TRIDIUM

Division 25 Specification

SECTION 25 0000 – ENTERPRISE INTEGRATED FACILITY MANAGEMENT AND CONTROL SYSTEM

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SECTION 25 0000 – ENTERPRISE INTEGRATED FACILITY MANAGEMENT AND CONTROL SYSTEM.

PART 1 – GENERAL

1.1 INTENT

The intent of this specification is to define a System Integration and Automation Strategy and Topology to form an Enterprise Facility Management and Control Systems (EFMCS) that is a common platform that will allow for a consistent graphical user interface, system integration and control platform to manage the smart building infrastructure. This system will require the services of a Master System Integrator (MSI)

This section defines the following major systems, subsystems and components that make up the IoT and Integrated Automation Topology, and is based on the open standard Niagara Framework in order to provide the most comprehensively cybersecure with broadest options for acquisition, service and support:

INTEGRATION PLATFORM

A. Niagara Framework and Niagara Web Supervisor N4.x (product info)
(as of late January, 2026, Niagara 4.14(u4) is the current feature release, and the Long Term Support version will be N4.15u3) – click here for features by release)
B. Niagara Workbench

OPERATIONAL TECHNOLOGY NETWORK (OTN)

Facility Network with defined VLANs and systems security

JACE (Controller) Devices

Vykon Jace – JACE 9000 Series (or equivalent OEM Open NIC JACE) (product info)
Vykon Edge 10 Device (or equivalent OEM Niagara Edge device) (product info)

This section requires close coordination with multiple specification sections including SECTION 23 DIRECT DIGITAL CONTROL SYSTEM FOR HVAC. The Systems Integration Matrix and specifications further define the necessary coordination.

A. Facility Services Divisions
1. Division 14 – Elevator Systems
2. Division 14 – Pneumatic Tube System
3. Division 23 – Heating Ventilation and Air Conditioning (HVAC)
Associated Piping (Covered in Division 23 scope of work). Division 22 will be connected through Division 23
4. Division 25 – Integrated Automation
5. Division 26 – Electrical, Lighting Control and Electric Metering
6. Division 27 – Communications
7. Division 28 – Security, Access Control and Digital Addressable Fire Alarm System

B. Refer to drawings (insert drawing number here) for a diagrammatic representation of the System Architecture/Topology.

C. Refer to the System Integration Matrix for detailed description of the systems to be integrated and the responsibilities of each associated division.

1.2 SUMMARY

This section describes the Master Systems Integrator's (MSI) scope for the Integration Platform for the project.

A. Coordinates the responsibilities of the Mechanical and Electrical and Control trade contractors pertaining to control products or systems, furnished by each trade, that will be integrated by this Division.

B. All labor, material, equipment, and software not specifically referred to herein or on the plans, that is required to meet the functional intent of this specification, shall be provided without additional cost to the owner.

C. It is the owner's goal to implement an O*pen System* that will allow products from various suppliers to be integrated into a unified system to provide flexibility for expansion, maintenance, and service of the system. The owner shall be the named license holder of all software associated with any and all incremental work on the project(s).

1.3 MASTER SYSTEMS INTEGRATOR (MSI):

A. The Master Systems Integrator (MSI) shall connect the building stakeholders with their building control systems and provide useful, meaningful, and important information and control capabilities. The MSI is responsible for the integration of building control services such as HVAC, Life Safety, Electrical Distribution, Lighting Control, Security, various Cloud Services, IAQ and other controlled assets as shown in the systems architecture. The MSI shall provide a unified database and graphical user interface tools by collaboration with the owners building control needs. Division 23 shall provide certain Niagara based products, controls, and programming services that require extensive coordination with this division. Division 26 shall provide an integrated Lighting Control System that requires extensive coordination with this division.

B. Roles & Responsibilities: Services required but not limited to:

1. Install Niagara Web Supervisor server software platform licensed to be capable of handling the entire portfolio in a location defined by the owner. Provide an Unlimited Niagara Supervisor license unless otherwise specified.
2. Co-ordinate with owner on proper use of IT within the Enterprise to include but not limited to Authentication, Security Certificates, SSL, Active Directory and or any owner IT requirements. Jointly develop integrated software plan with the owners' building team and vendors to make sure all systems will communicate properly.
3. Review and meet with building team to ensure the building control system information will be accessible and useful.
4. Develop the software layer responsible for integration, aggregation and communications to the building control systems.
5. Standardize software tagging library, templates, and menu hierarchy system, develop strategy for long term template maintenance.
6. Create and maintain graphical controls, monitors and dashboards as defined by the functional requirements of the system.
7. Configure alarm interface / controls, scheduling, and user management capabilities.
8. Commission connected systems for usability and sustainability (all the software tools should be incorporated).
9. Document software maintenance strategy and upgrade procedures.
10. Configure and set up the Building Operations Center Console. Set up displays and software to manage displays. Add browser connection from console to Niagara Web Supervisor Server Software. PC Hardware and Displays will be provided by the owner. Mount displays, PC, Keyboards etc. in console.

C. Qualifications: Specific Requirements per Company

1. Experience in implementing Niagara framework similar for projects of similar size and scope.
2. Must have a successful history in the design and installation of Niagara Framework
3. Must have 5 years consecutive licensing capabilities with the Niagara Framework.
4. Must have a minimum of 2 employed individuals who meet System Requirements per individual.
5. Firms shall have specialized in and be experienced with the installation of the Niagara Framework for not less than five years from the date of final completion on at least three (3) projects of similar size and complexity. Submittals shall document this experience with references.

D. Specific Requirements: per individual

1. Must have 3 years' experience with the firm represented.
2. Proof of Niagara 4 Certification.
3. List and describe a Niagara Enterprise (more than one building) integration project and the programmer's involvement.
4. List and describe a Niagara integration project involving multiple communication protocols or databases.
5. List and describe a Niagara integration project involving multiple platforms such as HVAC, Lighting Control, Security, Life Safety, Utilities, and other building control and or monitoring systems.

1.4 APPROVED MASTER SYSTEMS INTEGRATORS

Vykon (or equivalent OEM) Authorized Master System Integrator (insert qualified or integrators and/or OEM brands here)

1.5 SCOPE OF WORK

The Integration Platform shall include, but not be limited to, the following components/sub systems to provide a fully functional platform required for integrating the systems shown on the system architecture/topology on drawing- *(insert drawing number here)*:

1. Niagara Web Supervisor
2. Niagara Workbench
3. Associated Niagara drivers and applications
4. Niagara based hardware platforms (JACE)
5. Installation, engineering, programming. commissioning

A. The intent of this specification is to provide a system that is consistent with BMS systems throughout the owner's facilities running the Niagara 4 Framework.

B. The MSI shall furnish all labor, materials, and equipment necessary for a complete and operating Integration Platform, utilizing Direct Digital Controls as shown on the drawings and as described herein. Drawings are diagrammatic only. All controllers furnished in this section shall communicate on a peer-to-peer bus over an open protocol bus (Examples: LonTalk, BACnet, MODBUS). The MSI shall submit a Data Plan that includes database standards, graphics, dashboards, data tagging and program guidelines for the Engineer's review.

C. All data collected from disparate Operational Technology (OT) systems shall be placed in a single location (Centralized Database) that can be accessed and used by other integrated systems and software. Data shall be managed in a logical and organized fashion that integrated systems can use.

