TRIDIUM

Division 25 Design Guide

Specifying a Niagara Framework Infrastructure

October 2022

Contents

Introduction

The technologies associated with today's facility control systems are complex. Proper design and implementation requires thorough research and understanding of the features, benefits and applications of the graphical user interface, open protocols, enterprise connectivity, legacy systems, multiple system integration, third party software applications, and other concepts. As an effort to assist with the delivery of high performance facilities, Tridium is providing these design specifications to assist design engineers, contractors and end users identify the requirements, delineate responsibilities and define the details to maximize the performance of Integrated Automation Systems.

Terminology

The terminology used to describe the automated monitoring and control of equipment within a facility has evolved from Building Control System (BCS), to Build Automation System (BAS), to Facility Management System (FMS), to Integrated Automation System (IAS). Systems that are dedicated to energy monitoring and management may be referred to as Energy Management Control Systems (EMCS). Large users who have integrated numerous facilities over a secure enterprise have also used the terms Global Building Management System (GBMS), Integrated Facility Management System (IFMS), Utility Monitoring and Control System (UMCS), etc.

Regardless of the terminology, all of these systems utilize a variety of advanced products, protocols and applications.

Evolution – DDC and Division 15

As building technology evolved, so did the process to design, specify and implement the control systems. Electronic HVAC control devices were first introduced in the late 1970's early 1980's. These devices provided automated control of mechanical HVAC equipment. By default, Direct (or Distributed) Digital Controls (DDC) became the responsibility of mechanical contractors and were therefore specified under Division 15, the Mechanical specification section. Since all DDC control systems were proprietary at that time, the design engineers typically wrote basic performance specifications and left the control system design up to the mechanical contractors and their preferred DDC manufacturers. The DDC system market was heavily dependent on control system vendor relationships with mechanical contractors.

As BAS technology continued to advance, DDC systems became more powerful and complex. In the early 1990's open protocols including LonWorks and BACnet were introduced. There became a need to provide more detailed designs and specifications to properly implement these advanced technologies. Engineers utilized Section 15900 to define the requirements for the BAS, but as BAS technology advanced, design requirements grew and section 15900 became too large to efficiently manage. Control system specifications needed their own section to highlight the capabilities and requirements of the systems and to drawn the attention of the bidders.

Evolution - Open Protocols and Division 17

Design engineers began using Division 17 as a way to delineate the more complex design requirements of enterprise based, open protocol systems. Division 17 was utilized to define the responsibilities of a System Integrator, and brought attention to the requirements of an advanced control system and the associated design. Open protocols enabled design engineers to develop design drawings that defined the control system down to the field device without locking the system and/or client in to a single vendor. Open competition for the implementation, operation and maintenance of a BAS throughout the lifecycle of a facility became a reality, **when the system was properly design, specified and enforced**. Division 17 was a major factor in the realization of this goal. But Division 17 was just an interim solution.

Evolution – Integrated Automation Systems and Division 25

In 2004, Master Format expanded from a 5-digit, 16-division system to a 6-digit and 50-division system. The Construction Specifications Institute (CSI) ceased to license and support Master Format 95 on December 31, 2009. The 50 division Master Format includes Division 25 which is dedicated to Integrated Automation Systems, and defines a unified structure for the design, specification, and implementation of building technologies.

Tridium Guide Specifications and Design Guide

Tridium has provided the details for three applications of the Division 25 specification:

1. Full specification to detail the requirements of large projects
2. Abbreviated specification for smaller projects
3. Full “Split” specification that delineates the responsibilities between a Network Integrator and a System Integrator.

When properly applied, implemented, commissioned and maintained, Integrated Automation Systems can provide efficiencies and benefits never before realized. While the potential rewards are lucrative, it is important to understand all of the processes required to successfully implement an Integrated Automation System. Tridium’s Guide Specifications in conjunction with this Design Guide will streamline the process to understand, create, implement, enforce and ultimately realize the goals of a high performance Integrated Automation System.

Some renovation projects utilize existing design documents and therefore may require the engineer to incorporate control system requirements into Division 15 or 17 specifications. In these cases, the details provided within Tridium’s Division 25 Guide Specifications can be reformatted by the engineer and applied to Division 15 or 17.

Guide Specifications

These Guide Specifications are intended to be used by the design engineers as a template and design guide for the critical aspects of an Integrated Automation System. The Guide Specifications are provided in design document format to facilitate the development of a complete set of deliverable design documents.

The engineer shall select the appropriate section(s) within the Full, Abbreviated or Split Specification templates to use within their project design. It is very important that the engineer thoroughly understand the importance of the concepts presented within each paragraph of the specifications. Do not use any concepts that are not understood and equally important, do not delete any sections without understanding the impact that the deletion will have on the project. It is the engineer’s responsibility to confirm the details within these specification guides, and to deliver design documents that meet the intent of the project.

Note that throughout each section there are multiple areas that require the engineer’s input. These areas are highlighted in **<Bold, Red Lettering and enclosed in angled brackets>.** The engineer must pay particular attention to these sections as they require design input that will be unique to the project conditions or expectations.

Division 15

Division 15 specifications should not be used unless the client requires the old 16-division Master Format and will not allow the use of Division 17. Section 15900 is a single section that typically contains all of the details provided within the multiple sections of Division 25. Therefore Section 15900 can be lengthy and cumbersome, but if used, must contain the details necessary to implement an Integrated Automation System.

If Division 15 is required, the engineer can utilize the Full or Abbreviated Division 25 specifications as the basis for Section 15900. It is important that all of the concepts are properly understood and applied to the project. The engineer should not delete any sections without considering the impact of the deletion on the performance of the project. The specifications should be tightly coordinated with the design drawings to illustrate the expected performance.

Division 17

Division 17 specifications should also not be used unless the client requires the old 16-division Master Format. Division 17 for IAS was an interim approach that typically contained 13 sections:

17110	System Integrator Qualifications
17115	Summary of Work
17120	Codes and References
17125	Submittals
17130	Integrated Automation System Inputs/Outputs
17135	Electrical Requirements
17140	Integrated Automation System Field Panels
17148	Network Electronics
17150	Integrated Automation System Software
17155	Commissioning of Integrated Automation System
17160	Integrated Automation System Operation and Maintenance
17165	Integrated Automation System Training
17195	Sequences of Operation

The multiple sections within the Division 17 format are similar to those within the Division 25 format. If Division 17 is required, the engineer can utilize the Full or Abbreviated Division 25 specifications as the basis for Division 17. It is important that all of the concepts are properly understood and applied to the project. The engineer should not delete any sections without considering the impact of the deletion on the performance of the project. The engineer can use the Division 25 guide specifications and design guide to meet the requirements of all 13 sections within Division 17. The specifications should be tightly coordinated with the design drawings to illustrate the expected performance.

Division 25

Full Division 25 specifications should be used for most single site projects. Division 25 contains 12 sections:

25 00 00	Integrated Automation System General
25 05 00	Common Work Integrated Automation System
25 08 00	Commissioning of Integrated Automation System
25 11 00	Integrated Automation System Inputs/Outputs
25 11 05	Advanced Power Meters
25 11 09	Network Electronics
25 12 00	Third Party Interfaces
25 14 00	Integrated Automation System Field Panels
25 15 00	Integrated Automation System Software
25 60 00	Integrated Automation System Operation and Maintenance
25 70 00	Integrated Automation System Training
25 90 00	Sequences of Operation

The engineer should use and understand the requirements of all 12 sections. The specifications should be tightly coordinated with the design drawings to illustrate the expected performance.

An Abbreviated Division 25 specification, consolidated into a single 25 00 00 section, is provided for application within smaller projects where the details within a full specification are not required.

Division 25 Split Specification

Division 25 split specifications should be used to maintain continuity and competitiveness for multiple site projects. The Division 25 split specification contains 21 sections:

NI and SI	25 00 00	Integrated Automation System General
SI	25 05 00	Common Work Integrated Automation System
SI	25 08 00	Commissioning of Integrated Automation System
SI	25 11 00	Integrated Automation System Inputs/Outputs
SI	25 11 05	Advanced Power Meters
SI	25 12 00	Third Party Interfaces
SI	25 14 00	Integrated Automation System Field Panels
SI	25 15 00	Integrated Automation System Software
SI	25 60 00	Integrated Automation System Operation and Maintenance
SI	25 70 00	Integrated Automation System Training
SI	25 90 00	Sequences of Operation
NI	25 05 50	Common Work Integrated Automation System
NI	25 08 50	Commissioning of Integrated Automation System
NI	25 11 55	Advanced Power Meters
NI	25 11 59	Network Electronics
NI	25 12 50	Third Party Interfaces
NI	25 14 50	Integrated Automation System Field Panels
NI	25 15 50	Integrated Automation System Software
NI	25 60 50	Integrated Automation System Operation and Maintenance
NI	25 70 50	Integrated Automation System Training
NI	25 90 50	Sequences of Operation

Note that the responsibilities between like sections (e.g. 25 05 00 – SI and 25 05 50 – NI) must be tightly coordinated as these sections work together to provide a complete IAS scope of work. The engineer should use and understand the requirements of all 21 sections including the interaction between the NI and SI. The specifications should be tightly coordinated with the design drawings to illustrate the expected performance. The design drawings provide a tool to delineate responsibilities between the NI and SI by providing a visual point of demarcation, typically the Tridium JACE network controller.

Design Guide – Division 25

Division 25 is the recommended division to specify Integrated Automation Systems and should be used for all new construction and renovation projects. The engineer should only use Division 15 or 17 if required by the owner to expand upon legacy design documents.

The Guide Specifications are provided in a format that require design engineers to pay particular attention to the concepts highlighted in **<red>**, understand how these concepts impact the design and modify them to meet the unique requirements of the project. The Design Guide provides additional instruction regarding the intent of important concepts within the specifications, requirements that must be confirmed during submittal review and construction administration, and features that are integral to the performance of the design. The Design Guide was created as a supplement to the Guide Specifications and is organized by section.

The Design Guide directly references the Division 25 Guide Specification. If required, Division 15 and 17 Specifications can derived from the Division 25 Guide Specifications. The design assistance provided below for Division 25 can be directly applied to Division 15 and Division 17 by cross referencing the respective sections.

Section 25 00 00 – Integrated Automation Systems (IAS) General

Section 25 00 00 provides an overview of the project and defines the requirements for the products, contractors, technologies, codes, quality assurance and architecture. Section 25 00 00 defines the basis of design. It is important to tightly coordinate this section with the design drawings including the network architecture diagram, floor plans, schedules and sequence of operations.

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

The design of an IAS will overlay the design of the mechanical and electrical systems. It is important to coordinate the IAS design with the design of these systems. Include references to other documents, design drawings and specifications within this section to assist with the coordination.

A concept that is new to project design is that the control system can now be designed down to the device level. This creates a coordination issue that Project Managers have not had to address in the past, that is coordination of mechanical, electrical and control system designs. Since the IAS utilizes the Mechanical and Electrical system design drawings as the basis of design, including floor plan backgrounds for the network architecture design, the IAS design cannot be completed until the Mechanical and Electrical system designs are completed. The Project Manager must be aware of this constraint as the IAS design engineer must be provided sufficient time to compete the IAS design after the mechanical and electrical designs are complete. If the mechanical and electrical systems are changed, the IAS design will have to accommodate the change.

1.03 SCOPE OF WORK

This section provides an overview of the scope of work for the IAS contractor. Specific details regarding the design of the system should be provided in an overview but detailed format. The detail provided in the following paragraphs will provide a solid definition of the intent of the design and should be tightly coordinated with the design documents.

A. Define whether this is an expansion of an existing system, or the implementation of a new system.

The Guide Specification hard specs the Tridium Niagara platform as the platform for implementation of the IAS. If the client does not allow a product to be hard spec'd, add "or equivalent".

The Tridium JACE network controllers are available in a variety of formats, each with its own set of capabilities, costs, features and benefits. The design will dictate the number and type of JACEs required to meet the project intent. A Tridium Niagara N4 web supervisor is utilized when more than one JACE is installed within the facility. If a single JACE can be utilized, specific versions of the JACE provide a web user interface for direct access.

B. The engineer should layout the design of the control system including the field level devices and network architecture. The layout will include the location and type of controllers required to meet the design intent. Use the mechanical and/or electrical floor plans as a background for the layout of the control system network architecture. The network architecture diagram will provide the details necessary to enable proper selection of the JACE controllers. The engineer can either select and hard spec the JACEs required (JACE 8000, Edge10, Third Party, etc.) for the project (especially if the project is to expand an existing system) or can use the selection of the JACE controllers as an evaluation factor for the bidders. Note that there could be a significant variance in the proposed cost based on the JACE that is being provided. It is important for the engineer to evaluate the proposed JACE and verify that it meets the intent of the design. Changing the JACE controllers after contract award could be costly.

C. Provide reference to a detailed network architecture diagram. This diagram should detail the number and location of the network controllers as well as the number and location of field level devices. This diagram is typically provided as an elevation view of each facility, and an aerial view of a campus of facilities. If multiple facilities are included in the architecture, a network cloud diagram should also be provided to illustrate all of the primary components of the system.
This diagram should also reference the individual floor plan diagrams that detail the location of each controller and the layout of the local communication cabling. Both the network architecture diagram and the individual floor plan diagrams should be used as the basis for the as-built record documents.

D. Provide the details for the control system design. Do not leave this up to the IAS contractor as there are a wide variety of options for every system and the details presented in the section are necessary to obtain competitive bids that can be fairly evaluated. If the project involves expansion of an existing system the design must be coordinated with the characteristics and technical requirements of the existing system.

An important design concept that must be defined upfront is the field level protocol. Although LonWorks, BACnet, Modbus, etc. are promoted as Open Protocols the design engineers must understand their client's definition of "Open" and must design the system to meet their expectations. Most end user's expect open systems to enable competitive bids for the maintenance, expansion and support of the control system throughout the lifecycle of each facility. The use of open protocols does not guarantee the delivery of an open system. The design engineer should thoroughly understand how the use of specific protocols, and ultimately the design of the control system, will influence the “Level of Openness” of the installed system.

