Software.

Monitoring and Control Software is specified in Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION.
{/NIAGARA FRAMEWORK}

PART 3 EXECUTION

**********

**NOTE: Use the bracketed text for retrofit projects only. For new construction, the existing conditions survey may not be required and may be removed (be sure to remove the report from the submittals as well). Keeping it as a requirement, however, will ensure that the Contractor checks the mechanical equipment prior to beginning controls installation.**

**This should allow problems to be caught and addressed earlier.**

**********

3.1 CONTROL SYSTEM INSTALLATION{NIAGARA FRAMEWORK}3.1.1 Niagara Framework Engineering Tool

**********

**NOTE: If the installation has a Niagara Framework Engineering Tool keep the first bracketed text and provide the software name and version number in the space provided. If the installation does not have a Niagara Framework Engineering Tool keep the seconded bracketed text.**

**********

[The project site currently has the [_____] Niagara Framework Engineering Tool. If this software is not adequate for programming the Niagara Framework Supervisory Gateways provided under this project, provide a Niagara Framework Engineering Tool.][Provide a Niagara Framework Engineering Tool.]
{/NIAGARA FRAMEWORK}

3.1.2 Building Control Network (BCN)

**********

**NOTE: Note that the term BCN is used across multiple specification including those using different protocols, and "network" is used in the generic sense to refer to the entire system. In BACnet this is called the Internetwork but the term BCN is still used for consistency across specification.**

**********

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

Except {NIAGARA FRAMEWORK}for the IP Network and {/NIAGARA FRAMEWORK}as permitted for the non-BACnet side of Gateways, use exclusively ASHRAE 135 networks.

3.1.2.1 Building Control Network IP Backbone

**********

**NOTE: Select the appropriate bracketed options to indicate whether the FPOC location is shown on a drawing or to specify the BPOC location here.**

**********

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

room.

Use UDP port 0xBAC0 for all BACnet traffic on the IP network. {NIAGARA FRAMEWORK}(Note that in a Niagara Framework system there may not be BACnet traffic on the IP Network){/NIAGARA FRAMEWORK}

3.1.2.2 BACnet MS/TP Networks

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

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

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

**********
**NOTE: 3-wire media (twisted pair with reference), which is required by this section, allows for both 2-wire and 3-wire MS/TP devices to co-exist on the same bus. Please refer to ASHRAE 135 (2012), subpart 9.2.2.1.1.4.**
**********

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

d. For 18 AWG cable, use segments with a maximum length of 1200 m4000 ft. When using greater distances or different wire gauges comply with the electrical specifications of TIA-485.

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

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

g. Connect each MS/TP network to the BCN backbone via {NIAGARA FRAMEWORK}a Niagara Framework Supersisory Gateway configured as {/NIAGARA FRAMEWORK} a BACnet Router.

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

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

3.1.2.3 Building Control Network (BCN) Installation

Provide a building control network meeting the following requirements:

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

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

c. Traffic between BACnet networks must be exclusively via BACnet routers. {NIAGARA FRAMEWORK}

d. Use the Fox protocol for all traffic both originating and terminating at Niagara Framework components. Use the Fox protocol for all traffic originating or terminating at a Niagara Framework UMCS (including traffic to or from a future UMCS). All other traffic, including traffic between ASHRAE 135 devices and traffic between Niagara Framework Supervisory Gateways and ASHRAE 135 devices must be in accordance with ASHRAE 135. {/NIAGARA FRAMEWORK}

3.1.3 DDC Hardware

**********
**NOTE: Indicate whether enclosures must be lockable.**
**********

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

a. Except for zone sensors (thermostats), install all Tethered Hardware within 2 m 6 feet of its base unit.

