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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2016

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

SECTION 23 09 00

INSTRUMENTATION AND CONTROL FOR HVAC

11/15

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QC Checklist for Niagara Framework Based LonWorks Systems

QC Checklist for Niagara Framework Based BACnet Systems

QC Checklist for 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

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SECTION 23 09 00

INSTRUMENTATION AND CONTROL FOR HVAC 11/15

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 items(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 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 in 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 in curly braces ("{" and "}") brackets. For example, the following text would be shown to be in Army tailoring option tags:
 {ARMY}Blah blah blah{/ARMY}

These temporary tags are in turn in the "MANUAL TAILORING TAGS" tailoring option. When managing tailoring options for this specification DESELECT

the "MANUAL TAILORING TAGS" tailoring option to remove these temporary tags.

WARNING - YOU HAVE NOT DESELECTED THE "MANUAL TAILORING TAGS" TAILORING OPTION. YOU MUST DESELECT THIS TAILORING OPTION.

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 BACnet{/NIAGARA BACNET}
{NIAGARA LONWORKS}Niagara LonWorks{/NIAGARA LONWORKS}
{BACNET}BACnet{/BACNET}
{LNS}LNS{/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. Only ONE of the four tailoring options related to the services should be used. You have currently included 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 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.

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,] {LNS or NIAGARA LONWORKS}Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS

{/LNS or NIAGARA LONWORKS}{BACNET or NIAGARA BACNET}Section 23 09 23.02
BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS
{/BACNET or NIAGARA BACNET} and other referenced Sections.

1.1.1.1 System Requirements

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

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.
- 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{AIR FORCE}, unless otherwise pre-approved by the Contracting Officer{/AIR FORCE}.
- 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.
- {NIAGARA BACNET or NIAGARA LONWORKS}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="*" {/NIAGARA BACNET or NIAGARA LONWORKS}

1.1.1.2 End to End Accuracy

NOTE: This paragraph is referenced 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.

1.1.1.3 Verification of Dimensions

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

1.1.1.4 Drawings

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

1.2 RELATED SECTIONS

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

Related work specified elsewhere:

- a. {LNS or NIAGARA LONWORKS}Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS{LNS or NIAGARA LONWORKS}{BACNET or NIAGARA BACNET}Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS{BACNET or NIAGARA BACNET} DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS
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 01 91 00.15 TOTAL 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 (2012; Addenda AR 2013; Errata 1 2013; INT 1-9 2013; Errata 2 2013; INT 10-12 2014; Errata 3-4 2014; Addenda AI-AY 2014; INT 13-19 2015; Errata 5 2015; Addenda AJ-BC 2016) BACnet-A Data Communication Protocol for Building Automation and Control Networks

ASHRAE FUN IP (2013; Addenda and Corrigendum 2013) Fundamentals Handbook, I-P Edition

ASHRAE FUN SI (2013; Addenda and Corrigendum 2013) Fundamentals Handbook, SI Edition

CONSUMER ELECTRONICS ASSOCIATION (CEA)

CEA-709.1-D (2014) Control Network Protocol Specification

CEA-709.3 (1999; R 2004) 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 (2014) Enclosures for Electrical Equipment
(1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2014; AMD 1 2013; Errata 1 2013; AMD 2
2013; Errata 2 2013; AMD 3 2014; Errata
3-4 2014; AMD 4-6 2014) National
Electrical Code

NFPA 90A (2015) 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)

UNDERWRITERS LABORATORIES (UL)

UL 5085-3 (2006; Reprint Nov 2012) 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.

1.4.1 Alarm Generation

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.

{NIAGARA LONWORKS}For Niagara Framework LonWorks Systems, Alarm Generation is the creation of alarm events using the Niagara Framework Alarm Service
{/NIAGARA LONWORKS}

{BACNET or NIAGARA BACNET}In BACnet, Alarm Generation is the creation of alarm events {NIAGARA BACNET}using the Niagara Framework Alarm Service, or {/NIAGARA BACNET}using Event Reporting as defined in ASHRAE 135 in one of three ways:

- a. Intrinsic Alarm Generation using Intrinsic Reporting
- b. Local Algorithmic Alarm Generation using Algorithmic Reporting where the referenced property is in the same device as the Event Enrollment Object
- c. Remote Algorithmic Alarm Generation using Algorithmic Alarming where the referenced property is in a different device than the Event Enrollment Object.{/BACNET or NIAGARA BACNET}

{LNS or NIAGARA LONWORKS}1.4.2 Application Generic Controller (AGC)

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 (GPCC).{/LNS or NIAGARA LONWORKS}

{LNS or NIAGARA LONWORKS}1.4.3 Application Specific Controller (ASC)

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.{/LNS or NIAGARA LONWORKS}

{BACNET or NIAGARA BACNET}1.4.4 Building Automation and Control Network (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.{/BACNET or NIAGARA BACNET}

{BACNET or NIAGARA BACNET}1.4.5 BACnet Advanced Application Controller (B-AAC)