D. All OT points shall include metadata tagging in accordance with the selected ontology of the Owner (Project Haystack, Brick, Custom…) The MSI shall lead at least one tagging workshop (see Section 3, Execution).

E. System architecture shall fully support a multi-vendor environment and be able to integrate third party systems via existing vendor protocols including, as a minimum, LonTalk, BACnet and MODBUS.

F. System architecture shall provide secure Web access using any of the current versions of Microsoft Edge, Mozilla Firefox, or Google Chrome browsers from any designated computer on the owner's LAN.

G. All control devices furnished with this Section shall be programmable directly from the Niagara 4 Workbench embedded toolset for this project. The use of configurable or programmable controllers that require additional software tools or tools that require a specific Niagara 4 license brand to operate for post-installation maintenance shall not be acceptable.

H. Any control vendor that shall provide additional BMS server software shall be unacceptable. Only systems that utilize the Niagara 4 Framework shall satisfy the requirements of this section.

I. The integration platform server shall host all graphic files for the control system. All graphics and navigation schemes for this project shall match those that are on the Niagara 4 Framework server.

J. A laptop computer shall be provided by the owner for installation of engineering/programming software (Niagara 4 Workbench) by the MSI.

K. Owner shall receive all Administrator level login and passwords for engineering toolset at first training session. The Owner shall have full licensing and full access rights for all network management, operating system server, engineering and programming software required for the ongoing maintenance and operation of the BMS.

L. OPEN NIC STATEMENTS - All Niagara 4 software licenses shall have unrestricted interoperability in accordance with the Niagara Compatibility Statement (NiCS) following the Tridium Open NiCS Specification and shall 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.dat file:

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

In any case, the end user shall maintain the right to instruct the contractor to modify any software license, regardless of supplier, as desired by the end user. The contractor shall not install any “brand-specific” software, applications, or utilities on Niagara Framework-based devices. The use of any proprietary third-party translators, gateways or repeaters is not permitted. All existing controllers must have the latest security patches and firmware upgrades implemented on the devices.

All hardware and field-level devices installed shall not be limited in their ability to communicate with a specific brand of Niagara Framework JACE. They shall also be constructed in a modular fashion to permit the next generation and support components to be installed, in replacement of or in parallel with existing components.

All controllers must be able to be programmed within the Niagara Workbench. At the completion of the project, the owner shall be given all existing platform and station login credentials to include super user (admin) usernames, passwords and passphrases. Each device, controller, or other equipment intended for master system integration shall be delivered with all application software required to provide a complete and functional control system in accordance with these specifications.

M. All JACE hardware licenses and certificates shall be stored on local MicroSD memory card employing encrypted “safe boot” technology.

L. All products of the Integration Platform shall be provided with the following agency approvals. Verification that the approvals exist for all submitted products shall be provided on request, with the submittal package. Systems or products not currently offering the following approvals are not acceptable.

1. Federal Communications Commission (FCC), Rules and Regulations, Volume II -July 1986 Part 15 Class A Radio Frequency Devices.
2. FCC, Part 15, Subpart B, Class B
3. FCC, Part 15, Subpart C
4. FCC, Part 15, Subpart J, Class A Computing Devices.
5. UL 504 - Industrial Control Equipment.
6. UL 506 - Specialty Transformers.
7. UL 910 - Test Method for Fire and Smoke Characteristics of Electrical and Optical-Fiber Cables Used in Air-Handling Spaces.
8. UL 916 - Energy Management Systems All.

1.6 SPECIFICATION NOMENCLATURE

Acronyms used in this specification are as follows:

FMCS	Facility Management and Control System
NWS	Niagara Web Supervisor
BMS	Building Management System
OTN	Operational Technology Network
TCS	Temperature Control System
HVAC	Heating, Ventilating and Air Conditioning.
JACE	Java Application Control Engine
GUI	Graphical User Interface
SPOG	Single Pane of Glass
FDD	Fault Detection and Diagnostics
DDC	Direct Digital Controls
LAN	Local Area Network
WAN	Wide Area Network

1. Actuator: Control device that opens or closes valve or damper in response to control signal.
2. AI: Analog Input.
3. AO: Analog Output.
4. Analog: Continuously variable state overstated range of values.
5. Discrete: Binary or digital state.
6. DI: Discrete Input.
7. DO: Discrete Output.
8. FC: Fail Closed position of control device or actuator. Device moves to closed position on loss of control signal or energy source.
9. FO: Fail open (position of control device or actuator). Device moves to open position on loss of control signal or energy source.
10. IBC: Interoperable BACnet Controller
11. IDC: Interoperable Digital Controller.
12. ILC: Interoperable LON Controller.
13. Modulating: Movement of a control device through an entire range of values, proportional to an infinitely variable input value.
14. Motorized: Control device with actuator.
15. NAC: Network Area Controller.
16. NC: Normally closed position of switch after control signal is removed or normally closed position of manually operated valves or dampers.

17. NO: Normally open position of switch after control signal is removed; or the open position of a controlled valve or damper after the control signal is removed; or the usual position of a manually operated valve.
18. OOT: Object Oriented Technology
19. OSS: Operating System Server, host for system graphics, alarms, trends, etc.
20. Operator: Same as actuator.
21. PC: Personal Computer.
22. Peer-to-Peer: Mode of communication between controllers in which each device connected to network has equal status and each shares its database values with all other devices connected to network.
23. PICS: BACnet Product Interoperability Compliance Statement.
24. PID: Proportional-Integral-Derivative control, control mode with continuous correction of final controller output element versus input signal based on proportional error, its time history (reset) and rate at which it's changing (derivative).
25. Point: Analog or discrete instrument with addressable database value.

1.7 SUBMITTALS

A. Eight copies (unless specified otherwise) of shop drawings of the entire Integrated Platform shall be submitted and shall consist of a complete list of equipment and materials, including manufacturers catalog data sheets and installation instructions. Shop drawings shall also contain complete wiring and schematic diagrams, software descriptions, calculations, and any other details required to demonstrate that the system has been coordinated and will properly function as a system. Terminal identification for all control wiring shall be shown on the shop drawings. *Engineering note: Specify document format: PDF (editable), Word, Excel, .dwg…)*

B. Submittal shall also include a trunk cable schematic diagram depicting operator workstations, control panel locations and a description of the communication type, media, and protocol. Though the Division 23 contractors shall provide these diagrams for their portions of work, the Master Systems Integrator shall be responsible for integrating those diagrams into the overall trunk cable schematic diagrams for the entire Virtual Local Area Network (VLAN).

C. Submittal shall also include a copy of each of the graphics developed for the Graphic User Interface including a flowchart (site map) indicating how the graphics are to be linked to one another for system navigation. The graphics are intended to be 80% - 90% complete at this stage with the only remaining changes to be based on review comments from the A/E design team and/or EMU.

D. Upon completion of the work, provide a complete set of 'as-built' drawings and application software on compact disk. Drawings shall be provided as AutoCAD™ or Visio™ compatible files. Eight copies of the 'as-built' drawings shall be provided in addition to the documents on compact disk. Division 23 and 26 contractors shall provide as-builts for their portions of work. The Division 25 contractor shall be responsible for as-builts pertaining to overall BMS architecture and network diagrams. All as built drawings shall also be installed into the integrated platform server in a dedicated directory.

