

Technical Bid Specification

Collaborative Process Automation System

For the Power and Process Industries

Read Me before using:

All products / requirements are included in this spec (i.e. all I/O types such as SIL 3, IS, G3, etc., Batch, AO, etc.). In addition, the specification will require personalization to highlight your specific industry group's qualifications (mainly sections 1, 11, and 12) and to address specific project requirements (sections 2 through 10). Note, we have provided section 1, 11 and 12 as a starting point (or set of suggestions) for the industry groups. These sections require review and editing by each individual (or individual group) to match the group's specific qualifications and specific project requirements. Finally, the specification refers to Attachment 1, which includes specific project data (i.e. I/O locations, type, count, architecture / # type of workstations, etc.). Attachment 1 will need to be updated on a project by project basis. For your convenience, we have summarized the specification's Attachment 1 references at the end of the document. Also, you will see throughout the document text highlighted in **blue**. This indicates input/personalization is required by user.

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# GENERAL INFORMATION

## Overview

* + 1. This specification defines the minimum functional requirements for a Collaborative Process Automation System (CPAS) for operation in a \_\_\_\_\_\_\_\_ process plant. Bidders shall clearly identify any exception to the requirements of this specification.
    2. The function of the CPAS is to provide safe operation of the entire plant. The CPAS shall meet the objective of maximizing plant availability while reducing the risk of overall plant operation by providing a common environment for production control, safety supervision, and production monitoring.
       1. To maximize safe plant operation, it is desirable to have safety automation fully integrated into the scope of the overall process operations environment.
       2. Safety automation operational access shall be done directly from the normal operations interface.
       3. Safety control configuration shall be done with same engineering tool as all other control configuration.
       4. Safety controllers shall be part of the same hardware family as the standard process controller hardware.
       5. Safety controllers shall be capable of residing on the same control network as the standard process controllers.
       6. Safety controllers shall be capable of sharing I/O information and safety control status information in a direct peer-to-peer function with standard process controllers.
       7. Safety controllers shall offer the option of executing both safety control and normal process control within the same hardware even if this feature is not used in the initial project definition.
    3. No deviations from this specification (and its attachments) shall be permitted without a written request and subsequent written approval from the Buyer.

## Project Scope

* + 1. The Supplier shall have full system responsibility for furnishing a complete and workable system and furnish all equipment and services to meet the functional requirements of this specification. The Supplier must fully understand the job to be done, and it shall by the Supplier’s responsibility to resolve any questions or uncertainties arising from this specification prior to entering into a contract.
    2. The system offering shall include:
       1. Factory fabricated and 100% I/O tested with hardware simulation.
       2. Hardware simulation shall be available as a software switch within the control configuration toolkit.
       3. Hardware simulation should provide the ability to force signals and test all connected control logic and graphics presentation of the data.
       4. Closed loop simulation of process control loops.
       5. Interconnection cables with plug in connections at each end.
       6. Nameplates for equipment cabinets and individual devices.
       7. Engineering and configuration services for implementing the control and data acquisition functions.
       8. Field services, including system startup and commissioning, and applications engineering.
       9. Provide as an option, a simulator (as described in Section xx) to train operators and engineering personnel.

## Project Schedule

* + 1. The Supplier shall provide a project schedule of events with the time periods between receipt of a purchase order to delivery and start-up of the system. Schedule shall include but not be limited to initial project “kick-off” meeting, hardware and software configuration schedule, engineering design “cut-off” dates, system assembly schedule, system checkout schedule, system support training, operator training, Factory Acceptance Test (FAT) dates, system shipment dates, estimated installation time, and expected start-up time.

## Requirements for Supplier’s Proposal

* + 1. The following activities must be included with the supplier’s proposal:
       1. List all technical and commercial exceptions and clarifications to the specifications referenced to the relevant paragraphs.
       2. List of any features and benefits not required by the specifications, but included in the base bid price.
       3. List and description of any unsolicited options that can improve the project success. Describe in detail how the options will improve the economics of this project.
       4. System overview drawing denoting quantity and location of major equipment (i.e. system cabinets, operator consoles, engineering workstations, printers and hard copiers).
       5. Equipment list identifying quantities of major system components.
       6. Product specification for major components including cabinets, power supplies, termination units, each type of control or input / output module, operator console, etc.
       7. List of similar projects in progress or completed by supplier.

## Supplier Qualifications

* + 1. Qualified suppliers must have a fully demonstrable commitment to the \_\_\_\_\_\_\_ industry. Proof of commitment must include a significant installed base of CPAS, continuing investment in technology, and existing standards for control and monitoring applications.
    2. The installed base must consist of at least XX successful \_\_\_\_\_\_\_\_ applications. These must include:
       1. *List application features (i.e. for Power Plant applications, list: Boiler Controls, Advanced Feedwater Controls, Burner Management, etc.)*
       2. *……*
    3. The Supplier must be able to demonstrate a continuing commitment to the \_\_\_\_\_\_\_\_ industry through development of technology that has direct benefit to the industry. Technology advancements should include:
       1. CPAS hardware improvements to meet needs of the entire facility
       2. Application programs that assist in the reduction of overall production costs.
    4. Further proof of the Supplier’s qualifications will be demonstrated by standard “best practice” applications developed by the Supplier. The standard applications must be field-proven through successful installations, and of such variety so as to validate the Supplier as a reliable source of technology for the \_\_\_\_\_\_\_\_\_ industry. Standard applications must include:
       1. *List industry applications (i.e. for utility industries, this might include: Boiler Controls, Draft Controls, Feedwater Controls, Combustion Controls, Steam Temperature Controls, Burner Management (fully automatic and integrated with DCS hardware), etc.*
       2. *…..*