Tightly coordinate the details of this section with the IAS drawings. This section should list all of the equipment to be controlled as shown on the IAS design drawings. The IAS drawings should detail the control system requirements for each piece of mechanical, lighting and electrical equipment, using the design drawings from the mechanical, lighting and electrical engineers as backgrounds. The IAS drawings shall also illustrate the location of each controller (e.g. VAV) on the floor plans provided by the architects, mechanical and electrical engineers. The development of the IAS drawings requires tight coordination with the other engineers and architects since their drawings will be utilized as backgrounds for the control system design. Proper time must be allotted to the IAS engineer as the IAS network architecture design cannot be completed until all mechanical and electrical devices are located on the floor plans.

Tridium provides drivers for a variety of legacy systems. The drivers provided by Tridium have been developed and tested to meet Tridium’s requirements and therefore provide a known level of reliability. It is recommended that the design engineer require the use of the legacy system software drivers provided by Tridium and trusted third-party Niagara certified developers and avoid the use of third party hardware gateways whenever possible.

Integration of intelligent electric, gas and water meters can provide valuable consumption data for the control system. The engineer should discuss energy management expectations with the client to determine how utility meters can be integrated into the design to facilitate performance validation, analytics, demand response, etc. The method utilized to integrate these meters should be specified with this section. Intelligent utility meters are most commonly available with a Modbus communication interface but versions of BACnet and LonWorks meters are also available. Many existing meters can be retrofit with a pulse output modules. The project may include utility meter work performed by other contractors (e.g. EMCS contractors). The work of the EMCS and IAS contractors must be clearly delineated and coordinated to insure reliable transfer of energy consumption data.

Manufacturers of packaged equipment (e.g. computer room air conditioners) and electrical equipment (e.g. ATS, UPS, Gen Sets) often provide a communication option that includes Modbus. Coordinate the design of the IAS with the mechanical and electrical engineers to insure they specify the appropriate communication option within their design. The cost to include communication with the equipment is minor. The cost to retrofit the equipment after it is installed could be significant.

The Graphical User Interface development represents another aspect of the system that could vary tremendously. The engineer should define the graphics standards including the preferred navigation method. The engineer should include screen captures within the design documents to detail the expectations for GUI presentation and navigation. Tridium has developed a Graphics Standards Document to assist engineers with the development of GUIs. Review this document and utilize the concepts that are presented to provide direction to the bidders. This document is provided by Tridium to be utilized by engineers as a reference within their design documents.

1.04 GENERAL IAS INSTALLATION SCOPE OF WORK

A. Specify the basis of design for the IAS. The engineer should specify the protocol(s) and certification(s) that are required to be used within the system design. This selection should not be determined by the contractor as each protocol represents a different set of features and benefits. The performance of the system can be maximized to meet the goals of the end user if the engineer designs the system upfront. In order to properly design the system, the engineer must thoroughly understand the differences between BACnet, LonWorks, Modbus and any other protocol that will be allowed. Coordinate the details in this section with the IAS drawings. List all of the equipment classifications that are to be integrated into the IAS. If BACnet IP is specified, a detailed I/O summary should be provided as, unlike LonWorks or BACnet MSTP only, BACnet IP points “served” to the network will be discoverable by the IAS system. Failure to specify the necessary points can result in only exposing a minimum number of BACnet points from the equipment vendor and result in unnecessary and potentially costly change orders.

   Identify smart equipment that can be provided by equipment manufacturers (e.g. CRAC, ATS, and UPS). Manufacturers can provide equipment with communication options (e.g. Modbus, SNMP) that the system design should directly incorporate. It is much less expensive and much more reliable to order a piece of equipment with a manufacturer installed and tested communications option. However, this requires that the control system design engineers coordinate their specifications with the mechanical and electrical system design engineers.

B. Specifically identify the type of controllers that must be provided by the IAS contractor. Coordinate the devices with the IAS design drawings. Do not leave the selection of device type and required protocol open for the IAS contractor to select as it will have a direct impact on the performance of the system and will adversely affect the engineer’s ability to fairly evaluate the proposals.

C. Niagara based products are available from several manufacturers including Distech, Vykon, Honeywell (WEBS), Johnson Controls (FX) and others. Several of these manufacturers offer other solutions in addition to Niagara. The Niagara solution provided by each manufacturer is identified in brackets (), e.g. (WEBS). Other solutions offered by the manufacturers are not Niagara and may not seamlessly integrate with Niagara systems. The engineer must confirm that the vendor proposals utilize Niagara prior to contract award.

D. If desired, the owner shall be able to engage third party IAS contractors to support, maintain and expand the IAS throughout the lifecycle of the facility. Ownership of all documentation, data files, software code, administrator level passwords, etc. is required to enable support from third party vendors. If the ownership for key pieces of information is withheld from the facility owner/operator, third party IAS contractors will not be able to provide support for the IAS.

E. The Niagara Compatibility Statement (NICS) must be verified to be the wild card "*". Setting the "Accept Station In", "Accept Station Out", "Accept Tool In" and "Accept Tool Out" to "*" will allow open access for all Niagara suppliers. To enable future support through third party IAS contractors, the owner shall maintain the right to direct Tridium to modify any software license.

F. This section backs up the integrated design and requires that the IAS contractor coordinate with the mechanical and electrical contractors to insure they are ordering and installing equipment with the correct communication interfaces. A key point of coordination is connectivity. While the mechanical and electrical contractors are required to provide the equipment with the correct communication modules, it is the IAS contractor's responsibility to provide connectivity. The IAS contractor will need to work with other contractors to facilitate authorized access to their systems and confirm proper operation. The Niagara Integration Matrix is a powerful tool to document the coordination among the different division and vendors.

G. The IAS design should limit the types of protocols used to integrate various pieces of intelligent equipment. For example, Modbus is a popular protocol for industrial equipment manufacturers and is offered as a common communication option for electrical equipment (e.g. ATS, UPS, switch gear, meters, etc.) and mechanical equipment (e.g. CRACs, VFDs, etc.). If the majority of the equipment for the project is available with a common protocol interface (e.g. Modbus), the design can be streamlined by requiring other pieces of equipment to also use Modbus, even if they offer multiple communication options (e.g. BACnet, LonWorks, or Modbus).

H. Once a protocol is selected for integration of mechanical and electrical equipment, it is important to coordinate with the electrical and mechanical design engineers to insure the various contractors provide the required communication interfaces. This paragraph enables the IAS design engineer to specify the exact protocol that must be used for each specific piece of equipment. The communication protocol requirement should be clearly illustrated on the IAS network architecture diagram.

I. The IAS contractor may be responsible for the installation and operation of the FAC LAN as an integral part of the network architecture. The FACLAN should be clearly illustrated on the IAS network architecture diagram.

J. IAS technology is designed to be updated and expanded. While the modular requirement is a general statement it is supported by the details provided within the remainder of the specifications.

K. Software and hardware downward compatibility is very important for expansion projects. The engineer must validate that the IAS software and hardware installed on Phase II is compatible and seamlessly integrates with the software installed on Phase I. If it is not compatible it will be the IAS contractor’s responsibility to upgrade the Phase I software and/or hardware.

O. The use of a Commissioning Authority should be determined during the design phase. The work of a CxA will require participation of the IAS contractor, and therefore must be accounted for within their proposal. Research the commissioning process and specify the number of hours that will be required from the IAS contractor. If a CxA is not engaged, the system testing and commissioning should be performed by the design engineer.

V. The development of detailed IAS drawings is integral to the success of the project. IAS drawings will clearly illustrate the intent of the design enabling competitive bids, and will be used extensively during construction administration and commissioning to validate the installed system. A properly designed and illustrated system will significantly reduce, or possibly eliminate, change orders as they provide clear and detailed direction regarding the installation and operation of the system.

1.05 CODES

A. Confirm the basis for code compliance and specifically state the requirements in this section.

B. List all of the applicable codes

1.06 REFERENCE STANDARDS

C. Review the list of standards and adjust the list according to the standards that apply to the project design. Identification of the applicable standards will improve the quality of the installation, reduce the possibility of change orders, and provide support for the design intent.

1.08 COORDINATION OF WORK WITH EXISTING CONDITIONS

A. It is important to require that the IAS contactor coordinate with other trades and report any discrepancies to the Owner. The IAS will be coordinated with the designs for Mechanical, Electrical, Architectural, Security, Lighting and other divisions. Coordination is a team effort. All engineers and contractors must understand how their responsibilities interact with the scope of work for others.

B. C. D. E. G. and H.
Equipment provided by other contractors must be equipped with the correct communication interfaces. Coordinate the communication requirements with other divisions. IAS contractor must coordinate logistics with other contractors regarding installation, wiring, programming, commissioning. Coordination of schedules, location and access to equipment is the IAS contractor's responsibility. Delays caused by the unavailability of equipment or other conflicts shall not become justification for change orders.

1.09 PARTS LIST

A. Detailed submittal review of all the parts that will be used within the IAS is critical to the success of the installation. Simply confirming the use of open protocols within the proposed system is not enough. The engineer must confirm that the individual components meet the intent of the design. The engineer must understand how each selected protocol works, how the manufacturers have applied that protocol (head end, master controller, field level device), and how products are installed, managed, programmed and maintained, such that the engineer can evaluate if the proposed devices adhere to the design intent. This is a very complex subject that requires effort to learn and apply properly. It is recommended that at a minimum engineers attend training on Tridium, LonWorks and BACnet so that they understand the features, benefits and issues associated with the proper design and application of IAS.

1.10 DEFINITIONS

G. The definitions should be adapted to meet the intent of the design. For example, Application Specific Controllers are a common component within IAS for equipment that has a common application (e.g. VAV boxes). However, ASCs are available in a wide variety of formats including LonWorks, BACnet and proprietary. The definition for the ASC must match the design intent to avoid any conflicts in the design documents. For example, some manufacturers of BACnet systems have implemented the BACnet protocol down to the device level (ASC), while others have implemented the BACnet protocol within a main or supervisory controller and utilize a proprietary protocol on the device level (ASC). The engineer shall define the level of protocol implementation within the design for all control devices and adapt the definitions of all terminology to conform to the design intent.

Delete definitions that are not applicable to the design.

GG. DLN or Device Level Network is used synonymously with Local Operating Network. LON is a common abbreviation for Local Operating Network. Since LON is also commonly used as an abbreviation for LonWorks, the Guide Specifications utilize DLN in place of LON to avoid any confusion.

PP. The IAS definition should be adapted to properly represent the design intent. A Tridium based IAS can be considered a two tier network where the Tridium JACE network controllers and the Web Supervisor reside on the first tier and the control devices reside on the second tier. It may be beneficial to define a third tier when the control device network consists of Master and Slave controllers. Some network designs based solely on IP based devices may have all IP based devices on a single IT/OT network

QQ. Adjust all definitions to meet the design intent. Confirm that all protocol references match the design to avoid conflicts.

1.11 ABBREVIATIONS

A. Confirm all abbreviations that are used throughout the design documents are defined in this section. Delete the abbreviations that are not used in the design documents.

1.12 QUALITY ASSURANCE

A. The manufacturer of the components used as the basis for enterprise connectivity will have a significant impact of IAS performance and reliability. Tridium is the IAS market leader in this area. No substitutions should be allowed.

B. Open protocol associations including LonWorks and BACnet offer testing and certification of devices that conform to their standards. LonMark (LonWorks) and BTL (BACnet) certifications guarantee that a certain level of interoperability has been verified for the certified device. This does not guarantee that the installed system will be open, but it is the basis for creating a system that can be open. If LonWorks or BACnet devices are utilized that are not certified, the engineer must verify that the device is applied in a way that meets the design intent including communication, configuration, network management, and programming.

C. The use of communication protocols for smart equipment should be limited to the drivers available from Tridium, e.g. LonTalk, BACnet, SNMP, Modbus etc. The communication requirements for all smart equipment should be coordinated to limit the number of protocols that must be implemented and supported by the system. For most cases (e.g. CRAC, ATS, UPS, Electric Meters), Modbus is the preferred integration protocol for smart equipment due to its wide adoption and strong performance history. Many newer systems now use various custom APIS. Niagara has the necessary tools to interface with these custom APIs. However there is generally a higher programming cost to accommodate these APIs.

H. It is highly recommended that products have a proven performance history before that are allowed to be incorporated into the design. This recommendation is based on the fine tuning and update process that new control products typically experience when they are first introduced to the market.

1.13 INSTALLER'S QUALIFICATIONS

A. The installer's qualifications must be verified during bid evaluation and confirmed during submittal review. Integrated Automation Systems that utilize enterprise connectivity and open protocols are very powerful and feature rich, but they are also very complex and require knowledge, dedication and experience to properly implement. The worldwide network of Tridium System Integrators is very strong. New SIs are drawn to this network every year and begin the learning process. For large integrated projects, the 5 year experience requirement will weed out the integrators that are still learning and will provide a strong basis for selection.

B. SIs may offer multiple product lines for the control devices. The learning curve for each product line also requires experience. Even if the SI has 5 years or more experience with Tridium, it is important that they demonstrate control product expertise through completion of at least three similar projects.

C. While the company may meet the control system experience requirements specified in A and B, it is important to verify that the individuals assigned to the project also have a minimum level of knowledge and experience. The IAS contractors should identify the individuals that will be assigned to this project during the bid phase and the engineer should verify that the company and individuals meet the stated requirements. The responsible Project Engineer should be Niagara certified. Certification proof should be required on all projects, especially large or complex projects.

D. Service is critical to the long term operation and maintenance of the system. The IAS contractor must demonstrate their ability to provide service. References should be checked to verify the level of performance and satisfaction.

E. The distance requirement will be based on the area of the country. While there is a strong network of Tridium SIs throughout the world, some areas are supported by IAS contractors that service a wider geographical footprint. The engineer should explore the local IAS contractor market to determine the distance limitations that meet the required response time while creating a competitive market that supports at least 3-5 IAS contractors.

1.14 BID PACKAGE SUBMITTAL

A. The bid package submittal must require submission of enough information to enable fair evaluation of bidders while insuring the proposed hardware, software, IAS contractor, network architecture, construction sequence and installation logistics meet the overall project requirements and design intent. The one-line network architecture diagram must be provided and evaluated to verify components, architecture and understanding of the project.

1.15 SUBMITTALS

A. Coordinate the IAS submittals with Division 1.

B. It is imperative that the contractor submittals be thoroughly reviewed to insure that the products proposed for use within the IAS meet the design intent. The submittals will be used throughout the construction administration process to confirm compliance to performance requirements.