1.8 QUALITY ASSURANCE

A. Codes and Standards: North American

1. UL Compliance: Provide electrical components of Division 25 control systems which have been UL-listed and labeled and comply with NEMA standards. Provide control devices, which are UL listed as a signal appliance.
2. NEMA Compliance: Comply with NEMA standards pertaining to components and devices for Division 25 control systems.
3. NFPA Compliance:
4. NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" (Where

applicable to control systems and control sequences).
5. NFPA 72 “National Fire Alarm and Signaling Code”
6. NFPA 33 “Standard for Spray Application Using Flammable or Combustible Materials” (Where applicable for manufacturing requiring explosion proof DDC equipment).
7. National Electric Code (NEC)
8. National Electrical Safety Code (NESC)
9. American National Standards Institute (ANSI)
10. American Society for Testing and Materials (ASTM)
11. Occupational Safety and Health Association (OSHA)
12. Institute of Electrical and Electronic Engineers (IEEE)
13. Any other applicable Federal, State, Provincial and/or Local Codes
14. ASHRAE current edition

B. The Master Systems Integrator shall have a full service DDC office within 50 miles of the job site. This office shall be staffed with applications engineers, software engineers and field technicians. This office shall maintain parts inventory and shall have all testing and diagnostic equipment necessary to support this work, as well as staff trained in the use of this equipment.

C. Single Source Responsibility of Supplier: The Master Systems Integrator shall be responsible for the complete installation and proper operation of the control system. Master Systems Integrator shall exclusively be in the regular and customary business of design, installation, and service of computerized building management systems similar in size and complexity to the system specified. The Master Systems Integrator shall be the manufacturer of the primary DDC system components or shall have been the authorized representative for the primary DDC components manufacturer for at least 5 years. All control panels shall be assembled by the Control System Contractor.

D. Equipment and Materials: Equipment and materials shall be cataloged products of manufacturers regularly engaged in the production and installation of specified Division 25 systems. Products shall be the manufacturer's latest standard design and the manufacturer’s latest standard design and comply with Division 25 requirements.

1.9 COORDINATION WORKSHOPS:

A. The MSI shall conduct Coordination Workshops that include, at a minimum, the following three session types listed below. The MSI, General Contractor and associated sub-contractors shall provision for as many workshops as are deemed necessary by the Owner to address all facets of the BAS components and configuration.

B. Network configuration workshop
a. The MSI shall participate in a network configuration workshop for establishing the network parameters for the project. The ongoing network requirements and documentation shall be established during the workshop and presented as a submittal for approval following the meetings.

C. Graphics workshop
a. The MSI shall lead workshops establishing the graphics package for the project. The final graphics workshop shall be a live graphics review meeting.

D. Analytics and alarming workshop
a. The MSI shall lead analytics and alarming workshops with the Owner’s Operations group, design team and commissioning agent for establishing the requirements for analytics and alarms for the project. The alarm standard shall include a holistic review of alarming standards to help facilitate a new paradigm for operations for alarms, faults, and operational efficiencies, moving to a proactive maintenance model.

1.10 PRE-INSTALLATION MEETINGS

As required by the General Contractor

1.11 DELIVERY, STORAGE AND HANDLING

Maintain integrity of shipping cartons for each piece of equipment and control device through shipping, storage and handling as required to prevent equipment damage. Store equipment and materials inside and protected from weather.

1.12 JOB CONDITIONS

Cooperation with Other Trades: Coordinate the Work of this section with that of other sections to ensure that the Work will be carried out in an orderly fashion. It shall be this Contractor's responsibility to check the Contract Documents for possible conflicts between his Work and that of other crafts in equipment location, pipe, duct and conduit runs, electrical outlets and fixtures, air diffusers and structural and architectural features.

1.13 SEQUENCING

Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress.

PART 2 – PRODUCTS

2.0 INTEGRATION PLATFORM

Tridium Niagara Framework version N4.x (current supported release – see Section 1.1)
(optionally including Niagara Security and Niagara Analytics)

The FMCS shall be comprised of Java Application Control Engine or Controllers (JACE) within each facility. The JACE shall connect to the owner's local network, wide area network, or operational technology network (OTN) depending on configuration. Each JACE is capable of communicating to LonMark/LonTalk (IDC) and/or BACnet (IBC) controllers and other open and legacy protocol systems/devices.

A. Supervisory Control Software: Niagara Framework Web Supervisor N4.x (product info)
B. Engineering Software: Niagara Workbench
C. Network Controller Manufacturers:

Subject to compliance with requirements, provide products and services by one of the following:

Vykon JACE-9000 (JACE-9000), EDGE -10 (VEC-10) with corresponding IO and Communications modules

Acceptable Manufacturers (OEMs) ***(Insert any additional OEM brands here)***

2.1 GENERAL

A. The Integration Platform shall be comprised of a network of interoperable, stand-alone digital controllers, a network area controller, graphics and programming and other control devices for a complete system as specified herein.
B. The installed system shall provide secure strong password access to all features, functions and data contained in the overall BMS.

2.2 ARCHITECTURE

A. The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system utilizing Open protocols in one open, interoperable system.
B. The supplied computer software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system. Physical connection of any BACnet control equipment, such as chillers, shall be via Ethernet or IP.
C. All components and controllers supplied under this contract shall be true "peer-to-peer" communicating devices. Components or controllers requiring "polling" by a host to pass data shall not be acceptable.
D. The supplied system shall incorporate the ability to access all data using HTML5 enabled browsers without requiring proprietary operator interface and configuration programs or browser plug-ins. An Open Database Connectivity (ODBC) or Structured Query Language (SQL) or approved compliant server database is required for all system database parameter storage. This data shall reside on the Niagara Enterprise Web Supervisor VM hosted by the owner. See network diagram for details.
E. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network.
F. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for network connected user interfaces.
G. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote connected user interfaces.

2.3 SERVER HARDWARE

The main server shall be mounted in the server rack in a location designated on the drawings. Server shall be provided with a keyboard and mouse. All Hardware and OS, VWM software will be provided by the owner.

2.4 FIREWALL and DNS SERVER *(provided by Owner)*

2.5 SERVER RACK *(provided by Owner)*

A. Shall be standard four post frame cabinets, wall mounted cabinets with 0.375" square mounting holes on front and back rails for a minimum of 42 standard EIA rack spaces. Provide with (25) 12-24 cage nuts and screws for square mounting holes.
B. Shall be UL Listed, designed to be self-standing with leveling feet, constructed of steel or aluminum, shall be firmly fastened to the floor, fastened to ladder rack for extra support, and properly grounded.
C. Shall be provided with perforated, quick release, lockable front, and rear doors.
D. Shall be provided with (2) locking, easy to remove side panels.

2.6.1 IoT SERVER SOFTWARE – Niagara Web Supervisor - NWS

The IoT Server Software shall allow multiple Niagara-based JACE controllers, along with other IP-based controllers, to be networked together through the Enterprise OT Network. This software shall provide real-time graphical information to standard Web-browser clients and provide server-level functions. These functions include centralized data logging/trending, alarming, tagging, archiving to external databases, alarming, dashboarding, system navigation, master scheduling, database management, and integration with other enterprise software applications through custom APIs where required. A comprehensive graphical engineering toolset for application development shall be provided (Niagara 4 Workbench)

A. The BAS Contractor shall provide system software based on server/thin-client architecture, designed around the open standards of web technology. The BAS server shall communicate using Ethernet and TCP. Server shall be accessed using a web browser over Owner intranet and remotely over the Internet.