# ARCHITECTURE

## General

* + 1. The CPAS shall have an open architecture design allowing for easy integration of disparate plant devices and data. It shall be configured utilizing a common configuration approach and require minimal programming skills. To ensure that the useful life of the system is maximized, commercially available communication network hardware shall be used.
    2. The CPAS shall consist of process control units, user interfaces, and system support equipment that have access to system-wide data via a single [redundant] high-speed ethernet communications network. The control logic for a specific loop shall reside within one controller, thereby optimizing loop performance and control network communications. Where a single loop must reside in a single controller, it shall also be possible to distribute a single, large control application across more than one time execution task within that controller or across more than one physical controller.
    3. The CPAS shall be capable of everything from single loop to large, integrated safety and automation applications encompassing thousands of I/O points. Commonality of hardware, software structures, and communications strategies is required to minimize spare parts and training.
    4. The CPAS shall have the capability of using an external time master device and shall provide a mechanism where all system nodes (PC servers, PC workstations, controllers, SOE I/O) rely on a single time master that can migrate to other nodes on the system if the current time master node fails. The use of IRIG-B GPS clock is an example of an external time master appropriate for time synchronization.

## CPAS Software Platform

* + 1. The CPAS Software Platform shall facilitate easy deployment, reproduction, and maintenance of Owner’s proven “Best Practices” standards. The platform shall allow for adaptation of standards to meet specific needs with minimum engineering or revalidation. “Best Practice” standards shall extend beyond control algorithm to include such items as faceplates, documentation links, graphic elements, trends, history log configuration, field device diagnostics, etc. Modification of these “Best Practice” standards shall be automatically propagated to all CPAS use instances. Supplier shall provide details on how this is accomplished in their system.
    2. The CPAS Software Platform shall allow the system user to configure, maintain and view all plant functions. As a minimum, the functions shall support:
       1. Operations
       2. Alarm and events
       3. Trending
       4. Reporting
       5. Control
       6. Engineering
       7. Maintenance
       8. History data collections
       9. Batch management
       10. Asset management
       11. Device management
       12. Electrical Integration
       13. Integrated Safety Automation
    3. In an effort to operate and engineer efficiently, reduce system support costs, and extend the useful life of the system, the CPAS Software Platform shall organize, manage, and consolidate information for various plant and process equipment in a single, user friendly, environment.
    4. The CPAS Platform shall use object-like placeholders for real world plant entities such as control tags, motors, pumps, valves, transmitters, reactors, tanks, and plant areas. It shall be possible to connect or reference related information and functionality to these entities.
    5. The main interface to the CPAS Software Platform, described herein, shall include tree navigation, panes for previewing, and property listings. This interface shall enable creation, deletion and organization of various plant ‘objects’ by function, location, control hardware, object type, or customized tree structure.
    6. The CPAS Software Platform shall promote engineering efficiency by using object-oriented features such as object types and inheritance characteristics. For example, when adding a trend display to a control tag of a specific type, such as a flow controller, the user shall have the option of associating the display to all tags of that type by adding it to the object type generically.
    7. The CPAS Platform shall connect to the Supplier’s controllers and other plant control systems and applications, such as PLCs or Computerized Maintenance Management Systems (CMMS), via standards such as OPC, TCP/IP, ActiveX, HTML, and XML. Connectivity to these plant systems shall be configurable without requiring special application development. If OPC is used to connect to control systems, both OPC DA for data and OPC AE for alarm and events, shall be available in order to display the control systems alarm and events as well as numeric data.
    8. The CPAS Software Platform shall also serve data to external applications via OPC DA (Data Access) and OPC HDA (History Data Access) without the need for a special server or dedicated PC using a third party OPC server.
    9. The CPAS Software Platform shall allow the linking and displaying of documentation in various formats such as the latest versions of Microsoft Office (Word, Excel, and Powerpoint), Adobe Acrobat PDF, and AutoDesk drawings in web format, Crystal Reports, etc.
    10. The CPAS user environments for any type of user shall allow information about a single entity to be navigated in any sequential basis without having to return to a fixed starting point to maximize user effectiveness. An example of this would be:
        1. From an alarm list, to select the alarm entry and navigate to an alarm action document
        2. From the alarm action document, navigate to the faceplate for the loop or device.
        3. From the faceplate, navigate to a trend for the loop or device
        4. From the trend, navigate to a video camera selection to view the area remotely
        5. From the video camera window, navigate to an asset management environment to view the current faults or deficiencies for the device
        6. From the asset management window, navigate to a work order entry form that contains specific device information related to the selected device and be able to complete the form and submit it to the plant CMMS.
        7. Navigate from the entry form to the actual work order
        8. Navigate to the next logical point … etc.
    11. Security and Access Control
        1. The CPAS shall include a configurable, comprehensive user security and access control function. This function shall govern the presentation of and access to displays, data, and system functions at all system workstations.