C. The electronic submittals, as built drawings, O&M manuals and other documentation should be integrated into the IAS. The user should be able to access these documents from the IAS workstation to facilitate efficient operation and maintenance.

D. Carefully review the qualifications of the proposed system, the installer and key personnel. During construction administration the engineer should confirm that the proposed personnel are onsite and performing the work specified.

E. Carefully review the projects presented as past experience. The submitted projects should be of similar size/complexity utilizing the Tridium Niagara Framework **AND** the proposed control system.

F. Only certified Tridium Niagara programmers should be allowed to work on the project. The engineer should verify that the programmers working on the project are the same personnel listed as Tridium Niagara certified.

G. Only certified LonWorks®, BACnet, MODBUS programmers should be allowed to work on the project. The engineer should verify that the programmers working on the project are the same personnel listed as LonWorks®, BACnet, MODBUS certified.

H. The success of the project is based on the knowledge level and experience of the personnel. It is important to maintain the proposed team throughout the entire construction process, especially the programmers. Quality IAS programmers are a valuable commodity and SIs often spread their programmers over several projects. The engineer should verify the qualifications of all the proposed personnel and make sure the team is maintained throughout the project.

I. System Integrators should have backup personnel for all categories. SIs with strong backup personnel should receive higher evaluation ratings than those without backup.

J. Certifications should be provided for all personnel employed by the SI, not just the personnel that have been assigned to this project. A list of all certified personnel will enable the engineer to evaluate the strength of the SI.

K. Obviously the longer an SI has been representing a product line the better. Be wary of SIs that represent multiple lines or have a history of jumping from one manufacturer to the next. This could be a sign of business or performance related issues.

L. The engineer should discuss the performance, navigation and presentation of the GUI with the client during the design phase and clear direction should be provided via the design documents (e.g. Tridium's Graphics Standards Guide). The IAS contractor shall demonstrate their understanding of the GUI requirements by presenting screen shots for previous projects. These screen shots may differ from the GUI standards, but will demonstrate a level of expertise. The engineer should confirm successful completion by contacting the previous clients and verify the performance of the system.

M. and N.
The electronic version of the product data will become part of the IAS. The IAS contractor shall provide links to this data and update it as required. Modify the list provided to reflect the equipment that will be required for the implementation of the IAS.

O. Open standards are supported by several organizations including LonMark International and BACnet. These organizations offer device certification to confirm compliance to their standards. When LonWorks and/or BACnet devices are utilized within the design, the engineer should define how the technologies are to be applied, including device certification. The engineer should then review the submitted documentation and confirm that the submitted information meets the design intent. Engineers must be trained on LonWorks and BACnet technologies in order to properly design an IAS that is based on these technologies. Refer to www.tridium.com, www.lonmark.org, www.bacnet.org for more information on training.

P. The electronic submittals, as built drawings, O&M manuals and other documentation will be integrated into the IAS.

Q. The engineer must thoroughly review the IAS shop drawings to confirm that the proposed system meets the design intent.

The architecture diagram will identify the number and type of JACE network controllers along with the number and type of equipment controllers.

The floor plans should identify the location of all of the primary IAS components including Servers, Network Controllers, equipment controllers, wiring etc. Properly developed Shop Drawings should become the basis for the As-Built drawings.

R. Control logic must be properly documented for long term sustainability. Each programmer will have a unique style of programming that they developed through experience. Without proper documentation it could be difficult for a new programmer to decipher the logic of the original programmer. Proper documentation will assist future programmers with the operation and maintenance of the IAS.

S. Record or As-Built documents are extremely valuable for the operation, maintenance, upgrade and support of the IAS and therefore must accurately illustrate the installed condition of the IAS. The engineer should spot check high volume devices (e.g. VAV) to verify location, wiring, programming, etc. and should 100% verify all large pieces of equipment including air handling units, boilers, chillers, etc.

1.16 SYSTEM ARCHITECTURE

A. The design of the system architecture will define the IAS performance. It is the engineer's responsibility to thoroughly understand the concepts presented in this section as it forms the basis for the design.

B. All of the components listed in this section are necessary and the engineer must fully understand all of them. The engineer must evaluate the impact that any modifications will have on the overall performance and operation of the system.

Connectivity to the client's WAN requires engagement of the client's IT department. The IAS will be connected to their highly secure and protected network. The engineer should approach the IT department, explain the intent of the project and ask for their assistance with the design and implementation of the network connectivity. Depending on the level of security and IT processes that the host organization has in place, the engineer and/or IAS contractor may have to submit the IAS hardware and software for certification and accreditation. The certification and accreditation (C&A) process will typically evaluate the level of risk associated with any device that directly touches the wide area and local area networks. The C&A process may require more than 6 months to complete. If the implementation schedule dictates that the installation and commissioning of the system must begin before the C&A process is complete, it may be possible to install a managed switch or router between the Network Controller and the client's WAN or LAN as an interim solution. Discuss this option with the IT Manager to determine if it is acceptable.

The engineer must thoroughly understand the operation and maintenance of the WAN, LAN, FAC LAN, and DLN. The IAS design will define how these networks interact. There are many resources the engineer can utilize to help with the details, challenges and how to mitigate issues, including Tridium's Niagara Hardening Guide. It is highly recommended that the engineer design the IAS, including the network architecture, to meet client expectations. The design of the IAS should be implemented by the IAS contractor, not designed by the low bid contractor.

An independent OT Network design may be preferred or required. However, close coordination with the owners IT department may be required to conform to corporate cyber and network standards.

C. Data shall be accessible by all devices, controllers, workstations, and servers and shall not be restricted.

D. The system (at the supervisor and the network controllers) shall be accessed locally and remotely (where allowed) through a standard web browser. The Tridium Niagara Framework provides browser-based access utilizing secure encrypted technologies.

F. Communication speed should be specified and confirmed to verify the required level of performance. If a network segment is overloaded the response time may be negatively impacted. The timing for all of the events listed in this section should be tested during construction administration under 100% (all equipment online and functional) operating condition.

G. The Tridium Niagara EnterpriseSystems Server is also known as the Web Supervisor. The web supervisor coordinates the activities of multiple JACE network controllers.

J. Management of the IAS database is critical to the long term sustainability of the system. The Owner must have full, unrestricted access to the database and all software tools utilized to manage, configure, program and commission each individual device. This must be verified during construction administration. Substantial completion should be granted until all software, databases, passwords, etc. turned over and verified.

1.17 SUBSTITUTIONS

A. Substitutions may adversely impact the performance of the IAS. While it is acceptable to substitute equipment, it is the engineer's responsibility to verify that the equipment proposed for substitution meets the original intent of the design AND the performance level of the equipment originally proposed during the bidding and submittal process.

D. The engineer shall evaluate the total impact that substitutions will have on the IAS. The engineer must enforce the design requirements to maintain the system performance and identify any cost savings that may be returned to the Owner if the substitution is accepted.

1.19 WARRANTY AND SOFTWARE MAINTENANCE

A. A typical IAS warranty is 12 months. If the Owner requires a longer duration, the engineer shall highlight the duration in the pre-bid meeting or solicitation as the extended warranty will have an associated cost. The extended warranty should be acknowledged by each bidder and accounted for within their bid.

B. Software is a continuous and rapidly evolving technology. It is recommended the engineer specify a 3 year software maintenance package as part of the base bid to insure the system software is updated as enhancements are developed.

PART 2 - PRODUCTS

2.02 MANUFACTURERS

A. The acceptable manufacturer shall be Tridium. The Tridium Niagara Framework is the basis for the IAS design and sets baseline for features and performance. By including Tridium as the acceptable manufacturer the bidders will have to meet Tridium's level of performance and functionality. Niagara Framework products are available from multiple sources and should be acceptable to use for the project. No substitutions shall be allowed. The latest revision of the Niagara Framework on the date of acceptance shall be utilized.

PART 3 - EXECUTION

3.02 INSTALLATION

B. The IAS contractor must provide complete, fully operable systems, including everything required to implement a complete system even if it is not identified within the specifications and/or design drawings.

D. The IAS drawings illustrate the design intent. It is the IAS contractor's responsibility to utilize these drawings as the basis for their design and implementation. The IAS contractor cannot deviate from these drawings unless the deviation is brought to the attention of, and accepted by, the Owner.

3.03 DIGITAL CONTROL PANELS, CONTROLLER QUANTITY AND LOCATION

A. The quantities and locations of the digital control panels/controllers shall be determined by the engineer and represented on the IAS drawings.

C. It is the IAS contractor's responsibility to confirm that the quantity of controllers specified within the IAS design is sufficient to meet the design and performance requirements.

D. The engineer should modify the list in this section to meet the specific requirements of the project.

3.04 NETWORK MANAGEMENT FUNCTIONAL REQUIREMENTS

A. The management of all the devices within the network is critical to the success of the IAS. The IAS contractor shall be the sole point of responsibility for the management of the system.

3.06 CONTROL POWER SOURCE AND SUPPLY

A. The IAS contractor is responsible for powering all of the IAS devices. Certain network devices may be the responsibility of the IT department. It is the IAS contractor's responsibility to coordinate all power requirements.

Section 25 05 00 – Common Work Results for Integrated Automation

Section 25 05 00 defines the electrical requirements for the common work results including the methodology that must be followed for the installation of power, signal and communication wiring. The responsibility for each type of wiring must be defined and coordinated with the IAS drawings to avoid any confusion. The methods and procedures defined in this section are necessary to realize the desired system performance and avoid degradation of signals, interference or damage.

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

C. Tightly coordinate this section with others sections that contain electrical work to clearly define responsibility for each aspect of the system. The responsibility for electrical wiring should also be coordinated with the design drawings.

1.03 SUMMARY

B. Define the IAS contractor's responsibilities as they relate to the electrical wiring. Use the list in this paragraph to clearly define the provision and installation of all power, signal and communication aspects of the IAS. Coordinate and reinforce the electrical requirements with the IAS network architecture and other design drawings.

1.05 GENERAL INSTALLATION REQUIREMENTS

A. The installation of all low voltage power, LAN and DLN communication trunks are the responsibility of the of the IAS contractor. The wiring shall be protected in conduit in the specified locations regardless of code requirements.

D. Splices are not permitted within any communications cables. Splices in communication cable disrupt the physical characteristics (twists) of the cable and will degrade the performance and throughput of the cable. High speed communication cables (e.g. Level IV, Category 5E, Category 6) are comprised of wires that are twisted at a precise interval to maximize communication speeds by minimizing interference and coupling that occurs when wires are run in parallel.

E. A spare DLN cable should be installed for future use. The cost to run a spare cable during installation is minimal when compared to the cost to run a cable in the future. The spare DLN must be properly documented, color coded and labeled to enable its use for future maintenance or expansion.

I. Proper tagging and documentation is critical for efficient operation, maintenance and expansion. Tagging will reduce long term operational costs. Tagging can be cumbersome and is therefore commonly ignored by IAS contractors. The engineer should confirm proper tagging through multiple spots checks during construction administration. Tagging should be performed as the wiring is installed, not at the end of the project.

K. The installation of low voltage control cabling is commonly installed above the ceiling, which could be a plenum. Confirm that plenum cabling is allowed by code and the owner. Modify this section if plenum cabling is not permitted.
L. Class 1 power wiring can interfere with the control signals and communication within Class 2 low voltage wiring and must not be run in the same conduit.
O. Wiring must be neatly run and secured.
P. The engineer should confirm that the IAS contractor has properly secured wiring. Special attention should be paid to low voltage signal and communication wiring that is above ceilings, where it is time consuming to properly install and secure wiring. Make sure wiring of any type is not allowed to rest on top of the false ceiling or fixtures.

PART 3 – EXECUTION - Refer to additional detailed execution requirements the standard Niagara Framework Guide Specifications.

3.01 NETWORK COMMUNICATION REQUIREMENTS

A. The throughput of the technologies that are deployed will be dependent on the characteristics of the cabling. The engineer must confirm the type of communications cable required by the technologies used within the design.

3.02 SURGE PROTECTION

A. The engineer should research the technologies and potential device manufacturers that may be used within the design to meet the manufacturer recommendations for surge protection. The engineer should confirm that surge protection is addressed in the IAS contractor's submittals and during construction administration.

3.03 POWER

The IAS contractor is responsible for providing power to all control units. This section should be utilized to delineate responsibilities for any unique characteristics of the project. Typically the IAS contractor will provide a licensed electrician to run 120 VAC power from the breaker panel to the control panel. The engineer should clarify the point of demarcation for the power electricians and the IAS contractor. Coordinate the responsibilities with the design documents for IAS, electrical, mechanical, security, network and any other section that requires electrical work.

3.04 INPUT/OUTPUT AND ANCILLARY HARDWARE WIRING

A. The engineer should research the technologies and manufacturers that may be used within the design to meet the required characteristics for the control wiring. The characteristics listed in this section are typical, but may vary and should be confirmed.
B. Interlock wiring is critical for the performance and operational safety of some equipment types. The IAS design engineer should consult with the mechanical and electrical design engineers to determine if there are any required interlocks between equipment (e.g.

Chiller flow switches, Chemical treatment wiring, etc.) Interlocks are typically determined by the mechanical and electrical system designers and included within their design documents. The IAS design engineer must identify these interlocks, properly reference them within the IAS design and confirm that they have been implemented during construction administration. Coordinate with Division 26 Electrical Requirements.

3.05 CONDUIT AND FITTINGS

This section should be tightly coordinated with other electrical specifications, including Division 26. The IAS design engineer should confirm that all conduit and fitting specifications and procedures match those of other specification sections.

3.06 IDENTIFICATION

Proper tagging, labeling, color coding and documentation is critical for the long term maintenance and operation of the IAS. The engineer should use this section to define the requirements for how panels, controllers, equipment, and wiring will be identified.

Section 25 08 00 – Commissioning of Integrated Automation

The application of commissioning the IAS has grown significantly over the last several years. Section 25 08 00 should be included if a third party Commissioning Authority (CxA) is to be engaged for the project. If the project does not have a CxA, this section could also be used to define a commissioning process that will be implemented by the owner or engineer.

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

C. If a CxA is required for the project, Commissioning Specifications will be provided to define the commissioning process. The IAS specifications should be coordinated with the commissioning specifications to properly define how the IAS contractor must interact with the CxA. The commissioning process will require that the IAS contractor provide assistance to the CxA to implement the test procedures and verify the results. The IAS contractor must account for the time to assist the CxA in their proposed fee.