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.{/BACNET or NIAGARA BACNET}

{BACNET or NIAGARA BACNET}1.4.6 BACnet Application Specific Controller (B-ASC)

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.
{/BACNET or NIAGARA BACNET}

{BACNET or NIAGARA BACNET}1.4.7 BACnet Building Controller (B-BC)

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.{/BACNET or NIAGARA BACNET}

{BACNET or NIAGARA BACNET}1.4.8 BACnet Broadcast Management Device (BBMD)

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. {/BACNET or NIAGARA BACNET}

{BACNET or NIAGARA BACNET}1.4.9 BACnet/IP

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. {/BACNET or NIAGARA BACNET}

{BACNET or NIAGARA BACNET}1.4.10 BACnet Internetwork

Two or more BACnet networks, connected with BACnet routers. In a BACnet internetwork, there exists only one message path between devices. {/BACNET or NIAGARA BACNET}

{BACNET or NIAGARA BACNET}1.4.11 BACnet Interoperability Building Blocks (BIBBs)

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)
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)

{/BACNET or NIAGARA BACNET}

{BACNET or NIAGARA BACNET}1.4.12 BACnet Network

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

{/BACNET or NIAGARA BACNET}

{BACNET or NIAGARA BACNET}1.4.13 BACnet Operator Display (B-OD)

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.

{/BACNET or NIAGARA BACNET}

{BACNET or NIAGARA BACNET}1.4.14 BACnet Segment

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

{/BACNET or NIAGARA BACNET}

{BACNET or NIAGARA BACNET}1.4.15 BACnet Smart Actuator (B-SA)

A simple actuator device with limited resources intended for specific applications.{/BACNET or NIAGARA BACNET}

{BACNET or NIAGARA BACNET}1.4.16 BACnet Smart Sensor (B-SS)

A simple sensing device with limited resources.
{/BACNET or NIAGARA BACNET}

{BACNET or NIAGARA BACNET}1.4.17 BACnet Testing Laboratories (BTL)

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.
{/BACNET or NIAGARA BACNET}

{BACNET or NIAGARA BACNET}1.4.18 BACnet Testing Laboratories (BTL) Listed

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".
{/BACNET or NIAGARA BACNET}

1.4.19 Binary

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'.

{LNS or NIAGARA LONWORKS}1.4.20 Binding

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.
{/LNS or NIAGARA LONWORKS}

{BACNET or NIAGARA BACNET}1.4.21 Broadcast

Unlike most messages, which are intended for a specific recipient device, a broadcast message is intended for all devices on the network.
{/BACNET or NIAGARA BACNET}

1.4.22 Building Control Network (BCN)

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

1.4.23 Building Point of Connection (BPOC)

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

{LNS or NIAGARA LONWORKS}1.4.24 Channel

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.

{/LNS or NIAGARA LONWORKS}

1.4.25 Commandable

See Overridable.

{BACNET or NIAGARA BACNET}1.4.26 Commandable Objects

Commandable Objects have a Commandable Property, Priority_Array, and Relinquish_Default Property as defined in ASHRAE 135, Clause 19.2, Command Prioritization.{/BACNET or NIAGARA BACNET}

1.4.27 Configurable

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.

{BACNET or NIAGARA BACNET}

In a {NIAGARA BACNET}Niagara Framework {/NIAGARA BACNET}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 {NIAGARA BACNET}
- 3) via the Niagara Framework{/NIAGARA BACNET}.

Note this is more stringent than the ASHRAE 135 definition.

{/BACNET or NIAGARA BACNET}

{LNS or NIAGARA LONWORKS}1.4.28 Configuration Property

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).

{/LNS or NIAGARA LONWORKS}

1.4.29 Control Logic Diagram

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

{BACNET or NIAGARA BACNET}1.4.30 Device

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

{/BACNET or NIAGARA BACNET}

{BACNET or NIAGARA BACNET}1.4.31 Device Object

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.
{/BACNET or NIAGARA BACNET}

{BACNET or NIAGARA BACNET}1.4.32 Device Profile

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).
{/BACNET or NIAGARA BACNET}

1.4.33 Digital Controller

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)

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.

{LNS or NIAGARA LONWORKS}1.4.35 Domain

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. {/LNS or NIAGARA LONWORKS}

{LNS or NIAGARA LONWORKS}1.4.36 Explicit Messaging

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. {/LNS or NIAGARA LONWORKS}

{LNS or NIAGARA LONWORKS}1.4.37 External Interface File (XIF)

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. {/LNS or NIAGARA LONWORKS}

1.4.38 Field Point of Connection (FPOC)

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.

{NIAGARA BACNET or NIAGARA LONWORKS}1.4.39 Fox Protocol

The protocol used for communication between components in the Niagara Framework. By default, Fox uses TCP port 1911. {/NIAGARA BACNET or NIAGARA LONWORKS}

{LNS or NIAGARA LONWORKS} 1.4.40 Functional Profile

A standard description, defined by LonMark, of one or more LonMark Objects used to classify and certify devices. {/LNS or NIAGARA LONWORKS}

1.4.41 Gateway

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.