B. The intent of the thin-client architecture is to provide the operator(s) complete access to the BAS system via a web browser. The thin-client web browser Graphical User Interface (GUI) shall be browser and operating system agnostic, meaning it will support HTML5 enabled browsers without requiring proprietary operator interface and configuration programs or browser plug-ins. Microsoft, Firefox, and Chrome browsers (current released versions), and Windows as well as non-Window operating systems. All browsers shall comply with the owner's IT standards.

C. The BAS server software shall support at least the following server platforms (Windows 11 and 10 Pro x64-bit; Windows Server 2022 and 2019; Linux x64-bit: RedHat Enterprise Linux 8.7, Ubuntu 22.04). The BAS server software shall be developed and tested by the manufacturer of the system stand-alone controllers and network controllers/routers.

D. **Graphical User Interface** (GUI): The BMS platform shall provide the Single Pane of Glass that displays all building, integrated building, and building-related information for: monitoring, management, and control. The GUI shall be browser-based utilizing HTML5 graphics with responsive web design (RWD) graphics for multi-platform support:

1. Trending.
2. Scheduling.
3. Electrical demand limiting.
4. Energy Aggregation and Analytics.

5. Downloading Memory to field devices.
6. Real time 'live' Graphic Programs.
7. Tree Navigation.
8. Parameter changes of properties.
9. Set point adjustments.
10. Alarm / event information.
11. Configuration of operators.
12. Execution of global commands.
13. Add, delete, and modify graphics and displayed data.

E. **Software Components**: All software shall be the most current version. All software components of the BAS software shall be provided and installed as part of this project. BAS software components shall include:
   1. Server Software, Database and Web Browser Graphical User Interface.
   2. 5 Year Software Maintenance license. Labor to implement not included.
   3. Embedded Configuration Utilities for future modifications to the system and controllers.
   4. Embedded Graphical Programming Tools.
   5. Embedded Direct Digital Control software.
   6. Embedded Application Software.

F. **BAS Server Database**: The BAS server software shall utilize a Java Database Connectivity (JDBC) compatible database such as: Niagara standard database, MS SQL 8.0, Oracle 8i or IBM DB2. Owner's IT will provide any non-Niagara DB licenses if required.

G. **Thin Client** - Web Browser Based: The GUI shall be thin client or browser based and shall meet the following criteria:

   1. Web Browser's for PC's: Only the current released browser (Explorer/Firefox/Chrome) will be required as the GUI and a valid connection to the server network. No installation of any custom software shall be required on the operator's GUI workstation/client. Connection shall be over secured owner's Operational Technology Network.
   2. Secure Socket Layers: Communication between the Web Browser GUI and BAS server shall offer encryption using 128-bit encryption technology within Secure Socket Layers (SSL). Communication protocol shall be TLS 1.3

H. Web Browser Graphical User Interface

   1. Web Browser Navigation: The Thin Client web browser GUI shall provide a comprehensive user interface. Using a collection of web pages, it shall be constructed to "feel" like a single application and provide a complete and intuitive mouse/menu driven operator interface. It shall be possible to navigate through the system using a web browser to accomplish requirements of this specification. The Web Browser GUI shall (as a minimum) provide for navigation, and for display of animated graphics, schedules, alarms/events, live graphic programs, active graphic set point controls, configuration menus for operator access, reports and reporting actions for events.

   2. Login: On launching the web browser and selecting the appropriate domain name or IP address, the operator shall be presented with a login page that will require a login name and strong password. Navigation in the system shall be dependent on the operator's role-based application control privileges.

   3. Navigation: Navigation through the GUI shall be accomplished by clicking on the appropriate level of a navigation tree (consisting of an expandable and collapsible tree control and/or by selecting dynamic links to other system graphics. Both the navigation tree and action pane shall be displayed simultaneously, enabling the operator to select a specific system or equipment and view the corresponding graphic. The navigation tree shall as a minimum provide the following views: Geographic, Network, Groups and Configuration.
      a. Geographic View shall display a logical geographic hierarchy of the system including cities,

sites, buildings, building systems, floors, equipment, and objects.

b. Groups View shall display Scheduled Groups and custom reports.
c. Configuration View shall display all the configuration categories (Operators, Schedule, Event, Reporting and Roles).

4. **Action Pane:** The Action Pane shall provide several functional views for each subsystem specified. A functional view shall be accessed by clicking on the corresponding button:
   a. Graphics: Using graphical format suitable for display in a web browser, graphics shall include aerial building/campus views, color building floorplans, equipment drawings, active graphic set point controls, web content and other valid HTML elements. The data on each graphic page shall automatically refresh.
   b. Dashboards: User customizable data using drag and drop HTML5 elements. Shall include Web Charts, Gauges, and other custom developed widgets for web browser. User shall have ability to save custom dashboards.
   c. Search: User shall have multiple options for searching data based upon Tags. Associated equipment, real time data, Properties, and Trends shall be available in result.
   d. Properties: Shall include graphic controls and text for the following: Locking or overriding objects, demand strategies, and any other valid data required for setup. Changes made to the properties pages shall require the operator to depress an 'accept/cancel' button.
   e. Schedules: Shall be used to create, modify/edit and view schedules based on the systems hierarchy (using the navigation tree).
   f. Alarms: Shall be used to view alarm information geographically (using the navigation tree), acknowledge alarms, sort alarms by category, actions and verify reporting actions.
   g. Charting: Shall be used to display associated trend and historical data, modify colors, date range, axis, and scaling. User shall have ability to create HTML charts through web browser without utilizing chart builder. User shall be able to drag and drop single or multiple data points, including schedules, and apply status colors for analysis.
   h. Logic - Live Graphic Programs: Shall be used to display' live' graphic programs of the control algorithm, (micro block programming) for the mechanical/electrical system selected in the navigation tree.
   i. Other actions such as Print, Help, Command, and Logout shall be available via a drop-down window.

I. **Color Graphics**: The Web Browser GUI shall make extensive use of color in the graphic pane to communicate information related to set points and comfort. Animated. gifs or .jpg, vector scalable, active set point graphic controls shall be used to enhance usability. Graphics tools used to create Web Browser graphics shall be non-proprietary and conform to the following basic criteria:

1. Display Size: The GUI workstation software shall graphically display in a minimum of 1024 by 768 pixels 24-bit True Color.
2. General Graphic: General area maps shall show locations of controlled buildings in relation to local landmarks.
3. Color Floor Plans: Floor plan graphics shall show heating and cooling zones throughout the buildings in a range of colors, as selected by Owner. Provide a visual display of temperature relative to their respective set points. The colors shall be updated dynamically as a zone's actual comfort condition changes.
4. Mechanical Components: Mechanical system graphics shall show the type of mechanical system components serving any zone using a pictorial representation of components. Selected I/O points being controlled or monitored for each piece of equipment shall be displayed with the appropriate engineering units. Animation shall be used for rotation or moving mechanical components to enhance usability.
5. All graphics shall be compatible with any desktop, mobile device or tablet.
6. Minimum System Color Graphics: Color graphics shall be selected and displayed via a web browser for the following:
7. Each piece of equipment monitored or controlled including each terminal unit.
8. Each building.