D. Numerous commissioning forms will be developed by the engineer and utilized by the CxA for Contractor Check Out (CCO). Add a reference to the forms that are relative to the IAS scope of work.

1.02 SUMMARY

A. The engineer should summarize the overall commissioning process as it relates to the IAS contractor. The IAS contractor must be fully aware of their role in the commissioning process and must account for the work they are to provide in their initial proposal.

B. The engineer should reference documentation that defines the commissioning process, including commissioning specifications.

F. If the project does not engage a third party Commissioning Authority this specification section should be modified to reference the party responsible for commissioning the systems (e.g. Design Engineer, Architect, Owner's Representative, etc.).

H. Highlight the use of a CxA and/or the requirement to assist with advanced commissioning processes within the initial RFP solicitation and/or pre-bid meeting. If the project includes a cost template for fee submission, include a line that specifically addresses costs for IAS commissioning assistance.

1.04 CONTRACTOR RESPONSIBILITIES FOR CONTRACTOR CHECK OUT PROCEDURES

A. It is the contractor's responsibility to confirm that the IAS sub-systems are ready for commissioning before they are submitted for testing. If the IAS sub-systems fail the performance verification tests the IAS contractor will be responsible for correcting the performance issues and providing assistance for re-testing at no additional charge. The IAS contractor may also be required to compensate the owner for the cost of re-testing (e.g. additional effort required of CxA, owner, engineer, other contractors, etc.).

B. The functional performance testing and GUI acceptance testing should be tightly coordinated with the commissioning specifications and check-out forms. This paragraph will define the scope of services that the IAS contractor must provide to the CxA and/or Owner.

C. The commissioning process will reveal performance issues that were previously unknown and/or unexpected. In many cases these issues can be addressed through software optimization. The engineer should specify the number of hours of software optimization assistance that the IAS contractor must provide in their base bid. The amount of time reserved for this activity will vary based on the complexity of the system, thoroughness of the design and expectations of the Owner.

D. It is important to include this paragraph to protect the owner from additional CxA costs created by aggressive billing practices. Requests for progress payments and/or claims for sub-system completion may be submitted before the work was actually completed. These requests and/or claims may trigger performance verification testing (PVT) by the CxA. If the system is not completely installed and tested, it most likely will fail the PVT, and will need to be retested. This paragraph will put the IAS contractor on notice that they are responsible for the total costs of re-testing, not just their costs. Recovery of damages associated to re-testing will be at the owner's discretion.

1.05 SUBMITTALS

A. The CxA will need to review and utilize the IAS contractor submittals to refine and implement their commissioning procedures. The CxA may require additional information that is above and beyond the initial submittal requirements (e.g. manufacturer start-up procedures, field check out sheets, factory testing check out forms, point to point check out documentation, etc.). The IAS contractor must abide by the CxA's requests.
Project schedule milestones are important to define and enforce as the CxA's schedule will be coordinating the work of several contractor's. If a contractor falls behind schedule it may impact the work of other contractor's, and at minimum the CxA.
The CxA will utilize the IAS GUI as a primary tool for PVT of not only the IAS but also the mechanical and electrical systems. The IAS schedule should be coordinated to install the Tridium Niagara framework as soon as the construction schedule and facility can support the installation.

PART 2 - PRODUCTS

2.03 TAB AND CxA PORTABLE OPERATORS TERMINAL

A. The IAS contractor shall provide the CxA and TAB contractors will full read/write access to enable these contractors to perform start-up and verification testing through the manipulation of setpoints and overrides.

B. Some IAS systems require a higher level of access to adjust configuration parameters. The IAS contractor must either provide CxA and TAB contractor access to these databases, or provide a technician to adjust the required parameters under direction of the CxA and/or TAB contractor.

C. Terminal Unit controllers and other control devices spread throughout a floor require local visibility of the equipment and on floor access to the GUI. Local connectivity to the Tridium Niagara framework will be provided by the IAS contractor throughout all floors that require local testing. The connectivity must be easily accessible by the CxA and TAB contractors. A hand held calibration unit may also be provided in lieu of GUI connectivity provided all devices in a given area can be calibrated.

PART 3 - EXECUTION

3.02 IAS CONTRACTOR'S CHECK OUT (CCO) START-UP TESTING, ADJUSTING, CALIBRATION

A. It is the IAs contractor's responsibility to confirm that the systems are fully installed and fully functioning prior to CCO, and must provide documentation to the CxA/Owner that verifies the specified tests were performed.

B. The engineer shall specify the CCO testing procedures for each piece of equipment. The CxA shall further refine these procedures.

   Item 4. Testing, Adjusting and Balancing of Air and Water requires detailed attention. The IAS design engineer is automating the performance requirements designed and specified by the mechanical engineer. These performance characteristics should be referenced in this paragraph.

   Item 13 requires modification by the engineer to define control loop tolerance and response times required by the sequence of operation for the specific equipment being controlled.

   Item 14 address the installation and operation of the control system. The testing parameters listed in this paragraph are important for the performance and long term operation of the system. The engineer should add additional control system requirements unique to their IAS design.

   Item 15 address the installation and operation of the Graphical User Interface. The engineer should specify and highlight all GUI requirements that are important for the operation of the GUI. This section will need to be adjusted to meet the graphic standards of the Owner.

C. The IAS GUI will be utilized as a tool to test the operation of equipment installed by other contractors. The IAs contractor will be responsible for assisting with access, startup and testing of these systems.

D. The IAS contractor must document that testing has been performed prior to submission for testing by the CxA and/or Owner.

3.03 IAS SENSOR CHECKOUT AND CALIBRATION

A. Sensor location is critical for system performance. Whether the sensors are located within ductwork, piping or a large assembly hall, proper media flow (air, water, gas) and sampling is critical for proper operation. The IAS engineer should confirm that sensor locations are properly illustrated on the design documents, and that the IAS contractor installed them in the correct locations.
Tolerances for sensors vary with the application. Systems with slower response typically have greater tolerances, while critical systems may have tighter tolerances and higher accuracy requirements. The IAS engineer should validate the acceptable tolerances and accuracies with other design engineers. Use AHSRAE recommendations as a guideline for HVAC control.

B. Sensor calibration and periodic re-calibration is necessary to maximize system performance. While most sensors are factory calibrated, variances can arise during installation due to installation issues including electrical interference and long wire runs. The calibration and accuracy of sensors should be spot checked by the IAS engineer during construction administration, including installation, performance verification testing and commissioning.

3.04 COIL VALVE LEAK CHECK

A. A number of issues can cause a control valve to leak. The most common control issues for new construction are related to improper installation, internal or external valve obstruction, sizing of the valve or the stroke range for actuators. Valve installation and valve control are typically provided by different contractors. A common problem involves the improper installation of an actuator such that the valve cannot fully open or fully close, either due to misalignment, obstruction or mis-matched stroke ranges. Control valves should never be installed with the stems turned down as long term, sediment buildup around the stem packing will cause premature seal failures. The IAS engineer should verify the make and manufacturer of the valves and actuators during the submittal review process and validate the approved valve and actuators have been properly installed.
The most common issue for renovation projects that involve re-use of existing valves is degradation of the valve seat. If the existing valve is leaking and cannot be reseated the valve must be replaced. The IAS engineer should investigate the re-use of existing valves through testing and discussion with facility engineers before allowing them to be utilized in the renovation project. The responsibility for replacement of existing valves that fail to perform must be clearly delineated in the design. A percentage of anticipated valve failures and the costs for the associated replacements should be included within the proposal to avoid future change orders.

3.05 VALVE STROKE SETUP AND CHECK

A. The operation of all critical valves should be verified by the IAS engineer during construction administration. Additional details can be added to this section by the IAS engineer to address specific concerns for critical equipment.

3.06 ACCEPTANCE OF THIRD PARTY INTERFACES

A. Third party interfaces are commonly used to integrate disparate subsystems. The engineer should clearly delineate responsibility for the installation, testing, commissioning and integration of these devices. Typically it is the installing trade's responsibility to insure that they installed communicating device is operational. The IAS specifications and design drawings should be coordinated with each other and all associated electrical, mechanical and other drawings and specifications to clarify, reiterate and reinforce responsibilities.

3.07 SUMMARY OF IAS ACCEPTANCE PROCEDURE

A. The IAS acceptance procedures should be thoroughly reviewed by the IAS engineer and coordinated with the Owner and Commissioning Authority. The IAS engineer should confirm that schedules are being coordinated between the IAS contractor, other trade contractors and the Commissioning Authority.
The detail provided in this section enables the IAS contractor to understand the level of effort that will be required during the IAS Acceptance Procedure. Note that Substantial Completion and, the associated payments that will be approved, is not granted until steps 23 and 24. Substantial completion also triggers the start of the warranty phase.

3.08 IAS DEMONSTRATION

A. It is important to demonstrate the IAS on the actual equipment that will be utilized by the facility engineers and operators. The information listed in this section shall be prepared by the IAS contractor prior to demonstration.
B. The Owner and CxA must be satisfied with the performance of the system. Coordinate review and acceptance of all documentation with the Owner, CxA and Engineer prior to scheduling physical demonstration of the system. Re-tests are costly and the Owner/CxA shall reserve the right to be compensated for the cost of re-testing when the retest is directly attributed to the IAS contractor's failure to meet the requirements of the contract documents
C. Verification of equipment performance often requires the use of calibrated instruments and specialty tools. The IAS contractor shall provide all the instruments and tools required for performance verification and engineer shall verify that the instruments have been properly calibrated.
G. The engineer should decide which operating sequences the IAS contractor should demonstrate.

H. Contractor Check Out lists should be followed and documented for all demonstrations. The CCO lists will provide a record of verified performance, identify issues and document resolution.

3.09 IAS ACCEPTANCE PERIOD AND PROCEDURE

A. The acceptance procedure should not be a snapshot of system performance, it should verify proper operation over a two week (or longer) acceptance period.
B. An analysis of trends and alarm logs for the selected systems will enable identification of performance issues. Issues must be corrected and verified prior to scheduling of functional performance testing.
D. Detailed functional testing will be provided by the Engineer, Owner or CxA after the basic performance has been verified over a two week (or longer) acceptance period.
F. Training and turnover of final documentation can be provided after substantial completion is granted, however, it is important to reserve an adequate amount of fee for the remaining deliverables.

3.10 TREND LOGS

A. The number and type of trend logs that will be of value varies for the Acceptance Phase, Functional Performance Testing and General Operation. The engineer should clearly define the requirements for trending during all phases of implementation and operation.

3.11 TREND GRAPHS

A. The number and type of trend graphs that will be of value varies for the Acceptance Phase, Functional Performance Testing and General Operation. The engineer should clearly define the requirements for trending during all phases of implementation and operation.

3.12 SOFTWARE OPTIMIZATION ASSISTANCE

A. It is highly unlikely that the initial operation of the newly installed IAS will meet 100% of the Owner’s expectations. The specifications should require time for an IAS Technician to work with the Owner to fine tune the operation of the system. The amount of time reserved for this activity will vary based on the complexity of the system, thoroughness of the design and expectation of the Owner.

3.13 WARRANTY PHASE IAS OPPOSITE SEASON TRENDING AND TESTING

A. Trends shall be examined throughout the warranty phase to confirm proper operation is being maintained. The Engineer or Owner may need to adjust the points that are being trended to properly identify and resolve issues. The engineer should identify this continuous evaluation service within the scope of work for their construction administration services, and include fee to support this work. The non-biased evaluation services of a third party engineer will alleviate potential finger pointing between the facility engineers and IAS contractor during the warranty phase.

B. Most environments experience at least two distinct environmental seasons where the need for heating and cooling vary drastically. Some environments also include extended switchover periods where the need for heating and cooling can vary on a day to day basis for several weeks or even months. The operation of the IAS should be tested and validated as part of the functional performance test throughout all operating environments. While it is common practice to test opposite season operation, it is equally or even more important to test the system during the complex switchover periods where continual startup and shut down of large heating and cooling systems can become difficult and inefficient.

Section 25 11 00 – IAS Materials, I/O Devices, and Sensors

Integrated Automation Systems utilize a wide variety of end devices to monitor and control mechanical equipment. Section 25 11 00 enables the engineer to specify the type, quality, resolution and other attributes of each end device. It is very important that the information within this section be thoroughly evaluated by the IAS design engineer and verified by the mechanical engineer to insure that the input and output end devices are of sufficient quality and resolution for the required applications.

This section is a comprehensive sample of the types of end devices that may be utilized to control and monitor the mechanical systems. However, there may be other devices that are required to maintain proper operation of the system. It is the IAS design engineer's responsibility to review the mechanical system design and identify all of the end devices that are required to monitor and control the mechanical equipment.

The specification of the end devices should be coordinated with the IAS and mechanical design drawings. Typically the mechanical design drawings are utilized as backgrounds for the IAS design drawings. Mechanical system floor plans shall be utilized as backgrounds for the IAS network architecture to identify the location for each piece of equipment (AHU, VAV, etc.).

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

B. The list of equipment should be inclusive of all the primary mechanical equipment types. It is important to coordinate this section with the design drawings to insure all equipment types are included in the design. Delete the equipment types that are not part of the design.

1.02 SUMMARY

A. The IAS design drawings must be coordinated with the design drawings of all the other Divisions that include equipment to be controlled and/or monitored. It is imperative that the IAS design engineer fully document the interaction between the IAS control system requirements and the operation of each subsystem (mechanical, electrical, utility, security, lighting, etc.)
B. Identify all of the products that will be discussed in this section. Delete the products that are not needed and include additional items required by the design. This paragraph should enable the IAS contractor to quickly identify the devices required to meet the scope of work.
C. Responsibility for the electrical work must be tightly coordinated between the Division 26 contractor and the Division 25 contractor. While responsibility for the IAS field wiring is obvious, the specifications and design must clearly define responsibility for standard, emergency and backup power.

D. The I/O devices installed by the IAS contractor may be attached to valves, wells, actuators and other devices. The responsibility to install these devices could be assigned to the IAS contractor or other contractors (mechanical, electrical, plumbing). The design engineers must closely coordinate the individual specification sections such that the responsibility for installation of each apparatus is clearly defined, coordinated and supported by the respective specification sections and design drawings. Utilize key notes within the design drawings to highlight responsibilities.