{NIAGARA BACNET or NIAGARA LONWORKS} A Niagara Framework Supervisory Gateway is one type of Gateway. {/NIAGARA BACNET or NIAGARA LONWORKS}

{LNS or NIAGARA LONWORKS}1.4.42 General Purpose Programmable Controller (GPPC)

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. {/LNS or NIAGARA LONWORKS}

1.4.43 IEEE 802.3 Ethernet

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)

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)

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

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

1.4.47 IP subnet

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.

{NIAGARA BACNET or NIAGARA LONWORKS}1.4.48 JACE (Niagara Framework)

Java Application Control Engine. See paragraph NIAGARA FRAMEWORK SUPERVISORY GATEWAY {/NIAGARA BACNET or NIAGARA LONWORKS}

1.4.49 Local-Area Network (LAN)

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

1.4.50 Local Display Panels (LDPs)

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.

{LNS or NIAGARA LONWORKS}1.4.51 LonMark

See paragraph LONMARK INTERNATIONAL. Also, a certification issued by LonMark International to CEA-709.1-D devices. {/LNS or NIAGARA LONWORKS}

{LNS or NIAGARA LONWORKS}1.4.52 LonMark International

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. {/LNS or NIAGARA LONWORKS}

{LNS or NIAGARA LONWORKS}1.4.53 LonMark Interoperability Association

See paragraph LONMARK INTERNATIONAL. {/LNS or NIAGARA LONWORKS}

{LNS or NIAGARA LONWORKS}1.4.54 LonMark Object

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). {/LNS or NIAGARA LONWORKS}

{LNS or NIAGARA LONWORKS}1.4.55 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. {/LNS or NIAGARA LONWORKS}

{LNS or NIAGARA LONWORKS}1.4.56 LonWorks Network Services (LNS)

A network management and database standard for CEA-709.1-D devices. {/LNS or NIAGARA LONWORKS}

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

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. {/LNS}

1.4.58 MAC Address

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

{BACNET or NIAGARA BACNET}1.4.59 Master-Slave/Token-Passing (MS/TP)

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

1.4.60 Monitoring and Control (M&C) Software

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.

{BACNET or NIAGARA BACNET}1.4.61 Network Number

A site-specific number assigned to each network. This network number must be unique throughout the BACnet internetwork. {/BACNET or NIAGARA BACNET}

{LNS or NIAGARA LONWORKS}1.4.62 Network Variable

See paragraph STANDARD NETWORK VARIABLE TYPE (SNVT). {/LNS or NIAGARA LONWORKS}

{LNS or NIAGARA LONWORKS}1.4.63 Network Configuration Tool

The software used to configure the control network and set device configuration properties. This software creates and modifies the control network database{LNS} (LNS Database){LNS}. {/LNS or NIAGARA LONWORKS}

{NIAGARA BACNET or NIAGARA LONWORKS}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. {/NIAGARA BACNET or NIAGARA LONWORKS}

{NIAGARA BACNET or NIAGARA LONWORKS}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". {/NIAGARA BACNET or NIAGARA LONWORKS}

{LNS or NIAGARA LONWORKS}1.4.66 Node

A device that communicates using the CEA-709.1-D protocol and is connected to a CEA-709.1-D network. {/LNS or NIAGARA LONWORKS}

{LNS or NIAGARA LONWORKS}1.4.67 Node Address

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). {/LNS or NIAGARA LONWORKS}

{LNS or NIAGARA LONWORKS}1.4.68 Node ID

A unique 48-bit identifier assigned (at the factory) to each CEA-709.1-D device. Sometimes called the Neuron ID. {/LNS or NIAGARA LONWORKS}

{BACNET or NIAGARA BACNET}1.4.69 Object

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. {/BACNET or NIAGARA BACNET}

{BACNET or NIAGARA BACNET}1.4.70 Object Identifier

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. {/BACNET or NIAGARA BACNET}

{BACNET or NIAGARA BACNET}1.4.71 Object Instance

See paragraph OBJECT IDENTIFIER {/BACNET or NIAGARA BACNET}

{BACNET or NIAGARA BACNET}1.4.72 Object Properties

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. {/BACNET or NIAGARA BACNET}

1.4.73 Operator Configurable

{NIAGARA LONWORKS or NIAGARA BACNET}For Niagara Framework Systems, a property, setting, or value is Operator Configurable when it is configurable from a Niagara Framework Front End. {/NIAGARA LONWORKS or NIAGARA BACNET}

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

{BACNET}For BACnet systems, a property, setting, or value in a device is Operator Configurable when it is Configurable and is either:

- a. a Writeable Property of a Standard BACnet Object; or
- b. a Property of a Standard BACnet Object that is Writeable when Out_Of_Service is TRUE and Out_Of_Service is Writeable. {/BACNET}

1.4.74 Override

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.