        2. The CPAS shall provide the option that each user be assigned an individual account with a unique User Identification (User ID) and password combination. The system shall support an unlimited number of unique user accounts. It shall be possible to administer user access rights through enforcement of domain policies.
        3. The system shall require individual users to establish and maintain a confidential password associated with their account. The system shall enforce the modification of the password at regular intervals. This interval shall be established by the system administrator.
        4. The system shall support the enforcement of configured rules associated with the creation of User passwords. This will enable the CPAS to conform to established IT security policies within the facility / corporation / enterprise.
        5. The system shall support the organization of users into one or more groups for the purpose of establishing system access and permission profiles on a group-by-group basis. The system shall have the ability to define what system functions and screens are visible to a user group. The system shall have the ability to define what system operations can be performed by a user group.
        6. It shall be possible to restrict access to other workstation functions and applications (i.e. desktop, word processor, shutdown scripts) based upon the profile of the logged in user.
        7. By default, the system shall be delivered in a secure, locked down state that includes preconfigured security settings for windows services, files, directories, registry keys, groups and group policies. Groups and group policy settings shall define and/or restrict windows desktop access based upon the user’s role. In addition, the Supplier shall provide documentation of the preconfigured windows settings.
        8. It shall be possible to switch the logged-in user from within the CPAS application without returning to the Operating System login dialog. The function of switching a user shall not result in the loss of the currently displayed screen or require re-navigation to the function currently displayed.
        9. The system shall support the automatic logoff of a user session after a pre-established duration of inactivity at the workstation. This duration shall be configurable by the system administrator.
        10. Any changes made to objects in the CPAS Software Platform shall be tracked in a single audit trail event log. These changes include operation, engineering, and maintenance actions (for example, an operator changing a setpoint, an engineer changing or deleting a configuration parameter, or a technician calibrating a device). The audit event messages shall include but not be limited to:
            1. The date and time the change was made
            2. User name of the individual making the change
            3. Location from where the change was made (i.e. Workstation name)
            4. The item that the change was made to.
        11. For an additional layer of accountability, selected system actions may be configured to require electronic signature prior to the commitment or implementation of the action. Electronic signature shall consist of the presentation of a dialog requesting the entry of the User ID and password of the currently logged in user. It shall be possible to require a second electronic signature consisting of the presentation of a dialog requesting the entry of the User ID and password of a different user. A specific User or User Group membership may be required to fulfill the requirements of the electronic sign-off. The Electronic Signature feature shall meet the requirements established for regulated industries according to 21 CFR Part 11 of the Code of Federal Regulations for the Food and Drug Administration (FDA).
        12. To assure that CPAS configuration data changes are not done after the data has been reviewed and approved; it shall be possible to sign configuration data and report data with a digital signature. The signature must be made invalid if the underlying data has been changed.
        13. The CPAS should be tested for tolerance to malicious attacks. The system should be tested against third party protocols such as Wurldtech’s Achilles Satellite Unit and Mu Dynamic’s Mu-8000. Vender should supply a list of security test protocols and certifications attained.
        14. The CPAS servers and clients shall use virus scanner software to prevent malware from embedding itself into the system. Either McAfee VirusScan® Enterprise or Symantec Endpoint Protection products are requested. If the supplier does not use one of these virus protection products, an explanation of what product is used and why that product was selected for use by the vendor is required.
        15. In conjunction with virus scanning software, the CPAS shall implement application whitelisting as an addition protection model. The owner believes that whitelisting, the process of defining a list of approved that applications that can install and run on the system provides a higher degree of security than the traditional blacklisting to prevent applications from being installed. Cryptzone’s SE46 Application Whitelisting Solution or a market recognized equivalent shall be used. The supplier shall identify if whitelisting is used and what solution software is used.
        16. The system supplier shall maintain a service to determine compatibility of software with the system including virus scanner updates, Microsoft security patches, and any third party software or software updates that are used in conjunction with the system. Reports concerning updates shall be available to system owners within two weeks of update releases.
        17. The system architecture shall support accepted IT security principles such as Defense in Depth and Security Zones. The supplier shall provide generic network architecture depiction or other documentation illustrating how the system may be configured to utilized these concepts.
    12. The system shall support thirty-two (32) alphanumeric character tag names as a minimum.
    13. The system shall provide a common set of engineering unit abbreviations to be used for display on graphics, reports, logs, trends, etc. It shall be possible to modify the list with additional abbreviations per project requirements.