1.04 WORK BY OTHERS

This section enables the IAS design engineer to specifically delineate responsibilities for the installation of control valves, control dampers, taps, wells, switches, meters, power wiring, etc. The responsibilities must be coordinated with the respective divisions. Add paragraphs as required to define all installation responsibilities required for the project.

PART 2 - PRODUCTS

2.02 MATERIALS AND EQUIPMENT

A. Pneumatic controls are typically only used on renovation projects for older facilities that have an existing pneumatic system. Control of pneumatic systems can be problematic so it is important for the IAS and mechanical engineers to evaluate the condition of the pneumatic actuators, lines, dryers, compressors, etc. before expanding or renovating an existing system. In many cases the cost to repair and maintain the existing pneumatic system will not justify reuse of the existing actuators. The cost to migrate to a full electronic system should consider lifecycle costs, not just initial installation savings.

D. Color codes for communication wiring are important for long term maintenance, operation and troubleshooting. The IAS design engineer should confirm during construction administration that the proper color codes were implemented and maintained throughout the system.
Each manufacturer has recommendations for wire type that should be used throughout their systems. These recommendations are primarily based on the technology implemented on each level of the system (DLN, FACLAN, Field Controllers). The IAS design engineer must understand, specify and confirm installation of the proper wire types and color codes. Improper wire types can adversely affect system performance.

E. The IAS design engineer should closely coordinate all references to Division 25 electrical work with Division 26 specifications and electrical design drawings.

2.03 STANDARD SERVICE CONTROL VALVES

This section incorporates a variety of control valves. It is recommended that the IAS design engineer verify the use of each type, add/delete types as required and modify the paragraphs in this section to reflect the sizing requirements of the project. The IAS engineer should work with the mechanical engineer to verify the specifications for each valve type including the list of acceptable manufacturers.

2.04 CRITICAL SERVICE CONTROL VALVES

This section should be tightly coordinated with the Control Valve Schedule. Valve sizing should be provided by the design engineers, not the IAS or mechanical contractors. The IAS design engineers and mechanical design engineers should work together to highlight and coordinate the specifications for the control valves, verify the proper valves are submitted and verify that the proper valves have been installed.

2.05 CONTROL DAMPERS

This section incorporates a variety of control dampers for a variety of applications. It is recommended that the IAS design engineer verify the use of each type, add/delete types as required and modify the paragraphs in this section to reflect the requirements for each application. The IAS engineer should work with the mechanical engineer to verify the specifications for each damper type.

2.06 ACTUATORS

This section incorporates a variety of actuators for a variety of electric and pneumatic applications. It is recommended that the IAS design engineer verify the use of each type, add/delete types as required and modify the paragraphs in this section to reflect the requirements for each application. The IAS engineer should work with the mechanical engineer to verify the specifications for each actuator type.

2.07 GENERAL FIELD DEVICES

The control of some equipment may require inputs and outputs that are not specifically defined in specification 25 11 00. The General Field Device section within 25 11 00 specifies that the use of general “two wire” transmitters must meet the defined level of quality, accuracy and resolution. The IAS design engineer should confirm the requirements in this section and carefully review the device submittals before approving for use on the project. Special attention should be paid towards these products during construction administration and commissioning to verify proper operation.

2.08 TEMPERATURE SENSORS

This section incorporates a variety of temperature sensors. It is recommended that the IAS design engineer verify the use of each type, add/delete types as required and modify the paragraphs in this section to reflect the requirements of the project. The IAS engineer should work with the mechanical engineer to verify the specifications for each sensor type including the list of acceptable manufacturers. Control system manufacturers will require the use of a specific sensor type. The IAS engineer must confirm that the sensor type required by the manufacturer is acceptable prior to approval of the control system submittals.

Setpoint adjustment enables occupants to have control over their environments. The level of user adjustment should be restricted through BAS software to a pre-defined range. The IAS design engineer should discuss the impact of setpoint adjustments with the owner. Energy consumption and control system operation can be adversely affected by large adjustment ranges. Occupants often set the thermostat at the lowest or highest setting with hopes that the room temperature will respond faster. The adjustment is then left in place and the space overheats or overcools, increasing energy consumption and decreasing the comfort level. A typical setpoint adjustment limit is +/- 1°F to 2°F.

Critical applications may require faster response and higher accuracy. The IAS engineer should consult with the mechanical engineer to determine if any of the equipment requires higher quality sensor.

Liquid immersion sensors are recommended over surface mount sensors as they provide a more accurate reading of the liquid temperature within the pipe. Coordination with the mechanical specification is required to insure pie taps (for thermowell installation) are installed by the mechanical contractor. Surface mount sensors are typically used only in renovation projects where the system cannot be shut down or hot tapped.

The IAS design engineer should identify the exact location for the installation of the outdoor air sensor. Confirm that the sensor has been properly installed during construction administration and commissioning.

Freezestats must be properly installed and cover the entire coil surface. The IAS and/or mechanical system design engineer should inspect 100% of the freezestats during construction administration to confirm that the sensor(s) have been properly installed. The freezestat should be directly monitored and alarmed by the IAS.

2.09 HUMIDITY TRANSMITTERS

The cost of the humidity sensor will vary significantly with the accuracy. The IAS design engineer must determine the accuracy and range required to effectively implement the sequence of operation defined by the mechanical design team.

The IAS design engineer should confirm the accuracy of the humidity sensor during submittal review and verify the approved sensor is installed during construction administration and commissioning.

2.10 CARBON MONOXIDE/NITROGEN DIOXIDE SENSORS

Confirm the listing (e.g. ETL, UL, etc.) and ppm required for CO and NO_2 sensors. If these sensors are not required delete this section.

2.11 CARBON DIOXIDE SENSORS

Confirm the listing (e.g. ETL, UL, etc.) and ppm required for CO_2 sensors. If these sensors are not required delete this section.

2.12 DIFFERENTIAL PRESSURE TRANSMITTERS

This section incorporates a variety of differential pressure transmitters to account for various media, pressures and applications. It is recommended that the IAS design engineer verify the use of each type, add/delete types as required and modify the paragraphs in this section to reflect the requirements of the project. The IAS engineer should work with the mechanical engineer to verify the specifications for each sensor type including the list of acceptable manufacturers.

2.13 SPACE STATIC PRESSURE SENSOR

The use of space static pressure sensors is determined by the mechanical system application. The IAS design engineer should work with the mechanical engineer to identify the areas where pressure control are required (e.g. clean rooms, kitchens, surgical suites) and confirm the specifications for the appropriate sensors.

2.14 AIR FLOW MEASURING STATIONS

Proper selection of airflow measuring stations is critical to system performance. The IAS design engineer must work closely with the mechanical design engineer to thoroughly understand the application and the air flow station requirements. The distance the air flow sensor can be installed from the fan source and any duct deviations, including changes in cross sectional area and direction, will determine the type of sensor that must be installed.

If the wrong type of sensor is installed or the sensor is installed improperly, the system will most likely experience problems with control of the environmental conditions. The IAS design engineer should trend the air flow data and compare it to the fan speed and space temperature to confirm proper operation.

Determine the type of flow station needed for the application, confirm the specifications and delete the types that do not apply to the project.

2.15 DIFFERENTIAL PRESSURE SWITCHES

Confirm the need for DP switches within the project design. Delete this section if DP switches are not required.

2.16 PRESSURE SWITCHES

Confirm the need for pressure switches within the project design. Delete this section if pressure switches are not required.

2.17 TRANSDUCERS

Electric to pneumatic transducers should only be required in retrofit projects where the existing pneumatic actuator will be reused. The IAS design engineer should confirm the reuse of existing pneumatic actuators, and identify the quantity and locations within the IAS drawings.

If the project does not include pneumatic actuators, delete this section.

2.18 CURRENT SWITCHES

Current switches represent a low cost method to provide feedback on the operation of an electrical device. The IAS design engineer should determine if feedback is required and select the appropriate type of current switch to provide the level of feedback desired.

Verify the specifications for the type of current switch(es) selected and delete the switches that do not apply to the project.

2.19 CURRENT TRANSFORMERS

The IAS design engineer should determine if utility metering is within the scope of work for the project. The type and size of the current transformers (CT) will be determined by the ability to disconnect utility power, the size of the service (maximum Amperage) and the type of utility meter. The size of the CT(600:1, 1000:5, 1200:1, etc.) should be provided by the IAS design engineer within this section and on a schedule within the IAS drawings.

Delete this section if utility metering is not within the scope of this project.

2.20 OUTDOOR STATIC PRESSURE SENSING TIP

If the project incorporates static pressure control the tip for the sensor should be specified in this section. Delete this section if a static pressure sensor is not required.

2.21 CONTINUOUS LEVEL TRANSMITTERS

Either confirm the details of this section or delete this section if a continuous level transmitter is not required.

2.22 - 28 FLOW METERS FOR STEAM/WATER/GAS SERVICE

There a multiple methods that can be utilized to detect steam, water and gas flow within a pipe. Each method has its own set of features, benefits and costs. The IAS design engineer should thoroughly research the options for metering and discuss the options with the owner.

The IAS design engineer should select the appropriate method, verify the specifications, delete the meters that are not required or do not apply, and clearly illustrate the type and location of the meters within the IAS design drawings.

2.29 PNEUMATIC CONTROL COMPONENTS

If the IAS is going to be integrated into an existing pneumatic system there are a number of associated devices that should be specified and designed. The IAS engineer should evaluate the existing system, including gauges, switches, pilot positioners, indicators and other devices to determine the requirements for integration. The new components will either be designed to match the existing, or will be upgraded. Confirm the goals and requirements of the owner.

2.30 ELECTRIC CONTROL COMPONENTS

This section incorporates a variety of electrical components that will be required to interface the IAS to the mechanical and electrical equipment. The components include switches, valves, freezestats, firestats, thermostats, relays, contactors, transformers, lights and horns. The IAS design engineer should review all of the items in this section, determine which components are necessary and which components should be deleted. Review the IAS design to identify any electrical components that are required but not listed, and add them to this section.

2.31 THERMOWELLS

Thermowells must be properly specified for each application. The IAS design engineer should identify the working pressures and specify the required thermowells. It is important to clearly define the responsibility for provision and installation of the thermowells in the specifications and IAS drawings.

2.33 NAMPLATES

Nameplates should be required for all major pieces of equipment, control panels, etc. This section should clearly define the types of equipment, panels and devices that must be provided with a nameplate, and how the nameplates should look. Coordinate this section with the mechanical and electrical specifications.

2.34 TESTING EQUIPMENT

Testing equipment must be calibrated and certified. The IAS design engineer should verify that the testing equipment has up to date calibration certifications.

PART 3 - EXECUTION

3.02 INSTALLATION OF CONTROL SYSTEMS

The IAS will contain a wide variety of devices that must work in concert to deliver efficient operation. Each device type will include recommendations for installation. This section enables the IAS design engineer to highlight specific installation requirements for each device type. Review this section, delete items that do not apply, add installation requirements that are missing, and modify the existing installation details to meet the project requirements.

Section 25 11 05 – Advanced Power and Energy Meters

Energy management is a primary goal of most Integrated Automation Systems. Advanced power and energy meters can provide real time energy consumption data directly to the IAS. This data can be utilized to implement a wide variety of energy management scenarios. Real time consumption data enables advanced sequences of operation to control the equipment and conserve energy (automated demand response), while detailed historical submeter data provides the means and methods to accurately bill tenants.

A wide variety of meters are available from basic to revenue grade. The appropriate meter should be selected for each application. Section 25 11 05 enables the engineer to specify the meter type, quality, resolution and other attributes for each application.

The specification of the meters should be coordinated with the IAS design drawings. Typically the architectural or mechanical floor plans are utilized as backgrounds for the IAS design drawings. These floor plans shall be utilized as backgrounds for the IAS network architecture to identify the location for each meter.

PART 1 - GENERAL

1.02 SUMMARY

A. The list of required meters should be included on a schedule within the IAS design drawings. It is important to coordinate this section with the IAS design drawings to insure all subsystems are properly monitored and included in the design.

C. There is a large variety of meters available on the open market. Each meter will provide a unique set of features and benefits from basic power consumption (e.g. kW, kWh, V, A and power factor) to high level analysis (e.g. harmonic distortion, power quality and anomaly capture). The cost associated with each meter is in direct proportion to the number of features, accuracy of the data, and storage capabilities.
If the facility has an existing energy management control system (EMCS) it may already have EMCS controllers. New meters can be directly connected to new IAS or existing EMCS controllers. The IAS design engineer must research the existing system to determine if an EMCS exists, and if so how can it be integrated. Many EMCSs are proprietary. Do not assume that the existing system can be integrated into the new system. Discuss the integration capabilities with the EMCS manufacturer.

D. If the EMCS metering system is independent of the IAS, the IAS design engineer must research the system, design the integration methods and delineate responsibilities between the current EMCS contractor and the future IAS contractor. There are many ways energy management software can be integrated into the IAs and the options change often. The IAS design engineer should discuss the options with the owner, including monitoring, utility bill validation, submetering, demand response, analytics, etc.

1.04 WORK BY OTHERS

A. Installation of power meters requires connection to high voltage power supplies. The responsibility for the installation of voltage taps, service disconnects and current transformers must be clearly delineated between the IAS contractor and the Division 26 contractor. Coordinate the specifications with Division 26, the electrical design drawings and the IAS design drawings.

1.05 SUBMITTALS

A. The IAS design engineer must carefully review the meter submittals to verify they meet the intent of the design. Meter accuracy, data, storage, communication and integration method must all be confirmed before the meter submittal can be approved.

1.06 QUALITY ASSURANCE

A. The IAS design engineer must carefully review the meter submittals to verify they meet the intent of the design. Meter accuracy, data, storage, communication and integration method must all be confirmed before the meter submittal can be approved.
B. It is recommended that all of the meters within each meter type be provided by a single manufacturer. However, different manufacturers may be used to maximize performance and minimize cost when various types are required (e.g. Type 1: Advanced power quality metering for the mains; Type 2: Basic submetering for equipment).
C. It is important to illustrate the meter types on the IAS drawings. Define the type and location on the floor plan diagrams, and provide specific installation instructions within the design details section.

1.07 PROJECT CONDITIONS

A. Utility interruptions must be tightly coordinated to avoid disruptions in the facility operation and/or construction schedule. Split core CTs provide the benefit of installing the new power meter without removing power. Solid core CTs require a power shut down as the power lines have to be physically disconnected in order to install the CTs.