1.4.75 Performance Verification Test (PVT)

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.

{BACNET or NIAGARA BACNET}1.4.76 Physical Segment

A single contiguous medium to which BACnet devices are attached (ASHRAE 135). {/BACNET or NIAGARA BACNET}

1.4.77 Polling

A device periodically requesting data from another device.

1.4.78 Points

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

{LNS or NIAGARA LONWORKS}1.4.79 Program ID

An identifier (number) stored in the device that identifies the node manufacturer, functionality of device (application & sequence), transceiver used, and the intended device usage. {/LNS or NIAGARA LONWORKS}

1.4.80 Proportional, Integral, and Derivative (PID) Control Loop

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

{BACNET or NIAGARA BACNET}1.4.81 Proprietary

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.

{/BACNET or NIAGARA BACNET}

{BACNET or NIAGARA BACNET}1.4.82 Protocol Implementation Conformance Statement (PICS)

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.

{/BACNET or NIAGARA BACNET}

1.4.83 Repeater

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

1.4.84 Router

A device that connects two {LNS or NIAGARA LONWORKS}channels{/LNS or NIAGARA LONWORKS}{BACNET or NIAGARA BACNET}networks{/BACNET or NIAGARA BACNET} 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 control {BACNET or NIAGARA BACNET}inter{/BACNET or NIAGARA BACNET}network and to control bandwidth usage.

1.4.85 Segment

A 'single' section of a control network that contains no repeaters or routers. There is generally a limit on the number of devices on a segment, and this limit is dependent on the topology/media and device type. {LNS or NIAGARA LONWORKS}For example, a TP/FT-10 network with locally powered devices is limited to 64 devices per segment.

{/LNS or NIAGARA LONWORKS}

{LNS or NIAGARA LONWORKS}1.4.86 Service Pin

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.

{/LNS or NIAGARA LONWORKS}

{BACNET or NIAGARA BACNET}1.4.87 Standard BACnet Objects

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

{/BACNET or NIAGARA BACNET}

{BACNET or NIAGARA BACNET}1.4.88 Standard BACnet Properties

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

proprietary. See Proprietary.
{/BACNET or NIAGARA BACNET}

{BACNET or NIAGARA BACNET}1.4.89 Standard BACnet Services

ASHRAE 135 services other than ConfirmedPrivateTransfer or
UnconfirmedPrivateTransfer. See paragraph PROPRIETARY.
{/BACNET or NIAGARA BACNET}

{LNS or NIAGARA LONWORKS}1.4.90 Standard Configuration Property Type (SCPT)

Pronounced skip-it. A standard format type (maintained by LonMark
International) for Configuration Properties.
{/LNS or NIAGARA LONWORKS}

{LNS or NIAGARA LONWORKS}1.4.91 Standard Network Variable Type (SNVT)

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.
{/LNS or NIAGARA LONWORKS}

{LNS or NIAGARA LONWORKS}1.4.92 Subnet

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.
{/LNS or NIAGARA LONWORKS}

{LNS or NIAGARA LONWORKS}1.4.93 TP/FT-10

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.
{/LNS or NIAGARA LONWORKS}

{LNS or NIAGARA LONWORKS}1.4.94 TP/XF-1250

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.
{/LNS or NIAGARA LONWORKS}

{LNS or NIAGARA LONWORKS}1.4.95 User-defined Configuration Property Type
(UCPT)

Pronounced u-keep-it. A Configuration Property format type that is defined
by the device manufacturer.
{/LNS or NIAGARA LONWORKS}

{LNS or NIAGARA LONWORKS}1.4.96 User-defined Network Variable Type (UNVT)

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.
{/LNS or NIAGARA LONWORKS}

1.4.97 UMCS

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.

1.4.98 UMCS NETWORK

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

{BACNET or NIAGARA BACNET}1.4.99 Writeable Property

A Property is Writeable 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 writeable when the Out of Service Property is TRUE; for purposes of this Section, Properties that are only writeable when the Out of Service Property is TRUE are not considered to be Writeable.
{/BACNET or NIAGARA BACNET}

1.5 PROJECT SEQUENCING

NOTE: Table I 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 I 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 I: 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 I 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 I the abbreviation AAO is used for 'after approval of' and 'ACO' is used for 'after completion of'.