## System Management

* + 1. The system shall provide a comprehensive suite of system management functions that simplify the task of system administration from set-up to operation and maintenance. The Owner views the system offering as an integrated system and not as a set of individual software components. As a result, system management functions shall oversee the entire system offering. Suppliers who provide applications as unique, individual products shall describe how they ensure compatibility and data consistency between applications and different versions of each software feature.
       1. Functions that must be part of the System Management tools include, but may not be limited to:
          1. Appearance and personalization of the CPAS System
          2. Server and client load balancing
          3. Maintenance configurations for the CPAS System
          4. Security configurations
          5. User administration
    2. In order to ensure system configuration integrity, system-wide backup and restore shall be possible. Only one backup shall be needed for:
       1. Control configuration
       2. Hardware configuration
       3. Historical data storage configuration
       4. Reporting definition
       5. Trend configuration
       6. Asset maintenance triggers configuration
       7. Operational faceplates
       8. Graphical elements
       9. Graphic displays
       10. Human system interface operational environment organization
       11. Links to related documentation
    3. Back-ups shall be initiated on either a manual or scheduled basis. Back-ups shall not impact performance of operation.
    4. It shall be possible to import / export subsets of the system configuration, such as individual applications, graphics, or device configurations.
    5. Collection tools shall be available to gather and consolidate system-wide diagnostic data for system maintenance purposes.
    6. The Supplier shall provide a software licensing management mechanism that does not affect running process operations. Interrupting or shutting down operations while modifying the license management mechanism is not acceptable. Specifically, the software licensing mechanism shall include provisions for:
       1. Expanding licensing parameters
       2. Upgrading functionality
       3. Licensing management function failure
    7. Software licensing for CPAS controllers shall be based on controller processing capacity and not on a tag or I/O count basis. The System owner desires not to need to manage licensing based on I/O or tags as expansions of applications within a controller may lead to a need to increase the licensing which results in time delays and transactional costs required to purchase the additional licensing. The owner desires to avoid these delays and transactional costs. If the supplier does not provide controller capacity licensing, then the licensing methods must be described in detail and maximum I/O or tag licensing for each controller must be supplied as the basis of the cost quotation so the owner can avoid the issue of licensing into the future.

## System Topology

* + 1. The system architecture is summarized in the attached CPAS System Overview Diagram in Attachment 1. *(must create a conceptual diagram to fit specific project requirements)*
    2. The system shall utilize an intuitive, easy-to-use, common system interface for direct access to plant equipment operation. The Human System Interface (HSI) hardware will include flat screen color monitors, keyboards, and pointing devices (i.e. mouse/trackball).
    3. System workstations will be distributed throughout the plant. Regardless of physical location, each shall have identical functionality and system data access. Upon user log-in, the workstation shall be automatically “tailored” to a workplace with specific user role and functions (i.e. Operator, Maintenance Technician, Engineer, and Supervisor Workplace).
    4. In addition to ‘rich’ clients, the CPAS system architecture shall accommodate remote access from ‘thin’ clients using standard PCs with minimum vendor specific software installed. These ‘thin’ clients shall provide operational capabilities and access to historical information. The same security methodology that is used for ‘rich’ clients shall be used for these remote ‘thin’ clients. The remote clients shall adhere to the various access controls that are generally supported by ‘rich’ operator workplaces.
    5. The CPAS single [redundant] high-speed communications network, referred to in this document as the Control Network, shall interconnect system servers and process controllers and shall not be affected during times of high traffic. For example, plant start-ups, process upsets, plant trips, or user-initiated data queries shall not cause the control network to lock-up or operate improperly.
    6. The Supplier shall provide detailed documentation on how to design and configure the Control Network, including supported network topologies, network redundancy, Domain Controller, DNS configuration, and recommended operating system configuration settings.
    7. To guarantee the integrity of all time-critical information, system-wide time synchronization shall be supported for all processing units handling time related data. For those units performing the time tagging (i.e. controller), accuracy of time distribution shall be +/- 0.5 ms, while alarm and event presentation of this timed stamped event shall have a resolution of 1 ms.
    8. The load on the Control Network shall be minimized to enhance time-critical response. Therefore in order to achieve modular process area independence, it shall be possible to group process controllers and their associated I/O into functionally independent control units.
       1. Within each control unit, local redundant controller-to-controller communications shall be possible. Physical separation of peer-to-peer links is desired. If one link requires repair/replacement, it shall not affect operation of the redundant controllers.
       2. All controller-to-controller communications shall use the same protocols (i.e. the intra- and inter- communications of local independent process control units shall utilize identical protocols) in order to minimize spare parts and the need for gateway components.
    9. The data protocol used by the data communication system shall safeguard against false data transmission, provide error detection / correction, and node failure detection. It shall initiate switch to the redundant channel or module upon failure of the primary. The failure and its successful switchover shall be annunciated to the operator.

## Availability and Reliability

* + 1. The system shall be designed such that a single point of component failure cannot cause loss of plant control.
    2. Fail-over redundancy designs shall be bumpless, immediate, and automatic without effect to control, operator display, calculations, data acquisition, or any other normal CPAS functions. All failovers shall be annunciated to the operator. CPAS operation shall not be interrupted in order to replace a redundant component.
    3. The following system areas shall be made redundant: (remove any items that do not require redundancy)
       1. Control network and associated communication components
       2. Base regulatory system functions (i.e. servers, process controllers, device communication interfaces)
       3. Power supplies and power feeds
       4. Process critical I/O modules (as identified in Attachment 1)
       5. Remote I/O communications
    4. It shall be possible to disconnect and reconnect either redundant Control Network while the system remains on-line and in control of the process.
    5. Redundant device interface communications shall permit either bus to be disconnected and reconnected while the system remains on-line and in control of the process.
    6. Redundant HSI interfaces may be supported through the use of multiple workstations.
    7. Loss of redundancy at a higher level shall not affect the redundancy options at a subordinate level. Redundancy options shall be multiplexed so that one failure does not have a cascade affect on the availability of other components. Failures shall be presented to users through standard CPAS alarm and event functions. Remote notification shall be possible through standard CPAS paging options.
    8. In the case of intermittent power failures, a reload of process controller configuration or user workstation information is not acceptable. Where battery backed RAM memory is proposed, batteries shall be sufficient to maintain system memories for a minimum of 48 hours. Batteries shall be replaceable without causing any interruption to component operation.
    9. Upon completion of the FAT, the CPAS shall include 20% spare capacity in all Process Controllers and associated I/O. Additionally, the Human System Interface shall include 20% spare capacity.
    10. The system shall be capable of real-time monitoring and reporting for the health status of all supplier-branded system components (power supplies, controllers, I/O modules, etc.) and the presentation of component failures shall be reported as system alarms within the composite alarm structure of the system.