1.08 COORDINATION

A. The location of the power meter should be identified in the IAS design drawing. Do not let the IAS contractor decide where the meter will be installed.
B. The provision and installation of the meters can be the responsibility of either the IAS contractor or the Division 26 contractor, or both. Clearly delineate responsibilities to provide, install and integrate the meters within the specifications and design drawings.
C. Connectivity of the new meters will be the responsibility of the IAS contractor. Enterprise based meters may be connected directly to the owner’s Private Wide Area Network. The IAS design engineer should provide a design that identifies the types of meters and the

required integration method(s) (e.g. connectivity to a JACE network controller, field level controller, or enterprise).

1.09 WARRANTY

Coordinate warranty requirements with all other sections.

PART 2 - PRODUCTS

2.02 MANUFACTURERS

A. Provide a list of acceptable manufacturers. If the project involves modification of an existing EMCS, the IAS design engineer should research the existing EMCS to understand the scope and operation of the system. The IAS design engineer can then address integration requirements for the EMCS and the IAS. Thorough understanding of the existing system will identify if the specification must require specific meter manufacturers.

B. A wide variety of smart meters are available with Modbus communication protocol. Modbus offers two methods for integration including Modbus RTU for direct connection to an IAS controller, or Modbus TCP/IP for enterprise connectivity.
Other meter communication options include LonTalk and BACnet. Use of meters with these protocols will streamline integration when the IAS is designed around open protocols.

2.03 ELECTRICAL METERS

A. The accuracy, storage capability, analysis capability, communication media and additional inputs should be defined to meet the requirements of the project. Note that advanced meters are expensive. The specified features should be based on actual project requirements and confirmed during submittal review and construction administration.

B. Panel mounted meters are commonly used for submetering. These meters can be conveniently located within the electrical panel of the system they are monitoring. These meters are typically lower cost because they offer fewer options for analytics, storage and communication. The IAs design engineer should match the meter specifications to the required performance.

C. Current and potential transformers are an important component of the metering design. The IAS design should include a schedule within the design drawings that identifies the CT ratios (e.g. 600:1) and the need for potential transformers.

D. Expansion of an existing system may require coordination between and existing EMCS contractor and the new IAS contractor. The IAS design engineer should thoroughly research the existing system, delineate responsibilities and coordinate the work of each contractor.

E. The meters may require recalibration over time. The IAS contractor shall verify the meter calibration before the end of the warranty period.

PART 3 - EXECUTION

3.02 INSTALLATION OF ADVANCED POWER METERS

C. The meter installation must be coordinated between the IAS contractor, Division 26 contractor and the existing EMCS contractor (if applicable). The IAS design drawings should clearly illustrate the location, type, connectivity method and responsibility demarcation points.

E. Closely coordinate work within live panels and/or utility shutdowns with the property manager.

3.03 FIELD QUALITY CONTROL

A. Verification of the meters should be included within the field verification or commissioning process. The IAS design engineer should verify that the commissioning specification includes verification of the meters.

3.04 NETWORK COMMUNICATIONS

A. The IAS design will define the method for network integration. The IAS design engineer should include detailed drawings that illustrate how the meters are integrated into the IAS along with the use of energy analytics or management software. This section of the specification should describe the meter system that is illustrated in the IAS design drawings.

B. If the facility has an existing EMCS, the IAS design engineer must thoroughly research the features of that system, design how the new IAS will interact with the existing IAS and specify the process to integrate the new meters. This section should define the process and coordinate the work of the IAS and EMCS contractors.

3.05 SOFTWARE INTEGRATION

B. The IAS network architecture design will identify the devices, server and applications that must be integrated into the new IAS. Modify this section to match the IAS design.

C. The IAS contractor is responsible for the integration of the required applications (e.g. Analytics, demand response, tenant billing, etc.). It is the IAS design engineer’s responsibility to clearly specify the required application integration, including interaction with the owner’s IT department.

3.06 TRAINING

A. Adjust the number of training hours to meet the complexity of the system. The level of training required is directly proportional to the complexity of the meter system including the number of meters, applications and integrated sequences of operation (e.g. load shedding).

Section 25 11 09 – Integrated Automation Network Electronics

The Integrated Automation System network architecture will include design of a Facility Local Area Network (FACLAN) to establish communication between the control devices, network controllers, local system servers, local workstations, remote workstations, remote servers and third party software applications. The facility owner's IT Department will be an integral part of the FACLAN design effort and must be included in the investigative, design and implementation phases of the project. The IAS design engineer must realize that the IT Department has the responsibility to maintain 100% uptime for the network that the organization depends on for day to day operations, typically has limited knowledge of facility automation systems, and is under a great deal of pressure to avoid even a minute of downtime. Integration of the IAS will add additional risk, and will require unwanted effort to mitigate that risk. The IT Department will have processes in place that vary considerably based on the type, size and security of the organization. Secure companies will have very detailed Certification and Accreditation processes for any device that touches their network. These processes must be thoroughly understood and applied by the IAS design engineer.

The IAS design engineer must work with the IT Department to properly define the processes that are necessary to use their network for IAS data transfer. Create a solid description of the intent of the IAS, including features and benefits. Present the design intent to IT Department, and ask for their assistance and participation in the design, implementation and operation of the IAS. Record and illustrate their requirements within these specifications and the design drawings.

PART 1 - GENERAL

1.02 SUMMARY

A. The list of required network electronics should clearly illustrated in the design drawings and included on a schedule within the IAS design drawings. It is important to coordinate this section with the IAS design drawings to insure all devices necessary to establish communication are properly defined.
B. The network architecture and the required network electronics should be designed with input from the owner's IT department. Their certification and accreditation procedures may require specific equipment to be sole sourced and specified within the design.

PART 2 - PRODUCTS

2.01 GENERAL

B. Identify specific network electronics that must comply with the owner's IT standards. Meet with the owner's IT department, explain the extent of the IAS and ask for their assistance with network electronics recommendations and requirements.

2.02 CONTROL SYSTEM SERVER (CSS) GENERAL REQUIREMENTS

The CSS general requirements listed in B. through H. of this section are the Niagara CSS requirements. Paragraph A. shall be used to define the owner's IT department requirements, and/or the use of the existing server within renovation projects.
This section may also be utilized to delineate responsibilities for installation, operation and maintenance. If the owner maintains a secure data center, the IAS contractor may not be allowed to enter the data center. The process to provide the server, create the image, install the software, and connect the CSS to the private WAN should be clearly defined.

2.03 IAS NETWORK SWITCHES

A. The design of the network architecture, including the requirements for the network switches should be discussed and approved by the owner's IT department. The IT department may have requirements to match the existing switches, and may decide to provide and install the switches for the IAS contractor.
The quantity and location of the network switches should be defined within the design drawings. A complete network architecture design should be provided and a schedule of network electronics should be included within the design drawings.

2.04 IAS FIELD NETWORK SWITCHES

A. A wide variety of field level switches are available on the market. The restrictions on the use of field switches may be less stringent as they typically do not directly touch the owner's private WAN. However, it is important to define the level of quality that must be provided for these switches as they will directly impact the throughput and reliability of IAS controller communication.
Utilize this section to define the physical and electrical requirements for the field level switches. It is highly recommended that only certified devices with a proven level of noise immunity and reliability be approved for use with the IAS.

2.05 ROUTERS

A. The use of routers should also be designed, specified and scheduled within the IAS drawings and specifications. The use of routers should be minimized and they increase the complexity and decrease throughput.
B. Routers may be used to isolate unnecessary network traffic between devices. However, the Niagara Framework facilitates the use of JACE network controllers to manage network traffic. It is recommended that the IAS network architecture be designed without routers, and utilize the JACE network controllers to manage traffic between disparate systems.
C. An acceptable use of a router is when the point count for a large piece of equipment exceeds the capability of a single programmable controller (PCU). If the design requires standalone operation, defined as uninterrupted operation in the event of a FACLAN

failure, a router can be utilized to create a sub-LAN to isolate two or more PCUs from the FACLAN.

E. System integration often requires conversion from one media to another. The IAS design drawings should clearly define the interconnection of each sub-system. Routers may be required to translate data between disparate media (e.g. wireless vs. hardwired) even if the same protocol is utilized on both sides of the router. Gateways, devices that translate data from one protocol to another, should be avoided if possible. It is recommended that the design incorporate the device drivers available within the Niagara framework to integrate various disparate protocols.

F. Define the physical, electrical and protocol characteristics of the routers. It is recommended that the IAS design include specifications for the use of router even if the IAS design does not incorporate the use of routers, as the IAS contractor may attempt to include them during implementation. The design should have clear requirements for the use of routers,

2.06 IAS NETWORK UPS

A. It may be important to maintain emergency power for key parts of the IAS. The sequence of operation for power fail situations will define how to design the back-up power system. Discuss the requirements with the owner and the rest of the project design team to determine Uninterruptable Power Supply requirements and clearly define the size, type, quantity and location of the UPS system.

2.07 PORTABLE OPERATOR TERMINAL (POT) / REMOTE WORKSTATION

A. A mobile device using a browser is the preferred portable tool. Portable tools may be required for some application controllers. Portable operator terminals are valuable tools for use in the field to troubleshoot and fine tune the operation of the systems. It is recommended that at least one POT be provided for this purpose. Consider the methods that will be utilized to connect the POT (e.g. wireless or hardwired) within the IAS network architecture design.

2.08 IAS EQUIPMENT RACK

A. The network electronics should be installed within a rack in a conditioned area. The facility may have racks that can be utilized and/or standards that must be followed. The IAS design engineer should research the requirements, identify the requirements in the IAS drawings and specify the requirements within this section.

2.09 WIDE AREA NETWORK CONNECTION

A. The owner’s IT department will be able to provide the IAS design engineer with their requirements for WAN connectivity. It is recommended that the IAS design engineer meet with the owner’s IT department, detail the intent of the IAS, and ask for the IT department's assistance and recommendations for connectivity, installation, operation and maintenance. Clearly define all of the WAN requirements within this section.

PART 3 - EXECUTION

3.02 INSTALLATION

It is important to modify and expand this section to highlight the installation processes and the required interaction with the owner's IT department. Confirm the requirements within this section and add detail obtained from the owner's IT department to clearly define the requirements and level of effort that the IAS contractor should expect relative to the provision, installation, commissioning, operation and maintenance of all the network electronics.

Section 25 12 00 – Third Party Interfaces for Integrated Automation

The Integrated Automation System network architecture design should be based on a primary protocol (e.g. LonWorks, BACnet, or proprietary). The base protocol for the control devices will define the features, benefits and restrictions of the IAS. It is imperative that the IAS design engineer understand the features, benefits, operation and restrictions of each protocol. Do not leave selection of the base protocol open to the IAS Contractor.

The term “Integrated Automation System” is derived from the integration of multiple sub-systems into a common automation system. Quite often these operation specific sub-systems utilize various protocols (e.g. Modbus). Sub-system protocols that differ from the base protocol are referred to as “third party protocols”. The IAS design engineer should research the available protocols for the required sub-system equipment, select the appropriate protocol(s), and detail the approved protocol(s) within the IAS design drawings and specifications. The IAS design should minimize the use of third party protocols.

PART 1 - GENERAL

1.02 SUMMARY

B. Packaged systems (e.g. Computer Room Air Conditioners, Variable Frequency Drives), large electrical equipment (e.g. Automatic Transfer Switches, Uninterruptable Power Supplies, Generators) and other major pieces of mechanical and electrical equipment can often be ordered with factory installed communication interfaces. The communication interfaces will streamline integration of the equipment into the IAS, if they are properly selected. The IAS design engineer should research the available communication options for all equipment that will be integrated into the IAS, and select a common protocol that will work for the majority of the sub-systems.

   Modbus is a popular option for integration of large equipment and metering. When selecting Modbus the IAS design engineer must decide if the integration method is to be via the network (Modbus/TCP) or direct connect (Modbus RTU).

PART 2 - PRODUCTS

2.02 EQUIPMENT MANUFACTURER PROVIDED INTERFACES

A. The approved open protocol selected for sub-system integration should be clearly illustrated in the IAS design drawings, coordinated with the electrical/mechanical design drawings, and clearly defined within the specifications.
B. The responsibility to provide the proper communication interface/interface must be coordinated with the sub-system designers. Mechanical, electrical, and other specialty contractors will provide the equipment with the communication interface already installed and tested. Provision of communication interfaces should not be the responsibility of the IAS contractor. The IAS contractor will integrate the communication interfaces provided

by other contractors. The contractors must be informed of the communication protocol requirement prior to ordering the equipment. The IAS design engineer must coordinate the design documents with other sub-system design engineers.

C. The IAS design drawings should clearly illustrate the sub-systems to be integrated via third party protocols. In addition to design illustrations, the IAS design engineer should provide a schedule/matrix for the required communication interfaces. The schedule should define the equipment, communication protocol, and the responsibility to provide the communication interface, programming labor etc. .
D. The integration of third-party sub-systems should be limited to the protocol drivers that are available within the Niagara framework. These drivers shall be purchased through Tridium or Niagara certified developer partners
E. The data that is to be exposed via the manufacturer provided communication interface shall be defined within the IAS drawings. The IAS design engineer shall provide a table within the IAS drawings that details the inputs and outputs that are to be integrated to/from the third party sub-system.

2.03 THIRD PARTY INTERFACES

A. The sub-systems and devices that are to be integrated via third party protocols should be defined by the IAS design engineer. A schedule of devices and protocols should be included in the IAS, mechanical and electrical design drawings to clearly illustrate all protocol requirements. Do not leave protocol selection open to the IAS contractor as the best long-term solution may not be the least expensive short term solution. Utilize the Tridium Integration Matrix for defining third-party interfaces.

PART 3 - EXECUTION

3.02 INSTALLATION

E. The IAS contractor is typically responsible for providing the communication wiring and installation from the JACE network controller to the device or sub-system that is to be integrated. Depending on the sub-system, the physical connection of the communication interface within the device or sub-system may have to be performed by a manufacturer’s representative.

3.03 PROTOCOL INTEGRATION

This section shall be utilized to define the third party protocols that must be used to integrate the sub-systems identified in the IAS design drawings. The protocols listed in this section will not be the base protocol of the IAS. This section is used to define the approved third party protocols and should be tightly coordinated with the IAS, mechanical, electrical and other design drawings.