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

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

3.1.3.1 Device Identifiers, Network Addresses, and IP addresses

**********
**NOTE: Each device requires a unique DeviceID and each network requires a unique Network Number; a BACnet system will not operate if there are duplicates. While it is a simple matter to ensure unique IDs for a single project, there is no mechanism in BACnet to avoid duplicates when a project is later integrated into an existing basewide UMCS.**
**The installation must manually track and manage DeviceIDs and Network Numbers among all their BACnet systems, networks, and devices. The UFC has information on suggested strategies. Coordinate with the installation and either instruct the contractor to coordinate with the installation, or provide ranges for DeviceIDs and Network Numbers. BACnet allows DeviceIDs in the range 0 - 4,194,302**

**and Network Numbers in the range 1 - 65,534. Coordinate IP addresses with the installation NEC or instruct the contractor to do so.**

**********

a. Do not use any Device Identifier or Network Number already used by another BACnet system at the project site. [Coordinate Device IDs and Network Numbers with the installation. The installation POC is [_____]] [Use Device IDs within the range of [_____] to [_____] and Network Numbers in the range of [_____] to [_____]].

b. [Use IP addresses within the range of [_____] to [_____]] [Coordinate device IP addresses with installation. The installation POC is [_____]].

3.1.3.2 {NIAGARA FRAMEWORK}ASHRAE 135 {/NIAGARA FRAMEWORK}Object Name Property and Object Description Property

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

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

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

**********

**NOTE: Indicate who is authorized to approve alternative object (point) names and descriptions.**

**********

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

{NIAGARA FRAMEWORK}3.1.3.3 Niagara Framework Point Names and Descriptions

Configure the names and descriptions of all Points in Niagara Framework Suprervisory Gateways as indicated on the Points Schedule and as specified.

3.1.3.4 Niagara Station IDs

Ensure that Niagara Station IDs of new Niagara Framework Supervisory Gateways are maintained as unique within UMCS front-end, including ensuring they do not conflict with any existing Niagara Station ID.
{/NIAGARA FRAMEWORK}

3.1.3.5 Hand-Off-Auto (H-O-A) Switches

**********

**NOTE: See also DDC Hardware in PART 2.**

**The bracketed text is a general requirement for**

**H-O-A switches and should only be included if such a requirement is absolutely necessary. It is best practice to use overrides in lieu of H-O-A switches. If H-O-A switches are specifically required by the project site it is best to remove the bracketed text and indicate which points require H-O-A switches on the Points Schedules.**

**Note that many sequences already have H-O-A switch requirements for motors independent of any other H-O-A requirements.**

**Select the desired capability for external switches for analog outputs**

**********

Provide Hand-Off-Auto (H-O-A) switches [for all DDC Hardware analog outputs and binary outputs used for control of systems other than terminal units, ]as specified and as indicated on the Points Schedule. Provide H-O-A switches that are integral to the controller hardware, an external device co-located with (in the same enclosure as) the controller, integral to the controlled equipment, or an external device co-located with (in the same enclosure as) the controlled equipment.

a. For H-O-A switches integral to DDC Hardware, meet the requirements specified in paragraph DIRECT DIGITAL CONTROL (DDC) HARDWARE.

b. For external H-O-A switches used for binary outputs, provide for overriding the output open or closed.

c. For eternal H-O-A switches used for analog outputs, provide for overriding [to 0 percent or 100 percent][through the range of 0 percent to 100 percent].

3.1.3.6 Local Display Panels

**********

**NOTE: Designer must indicate on each Points Schedule which points, if any, are to be displayed or adjustable from an LDP.**

**Designer should coordinate with the project site to determine number and location of LDPs needed and show on them on the drawings.**

**********

Provide LDPs to display and override values of {NIAGARA FRAMEWORK} points in a Niagara Framework Supervisory Gateway or {/NIAGARA FRAMEWORK} ASHRAE 135 Object Properties as indicated on the Points Schedule. Install LDPs displaying points for anything other than a terminal unit in the same room as the equipment. Install LDPs displaying points for only terminal units [in a mechanical room central to the group of terminal units it serves][_____]. For LDPs using WriteProperty to commandable objects to implement an override, write values with priority 10.

3.1.3.7 MS/TP Slave Devices

Configure all MS/TP devices as Master devices. Do not configure any devices to act as slave devices.

3.1.3.8 Change of Value (COV) and Read Property

a. To the greatest extent possible, configure all devices to support the SubscribeCOV service (the DS-COV-B BIBB). At a minimum, all devices supporting the DS-RP-B BIBB, other than devices controlling only a single terminal unit, must be configured to support the DS-COV-B BIBB.

b. Whenever supported by the server side, configure client devices to use the DS-COV-A BIBB.