9. Each floor and zone controlled.
10. See System Integration Matrix for details.

J. **Hierarchical Schedules**: Utilizing the Navigation Tree displayed in the web browser GUI, an operator (with proper access credentials) shall be able to define a Normal, Holiday or Override schedule for an individual piece of equipment or room or choose to apply a hierarchical schedule to the entire system, site or floor area. For example, Independence Day ' Holiday' for every level in the system would be created by clicking at the top of the geographic hierarchy defined in the Navigation Tree. No further operator intervention would be required and every control module in the system with would be automatically downloaded with the ' Independence Day' Holiday. All schedules that affect the system/area/equipment highlighted in the Navigation Tree shall be shown in a summary schedule table and graph.

1. **Schedules**: Schedules shall comply with the LonWorks and BACnet standards, (Schedule Object, Calendar Object, Weekly Schedule property and Exception Schedule property) and shall allow events to be scheduled based on:
   a. Types of schedules shall be Normal, Holiday or Override.
   b. A specific date.
   c. A range of dates.
   d. Any combination of Month of Year (1-12, any), Week of Month (1-5, last, any), Day of Week (M-Sun, Any).
   e. Wildcard (example, allow combinations like second Tuesday of every month).

2. **Schedule Categories**: The system shall allow operators to define and edit scheduling categories (different types of "things" to be scheduled; for example, lighting, HVAC occupancy, etc.). The categories shall include name, description, icon (to display in the hierarchy tree when icon option is selected) and type of value to be scheduled.
3. **Schedule Groups**: In addition to hierarchical scheduling, operators shall be able to define functional Schedule Groups, comprised of an arbitrary group of areas/rooms/equipment scattered throughout the facility and site. For example, the operator shall be able to define an 'individual tenant' group - who may occupy different areas within a building or buildings. Schedules applied to the ' tenant group' shall automatically be downloaded to control modules affecting spaces occupied by the ' tenant group'.
4. **Intelligent Scheduling**: The control system shall be intelligent enough to automatically turn on any supporting equipment needed to control the environment in an occupied space. If the operator schedules an individual room in a VAV system for occupancy, for example, the control logic shall automatically turn on the VAV air handling unit, chiller, boiler and/or any other equipment required to maintain the specified comfort and environmental conditions within the room.
5. **Partial Day Exceptions**: Schedule events shall be able to accommodate a time range specified by the operator (ex: board meeting from 6 pm to 9 pm overrides Normal schedule for conference room).
6. **Schedule Summary Graph**: The schedule summary graph shall clearly show Normal versus Holiday versus Override Schedules and the net operating schedule that results from all contributing schedules. Note: In case of priority conflict between schedules at the different geographic hierarchy, the schedule for the more detailed geographic level shall apply.

Alarms (and alarm management) are an important part of monitoring the performance of a well implemented control system. They help classify and prioritize the detection of abnormal conditions enabling operators to respond to the most critical alarms in a timely manner.

K. **Alarms**. Alarms associated with a specific system, area, or equipment selected in the Navigation Tree, shall be displayed in the Action Pane by selecting an ' Alarms' view. Alarms, and reporting actions shall have the following capabilities:

1. **Alarms View**: Each Alarm shall display an Alarms Category (using a different icon for each alarm

category), date/time of occurrence, current status, alarm report and a bold URL link to the associated graphic for the selected system, area or equipment. The URL link shall indicate the system location, address, and other pertinent information. An operator shall easily be able to sort events, edit event templates and categories, acknowledge, or force a return to normal in the Events View as specified in this section.

2. **Alarm Categories**: The operator shall be able to create, edit or delete alarm categories such as HVAC, Maintenance, Fire, or Generator. An icon shall be associated with each alarm category, enabling the operator to easily sort through multiple events displayed.

3. **Alarm Templates**: Alarm template shall define different types of alarms and their associated properties. As a minimum, properties shall include a reference name, verbose description, severity of alarm, acknowledgement requirements, and high/low limit and out of range information.

4. **Alarm Areas**: Alarm Areas enable an operator to assign specific Alarm Categories to specific Alarm Reporting Actions. For example, it shall be possible for an operator to assign all HVAC Maintenance Alarm on the 1st floor of a building to email the technician responsible for maintenance. The Navigation Tree shall be used to setup Alarm Areas in the Graphic Pane.

5. **Alarm Time/Date Stamp**: All events shall be generated at the DDC control module level and comprise the Time/Date Stamp using the standalone control module time and date.

6. **Alarm Configuration**: Operators shall be able to define the type of Alarm generated per object. A ' network' view of the Navigation Tree shall expose all objects and their respective Alarm Configuration. Configuration shall include assignment of Alarm, type of Acknowledgement and notification for return to normal or fault status.

7. **Alarm Summary Counter**: The view of Alarm in the Graphic Pane shall provide a numeric counter, indicating how many Alarms are active (in alarm), require acknowledgement and total number of Alarms in the BAS Server database.

8. **Alarm Auto-Deletion**: Alarms that are acknowledged and closed shall be auto-deleted from the database and archived to a text file after an operator defined period.

9. **Alarm Reporting Actions**: Alarm Reporting Actions specified shall be automatically launched (under certain conditions) after an Alarm is received by the BAS server software. Operators shall be able to easily define these Reporting Actions using the Navigation Tree and Graphic Pane through the web browser GUI. Reporting Actions shall be as follows:

    a. **Print**: Alarm information shall be printed to the BAS server's PC or a networked printer.
    b. **Email**: Email shall be sent via any POP3-compatible e-mail server (most Internet Service Providers use POP3). Email messages may be copied to several email accounts. Note: Email reporting action shall also be used to support alphanumeric paging services, where email servers support pagers.
    c. **File Write:** The ASCII File write reporting action shall enable the operator to append operator defined alarm information to any alarm through a text file. The alarm information that is written to the file shall be completely definable by the operator. The operator may enter text or attach other data point information (such as AHU discharge temperature and fan condition upon a high room temperature alarm).
    d. **Write Property**: The write property reporting action updates a property value in a hardware module.
    e. **SNMP**: The Simple Network Management Protocol (SNMP) reporting action sends an SNMP trap to a network in response to receiving an alarm.
    f. **Run External Program**: The Run External Program reporting action launches specified program in response to an event.
    g. Provide alarm recipients and escalation per direction from owner.

L. **Trends**: As system is engineered, all points shall be enabled to trend. Trends shall both be displayed and user configurable through the Web Browser GUI. Trends shall comprise analog, digital or calculated points simultaneously. A trend log's properties shall be editable using the Navigation Tree and Graphic Pane.