## CPAS Response Times

* + 1. Assuming worst case scenario and evaluating for both remote and local I/O situations, control loop response time shall be capable of executing at least as fast as the values listed below. Control loop response time is defined as the elapsed time between signal detection at the Input Module, through control logic execution, to response by the Output Module.
       1. Analog Control - Slow Loops at 1000 ms (i.e. temperature control)
       2. Analog Control - Fast Loops at 50 ms (i.e. flow / pressure control)
       3. Discrete/Logic Control - 50 ms (motor control/interlocks)
       4. Data Acquisition - 1000 ms
    2. Assuming worst case scenario, system response time shall not exceed 1000 ms. The system response time is defined as either elapsed time between user command and equipment feedback or process event occurrence and notification.
    3. Assuming worst case scenario, display refresh response time shall not exceed 2 seconds. Display response time is defined as the elapsed time between the display call-up command and display call-up with dynamic data included.
    4. Assuming worst case scenario, display update time shall not exceed 1 second. Display update time is defined as the time required to refresh dynamic data on an active display.
    5. Alarm and event resolution shall be 250 ms or better. For sequence of events (SOE), the resolution shall be 1 ms or better.
    6. It shall be possible to assign control loops to one of 32 configurable execution rates within a controller.

## Hot upgrade capability

* + 1. The CPAS shall provide for online hot upgrade capability for all system software for all redundant database and application servers. The definition of online hot upgrade means that plant processes need not be shutdown during the performance of software upgrade activities. This feature should apply to all major and minor software versions, plus any service packs, updates, or other software maintenance activities.
    2. The system supplier shall provide detailed documentation on the procedures recommended for executing such online hot upgrades as an attachment to the response to this specification.

## Use of software virtualization

* + 1. The CPAS software shall have a standard, supported solution feature to allow for software operation within a virtualized server or user workstation environment. At a minimum, system servers shall meet this requirement.
    2. The system supplier shall provide detailed documentation on how virtualization features are supported by the CPAS system as an attachment to the response to this specification.

## CPAS server and client hardware platforms

* + 1. Server and client PC hardware shall be available from Dell, HP, and Lenovo.
    2. Server and client PC hardware shall be selectable by the system owner within specifications that meet or exceed supplier’s requirements for performance, capacity, and operating system support.
    3. Server and client PC hardware shall be virtualized using the VMware® vSphere virtualization platform.
    4. Supplier shall provide a list of server and client PC hardware that has been tested and certified to function with the suppliers CPAS offering.
  1. CPAS networking hardware
     1. Supplier shall allow owner to select third party network equipment within specifications that meet of exceed supplier’s requirements for performance, capacity, and media connectivity.
     2. Supplier shall offer their own branded option for network hardware for owner consideration.
        1. In systems using Electrical Subsystem integration, the network hardware must be certified for use with the IEC 61850 standard.
     3. Supplier shall provide a list of network hardware that has been tested and certified to function with the suppliers CPAS offering.

# PROCESS CONTROLLERS

## General

* + 1. A Process Control Unit (PCU) shall consist of process controller modules, communication modules, I/O processors, power supplies, terminations, cabling, and miscellaneous hardware. Equipment shall be mounted inside Supplier’s system cabinets. Use of DIN rail mounting techniques is preferred. The PCUs shall be geographically and functionally distributed throughout the system (centralized) per the attached CPAS System Overview Diagram.
    2. Upon loss of network communication, individual PCUs shall continue their plant control functions without operator intervention.
    3. The system’s process controllers shall be capable of continuous, sequential, batch, safety, and advanced control. All functions shall be capable of being provided by one type of process controller. Suppliers that require different types of controllers to cover all possible applications must specify in the proposal, the different controller types offered and their functional capabilities.
    4. System process controllers shall be based on 32 bit or higher architecture microprocessors.
    5. The process controllers shall support applications using the following IEC 6-1131-3 programming languages:
       1. Function Block Diagram
       2. Sequential Function Chart
       3. Ladder Diagram
       4. Structure Text
       5. Instruction List
    6. In addition to supporting applications using the IEC 6-1131-3 programming languages described above, process controllers shall support a programming framework for pre-defined control algorithms. Process controllers shall have the ability to concurrently execute these algorithms with those created from the five IEC 6-1131-3 programming languages. Suppliers that are unable to meet this requirement must describe in their proposals what provisions they have for control programming flexibility. If special types of controllers are required to run a specific programming language, the Supplier shall specify whether the standard process controller can be field converted or the programmable version must be ordered initially.
    7. Based upon user privileges, a Process Controller’s tuning parameters shall be accessible / alterable from the Human System Interface.
    8. There shall be a difference reporting feature within the engineering environment to track, compare, and contrast different versions of the control configuration and custom graphics.
       1. The reporting feature shall provide for the comparison of two versions of the configuration; either the current to a previous version or two previous versions.
       2. The reporting feature shall provide a tree view of the logic configuration along with a detailed view of the content of the configuration.
       3. The reporting feature shall be able to provide a filtered view showing only the changed content, and not unchanged content.
       4. The reporting feature shall provide for printing the entire report or different filtered views of the report so the owner may maintain a physical record of the system changes for management of change records and reporting.