3.1.3.9 Engineering Units

**********

**NOTE: Coordinate with site and select either English or SI units for the building control system devices based on the standard used at the project site. Units must NOT be changed between BACnet projects at a site as units MUST be standardized across the entire UMCS. Also note that this choice affects how values are stored and/communicated in the system, not necessarily how they are displayed at the front end.**

**Keep the first section of bracketed text for SI (Metric) units, and the second for IP (English) units.**

**********

[ Configure devices to use SI (Metric) units as follows:

a. Temperature in degrees C

b. Air or natural gas flows in Liters per Second (LPS)

c. Water flow in Liters per Second (LPS)

d. Steam flow in kilograms per second (kg/s)

e. Diffential Air pressures in Pascals (Pa)

f. Water, steam and natural gas pressures in kiloPascals (kPa)

g. Enthalpy in kiloJoules per kilogram (kJ/kg)

h. Heating and Cooling Energy in kilowatt-hours (kWh)

i. Heating and Cooling load in kilowatts (kW)

j. Electrical Power: kilowatts (kW)

k. Electrical Energy: kilowatt-hours (kWh)][Configuee devices to use English (Inch-Pound) engineering units as follows:

a. Temperature in degrees F

b. Air or natural gas flows in cubic feet per minute (CFM)

c. Water in gallons per minute (GPM)

d. Steam flow in pounds per hour (pph)

e. Differential Air pressures in inches of water column (IWC)

f. Water, steam, and natural gas pressures in PSI

g. Enthalpy in BTU/lb

h. Heating and cooling energy in MBTU (1MBTU = 1,000,000 BTU))

i. Cooling load in tons (1 ton = 12,000 BTU/hour)

j. Heating load in MBTU/hour (1MBTU = 1,000,000 BTU)

k. Electrical Power: kilowatts (kW)

l. Electrical Energy: kilowatt-hours (kWh)]

3.1.3.10 Occupancy Modes

**********

**NOTE: Intent is to standardize mode enumerations for operational modes. Sequences will be defined in Specification Section 23 09 93 SEQUENCES OF OPERATION FOR HVAC CONTROL**

**********

Use the following correspondence between value and occupancy mode whenever an occupancy state or value is required:

a. OCCUPIED mode: a value of one
b. UNOCCUPIED mode: a value of two
c. WARM-UP/COOL-DOWN (PRE-OCCUPANCY) mode: a value of three

Note that elsewhere in this Section the Schedule Object is required to also support a value of four, which is reserved for future use. Also note that the behavior of a system in each of these occupancy modes is indicated in the sequence of operation for the system.

3.1.3.11 Use of BACnet Objects

{NIAGARA FRAMEWORK} Except as specifically indicated for Niagara Framework Objects, {/NIAGARA FRAMEWORK} Use only standard non-proprietary ASHRAE 135 Objects and services to accomplish the project scope of work as follows:

a. Use Analog Input or Analog Output Objects for all analog hardware I/O. Do not use Analog Value Object for analog hardware I/O) .

b. Use Binary Input or Binary Output Objects for all binary hardware I/O. Do not use Binary Value Objects for binary hardware I/O.

c. Use Analog Value Objects for analog setpoints.

d. Use Accumulator Objects or Analog Value Objects for pulse inputs.

e. For occupancy modes, use Multistate Value Objects and the correspondence between value and occupancy mode specified in paragraph

OCCUPANCY MODES.

f. {NOT NIAGARA FRAMEWORK} Use Schedule Objects and Calendar Objects for all scheduling. Use Trend Log Objects or Trend Log Multiple Objects for all trending and Notification Class Objects for trend log upload. Use a combination of Event Enrollment Objects,{/NOT NIAGARA FRAMEWORK} {NIAGARA FRAMEWORK}Use a combination of Niagara Framework Alarm Extensions and Alarm Services,{/NIAGARA FRAMEWORK} Intrinsic Alarming, and Notification Class Objects for alarm generation.

g. For all other points shown on the Points Schedule as requiring an ASHRAE 135 Object, use the Object type shown on the Points Schedule or, if no Object Type is shown, use a standard Object appropriate to the point.

{NIAGARA FRAMEWORK}3.1.3.11.1 Niagara Framework Objects

Points in the Niagara Framework Supervisory Gateway, even if used in a sequence or are shown on the Points Schedule, are not required to be exposed as BACnet Objects unless they are required to be available on the network by another device or sequence of operation (i.e. there is some other reason they are needed).