1. Viewing Trends: The operator shall have the ability to view trends by using the Navigation Tree and selecting a Trends button in the Graphic Pane. The system shall allow y- and x-axis maximum ranges to be specified and shall be able to simultaneously graphically display multiple trends per graph.
2. Local Trends: Trend data shall be collected locally by Multi-Equipment/Single Equipment general-purpose controllers, and periodically uploaded to the NWS server if historical trending is enabled for the object. Trend data, including run time hours and start time date shall be retained in non-volatile module memory. Systems that rely on a gateway/router to run trends are NOT acceptable.
3. Resolution. Each trended point will have the ability to be trended at a different trend interval. When multiple points are selected for displays that have different trend intervals, the system will automatically scale the axis. (see point list for details)
4. Dynamic Update. Trends shall be able to dynamically update at operator-defined intervals.
5. Zoom/Pan. It shall be possible to zoom-in on a particular section of a trend for more detailed examination and ' pan through' historical data by simply scrolling the mouse.
6. Numeric Value Display. It shall be possible to pick any sample on a trend and have the numerical value displayed.
7. Copy/Paste. The operator shall have the ability to pan through a historical trend and copy the data viewed to the clipboard using standard keystrokes (i.e. CTRL+C, CTRL+V).

M. **Security Access**: Systems Access from the web browser GUI to BAS server shall require a Login Name and Strong Password. Access to different areas of the BAS system shall be defined in terms of Role-Based Access Control privileges as specified:

1. Roles: Roles shall reflect the actual roles of different types of operators. Each role shall comprise a set of ' easily understood English language' privileges. Roles shall be defined in terms of View, Edit and Function Privileges.
   a. View Privileges shall comprise: Navigation, Network, and Configuration Trees, Operators, Roles and Privileges, Alarm/Event Template and Reporting Action.
   b. Edit Privileges shall comprise: Set point, Tuning and Logic, Manual Override, and Point Assignment Parameters.
   c. Function Privileges shall comprise: Alarm/Event Acknowledgement, Control Module Memory Download, Upload, Schedules, Schedule Groups, Manual Commands, Print and Alarm/Event Maintenance.

2. Geographic Assignment of Roles: Roles shall be geographically assigned using a similar expandable/collapsible navigation tree. For example, it shall be possible to assign two HVAC Technicians with similar competencies (and the same operator defined HVAC Role) to different areas of the system.

N. **Graphical Programming**. Niagara 4 Workbench 4.x or current version at commissioning.

O. Analytics - General

1. Provide a fault detection and analytic framework that utilizes a high-performance calculation engine. The engine shall permit real-time data to be combined with historical data using a set of wire and property sheets. The visual programming interface shall be used to define the algorithms (formulas) that analyzes the real-time and trend data collected from the BMS.

2. The output from the analysis shall be able to be visualized in charts, graphs and dashboards and be used as inputs to standard Niagara logic. Faults shall be prioritized according to the associated

system, location and the level of cost avoidance.

3. When applied to historical and real-time data, the framework algorithms shall provide the following analysis features:
    a. An open and extensible analytical environment that can easily customized.
    b. Analytic tools that apply to any data types available from building sub-systems.
    c. The ability to set-up complex analysis without custom programming.
    d. Support for third party API visualization application programs.

P. Niagara Cyber Security Dashboard

Implement a Niagara Security Dashboard as a centralized, easy-to-read and actionable view on the security posture of the entire Niagara infrastructure. The dashboard shall provide visual alerts in the event that any Niagara station in your network is set to allow non-secure connections. It shall display the status of required certificates for each station and shall identify whether running software modules and program objects are signed by their developers. Cyber dashboard shall present all the potential cyber issues at a glance and user shall be able to remediate them quickly for the protection of the Niagara network.

PART 3 EXECUTION

3.1 WORK REQUIRED BY CONTRACT DOCUMENTS

A. MSI shall furnish on-the-job supervision for the proper installation of devices in cooperation with, or as may be required by, other trades. This supervision shall include the following:
   1. Attend all GC and/or Owner meetings in order to disseminate pertinent information and action items to the respective trades.
   2. Provide supervision as required by others to properly perform installation work.
   3. Install, test, trouble-shoot and correct all system software provided under this specification.

B. The MSI shall furnish all material and labor to provide a complete and functional system, which operates in accordance with the requirements of this specification.

C. The MSI shall conduct all workshops as listed below
   1. Graphics Configuration Workshops
      a. Equipment and Floorplans
      b. Color Schema
      c. Navigation and Ease of Use
      d. Graphics Development Training
   2. Naming Conventions and Tagging Workshops
      a. Current Naming and future planned naming conventions
      b. Tagging in BMS Platform
   3. FDD, Analytics and Alarms workshops
      a. Current Alarms and trends
      b. Using FDD and Analytics on the BMS Platform
      c. Creating Custom Rules

D. MSI shall obtain all permits, approvals, fees, and charges required for this work.

E. MSI must verify IP network connectivity and sub-system connectivity schedule is coordinated for the timely installation of the server and the software. Contractor is to notify MSI of any conflicts in schedule, and any scope of responsibility that are conflicting with deployment.

F. The MSI shall furnish on-the-job supervision for the proper installation of devices in cooperation with, or as may be required by, other trades.

G. The MSI is responsible for delivering the hardware to the installation site, unloading, and securing the hardware.

H. The MSI shall ensure that all components specified or required to complete the installation satisfactorily are included, are compatible with each other, and are compatible with the conditions of installation and expected use.

I. The MSI shall ensure the overall effective integration and correctness of individual parts and of the whole system.

J. Provide a designated project manager who shall be responsible for the following:
   1. Construct and maintain project schedule.
   2. On-site coordination with all applicable trades and subcontractors.
   3. Authorized to accept and execute order and instructions from Owner/Architect
   4. Act as the single point of contact.

K. Site and Schedule Coordination:

1. MSI shall assist in coordinating space conditions to accommodate the work of each trade where work will be installed near or will interfere with work of other trades
2. MSI shall coordinate and schedule work with other work in the same area and with work dependent upon other work to facilitate mutual progress.
3. MSI shall integrate all facets of the integrated systems installation into the project construction schedule.

L. The MSI shall schedule and perform all backups for Servers and Network Integration Appliances, including JACE's or Stations.

M. Provisioning of Backups

1. MSI shall coordinate and document the backup policies for the following devices:
   a. Servers
   b. Databases
   c. Connected Devices including:
      1) Network Area Controllers
      2) Network Integration Appliances
      3) Controls integrator Equipment Including
         a) All Field Device Controllers (AHU's, TU's, etc...)
2. Coordinate the automation and frequency for all backups.
3. For Off-site backups, Niagara Recover shall be used to provide an automated cyber-protected back-up and recovery solution. See appendix for Niagara Recover Specification.

3.2 INSTALLATION OF CONTROLLERS

A. The FMCS shall be comprised of Java Application Control Engine or Controllers (JACE) within each facility. The JACE shall connect to the owner's local network, wide area network, or operational technology network (OTN) depending on configuration. Each JACE is capable of communicating to LonMark/LonTalk (IDC) and/or BACnet (IBC) controllers and other open and legacy protocol systems/devices.

B. Approved JACE models

1) Vykon JACE-9000 (JACE-9000)
2) Vykon EDGE -10 (VEC-10)
3) Corresponding IO and Communications modules

Approved Manufacturers: Subject to compliance with requirements, provide products and services by one of the following: *(insert Niagara OEM name(s))*

3.3 CYBERSECURITY

A. Provide commissioning engineer for cyber security testing and set up using the Niagara Hardening Guide and under direction of the owner's Corporate Cyber Security Team.
B. Attend planning, engineering, and commissioning meetings as required by the owner's Cyber Team.
C. MSI Shall configure and activate the Niagara Security Dashboard and Active Directory services.
D. The Station View shall show individual services including User Service, Fox Service, Web Service, Login Service, Authentication Service, and Module Permissions. The Supervisor view shall show all JACEs on the Niagara network, so Niagara users can quickly identify issues and triage outliers.
E. Provide necessary port and configuration data to owner's Cyber and IT teams.