TABLE I. PROJECT SEQUENCING			
ITEM #	TYPE	DESCRIPTION	SEQUENCING (START OF ACTIVITY OR DEADLINE FOR)
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 Configuration Software Programming Software Configuration Software {NIAGARA LONWORKS or NIAGARA BACNET} Niagara Framework Engineering Tool Niagara Framework Wizards {/NIAGARA LONWORKS or NIAGARA BACNET} {LNS or NIAGARA LONWORKS} XIF Files {/LNS or NIAGARA LONWORKS} {LNS} LNS Plug-Ins {/LNS}	[[_____] days]ACO #6
9	S	Draft As-Built Drawings 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	E	Execute PVT	AAO #9 and #11
13	S	PVT Report	[[_____] days]ACO #12

TABLE I. PROJECT SEQUENCING			
ITEM	TYPE	DESCRIPTION	SEQUENCING (START OF ACTIVITY OR DEADLINE FOR)
14	S	Controller Application Programs Controller Configuration Settings {NIAGARA LONWORKS or NIAGARA BACNET} Niagara Framework Supervisory Gateway Backups {/NIAGARA LONWORKS or NIAGARA BACNET} {LNS} Final LNS Database {/LNS}	[[_____] 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 to reflect only the submittals required for the project.

The Guide Specification technical editors have designated 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 submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation 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.

Use the "S" classification only in SD-11 Closeout Submittals. The "S" following a submittal item indicates that the submittal is required for the Sustainability Notebook to fulfill federally mandated sustainable requirements in accordance with Section 01 33 29 SUSTAINABILITY REPORTING.

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" designation; submittals not having a "G" designation are for [Contractor Quality Control approval.] [information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submittals with an "S" are for inclusion in the Sustainability Notebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

NOTE: Decide whether to require a specific drawing size (approx 279x432 mm 11x17inch or 557x860 mm 22x34 inch) or 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.

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

DDC Contractor Design Drawings as a single complete package: [_____] hard copies and [_____] copies on CDROM. 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.

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

Draft As-Built Drawings as a single complete package: [_____] hard copies and [_____] copies on CDROM. 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.

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

Final As-Built Drawings as a single complete package: [_____] hard copies and [_____] copies on CDROM. 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.

SD-03 Product Data

{ARMY}

Certificate of Networthiness Documentation; G[, [_____]]

Submit Certificate of Networthiness Documentation in PDF format on CD-ROM.

{/ARMY}

Programming Software; G[, [_____]]

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

Controller Application Programs; G[, [_____]]

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.

Configuration Software; G[, [_____]]

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

{BACNET or NIAGARA BACNET}

Controller Configuration Settings; G[, [_____]]

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.

{/BACNET or NIAGARA BACNET}

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

Submit Manufacturer's Product Data on CD-ROM.

{LNS}

XIF files; G[, [_____]]

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.

{/LNS}

{LNS}

Draft LNS Database; G[, [_____]]

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.

{/LNS}

{LNS}

Final LNS Database; G[, [_____]]

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.

{/LNS}

{LNS}

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

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.

{/LNS}

{NIAGARA BACNET or NIAGARA LONWORKS}

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

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.

{/NIAGARA BACNET or NIAGARA LONWORKS}

{NIAGARA BACNET or NIAGARA LONWORKS}

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[, [_____]]

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.]
{/NIAGARA BACNET or NIAGARA LONWORKS}

{NIAGARA BACNET or NIAGARA LONWORKS}
Niagara Framework Wizards; G[, [_____]]

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.
{/NIAGARA BACNET or NIAGARA LONWORKS}

SD-06 Test Reports

Existing Conditions Report

[Four][_____] copies of the Existing Conditions Report.

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

PVT Procedures; G[, [_____]]

PVT Report; G[, [_____]]

[Four][_____] copies of the PVT Report. The PVT Report may be submitted as a Technical Data Package.

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

[Four][_____] copies of the Pre-Construction QC Checklist.

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

[Four][_____] copies of the Post-Construction QC Checklist.

SD-10 Operation and Maintenance Data

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

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.

Training Documentation; G[, [_____]]

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.

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

Password Summary Report; G[, [_____]]

Provide [Two][_____] hardcopies of the Password Summary Report,
each copy in its own sealed envelope.

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

[Four][_____] copies of the Closeout QC Checklist.

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 Department of Defense Acquisition
Regulation Supplement (DOD FARS). 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, the Rights in
Technical Data and Computer Software Clause, DOD
FARS 52.227-7013, and the Data Requirements Clause,
DOD FAR 52.227-7031, 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.

{LNS or NIAGARA LONWORKS}1.8.1 Programming Software

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. {NIAGARA LONWORKS}For each type of Application Generic Controller (AGC) provided, 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. {/NIAGARA LONWORKS} Submit hard copies of user manuals for each software with the software submittal.

1.8.2 Controller Application Programs

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}LNS plug-in {/LNS}for that AGC in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. {/LNS or NIAGARA LONWORKS}

{BACNET or NIAGARA BACNET}1.8.3 Configuration Software

For 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.

1.8.4 Controller Configuration Settings

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

1.8.5 Programming Software

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

1.8.6 Controller Application Programs

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

{/BACNET or NIAGARA BACNET}

{LNS}1.8.7 LNS Plug-Ins

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.

{/LNS}

{NIAGARA LONWORKS}1.8.8 Niagara Framework Wizards

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.

{/NIAGARA LONWORKS}

{NIAGARA BACNET or NIAGARA LONWORKS} 1.8.9 Niagara Framework Supervisory Gateway Backups

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.