Use a Niagara Framework Supervisory Gateway as specified for all scheduling and trending. Use a Niagara Framework Supervisory Gateway as specified for all alarming except for intrisic alarming.

{/NIAGARA FRAMEWORK}3.1.3.12 Use of Standard BACnet Services

Except as noted in this paragraph, for all DDC Hardware {NIAGARA FRAMEWORK} (including Niagara Frameworks Supervisory Gateways when communicating with non-Niagara Framework DDC Hardware) {/NIAGARA FRAMEWORK} use Standard BACnet Services as defined in this specification (which excludes some ASHRAE 135 services) exclusively for application control functionality and communication.

DDC Hardware that cannot meet this requirement may use non-standard services provided they can provide identical functionality using Standard BACnet Services when communicating with BACnet devices from a different vendor. When implementing non-standard services, document all non-standard services in the DDC Hardware Schedule as specified and as specified in Section 23 09 00 INTRUMENTATION AND CONTROL FOR HVAC.

3.1.3.13 Device Application Configuration

a. For every property, setting or value shown on the Points Schedule or otherwise indicated as Configurable, provide a value that is retained through loss of power and can be changed via one or more of:

(1) BACnet services (including proprietary services)

(2) Hardware settings on the device{NIAGARA FRAMEWORK}3) Niagara Framework {/NIAGARA FRAMEWORK}

b. For every property, setting or value {/NIAGARA FRAMEWORK}in non-Niagara Framework Hardware{/NIAGARA FRAMEWORK} shown on the Points Schedule or otherwise indicated as Operator Configurable, provide a value that is retained through loss of power and can be changed via one or more of:

(1) A Writeable Property of a standard BACnet Object

(2) A Property of a standard BACnet Object that is Writeable when Out_Of_Service is TRUE and Out_Of_Service is Writeable.

{NIAGARA FRAMEWORK}(3) Using some other method supported by a Niagara Framework Supervisory Gateway

c. Configure Niagara Framework Supervisory Gateways such that the property, setting or value is configurable from a Niagara Framework Front End.

d. For every property, setting or value in a Niagara Framework Supervisory Gateway which is shown on the Points Schedule or otherwise indicated as Operator Configurable, configure the value to be configurable from within the Niagara Framework such that it can be configured from a system graphic page at a Niagara Framework Front End.

{/NIAGARA FRAMEWORK}

{NIAGARA FRAMEWORK} 3.1.3.14 Niagara Framework Engineering Tool

Use the Niagara Framework Engineering Tool to fully discover the field control system and make all field control system information available to the Niagara Framework Supervisory Gateway. Ensure that all points on the points schedule are available to the front end via the Fox protocol.

[3.1.3.15 Graphics and Web Pages

**********

**NOTE: Only include this requirement if requiring web pages served from the Niagara Framework Supervisory Gateway. Select options based on project requirements.**

**Note that serving web pages from the Niagara Framework Supervisory Gateway is normally not necessary as web pages will typically be served from a Niagara Framewwork front end.**

**The contractor will require a certificate for the Web Server (in order to use HTTPS as required here). Coordinate with the project site IT organization {ARMY}(NEC){/ARMY} to obtain this certificate.**

**********

Configure Niagara Framework Supervisory Gateways to use web pages to provide a graphical user interface including System Displays[ using the project site sample displays], including overrides, as indicated on the Points Schedule and as specified. Label all points on displays with [full English language descriptions][the point name as indicated on the Points Schedule][the point description as indicated on the Points Schedule][_____]. Configure user permissions for access to and executions of action using graphic pages. Coordinate user permissions with [the [Controls] [HVAC] [Electrical] shop supervisor][_____]. Configure the web server to use HTTPS based on the Transport Layer Security (TLS) protocol in accordance with RFC 5246 using a Government furnished certificate.
{/NIAGARA FRAMEWORK}

]3.1.4 Scheduling, Alarming, Trending, and Overrides

3.1.4.1 Scheduling
{NOT NIAGARA FRAMEWORK}
**********
**NOTE: Indicate the number of blank schedule objects required for later use. In determining this number keep in mind that this is for future support (adding more schedules after the system is completed) and that one schedule can be used for multiple HVAC systems.**
**********