## Control Functions

* + 1. A library of general process control and SIL-compliant functions (SIL2 and SIL3) sufficient to perform all control strategies required for plant control shall be included in the CPAS. The library shall include:
       1. Data acquisition functions such as signal linearization, square root extraction, ISA and IEC thermocouples, and RTD signals, time-based I/O filtering, and pulse input conversion (totalization).
       2. Math functions such as addition, subtraction, multiplication, division, exponential polynomial, square root, logarithms, fifth order polynomial, exponential (whole and fractional), lead-lag, flow compensation (temperature and pressure), dead time compensation, median select, ramp generation, time average, and totalization.
       3. Logic functions such as AND, OR, NOT, EXCLUSIVE OR, High/low select, signal selector switch, FLIP-FLOP, ON and OFF delays, Timer, Counter, and Pulse generator
       4. Control functions such as Proportional only (P), Proportional plus Integral (PI), Proportional plus Derivative (PD), Proportional plus Integral plus Derivative (PID). These control functions shall include the following features Auto-tuning, External Reset, anti-reset wind-up, setpoint tracking, Auto/Manual with bias control, Ratio Control, and Adaptive Gain.
       5. Safety critical functions such as process shutdown, and Fire and Gas supervision, etc.
       6. The ability to create user-defined functions for process / project specific applications and store them in user defined libraries for replication within the project of distribution and use in future projects...
    2. A data quality check shall be available for all inputs and calculated variables. Failure of this quality check shall be propagated to all control, alarm, and monitoring originating from this variable. It shall be possible to use the quality check as a digital input to affect control.
    3. Control loops shall be initialized to present values of inputs and outputs to provide procedural, bumpless transfer from manual to automatic. Automatic to manual switching shall also be procedural, bumpless transfer.
    4. Maximum and minimum setpoint limits shall be selectable by the Operator. Values shall be settable to one decimal point, in engineering units.
    5. When manual bias is provided between parallel final drives, a change in bias shall be achieved without process disturbance. Bias control shall respond to the demands of the control loop.
    6. When overrides are used (i.e. automatic limits, blocks, run-ups, run-downs, etc.), all affected control loops shall track the occurrence but shall not continue control action. When the override is removed, all affected control loops shall resume normal operations at the new process level without causing an upset or improper response of final drives.
    7. Each control loop shall include an Operator selectable deviation monitor, which will continuously compare the measured value and its set point. When a deviation exists for greater than “X” seconds, an alarm shall be generated and the control loop placed in Manual. The time delay shall be adjustable between 100 milliseconds and 180 seconds. The time delay shall be reset when the control loop is placed in Auto.
    8. Adaptive control techniques shall be used to alter feedforward and control loop parameters to suit the control operating conditions.
    9. Control windup protection shall be applied such that no internal or external limit, runback, or trip will result in unwanted control action being output.
    10. Characterization of control loop outputs shall be configurable to accommodate non-linear end elements such as valve or damper characteristics.
    11. Control output rates of change shall have configurable limits in engineering units or as a percent as required by the application of an individual control loop.
    12. Cascade control loops shall have the following qualities:
        1. Accept remote set points
        2. Configure the outer loop to have its output limited to the inner loop’s set point limits
        3. Perform automatic mode switching (Auto/Manual, Local/Remote) based on logic inputs (External or Internal)
    13. It shall be possible to dynamically change the following control parameters:
        1. Alarm limits
        2. Tuning parameters
        3. Sequence block inputs
    14. Algorithm calculations shall be performed in compliance with IEC 60559 “Binary floating-point arithmetic for microprocessor systems,” where floating-point values are handled with 32 bit single precision resolution.