[1.8.10 Niagara Framework Engineering Tool

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 {NIAGARA LONWORKS} 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS {/NIAGARA LONWORKS}{NIAGARA BACNET} 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS {/NIAGARA BACNET}. Submit software user manuals with the Niagara Framework Engineering Tool submittal.
{/NIAGARA BACNET or NIAGARA LONWORKS}

] {ARMY} 1.8.11 Certificate of Networthiness Documentation

NOTE: Include a copy of a blank Certificate of Networthiness (CoN) "Application Checklist" in the contract package. This document is available at <https://portal.netcom.army.mil/apps/networthiness/SitePages/Home.aspx> (as of December 2014), but this website requires a CAC login so may not be directly accessible to a Contractor.

For all software provided, provide documentation that an Enterprise Certificate of Networthiness exists, that a Limited Certificate of Networthiness for the project site exists, or provide a completed Certificate of Networthiness "Application Checklist".
{/ARMY}

1.9 QUALITY CONTROL CHECKLISTS

The {LNS} QC Checklist for LNS-Based LonWorks Systems {/LNS}{NIAGARA LONWORKS} QC Checklist for Niagara Framework Based LonWorks Systems {/NIAGARA LONWORKS}{BACNET} QC Checklist for Niagara Framework Based BACnet Systems {/BACNET}{NIAGARA BACNET} QC Checklist for BACnet Systems {/NIAGARA BACNET} in APPENDIX A of this Section must be completed by the Contractor's Chief Quality Control (QC) Representative and submitted as indicated. The QC Representative must verify each item indicated and initial in the space provided to indicate that the requirement has been met. The QC Representative must sign and date the Checklist prior to submission to the Government.

1.9.1 Pre-Construction Quality Control (QC) Checklist

Complete items indicated as Pre-Construction QC Checklist items in the QC Checklist.

1.9.2 Post-Construction Quality Control (QC) Checklist

Complete items indicated as Post-Construction QC Checklist items in the QC Checklist.

1.9.3 Closeout Quality Control (QC) Checklist

Complete items indicated as Closeout QC Checklist items in the QC Checklist.

PART 2 PRODUCTS

Provide products meeting the requirements of Section 23 09 13
INSTRUMENTATION AND CONTROL DEVICES FOR HVAC, {LNS or NIAGARA LONWORKS}
Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER
BUILDING CONTROL SYSTEMS{/LNS or NIAGARA LONWORKS}{BACNET or NIAGARA BACNET}
Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER
BUILDING CONTROL SYSTEMS{/BACNET or NIAGARA BACNET}, and this Section.

2.1 GENERAL PRODUCT REQUIREMENTS

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

2.2 PRODUCT DATA

Provide manufacturer's product data sheets documenting compliance with product specifications for each product provided under Section 23 09 13
INSTRUMENTATION AND CONTROL DEVICES FOR HVAC, {LNS or NIAGARA LONWORKS}
Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER
BUILDING CONTROL SYSTEMS{/LNS or NIAGARA LONWORKS}{BACNET or NIAGARA BACNET}
Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER
BUILDING CONTROL SYSTEMS{/BACNET or NIAGARA BACNET}, or this Section.
Provide product data for all products in a single indexed compendium, organized by product type. For each manufacturer, model and version (revision) of DDC Hardware {LNS or NIAGARA LONWORKS} 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{/LNS or NIAGARA LONWORKS}{BACNET or NIAGARA BACNET} 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 {/BACNET or NIAGARA BACNET}.

{LNS or NIAGARA LONWORKS} 2.2.1 XIF Files

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.
{/LNS or NIAGARA LONWORKS}

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.

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.

3.1.2 Existing Equipment Downtime

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

3.1.3 Existing Control System Devices

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

]3.2 INSTALLATION

Fully install and test the control system in accordance Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC, {LNS or NIAGARA LONWORKS} Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS{/LNS or NIAGARA LONWORKS}{BACNET or NIAGARA BACNET} Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS{/BACNET or NIAGARA BACNET}, 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 manner 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 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.

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.

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 through a link in the UFGS graphic table of contents at
<http://www.wbdg.org/ccb/NAVGRAPH/graphtoc.pdf>

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.

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.

- a. Submit DDC Contractor Design Drawings consisting of each drawing indicated with pre-construction information depicting the intended control system design and plans.
- b. Submit Draft As-Built Drawings consisting of each drawing indicated updated with as-built data for the system prior to PVT.
- c. Submit Final As-Built Drawings consisting of each drawing indicated updated with all final as-built data.

Sample drawings in electronic format are available via a link in the "Graphical Table of Contents" online at: <http://www.wbdg.org/ccb/NAVGRAPH/graphdoc.pdf>. These drawings may prove useful in demonstrating expected drawing formatting and example content and are provided for illustrative purposes only. These drawings do not meet the content requirements of this Section.

3.3.1 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.