Configure schedules in BACnet Scheduling Objects to schedule systems as indicated on the Points Schedule and as specified using the indicated correspondence between value and occupancy mode. If no devices supports both the SCHED-E-B and DM-OCD-B BIBBS for Schedule Objects, provide [5][_____] blank Schedule Objects in DDC Hardware BTL listed as B-BCs and supporting the SCHED-E-B BIBB for later use by the site.{/NOT NIAGARA FRAMEWORK}
{NIAGARA FRAMEWORK}Configure schedules in Niagara Framework Supervisory Gateway using Niagara Schedule Objects as indicated on the Points Schedule and as specified. When the schedule is controlling occupancy modes in DDC Hardware other than a Niagara Framework Supervisory Gateway use the indicated correspondence between value and occupancy mode.
{/NIAGARA FRAMEWORK}

**********
**NOTE: Indicate if a common schedule may be used for multiple Terminal Units (TUs). If allowing a common schedule for multiple TUs: keep the 'group of' bracketed text, and decide if TU groupings will be included on the drawings (keep the 'as indicated' bracketed text) or if the Contractor should decide on groupings (remove the 'as indicated' bracketed text).**
**********

Provide a separate schedule for each AHU including it's associated Terminal Units and for each stand-alone Terminal Unit (those not dependent upon AHU service)[ or group of stand-alone Terminal Units acting according to a common schedule[ as indicated]].

{NIAGARA FRAMEWORK}3.1.4.2 Alarm Configuration

Configure alarm generation and management as indicated on the Points Schedule and as specified. Configure alarm generation in Niagara Framework Supervisory Gateways using Niagara Framework Alarm Extensions and Alarm Services or in other DDC Hardware (not Niagara Framework Supervisory Gateways) using ASHRAE 135 Intrinsic Alarming. Configure alarm maganement and routing for all alarms, including those generated via intrinsic alarming in other devices, in the Niagara Framework Supervisory Gateway such that the alarms are able to be accessed from the Niagara Framework Frone End.

Where Intrinsic Alarming is used, configure intrinsic alarming as specified in paragraph "Configuration of ASHRAE 135 Intrinsic Alarm Generation". Configure a Niagara Framework Supervisory Gateway to provide a means to

configure the intrinsic alarm parameters such that the Intrinsic Alarm is configurable from the front end via the Niagara Framework.
{/NIAGARA FRAMEWORK}

3.1.4.3 Configuration of {NIAGARA FRAMEWORK}ASHRAE 135 Intrinsic {/NIAGARA FRAMEWORK}Alarm Generation

{NOT NIAGARA FRAMEWORK}Configure alarm generation as indicated on the Points Schedule and as specified using Intrinsic Alarming in accordance with ASHRAE 135 or Algorithmic Alarming in accordance with ASHRAE 135. Alarm {/NOT NIAGARA FRAMEWORK} {NIAGARA FRAMEWORK} Intrinsic alarm {/NIAGARA FRAMEWORK}generation must meet the following requirements:

a. Send alarm events as Alarms (not Events).

b. Use the ConfirmedNotification Service for alarm events.

c. For alarm generation, support two priority levels for alarms: critical and non-critical. Configure the Priority of Notification Class Objects to use Priority 112 for critical and 224 for non-critical alarms.

d. Number of Notification Class Objects for Alarm Generation:

(1) If the device implements non-critical alarms, or if any Object in the device supports Intrinsic Alarms, then provide a single Notification Class Object specifically for (shared by) all non-critical alarms.

(2) If the device implements critical alarms, provide a single Notification Class Object specifically for (shared by) all critical alarms.

(3) If the device implements both critical and non-critical alarms, provide both Notification Class Objects (one for critical, one for non-critical).

(4) If the device controls equipment other than a single terminal unit, provide both Notification Class Objects (one for critical, one for non-critical) even if no alarm generation is required at time of installation.

e. For all intrinsic alarms configure the Limit_Enable Property to set both HighLimitEnable and LowLimitEnable to TRUE. If the specified alarm conditions are for a single-sided alarm (only High_Limit used or only Low_Limit used) assign a value to the unused limit such that the unused alarm condition will not occur.

f. For all objects supporting intrinsic alarming, even if no alarm generation is required during installation, configure the following Properties as follows:

(1) Notification_Class to point to the non-Critical Notification Class Object in that device.