## Safety Critical Control Functions

* + 1. On this project, several process applications are designated as Safety Critical (as specified in Attachment 1). For these applications, the host controller and the corresponding safety critical control algorithms shall satisfy the Safety Integrity requirements for level 2 or 3 (SIL2 or SIL3) according to IEC 61508 Edition 2 and IEC 61511. The host controller is designated as a Safety controller.
    2. In order to reduce spare parts inventory, training requirements, and cost while improving reliability, the Safety controller shall be of the same family of devices as the process controller used in the balance of the system.
    3. Safety controllers shall be able to connect and communicate on the same control network as the basic process controllers.
    4. To further reduce system costs, it shall be possible to perform process automation algorithms within the Safety controller.
    5. Safety Instrumented Function (SIF) Programming
       1. The system shall provide a basic, yet sufficiently extensive library of safety functions and logic blocks to address most SIF logic solving requirements.
       2. It shall be possible for the owner to design specialized safety programming functions and save those solutions in a library for reuse within the project or future projects using the purchased system. The programming tools must limit the available functions and programming techniques available based on the desired SIL for the application.
       3. It shall be possible to configure SIF applications that include but may not be limited to:
          1. General process safety applications
          2. Burner Management for boilers and fired heaters
          3. Emergency shutdown
          4. Fire and Gas applications
          5. Machinery safety applications.
    6. SIL Access Control
       1. The system shall be completely configured with multiple level securities. In addition to system security and access management features defined in Section 2, a proper mechanism shall be used to prevent inadvertent alteration of safety critical variables. The mechanism shall provide for definition of access rights (identified as SIL access) to modify these variables (i.e. force, override, ranges) during on-line engineering, operation, and maintenance.
       2. The SIL access level shall be configurable based on the characteristics of each safety variable and the operation philosophy of the plant. At least three levels of SIL access shall be possible to define:
          1. Read Only – not possible to modify a safety variable on. This is the more restrictive access level and shall be the default access level.
          2. Confirm-online -- modification allowed upon human confirmation of requested action (Confirmed online write functionality).
          3. HW Confirm – Confirm access with additional interlock to a hardwired mechanism (i.e. key) that must be enabled to allow on-line modification.
    7. Bypass Management
       1. To maintain system availability, it may be necessary to inhibit specific safety critical inputs or outputs during plant operation (i.e. maintenance of field equipment). However, great care must be taken to ensure safety integrity is maintained. Therefore, it shall be possible to define the maximum number of concurrent forced inputs / outputs during the design phase for each safety critical control area.
       2. During operation, the number of active forces shall be indicated to the user via the user workplace. It shall be possible for the operator to set and reset forces from the workplace. For an emergency reset of all forces, a dedicated physical input to the controller shall be available.
    8. If the Supplier’s offering cannot meet the requirement listed in this section, the Supplier must take exception and provide clarification that lists the equipment, interfacing software or hardware, engineering requirements, training requirements, and maintenance support requirements necessary to meet this specification’s intent.

# I/O MODULES

## General

* + 1. I/O shall be modular, with each module supporting a specific signal type with a set amount of I/O channels. It shall be possible to inter-mix I/O modules of different types together in I/O clusters. Project I/O type, quantity, and location is tabulated in Attachment 1.
    2. I/O modules shall have flexible mounting features in that modules can be mounted locally with the process controller. In addition, it shall be possible to locate I/O modules remotely from the controller without affecting performance, hardware, or software configuration. When mounted remotely, communications between process controller and I/O cluster shall be redundant where redundant controllers are used.
    3. All I/O modules shall include on-board self-diagnostics. Detected faults shall be reported to plant personnel through each module’s status LEDs and through the system’s alarm and events features. The process value used in the CPAS application shall be synchronized with a status indication for each channel.
    4. I/O modules shall be “hot swappable,” allowing the I/O module to be removed and replaced under power without damage to themselves, disruption to other modules, or to the system itself. For critical I/O, as specified in Attachment 1, it shall be possible to repair a channel fault without affecting operation of the neighboring channels.
    5. The Supplier shall include I/O modules designed to withstand specified plant environment conditions. In general, I/O modules shall be manufactured to meet ISA-S71.04 severity level G3 requirements.
    6. The Supplier shall provide I/O modules with integrated intrinsic safety barriers. It shall be possible to mount modules with and without integrated I.S. barriers in the same I/O rack. This is required as a standard, integrated function. If the Supplier's system does not include this capability, the Supplier shall provide clarification and describe the intrinsic safety equipment and necessary interfacing software or hardware required between this equipment and the balance of the CPAS.
    7. The Supplier shall have the option to provide I/O modules for mounting in Class 1, Division 2 and Class 1, Division 1 hazardous areas as well as Zone 1 and Zone 2 classified areas (for I/O specified in Attachment 1). If the Supplier's system does not include this capability, the Supplier shall provide clarification and describe the intrinsic safety equipment and necessary interfacing software or hardware required between this equipment and the balance of the CPAS.
    8. For safety critical I/O (as specified in Attachment 1), the Supplier shall provide SIL 3 certified I/O modules per IEC 61508 Edition 2. It shall be possible to install these I/O modules in combination with other I/O module types and configured natively from the system’s engineering tool. If the Supplier’s system does not include this capability, the Supplier shall provide clarification and describe the SIL 3 certified I/O equipment and any necessary interfacing software or hardware required between this equipment and the balance of the CPAS.
    9. The Supplier shall clearly identify any I/O types required by this specification that the proposed CPAS cannot accept.
    10. All I/O modules shall meet the requirements of the IEC/EN 61000-4-5 for surge withstand capability test.
    11. For analog modules, current limiting on an individual I/O channel basis shall be used to protect I/O and lower the probability of loss of an entire module.
    12. When supplying system power to field devices, the module shall be protected from damage through fusing. At a minimum, fusing shall take place at the group level with each module segmented in to at least two groups.
    13. Linearization of thermocouple, RTD and other inputs shall be performed at the I/O channel level.
    14. The I/O modules shall have a keying arrangement protecting against personal danger and break-down of the module. The keying shall also prevent startup of a wrong module type in the specific position compared to the configuration in software.
    15. All I/O module field circuits shall be galvanic isolated from the system. During design phase, signal grounding shall be reviewed and documented.