3.3.2 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.

3.3.3 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.

3.3.4 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.

3.3.5 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.

3.3.6 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.

3.3.7 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.

3.3.8 DDC Hardware Schedule

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

3.3.8.1 DDC Hardware Identifier

The Unique DDC Hardware Identifier for the device.

3.3.8.2 HVAC System

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

{NIAGARA LONWORKS or LNS}3.3.8.3 Network Address

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

3.3.8.4 Unique Node ID

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

{/NIAGARA LONWORKS or LNS}

{NIAGARA BACNET or BACNET}3.3.8.5 Device Object Identifier

The Device Object Identifier: The Object_Identifier of the Device Object

3.3.8.6 Network Number

The Network Number for the device.

3.3.8.7 MAC Address

The MAC Address for the device

3.3.8.8 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.

3.3.8.9 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.

3.3.8.10 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.

3.3.8.11 Scheduling Information

Indicate whether the device is used for scheduling.

3.3.8.12 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.

{/NIAGARA BACNET or BACNET}

{NIAGARA LONWORKS or NIAGARA BACNET} 3.3.8.13 Niagara Station ID

The Niagara Station ID for each Niagara Framework Supervisory Gateway

{/NIAGARA LONWORKS or NIAGARA BACNET}

3.3.9 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:

3.3.9.1 Point Name

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

3.3.9.2 Description

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

3.3.9.3 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.

3.3.9.4 Settings

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

3.3.9.5 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.

3.3.9.6 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.

{BACNET or NIAGARA BACNET}3.3.9.7 Object and Property Information

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

{/BACNET or NIAGARA BACNET}

{LNS or NIAGARA LONWORKS}3.3.9.8 Primary Point Information: SNVT Name

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.

3.3.9.9 Primary Point Information: SNVT Type

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

{/LNS or NIAGARA LONWORKS}

{NIAGARA BACNET or NIAGARA LONWORKS}3.3.9.10 Niagara Station ID

The Niagara Station ID of the Niagara Framework Supervisory Gateway the point is mapped into. {/NIAGARA BACNET or NIAGARA LONWORKS}

{BACNET or NIAGARA BACNET}3.3.9.11 Network Data Exchange Information (Gets Data From, Sends Data To)

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

{/BACNET or NIAGARA BACNET}

{BACNET or NIAGARA BACNET}3.3.9.12 Override Information (Object Type and Instance Number)

For each point requiring an Override{NIAGARA BACNET} and not residing in a Niagara Framework Supervisory Gateway{/NIAGARA BACNET}, 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.

{/BACNET or NIAGARA BACNET}

{LNS or NIAGARA LONWORKS}3.3.9.13 Override Information (SNVT Name and Type)

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

{/LNS or NIAGARA LONWORKS}

{BACNET}3.3.9.14 Trend Object Information

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

{/BACNET}

{BACNET or NIAGARA BACNET}3.3.9.15 Alarm Information

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

3.3.9.16 Configuration Information

Indicate the means of configuration associated with each point. {NIAGARA BACNET or NIAGARA LONWORKS}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:
{/NIAGARA BACNET or NIAGARA LONWORKS}

{BACNET or NIAGARA BACNET}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.
{/BACNET or NIAGARA BACNET}

{LNS or NIAGARA LONWORKS}a. {LNS}Indicate "Plug-In" if the point is configurable via an LNS plug-in.{/LNS} {NIAGARA LONWORKS}Indicate "Niagara Framework Wizard" if the point is configurable via a Niagara Framework Wizard.
{/NIAGARA LONWORKS}

b. If the point is not configurable through {LNS}an LNS plug-in{/LNS}
{NIAGARA LONWORKS}a Niagara Framework Wizard{/NIAGARA LONWORKS}, indicate the network variable or configuration property used to configure the value.
{/LNS or NIAGARA LONWORKS}

3.3.10 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.

3.3.11 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.

3.3.12 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

3.3.13 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).

{LNS}3.5.3 Draft LNS Database

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. {/LNS}

3.6 PERFORMANCE VERIFICATION TEST (PVT)

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.

{LONWORKS}3.6.1.2 Temporary Trending Hardware

NOTE: For LNS-based LonWorks, trending is accomplished at the LNS 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.
{/LONWORKS}

3.6.1.3 Endurance Test

NOTE: Select the duration of the endurance test.

Include a a [one-week] [_____] endurance test as part of the PVT during which the system is operated continuously. {BACNET or NIAGARA BACNET or NIAGARA LONWORKS} Use the building control system {NIAGARA BACNET or NIAGARA LONWORKS} Niagara Treng Log {/NIAGARA BACNET or NIAGARA LONWORKS} {BACNET}BACnet Trend Log or Trend Log Multiple {/BACNET}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. {/BACNET or NIAGARA BACNET or NIAGARA LONWORKS} {LONWORKS}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. {/LNS} {LONWORKS or NIAGARA LONWORKS}The PVT must include a methodology to measure and record the network bandwidth usage on each TP/FT-10 channel during the endurance test.{/LNS or NIAGARA LONWORKS}

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-Built and completion of balancing. Do not conduct tests during scheduled seasonal off periods of base heating and cooling systems. If the system experiences any failures during the endurance test portion of the PVT, repair the system repeat the endurance test portion of the PVT until the system operates continuously and without failure for the specified endurance test period.