3.5 NIAGARA SERVICES AND FEATURES

A. Enable audit logs for all functions including system operation and programming and cyber security.
B. Set up Alarm Service recipients and escalation levels as directed by owner for 25 users.
C. Set up all roles and responsibilities as directed by owner. Coordinate with owners LDAP/Active Directory systems. 25 Users.
D. Graphics. Provide Graphics as described in System Integration Matrix and point lists. All graphics shall be designed using Niagara "Responsive Pane" to utilize a single graphic implementation to render on a variety devices and window or screen sizes (mobile, tablet desktop).
E. Set up schedules as directed by owner for each system and zone. Provide special schedules as directed by the owner.
F. Set up provisioning service to provide daily backups of all JACEs to the NWS.
G. Each point will be trended at default rate of 15 minutes unless otherwise directed.

Tagging is critical for the current or future ability of the BMS to provide contextually-rich data (data AND the associated meta-data) in order to provide meaningful reporting, analytics or operational data for a system. Niagara provides basic default tagging, but it is highly recommended to determine whether a standard ontology (Haystack, Brick…) will be used, or a custom tag dictionary will be deployed.

3.6 TAGGING AND ANALYTICS/FDD

A. The MSI shall coordinate with the Owner for ideal tagging methodology.
B. The Niagara Tagging standard shall be used for this project paired with a Building Location tagging Library. The building location tagging library shall include Compass Directional, which will be bi-directional (i.e., NE, SW, NW, SE) and the Building Level (i.e. 1st floor, 2nd floor, 3rd floor, etc.).

3.7 ANALYTICS/FAULT DETECTION AND DIAGNOSTICS

A. MSI shall utilize Niagara Analytics (or alternate Analytics Program) to provide an integrated solution for FDD that seamlessly presents in the SPOG.
B. Any alternative analytics engine must be integrated into the system and leveraged to its fullest potential. The analytics software must either be the system of record or be able to use the system of record in near real-time. The analytic engine must have the option for users to be able to write new analytic algorithms and rules, through a scripting language or otherwise. All integrated system points in the system shall be integrated and available for analytics in the software.
C. The analytic language must support Haystack, Brick or Owner selected Schema (determined through the tagging workshop). It must contain robust native functions, both mathematical and scripting specific.
D. Preconfigured Analytics:
E. End users must have the ability to tag specific data and have that data, whether current or historical, be available in one chart or page.
F. End users must have the ability to select points or graph types to better view data in a logical manner.
G. Historical data for any number of points must be available to be viewed on-demand and be user-sortable.
H. End directors must have the ability to view analytical data by selecting related equipment.
I. End users must have the ability to manipulate how data is presented. This includes choice among different styles of graphs and charts.
J. End users must have the ability to configure data of similar types to be viewed in the same chart or individually.
K. End users must have the ability to customize color coding for data visualizations.

3.8 ALARMS AND ESCALALATIONS

The MSI shall configure alarms to notify specified recipients and be recorded in the database. Normal conditions for an individual point are properties that may be set and edited, as desired, by a user with proper access and privileges. Alarms will notify that a device point has met a set of predefined conditions, such as the following:

- Offnormal: A value is outside its appropriate or expected range.
- Alert: Regular equipment maintenance or some other task is due to be performed.
- Fault: Occasionally, a device may report a value, which is so far out of range that it is obvious a device or system needs immediate attention.

A. Alarm escalation shall be employed to re-routes unacknowledged alarms if they have not been acknowledged within a specified amount of time. Three levels of escalation provide up to three opportunities to re-route an alarm notification if the alarm remains unacknowledged.

B. The system specification should define what alarms are desired within the BMS (Alarm creation) as well as Alarm routing (specify destinations (including archival). Notification of recipient(s) via email, alarm console, printer, or remote stations should be defined along with an outlined Acknowledgment from those who are notified. In the event a required acknowledgment is not received within the specified time, alarms can be escalated and re-routed to other designated alarm recipients.

C. Alarm Archives and Retention. Provide support for the Alarm Archive feature in the Alarm Service. The Orion Archive Alarm Provider added to the Alarm Service provides the mechanism to archive cleared and closed alarms..

3.9 WARRANTY *(See general Conditions for additional warranty requirements)*

A. All components, system software, and parts furnished and installed by the MSI shall be guaranteed against defects in materials and workmanship for 1 year of substantial completion. Labor to repair, reprogram, or replace these components shall be furnished by the MSI at no charge during normal working hours during the warranty period. Materials furnished but not installed by the systems integrator shall be covered to the extent of the product only. Installation labor shall be the responsibility of the trade contractor performing the installation. All corrective software modifications made during warranty periods shall be updated on all user documentation and on user and manufacturer archived software disks. The Contractor shall respond to the request for warranty service within 24 standard working hours.

B. Software Maintenance Agreement. Provide 5-year SMA for all Niagara software. MSI shall provide a 5-year SMA including Niagara Remote and Niagara Recover for remote engineering and off-site backup/recovery function.

3.10 SYSTEM STARTUP AND COMMISSIONING

A. Each point in the system shall be tested for both hardware and software functionality. In addition, each mechanical and electrical system under control of the BAS will be tested against the appropriate sequence of operation specified herein. Successful completion of the system test shall constitute the beginning of the warranty period. A written report will be submitted to the owner indicating that the installed system functions in accordance with the plans and specifications.

B. The MSI shall commission and set in operating condition all major systems integrations with system manufacturer's representatives, as applicable, and the Owner and Architect's representatives.

C. Startup Testing shall be performed for each task on the startup test checklist, which shall be initialed by the technician and dated upon test was completion along with any recorded data such as voltages, offsets or tuning parameters. Any deviations from the submitted installation plan shall also be recorded.

D. Required elements of the startup testing include:

1. Measurement of voltage sources, primary and secondary
2. Verification of proper controller power wiring.
3. Verification of component inventory when compared to the submittals.
4. Verification of labeling on components and wiring.
5. Verification of connection integrity and quality (loose strands and tight connections).
6. Verification of bus topology, grounding of shields and installation of termination devices.
7. Verification of point checkout.
8. Each I/O device is landed per the submittals and functions per the sequence of control.
9. Analog sensors are properly scaled, and a value is reported
10. Binary sensors have the correct normal position, and the state is correctly reported.
11. Analog outputs have the correct normal position and move full stroke when so commanded.
12. Binary outputs have the correct normal state and respond appropriately to energize/de-energize commands.
13. Documentation of analog sensor calibration (measured value, reported value and calculated offset).
14. Documentation of Loop tuning (sample rate, gain and integral time constant).

E. A performance verification test shall also be completed for the operator interaction with the system. Test elements shall be written to require the verification of all operator interaction tasks including, but not limited to the following:

1. Graphics navigation.
2. Trend data collection and presentation.
3. Alarm handling, acknowledgement, and routing.
4. Time schedule editing.
5. Application parameter adjustment.
6. Manual control.
7. Report execution.
8. Automatic backups.
9. Web Client access.