Section 25 14 00 – IAS Field Panels

The Integrated Automation System network architecture design will incorporate one or more tiers. The number of tiers within the architecture will be based on the technology utilized to control the field equipment (e.g. LonWorks, BACnet, or proprietary). The IAS design engineer must define the use of the Niagara JACE network controllers, programmable controllers, application specific controllers, and sensors/actuators. The base protocol selected for the IAS will define the performance of the system and must be thoroughly detailed in the IAS design drawings and specified within this section. Section 25 14 00 must also be tightly coordinated with Section 25 12 00 to clearly delineate the base protocol from third party integration protocols.

PART 1 - GENERAL

1.03 SUMMARY

A. The primary classifications for the IAS components define the tiers within the network architecture.

   Tier 1: Network Controller
   Tier 2: Application Specific Controllers, Programmable Controllers, Master Controllers
   Tier 3: Slave Controllers

   The selected technology will determine the number of tiers. For example, LonWorks is a peer to peer network technology where all intelligent devices are peers on the network and does not incorporate Master/Slave controller relationships. Therefore all of the LonWorks control devices, intelligent sensors and intelligent actuators will reside on Tier 2 and will be connected to a Network Controller on Tier 1.

   If BACnet is utilized as the primary protocol, the network architecture may incorporate a third tier. Tier 3 would include Slave controllers that are connected to and controlled by Master controllers on Tier 2.

   The IAS design engineer must thorough understand and apply the tiered architectures utilized by various manufacturers, technologies and protocols.

B. The IAS network architecture design should be briefly described in this paragraph. The base protocol for the design should be clearly stated. Do not leave selection of the base protocol open for the IAS Contractor to decide.
C. Further define the network architecture for the base protocol. This paragraph should describe the architecture that is illustrated within the IAS design drawings.
D. BTL certification is required for BACnet based systems.
E. Intelligent sensors and actuators are microprocessor based devices that can monitor and/or control field equipment without input from or connection to a higher level

controller. These devices are not commonly used within IAS as most sensors and actuators are connected to either a programmable or application specific controller.
All equipment types that are to be controlled and/or monitored by the IAS should be listed in this paragraph.
Wiring, enclosures and final connections for the IAS are the responsibility of the IAS contractor as defined in 10. High voltage power is the responsibility of the Division 26 contractor.

F. The IAS network architecture diagram should clearly illustrate the number of JACE network controllers that are required for the project. The IAS design engineer should understand the capabilities and capacities of the JACE network controllers and design the IAS network architecture to meet the system requirements. The IAS Contractor will base their pricing on the architecture design which may result in requests for change orders if not properly designed. It is important to leave the "(increase if required)" statement in this paragraph as this puts the financial responsibility to provide a complete and working system on the IAS Contractor.

G. The IAS design engineer must be aware of distance and resource limitations that are stated by each technology and manufacturer that applies that technology. The IAS design engineer should layout the wire runs on each floor plan to confirm each run is within the distance limits and to provide a recommended wire path for the installer. Utilize repeaters if necessary to stay within distance limits, but do not exceed resource limits.
Note: The detailed floor plans within the IAS design drawings provide a solid basis for as-built documentation, provided the recommended wire runs are followed by the IAS contractor.

H. The Network Controller will provide a variety of functions including integration to third party protocols. The protocols that can be utilized to integrate devices that do not use the base protocol should be stated in this paragraph. Coordinate this paragraph with Section 25 12 00.

I. The IAS network architecture should be designed around the capabilities of the various versions of JACE network controllers. The IAS design engineer should select the appropriate JACE network controllers to meet the IAS performance requirements. It is important for the IAS design engineer to understand the differences between JACE controllers, select the appropriate controller, confirm during submittal review and enforce during construction administration.
This paragraph should only include description(s) of the required JACE(s). Delete the descriptions for the JACE Network Controllers that are not to be used within the IAS. Tightly coordinate this paragraph with the IAS network architecture and floor plan design drawings. Include a schedule of network controllers with the IAS design drawings.

1.05 QUALITY ASSURANCE

LonMark International and ASHRAE have created certification processes for equipment that is based on LonWorks technology and the BACnet standard. If either of these technologies is utilized within the IAS design, the IAS design engineer should require the appropriate certification for the IAS control devices. The IAS design engineer must understand the value and application of each of these certification processes including the use of Functional Profiles (LonMark/LonWorks) and Protocol Implementation Conformance Statements (ASHRAE/BACnet). All field devices should be LonMark certified or BACnet BTL certified.

PART 2 - PRODUCTS

2.02 STAND-ALONE FUNCTIONALITY

A. Stand-alone functionality is a key performance requirement for the IAS. Stand-alone functionality is defined as continued operation, both monitoring and control, of the equipment in the event of a loss of communication. Each controller must have the inputs, outputs and intelligence to maintain the primary sequence of operation with or without network communication. Secondary variables, such as outside air temperature, that are not updated when network communication is lost shall be held at their last value until communication is restored.
   The IAS design engineer should design the network architecture and control system to enable stand-alone operation of all primary equipment. The list of equipment that requires stand-alone operation should be listed in this paragraph and coordinated with the IAS design drawings.
B. Networked I/O devices (intelligent sensors/actuators) should not be used within primary sequences of operation as their ability to provide updates is dependent on network communication.
C. Large pieces of equipment with high point counts may require their own sub-LAN to meet the stand-alone requirement. A router can be utilized to create and logically/electrically isolate the sub-LAN for a single piece of equipment that requires multiple controllers to operate.

2.03 NETWORK CONTROLLER

This section describes the features of the JACE network controllers. The IAS design engineer should fully understand the capabilities of the various JACE network controllers and properly apply them within the design of the network architecture.

A. The performance of the IAS design relies in part on the selection of the appropriate JACE network controllers. The IAs design engineer should specify the JACE network controllers that are required for use within the network architecture. This section should be closely coordinated with the IAS design drawings.

2.04 APPLICATION SPECIFIC CONTROLLER (ASC)

A. Application specific controllers are pre-programmed to provide a specific, high volume function, such as VAV terminal unit control. The ASCs will utilize the base protocol that was selected by the IAS design engineer.
E. The network architecture for ASC communication will be dependent on the selected technology, and the control system manufacturer's interpretation of that technology. The IAS design engineer should select the technology and design the IAS network architecture to meet the requirements of the selected technology. Do not leave the design of the IAS network architecture open to the IAS Contractor.
O. The IAS design engineer shall define the modes of operation for the ASCs. Verify that the modes described in this paragraph are applicable to the design and tightly coordinate this section with the sequences of operation such that there is no conflict between the multiple references within the specifications (Division 23, 25, 26, etc.) and IAS design drawings.

2.05 PROGRAMMABLE CONTROL UNIT (PCU)

A. Programmable Control Units enable custom control of larger or custom equipment. The PCUs will utilize the base protocol that was selected by the IAS design engineer.
E. The network architecture for PCU communication will be dependent on the selected technology, and the control system manufacturer's interpretation of that technology. The IAS design engineer should select the technology and design the IAS network architecture to meet the requirements of the selected technology. Do not leave the design of the IAS network architecture open to the IAS Contractor.
O. The IAS design engineer shall define the modes of operation for the PCUs. Verify that the modes described in this paragraph are applicable to the design and tightly coordinate this section with the sequences of operation such that there is no conflict between the multiple references within the specifications (Division 23, 25, 26, etc.) and IAS design drawings.

2.06 INTELLIGENT SENSORS AND ACTUATORS

A. The IAS design engineer should carefully consider the use of intelligent sensors and actuators. These devices are not commonly used within IAS as they do not meet the stand-alone functionality requirement. There are very few applications where intelligent sensors and actuators can be utilized in a reliable and stable manner as they rely on network communication for integrated operation.

2.07 REMOTE EXPANSION I/O

A. The JACE Network Controllers can utilize expansion I/O to enable direct monitoring and control from the network controller. These modules can be utilized to expand that capabilities of the system and cost effectively monitor and control additional devices without violating the stand-alone capability requirement because the RS-485 communication network is dedicated to the I/O devices. The design engineer must confirm the use and application of the expansion I/O during submittal review and construction administration.

2.08 CONTROL PANELS

A. Control panels should be standardized for the IAS. The design engineer should utilize this paragraph to define the control panel including type, listing, construction, labeling, and installation.

PART 3 - EXECUTION

3.01 PREPARATION

C. The IAS Contractor should install the communication wiring as shown on the IAS design drawings. Following the designed wire path will avoid conflicts, provide the basis for accurate as-builts, and facilitate troubleshooting.

3.02 INSTALLATION

D. The IAS design engineer should consider the value of providing the ACSs to the equipment manufacturer (e.g. VAV box manufacturer) for factory installation. Factory installation of high volume devices will decrease the amount of time required to install the devices, decrease the cost of installation, and increase the quality of the installation.
E. The IAS Contractor will be responsible for the operation of the IAS and must coordinate their activities with the Commissioning Authority. It is important that the IAS Contractor be aware of this role and include the cost to cover their time in their initial proposal.

3.03 SYSTEM ACCESS

A. The IAS is network based. The tools to manage, monitor and control the IAS will also be networked based. A low cost method to facilitate troubleshooting in the field is to require a hub with at least one available port within each control panel that houses a network controller.

3.04 HARDWARE APPLICATION REQUIREMENTS

A. Control systems based on enterprise connectivity and open protocols can provide numerous features and benefits to the building owner/operator. It is the IAs design engineer's responsibility to understand how to design the system, illustrate and specify the requirements within the design documents, confirm adherence to the design during submittal review, and verify conformance during construction administration.
B. Stand-alone capability is a key performance feature. A reliable and stable system must not be dependent on network communication for proper operation. It is the design engineer's responsibility to properly design the system to achieve stand-alone operation.
D. Application categories define the controllers that make up the IAS. The IAS design engineer should include the application category within the schedules that define the

individual controllers. Application Category 0 provides monitoring of non-critical inputs only. These values are not used within any sequences of operation or control loops. Monitoring of these points is form information only.

E. Application Category 1 is for ASCs. The IAS design engineer should identify all of the ASCs that will be utilized in the project as well as any special characteristics that may be required.
F. Application Category 2 is for General Purpose Terminal Controllers that could be ASCs or PCUs depending on functionality. The IAS design engineer should identify all of the applications that require more advanced ASCs and PCUs as well as any special characteristics that may be required.
G. Application Category 3 is for PCUs. The IAS design engineer should identify all of the applications that require PCUs as well as any special characteristics that may be required.

3.05 APPLICATION PROGRAMMING SOFTWARE TOOL

A. The IAS Contractor must provide all of the tools that were used to manage, configure, program and commission the IAS. If these tools are not provided that owner may be restricted with regards to future operation, maintenance, upgrade and expansion of the system. Provision and licensing of all software must be verified before substantial completion is granted.

3.06 CONTROL UNIT REQUIREMENTS

A. The IAS design engineer should identify all of the control units required for a complete IAS. Design of the IAs includes detailed specifications that are tightly coordinated with detailed drawings. The network architecture diagram will define the overall layout of the system. The floor plan diagrams will define how the devices within each floor are connected. The detail drawings will provide installation and commissioning details for each sub-system and device. The schedules will identify the quantity of devices as well as the requirements for each category of device.

Section 25 15 00 – IAS Software and Programming Tools

The lifecycle of the Integrated Automation System including implementation, operation, maintenance and expansion is dependent on the software and programming tools that are utilized to create the system. Section 25 15 00 provides a high level of definition for software requirements that must be thoroughly understood, applied and enforced by the IAS design engineer. Understanding of all the concepts presented in this section will provide a solid basis of knowledge for designing and implementing an effective IAS. Although this section only requires minor modifications to customize the content for project specific requirements, it is highly recommended that the IAS design engineers review this section in detail, and educate themselves on any concepts that are unclear. All of the concepts within this section must be applied properly to maximize the long term performance of the IAS.

Graphic standards are important to define upfront, as the quality, navigation and details provided can vary significantly, along with the cost to implement. Tridium has developed a graphics standards document that can be utilized as is, or as the basis for a customized document. It is highly recommended that the operation, appearance and navigation of the GUI be defined and included with the design documents to insure the IAS Contractors are fairly evaluated and held to a level of performance during implementation. It is especially important to provide graphic standards when the project involves multiple sites, over extended time frames, and potentially through multiple IAS Contractors. Graphic standards will reduce training times, increase reliability and improve the effectiveness of the Facility Engineers through standardization of GUI access for all facilities.

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. A graphic standards document is highly recommended. Tridium has developed and provided this document to assist IAS design engineers with the implementation of graphics standards. Utilize this document as is, or modify it to meet the owner’s requirements.

1.02 SUMMARY

A. The IAS design engineer should understand the importance of all the software described in this section.

D. The custom set-up should be defined by the IAS design engineer in the form of a graphic standards document. At minimum, screen captures should be provided along with the required screen navigation (e.g. tree structure vs. drop down menus).

E. Supervisory control strategies can be coordinated through the Niagara framework. It is important to define global or supervisory control strategies within the sequence of operation and IAS design drawings. The programming for each individual device is dependent of the sequences that must be performed locally, and those instructions that will be created globally (e.g. emergency shutdown). Upfront definition of the strategies will insure efficient implementation and enable the IAS Contractor to properly develop the programming.

F. Remote Access Servers and Wide Area Network support requirements should be discussed with the owner and the owner's IT department. The requirements for RAS and/or WAN connectivity should be coordinated with Section 25 11 09.

1.04 LICENSING

A. Long term, cost effective, reliable IAS operation is dependent on the owner's ability to competitively bid installation, maintenance, operation, troubleshooting and expansion of the IAS. Ownership and licensing of all the software, databases and tool sets utilized by the IAS Contractor to manage, configure, program and operate the IAS must be provided to the Owner.
If any one of the required software programs, databases or tool sets is not provided, the long term support of the IAS may be locked into an expensive sole source support contract with the original IAS Contractor.

1.05 NETWORK MANAGEMENT

A. The control devices within an IAS are intelligent, networked devices. As with personal computer networks, each device requires a method to uniquely identify the each device within a large network of devices. This process is referred to as network management. Network management will be performed by the IAS Contractor before, during and/or after installation of the devices.