(2) Limit_Enable to enable both the HighLimitEnable and LowLimitEnable

(3) Notify_Type to Alarm

{NOT NIAGARA FRAMEWORK}g. Use of alarm generation types:

(1) Only use algorithmic alarm generation when intrinsic alarm generation is not supported by the device or object, or when the specific alarm conditions cannot be implemented using intrinsic alarm generation.

(2) Only use remote alarm generation when the alarm cannot be generated using intrinsic or local algorithmic alarm generation on the device containing the referenced property. If remote alarm generation is used, use the same DDC Hardware for all remote alarm generation within a single sequence.

{/NOT NIAGARA FRAMEWORK}

{NIAGARA FRAMEWORK}g. Configure the Recipient_List Property of the Notification Class Object to point to the Niagara Framework Supervisory Gateway managing the alarm.

{/NIAGARA FRAMEWORK}

{NOT NIAGARA FRAMEWORK}3.1.4.4 Support for Future Alarm Generation

For every piece of DDC Hardware, support future alarm generation capabilities by supporting either intrinsic or additional algorithmic alarming. Provide one of the following:

a. Support intrinsic alarming for every Object used by the application in that device.

b. Support additional Event_Enrollment Objects. For DDC hardware controlling a single terminal unit, support at least one additional object. Otherwise, support at least [4][_____] additional Objects. Support additional Event_Enrollment Objects via one of the following:

(1) Provide unused Event_Enrollment Objects on that device.

(2) Support the DM-OCD-B BIBB and the creation of sufficient Event_Enrollment Objects on that device.

(3) Provide one or more devices in the IP network that support the AE-N-E-B BIBB and have unused Event_Enrollment Objects.

(4) Provide one or more devices on the IP network that support the AE-N-E-B BIBB, the DM-OCD-B BIBB, and the creation of sufficient Event_Enrollment Objects.

The total number of Event_Enrollement Objects required by the project is the sum of the individual device requirements, and the distribution of Event_Enrollement Objects among devices is not further restricted. (Note this allows a single device to contain many Event_Enrollement Objects satisfying the requirements for multiple devices.)

3.1.4.5 Trend Log Configuration

a. Configure trends in Trend Log or Trend Log Multiple Objects as indicated on the Points Schedule and as specified.

b. Configure all trend logs (including any provided to support future trends) to save data on regular intervals using the BUFFER_FULL event to request trend upload from the front end.

c. Configure Trend Log Objects with a minimum Buffer_Size property value of 1,000 and Trend Log Multiple Objects with a minimum Buffer_Size property value of 1,000 per point trended (for example, a Trend Log Multiple Object used to trend 3 points must have a Buffer_Size Property value of at least 3,000).

d. Configure a Notification Class Object in devices doing trending (including devices supporting future trends) to handle the BUFFER_FULL event.

e. When possible, trend each point using an Object in the device containing the point. When it is necessary to trend using a an Object in another device, all trends not on the same Device as the Object being trended must be on a singe device (i.e. all Trend Log and Trend Log Multiple Objects used for remote trending within a sequence must be on the same device).

f. For each trend log, including any trend logs provided to support future trending, configure the following properties as specified:

(1) Logging_Type: Set to Polling

(2) Stop_When_Full: Set to Wrap Around

(3) Buffer_Size: Set to 400 or greater.

(4) Notification_Threshold: Set to 90 percent of full

(5) Notification_Class: Set to the Notification Class Object in that device

(6) Event_Enable: Set to TRUE

(7) Log_Interval: Set to 15 minutes.

g. Future Trending support. Provide support for future trending:

(1) Provide one or more devices on the Building Control Network Backbone IP network which support both the T-VMT-E-B and DM-OCD-B BIBBs for Trend Log Objects. Provide sufficient devices to support the creation of at least [[_____] additional Trend Log Objects][one additional Trend Log Object for every terminal unit plus 4 additional Trend Log Objects for every non-terminal unit].

(2) Provide [[_____] additional Trend Log Objects][one additional Trend Log Object for every terminal unit plus 4 additional Trend Log Objects for every non-terminal unit] in one or more devices on the Building Control Network Backbone IP network that support the T-VMT-E-B BIBB for later use by the site.