3.6.3 PVT Report

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

{LNS}3.6.4 Final LNS Database

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.

{/LNS}

3.7 OPERATION AND MAINTENANCE (O&M) INSTRUCTIONS

Provide HVAC control System Operation and Maintenance Instructions which include:

- a. "Data Package 3" as indicated in Section 01 78 23 OPERATION AND MAINTENANCE DATA for each piece of control equipment.
- b. "Data Package 4" as described in Section 01 78 23 OPERATION AND MAINTENANCE DATA for all air compressors.
- c. HVAC control system sequences of operation formatted as indicated.
- d. Procedures for the HVAC system start-up, operation and shut-down including the manufacturer's supplied procedures for each piece of equipment, and procedures for the overall HVAC system.
- e. As-built HVAC control system detail drawings formatted as indicated.
- f. Routine maintenance checklist. Provide the routine maintenance checklist arranged in a columnar format, where the first column lists all installed devices, the second column states the maintenance activity or that no maintenance required, the third column states the frequency of the maintenance activity, and the fourth column is used for additional comments or reference.
- g. Qualified service organization list, including at a minimum company name, contact name and phone number.
- h. Start-Up Testing Report.
- i. Performance Verification Test (PVT) Procedures and Report.

[3.8 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. {NAVY}Most Navy projects will not use this requirement.{NAVY}

Provide services, materials and equipment as necessary to maintain the entire system in an operational state as indicated for a period of one year after successful completion and acceptance of the Performance Verification Test. 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.

3.8.1 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.

3.8.2 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.

3.8.3 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.

3.8.4 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][_____].

3.8.5 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.

3.8.6 Operation

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

3.8.7 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.

3.8.8 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.

3.8.9 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.

]3.9 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.

3.9.1 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.

3.9.2 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.

APPENDIX A

{LNS}

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

<u>QC CHECKLIST FOR LNS-BASED LONWORKS SYSTEMS</u>		
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	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).	____
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	(QC Representative Signature)	(Date)

{ LNS }

{ NIAGARA LONWORKS }

<u>QC CHECKLIST FOR NIAGARA FRAMEWORK BASED LONWORKS SYSTEMS</u>
<p>This checklist is not all-inclusive of the requirements of this specification and should not be interpreted as such.</p> <p>Instructions: Initial each item in the space provided (____) verifying that the requirement has been met.</p>
<p>This checklist is for (circle one:)</p> <p style="padding-left: 40px;">Pre-Construction QC Checklist Submittal</p> <p style="padding-left: 40px;">Post-Construction QC Checklist Submittal</p> <p style="padding-left: 40px;">Close-out QC Checklist Submittal</p>
Items verified for Pre-Construction, Post-Construction and Closeout QC Checklist Submittals:

<u>QC CHECKLIST FOR NIAGARA FRAMEWORK BASED LONWORKS SYSTEMS</u>		
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 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 is performed in Niagara Framework Supervisory Gateways.	____
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).	____

<u>QC CHECKLIST FOR NIAGARA FRAMEWORK BASED LONWORKS SYSTEMS</u>		
18	Programming software has been submitted for all General Purpose Programmable Controllers (GPPCs) and all Application Generic Controllers (AGCs).	____
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	(QC Representative Signature)	(Date)

{/NIAGARA LONWORKS}

{BACNET}

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

<u>QC CHECKLIST FOR BACNET SYSTEMS</u>		
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 Writeable are Writeable and Overrides have been provided as indicated	____
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	(QC Representative Signature)	(Date)

{/BACNET}

{NIAGARA BACNET}

<u>QC CHECKLIST FOR NIAGARA FRAMEWORK BASED BACNET SYSTEMS</u>
<p>This checklist is not all-inclusive of the requirements of this specification and should not be interpreted as such.</p> <p>Instructions: Initial each item in the space provided (____) verifying that the requirement has been met.</p>
<p>This checklist is for (circle one:)</p> <p style="padding-left: 40px;">Pre-Construction QC Checklist Submittal</p> <p style="padding-left: 40px;">Post-Construction QC Checklist Submittal</p> <p style="padding-left: 40px;">Close-out QC Checklist Submittal</p>

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 Intrinsic Alarming as indicated.	____
15	All Properties indicated as required to be Writeable are Writeable and Overrides have been provided as indicated	____
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<u>QC CHECKLIST FOR NIAGARA FRAMEWORK BASED BACNET SYSTEMS</u>	
	<div>(QC Representative Signature)<div>(Date)</div></div>

{/NIAGARA BACNET}

-- End of Section --