1.06 GRAPHICAL USER INTERFACE

The Niagara based graphical user interface is defined in this paragraph. While this paragraph does not require significant project specific modifications, it is important for the IAS design engineer to understand all of the concepts presented herein. The IAs design engineer should study this section and understand how all of the key concepts interact to provide the basis for an IAS GUI.
This paragraph should be tightly coordinated with the graphics standards document.

1.07 QUALITY ASSURANCE

B. IAS Contractor certification is a requirement that must be enforced. Successful implementation of an IAS based on the Niagara framework requires detailed training and demonstration of competency. The IAS design engineer should verify that the staff presented as certified are the staff performing the work.

C. The IAS design engineer should research the local market to identify the available Tridium Certified Integrators. These integrators should be evaluated for their performance history before being included in the specification.

PART 2 - PRODUCTS

2.02 SYSTEM SOFTWARE-GENERAL

A. The IAS Contractor is required to provide a complete and functioning system. It is possible that the system installed utilizes hardware and/or software tools that are in addition to those described in these specifications. This paragraph must be included to enforce the IAS Contractor’s responsibility to provide a complete and functioning system. Ownership and licensing of the hardware and/or software tools must be transferred to the owner before substantial completion is granted.

2.03 NETWORK MANAGEMENT SOFTWARE

The IAS Contractor is required to provide network management of all devices within the IAS. This paragraph defines the services that the network management software provides. The IAS design engineer should thoroughly understand the network management process.

2.04 PROTOCOL ANALYZER

A protocol analyzer is a tool that is used to verify, troubleshoot, and test communication networks.

2.05 CONTROLLER SOFTWARE

A. The features provided by the Network Controller are specified in this paragraph. This paragraph should be included in its entirety. The IAS design engineer should fully understand the operation of the network controller and its role with the IAS network architecture. Network controller details are provided in section 25 14 00.

B. The features provided by the Programmable Control Unit are specified in this paragraph. This paragraph should be included in its entirety. Programmable Control Units are typically utilized to control large pieces of mechanical equipment such as Air Handling Units. Programmable Control Unit details are provided in section 25 14 00.

C. The features provided by the Application Specific Controllers are specified in this paragraph. This paragraph should be included in its entirety. Application Specific Controllers are typically utilized to control smaller pieces of mechanical equipment that are utilized in high volume throughout the facility such as Variable Air Volume boxes. Application Specific Controller details are provided in section 25 14 00.

F. Control systems based on open protocols enable the IAS Contractor to define the traffic flow by selecting variables that will be exposed and linked to other objects (e.g. controllers, GUI). It is important for the IAs design engineer to define all of the data points that are to be exposed and linked to the GUI and to other control devices. The point database/summary table should be tightly coordinated with the graphics standards to verify the data is consistently represented.

2.06 APPLICATION PROGRAMMING DESCRIPTION

Application programming will either be graphical, pre-programmed “fill in the blanks” configuration, or line programming. All control system manufacturer provide PCUs or ASCs that employ one or more of these methods. This paragraph should be included in its entirety unless the owner is sole sourcing the expansion of an existing system, in which case the IAS design engineer should specify the specific program that must be utilized for device programming.

2.07 APPLICATION CONTROL LOGIC

The application control logic defines the capabilities of the programming logic with each controller. The functions described herein will enable the sequences of operation to be implemented. If the sequences of operation require functions that are not described in this paragraph, the IAS design engineer should expand the list to include the required functions.

2.08 APPLICATION BUILDER CAPABILITIES

The application builder capabilities define the Niagara graphics development tools that will be utilized to create the user interface screens. The IAS design engineer does not need to modify the details within this paragraph but should thoroughly understand the capabilities and flexibility of the Niagara framework.

2.09 REPORT WRITER

The report writer paragraph defines the report printing and scheduling features of the Niagara framework. The IAS design engineer does not need to modify the details within this paragraph but should thoroughly understand the reporting capabilities of the Niagara framework.

2.10 ENERGY MANAGEMENT APPLICATIONS

A primary function of most IAS is to manage energy consumption through continuous automated control of mechanical equipment. This paragraph defines a variety of energy management control functions that may be required to perform the required sequences of operation.

The IAS design engineer should review the sequences of operation and compare the sequences to the control logic applications defined in this paragraph. Although the current sequences may not utilize all of the control logic capabilities defined in this paragraph, it is of value to leave all of the control capability requirements in the specifications, as stated, to enable future expansion

2.11 GRAPHICAL USER INTERFACE SOFTWARE

The graphical user interface (GUI) software paragraph requires minimal input from the IAS design engineer. However, all of the concepts defined in A. through J. must be thoroughly understood. This paragraph defines the capabilities of the Niagara framework and the expected operation of the GUI. This paragraph should not only be included in its entirety, but it should be understood and applied in its entirety by the IAS design engineer.

Features defined in this paragraph are included in Tridium's Graphic Standards document.

PART 3 - EXECUTION

3.01 SYSTEM CONFIGURATION

A. The IAS Contractor is required to provide a complete and functioning system. The work of the IAS Contractor must be coordinated with the CxA as the GUI provided by the IAS Contractor is a valuable tool for the CxA to not only verify the operation of the IAS, but also the equipment the IAS controls.

3.02 SITE-SPECIFIC APPLICATION PROGRAMMING

A. The IAS Contractor must provide site-specific programming and databases to the owner. If the IAS Contractor does not provide all of the files created through custom programming the owner will not be able to engage the services of third party IAS Contractors to maintain, troubleshoot and expand the system after the warranty expires.

3.03 PASSWORK SETUP

A. Owners may have existing standards for username and password generation. The IAS design engineer should discuss username and password generation with the owner, and/or create their own standards for username/password generation.

3.04 POINT PARAMETERS

Open protocols enable the IAS Contractor to define the parameters for each point (input and output variables). It is important to define and record the key parameters for each point as they can affect the performance, maintenance, troubleshooting and expansion of the system.

For example, the transmission frequency could be based on a timed parameter (scanning frequency) or on a Change of Value (COV). COV systems are more efficient as they only transmit updates when the variable (e.g. temperature) exceeds a specified limit (e.g. 0.2°F).

The parameters for each point type listed in this paragraph should be included within a schedule. The schedule should be included within the specifications and/or the design drawings.

3.05 HISTORICAL DATA LOGGING

Historical data logging is an important feature for long term operation, fine tuning and troubleshooting. The IAS design engineer should include identification of the points that are to be trended within the point schedule created to identify the parameter detailed in 3.04. It is common to increase point trending during startup and commissioning to assist with verification of systems. The point schedule should identify the points that are to be trended long term.

3.06 TREND GRAPHS

Trend graphs should be provided as a way to visualize all historical logs. Anomalies are significantly easier to identify and resolve when the trend data is presented in a graphical format.

3.07 ALARMS

The IAS design engineer should define all required alarms within the point schedule. Alarms creation shall be discuss with the sub-system design engineers and the owner to enable efficient operation of the IAS while avoiding nuisance alarms.
This paragraph defines typical alarm parameters for alarms that are typically provided by the IAS. The IAS design engineer must review the list of parameters within this paragraph and make the appropriate adjustments to comply with the project requirements.

3.08 GRAPHIC SCREENS

A. Utilize the Tridium Graphic Standards document as the basis for illustration of the look, feel and functionality of the GUI.
B. The graphic standards should be followed exactly as shown in the standards document. Deviations from the standards will create confusion and inefficient operation. Deviations should be submitted for owner review and acceptance before implementation.
C. Submission of the deviations, or of newly created graphics that did not previously exist, will enable the IAS design engineer to review and approve the graphics before implementation by the IAS Contractor.
F. Coordination with the CxA is imperative as the IAS GUI will be a primary tool utilized by the CxA to verify performance of a variety of sub-systems. This coordination will require the IAS contractor’s time, and must be included within their original proposal. Commissioning requirements should be discussed during the pre-bid meeting.
G. Riser diagrams and floor plans are key components of the GUI. The graphic standards should detail the approach that must be followed to present the real-time and historical

data. The verbal description presented in this sub-paragraph must be tightly coordinated with the graphic standards.

H. Schematic diagrams provide valuable backgrounds for the development of user interface screens. The schematic diagram can be overlaid with the appropriate data points to create an easy to understand visual of the controlled equipment. The standard graphic library also enables schematic diagrams to be efficiently created for common types of mechanical equipment (e.g. AHUs, VAVs, etc.).

   Item 4: Summary graphics utilize a table format and are valuable for presenting the status of high volume equipment on a single page (e.g. 20 VAV boxes).

   Item 6: An electrical riser diagram is valuable for illustrating the layout of the electrical system and can greatly aid operation and troubleshooting of the system.

   Item 7: Power metering is a powerful method to verify energy savings, fine tune control strategies, and implement demand side load shedding strategies. The popularity of the Smart Grid grows every day, power metering and sub-metering are required to maximize the performance of a Smart Grid.

I. Alarm presentation should be defined within the graphic standards.

3.09 SITE SPECIFIC DEVELOPMENT CRITERIA

This paragraph provides screen captures and examples of how the GUI must be created. If a graphic standards document will not be included within the design documents then the IAS design engineer should utilize this section to provide screen captures and other details for how the GUI should be developed.

Section 25 60 00 – IAS Operation and Maintenance Manuals

Detailed operation and maintenance manuals support the long term performance of the overall system. The IAS will integrate a wide variety of advanced devices that must be maintained in order to sustain and maximize performance. Access to the O&M manuals should be easy and efficient. It is highly recommended that the manuals be provided in both hard copy and electronic media. The electronic version should link specific O&M pages to the appropriate graphical user interface screens, enabling users to quickly access relevant data while viewing the associated sub-system GUI screens.

PART 1 - GENERAL

1.02 SUMMARY

A. Division 1 should specify the requirements for operation and maintenance manuals for the overall project. It is important to coordinate Section 25 60 00 with the requirements of the Division 1 O&M specifications.

1.03 OVERVIEW

A. The O&M manuals should be provided in both hard copy and electronic media. The required number of hard copies should be discussed with the owner. The electronic media version of the O&M manuals should be linked to the GUI to facilitate access and efficiency.

C. A draft copy of the O&M manual should be provided to the IAS design engineer and the owner for review and approval before the manual are assembled.

1.04 CONTENTS OF O&M MANUAL

A. The contents of the O&M manuals should be specified in detail. The IAS design engineer should verify and expand upon this paragraph to insure all the key components of the IAS are addressed and organized.

C. Accurate as-built drawings are extremely valuable for long term operation, maintenance, troubleshooting and expansion. The IAS design engineer should verify the accuracy of the as-built drawings by spot checking wiring and device locations throughout the facility.

1.05 ELECTRONIC DOCUMENTATION

A. All user manuals should be provided in electronic format and linked to the associated pages within the GUI. The IAS design engineer should review this list and modify it as required to include manuals that are not listed, and to delete manuals that are not part of the project.

Section 25 70 00 – Integrated Automation Training Requirements

Training for all of the primary components of the IAS must be provided by the IAS Contractor. The IAS design engineer should define the training requirements within this section.

PART 2 - PRODUCTS

2.01 GENERAL

D. Video recording of the training sessions is highly recommended. Recording of the training sessions will facilitate the ongoing efficiency of staff by enabling them to review the training sessions at any time. The training sessions should become a standard part process for new employees and a support tool for existing employees. The training sessions should be linked to the GUI to facilitate access when and where it is needed.

PART 3 - EXECUTION

3.01 GENERAL INSTRUCTIONAL REQUIREMENTS

A. The operation of the IAS will be dependent on the programming created for the specific project and should not be generalized. It is important for the programmers that setup and commissioned the IAS to be involved with the training sessions. The IAS design engineer should attend the training sessions and interject questions and/or comments as appropriate to maximize the effectiveness of the training program.
B. The training must be site specific and utilize the GUI created for the facility.
C. The training workstations should be connected to and online with the IAS in real-time. Do not conduct training with demonstration software. User access can be restricted to "read only" during the training session to avoid accidental disruptions.
E. Video recording should be edited to enable efficient access and linking to the GUI.

3.02 ONSITE TRAINING PROGRAM

A. The IAS design engineer should determine and specify the required number of hours of training based the complexity of the system and the number of personnel to be trained.
B. Training should be provided once the IAS has achieved substantial completion, and should not be conducted as the system is installed and commissioned.
C. Training should include a walk though of the facility to identify and demonstrate the physical aspects of the system. A portable workstation should be utilized in the field to demonstrate the operation of individual components.
G. The IAS design engineer should specify all of the IAS components that must be addressed during training. The IAS design engineer should review all of the items contained within this list and modify the list to meet the scope of the project.

3.03 TRAINING DELIVERABLES

A. The purpose of the training program is to provide the facility engineers and operators with the knowledge they need to take control of the IAS. Therefore, the IAS Contractor must provide all of the tools that the O&M personnel will require to perform their jobs. All hardware and software, as defined throughout the Division 25 specifications, should be turned over to the owner at the completion of training.

Section 25 90 00 – Sequences of Operation for Integrated Automation

The sequences of operation should be provided by the design engineers for each sub-system. The IAS design engineer should assemble all of the sequences of operation and either include them within Section 25 90 00, or specify where the sequence of operation can be found. It is recommended that even if the sequences are provided within this section, that they also be provided within the IAS drawings for each subsystem. It is common practice for IAS programmers and technicians to utilize the IAS drawings during initial start-up. By copying the sequences of operation to the subsystem detail drawings, the IAS contractor will have easy access to all of the physical and logic aspects of the specific subsystem. It is highly recommended the approved sequence be incorporated into the graphical user interface for the end user's quick access and reference.

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

C. It is highly recommended that the sequences of operation be provided within the IAS design drawings for each subsystem.

1.03 CONTROL DIAGRAMS AND SCHEDULE

A. The IAS design engineer should provide detailed subsystem design drawings as an integral part of the IAS design. How the equipment is controlled, including the devices and sequences of operation required to maximize the efficiency of the IAS should be defined by the IAS design engineer within the specifications and design drawing.

1.04 SEQUENCES OF OPERATION

A. The IAS design engineer should assemble the sequences of operation required for each subsystem and record them in the IAS design drawings and Division 25 specifications. The sequences of operation and I/O devices required for each piece of equipment should not be left open for the IAS Contractor to define. The IAS design engineer should provide all of the required information to implement a complete and working system. Detailed schedules for required devices will facilitate fair evaluation of competitive bids.