(3) A combination of these two methods is permitted provided the total required number of Trend Log Objests is met.

{/NOT NIAGARA FRAMEWORK}{NIAGARA FRAMEWORK}3.1.4.6 Trending

Perform all trending using a Niagara Framework Supervisory Gateway using Niagara Framework History Extensions and Niagara Framework History Service exclusively. {/NIAGARA FRAMEWORK}

3.1.4.7 Overrides

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**DEISGNER NOTE: The strongly preferred method of Overrides is through Commandable Objects. Consider carefully before approving the other method specified here, and do not approve any other method of Overriding.**

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Provide an override for each point shown on the Points Schedule as requiring an override. {NIAGARA FRAMEWORK}Use the Niaagra Framework for all overrides to points in Niagara Framework Supervisory Gateways. For overrides to other points, provide an override to a point in a Niagara Framework Supervisory Gateway via the Niagara Framework where the Niagara Framework Supervisory Gateway overrides the other point as specified. {/NIAGARA FRAMEWORK}

Unless otherwise approved, provide Commandable Objects to support all Overrides {NIAGARA FRAMEWORK}in non-Niagara Framework Supervisory Gateway DDC Hardware{/NIAGARA FRAMEWORK}. With specific approval from the contracting officer, Overrides for points which are not hardware outputs and which are in DDC hardware controlling a single terminal unit may support overrides via an additional Object provided for the override. No other means of implementing Overrides may be used.

a. Where Commandable Objects are used, ensure that WriteProperty service requests with a Priority of 10 or less take precedence over the SEQUENCE VALUE and that WriteProperty service request with a priority of 11 or more have a lower precedence than the SEQUENCE VALUE.

b. For devices implementing overrides via additional Objects, provide Objects which are NOT Written to as part of the normal Sequence of Operations and are Writeable when Out_Of_Service is TRUE and Out_Of_Service is Writeable. Use this point as an Override of the normal value when Out_Of_Service is TRUE and the normal value otherwise. Note these Objects may be modified as part of the sequence via local processes, but must not be modified by local processes when Out_Of_Service is TRUE.

3.1.5 BACnet Gateways

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**NOTE: The intent of this is to allow the use of gateways to packaged equipment controllers not procured under the scope of the project this specification is used for and, to not allow the installation of a non-BACnet network connected to a BACnet network via a gateway.**

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The requirements in this paragraph do not permit the installation of hardware not meeting the other requirements of this section. All control hardware installed under this project must meet the requirements of this specification, including control hardware provided as part of a package unit or as part of equipment specified under another section. Only use gateways to connect to pre-existing control devices.

Provide BACnet Gateways to non-BACnet control hardware as required to

connect existing non-BACnet packaged units and in accordance with the following:

a. Each gateway must communicate with and perform protocol translation for non-BACnet control hardware controlling one and only one package unit.

b. Connect one network port on the gateway to the Building Control Backbone IP Network or to a BACnet MS/TP network and the other port to the single piece of controlled equipment.

c. Configure gateways to map writeable data points in the controlled equipment to Writeable Properties of Standard Objects{NIAGARA FRAMEWORK} or to Niagara Framework points{/NIAGARA FRAMEWORK} as indicated in the Points Schedule and as specified.

d. Configure gateway to map readable data points in the controlled equipment to Readable Properties of Standard Objects{NIAGARA FRAMEWORK} or to Niagara Framework points{/NIAGARA FRAMEWORK}as indicated in the Points Schedule and as specified.

e. Configure gateway to support the DS-COV-B BIBB for all points mapped to BACnet Objects.

f. Do not use non-BACnet control hardware for controlling built-up units or any other equipment that was not furnished with factory-installed controls. {NIAGARA FRAMEWORK}(Note: A Niagara Framework Supervisory Gateway is BACnet control hardware.){/NIAGARA FRAMEWORK}

g. Do not use non-BACnet control hardware for system scheduling functions.

h. Non-BACnet network wiring connecting the gateway to the package unit must not exceed 3 meters 10 feet in length and must connect to exactly two devices: the controlled equipment (packaged unit) and the gateway.

-- End of Section --