3.11 TRAINING

A. The MSI shall provide training to the Owner's representative and maintenance personnel on the NWS per the following description:

B. Training shall consist of a minimum of (40) hours of hands-on instruction geared at the operation and maintenance of the systems. MSI may use a combination of generic, Tridium approved, online and local system and project-specific operator training. The curriculum shall include:

1. System Overview
2. System Software and Operation
3. System access
4. Software features overview
5. Changing set-points and other attributes
6. Scheduling
7. Editing programmed variables
8. Displaying color graphics
9. Running reports
10. Workstation maintenance
11. Viewing application programming
12. Operational sequences including start-up, shutdown, adjusting.

END OF SPECIFICATION

APPENDIX for Guide Specifications for Niagara Cloud Suite

For owners who require connectivity to a 3rd party cloud solution or infrastructure, Niagara Data Service enables a certificate managed, contextualized building model for managed API access.

[Note to specifier: Provide additional details such as cloud connection technology (owner supplied, cellular etc., points list, networking details etc. as required.]

PART 1 - Niagara Data Services - NDS

A. Niagara Data Service™ is a Software as a Service (SaaS) offering within the Niagara Cloud Suite™. It builds upon the openness and extensibility of Niagara Framework® to support the systems integration and solution development services of Niagara Community partners, as well as the strategies and software choices of end-users.

B. Niagara Data Service extends API-based access to semantically enriched history data aggregated by the Niagara Framework. Data shall originate from on-premises control networks and is accessible via the Niagara Cloud Management Portal and APIs.

C. NDS shall upload and store historical data from Niagara Supervisors and JACE® controllers, complete with associated model data. Histories shall be delivered ready for down-stream applications to ingest and analyze. Tags and relations shall be maintained to drive analytics and machine-learning algorithms. System integrator (SI) shall design and build dashboards as specified and provide access to NDS for owner and engineer.

D. NDS for this project shall be fully integrated with Niagara Framework® including:
   1. Data Model Export via API
   2. API documentation.
   3. API shall allow for query directly from dashboards and analytics/ machine-learning (ML) tools designed and built by Tridium, Niagara Partners or Business Intelligence (BI) tools of customer choice.

E. NDS Service Execution
   1. NDS shall be provided by a Niagara authorized partner and hosted on a Tridium-managed Niagara Cloud Service. A three-year service contract for the project with SMA shall be provided. Owner shall have the option of procuring an extension to the contract with any Niagara certified cloud partner. NDS shall be included in the bid. System Integrator (SI) shall provide owner with necessary EULA information.
   2. SI shall enable API keys and SI shall enable API keys and set up the API Key for access. SI shall renew the API keys when they expire during the term of the contract.
   3. System Integrator (SI) shall provide for multiple user accounts.
      a. System Integrator - for ongoing maintenance of data as approved by the owner.
      b. Engineer - 1 account for access for period to be determined by owner.
      c. Owner - 3 accounts for access to all data and API.
   4. SI shall enable NDS in the Web Supervisor and JACEs.
      a. All histories and tagging data shall be made available for the NDS account.
      b. SI shall provide initial 4-hour training session for Engineer and Owner
         1) Training shall include chart development and API data query.
      c. An additional 4-hour follow up training shall be provided during the warranty period and scheduled by engineer/owner.
   5. SI shall create 25 initial NDS charts as directed by owner/engineer.

PART 2 - Niagara Recover

F. Niagara Recover™ (NR) is a SaaS offering within the Niagara Cloud Suite™ that provides backup and recovery functionality for Niagara stations. SI shall enable NR for all Niagara stations for this project.

G. Niagara Recover backup service shall maintain a current copy of Niagara station data in the event of a planned or unplanned outage that would otherwise interrupt operations and/or continuity of data collection. The Niagara Recover subscription shall allow owner/end users to achieve seamless, secure, and scalable backups of this Niagara system to the cloud — 24 hours a day, 7 days a week, 365 days a year. Owner shall have the ability to manage their Niagara Recover instances from the Niagara Cloud Suite Management Portal.

H. NR shall create a cyber-protected backup environment for project data, Niagara Recover features shall include:
   1. Automated and on-demand backups
   2. Backups enriched by meta-data details.
   3. Secure data encryption in motion and at rest
   4. Ability to set up alarms for backup failure.
   5. Flexible backup limits, so no on-demand backups are denied.
   6. Chunked data streaming, allowing backups of near-capacity JACE Niagara Stations.

I. NR shall Initiate a backup programmatically from a schedule or user action. Niagara Recover shall maintain up to 5 backups per instance. Backups shall be stored on rotation. The earliest of the 5 timestamped backups that has not been labeled as the preset “preferred backup” shall be overwritten. There shall be no limits on the size of the backup. When in Recover-mode, users shall select the last time-stamped backup or the “preferred backup.”

J. Subscribers shall select Niagara Instances to be backed up, either at the supervisory or field-JACE level. Storage efficiency shall be assured through Binary Large Object (BLOB) cloud architecture, with associated meta data maintained. Encrypted data shall be directly streamed to the Niagara Cloud account. Backups shall be initiated programmatically and on-demand from a Niagara station. Subscribers shall be able to list backups and retrieve backups at any time via the Management Portal.

K. All Subscribers to NR shall have access to the Niagara Cloud Management portal. From this portal, subscribers shall setup and access the following Niagara Cloud Suite services:

   1. Ability to create a partner-view hierarchy describing customer, project and subscribed device by hostID
   2. Ability to create and retrieve backups.
   3. Ability to assign users.
   4. View devices registered to their organization.
   5. View and retrieve backups.

L. Niagara Recover Execution
   1. NR shall be provided by a Niagara authorized partner and hosted on a Tridium-managed Niagara Cloud Service. A three-year service contract for the project with SMA shall be provided. Owner shall have the option of procuring an extension to the contract with any Niagara certified cloud partner. NR shall be included in the bid. System Integrator (SI) shall provide owner with necessary EULA information.
   2. System Integrator (SI) shall provide for multiple user accounts.
      a. System Integrator - for ongoing maintenance of data as approved by the owner.
      b. Owner – 2-accounts for access to all backups.
   3. SI shall enable NR in the Web Supervisor and JACE

PART 3 - Niagara Remote

M. Niagara Remote™ (NRMT) is a SaaS offering within the Niagara Cloud Suite™ that provides the ability to securely access the built-in web interface on your Niagara stations directly from the Niagara Cloud Management Portal without using a VPN. The user can connect to multiple stations at once and switch between them as needed.

N. User shall be able to:
   1. Troubleshoot a Niagara deployment.
   2. Perform regular engineering and maintenance work on their Niagara station.
   3. Access the Niagara UI to check the status of Niagara stations across a Niagara-based network.

O. Niagara Remote Execution
   1. NRMT shall be provided by a Niagara authorized partner and hosted on a Tridium-managed Niagara Cloud Service. A three-year service contract for the project with SMA shall be provided. The owner shall have the option of procuring an extension to the contract with any Niagara certified cloud partner. NRMT shall be included in the bid. System Integrator (SI) shall provide the owner with necessary EULA information.
   2. System Integrator (SI) shall provide for multiple user accounts.
      a. System Integrator - for ongoing maintenance of the station as approved by the owner.
      b. Owner – 2-accounts for access to all stations.
   3. SI shall enable NR in the Web Supervisor and JACE