## Analog I/O

* + 1. Analog Input
       1. The system shall be capable of supplying the 24 VDC loop power for 4 to 20 mA DC 2-wire or 3-wire transmitters. The choice of field or system power shall be user selectable for each point.
       2. The system shall also be capable of accepting 1 to 5 VDC, 0 to 5 VDC, 0 to 10 VDC, -20 to + 20 mA DC, -5 to +5 VDC, and -10 to +10 VDC inputs and 0(2) to 10 VDC and 0(4) to 20 mA.
       3. Instrument ground connections shall be made at the termination cabinet when originated from the CPAS, or at the external source when originated from the external power source.
       4. I/O modules shall be available with normal mode rejection meeting or exceeding 40 dB at line frequency and harmonics.
       5. I/O modules shall be available with common mode rejection meeting or exceeding 120 dB at line frequency and harmonics.
       6. Minimum isolation between points and ground shall be 50 VDC continuous and able to withstand voltage surge of 700 VDC for up to 1 minute.
       7. For critical Analog Inputs as specified in Attachment 1, galvanic isolation of inputs is required (channel to channel and channel to ground). Isolation shall be 250 VDC continuous and able to withstand voltage surge of 1900 VDC for up to 1 minute.
       8. Input shunt resistors shall be protected for over voltages up to +30V.
       9. Minimum acceptable resolution is 12 bits.
       10. Error (accuracy including linearity effects) shall be 0.1% of full scale or better.
    2. T/C Inputs
       1. The system shall be capable of receiving type B, C, D, E, J, K, L, N, R, S, T and U thermocouple inputs directly. Thermocouple type shall be user selectable on a per channel basis allowing various thermocouple types to be used on an individual module.
       2. Cold junction reference compensation and open circuit detection shall be provided. It shall be possible to distribute one CJT measurement to several thermocouple I/O modules. Alternatively for cold junction compensation, a fix junction temperature for the module may be set by the user (as a parameter).
       3. The system shall also be capable of receiving -30 to 75 mV (linear) input signals.
       4. The system shall provide automatic detection of thermocouple open-circuit conditions.
       5. Normal mode rejection shall meet or exceed 60 dB at line frequency and harmonics.
       6. Common mode rejection shall meet or exceed 120 dB at line frequency and harmonics.
       7. Minimum isolation between points and ground shall be 50 VDC continuous and able to withstand voltage surge of 700 VDC for up to 1 minute.
       8. Minimum acceptable resolution is 15 bits.
       9. Error (accuracy including linearity effects) shall be 0.1% of full scale or better.
    3. RTD Inputs
       1. The system shall be capable of receiving 100 ohm platinum, 10 ohm copper, 100 ohm nickel, 120 ohm nickel, and resistive potentiometer 3-Wire RTD inputs directly.
       2. The system shall provide automatic detection of open-circuit conditions.
       3. Normal mode rejection shall meet or exceed 60 dB at line frequency and harmonics.
       4. Common mode rejection shall meet or exceed 120 dB at line frequency and harmonics.
       5. Minimum isolation between points and ground shall be 50 VDC continuous and able to withstand voltage surge of 700 VDC for up to 1 minute.
       6. Minimum acceptable resolution is 12 bits.
       7. Error (accuracy including linearity effects) shall be 0.1% of full scale or better.
    4. Analog Outputs
       1. The system shall be capable of driving 500 ohm standard or up to 850 ohm total loop resistance at 4 to 20 mA DC.
       2. The system shall also be capable of driving 0 to 10 VDC, 0(4) to 20 mA DC, -20 to + 20 mA DC, 2 to 10 VDC, and -10 to +10 VDC outputs.
       3. The system shall be capable of supplying 24 VDC loop power. The choice of field or system power shall be user selectable for each point.
       4. The system shall be capable of providing a user selectable default option for each individual point in the event of loss of communication with controller.
       5. Outputs shall detect open field wiring.
       6. Minimum isolation between points and ground shall be 50 VDC continuous and able to withstand voltage surge of 700 VDC for up to 1 minute.
       7. For critical Analog Outputs as specified in Attachment 1, galvanic isolation of outputs shall be provided.
       8. Minimum acceptable resolution is 12 bits.
       9. Error (accuracy including linearity effects) shall be 0.1% of full scale or better.

## Digital I/O

* + 1. Digital Inputs
       1. The system shall be capable of receiving as inputs
          1. 24 VDC (up to 32 channels per module),
          2. 48 VDC (up to 16 channels per module),
          3. 120 VDC (up to 16 channels per module),
          4. 120 VAC (up to 16 channels per module), or
          5. 230 VAC (up to 8 channels per module).
       2. The system shall support both normally open and normally closed contacts.
       3. To filter out ‘process chatter,’ Digital Inputs shall include a filter to prevent response to signals of less than 20 millisecond duration. Additionally, to protect module circuitry, electrical-optical isolation to protect against voltage spikes shall be included.
       4. For critical Digital Inputs as specified in Attachment 1, isolation of inputs is required (channel to channel and channel to ground). Isolation shall be 250 VDC continuous and able to withstand voltage surge of 1900 VDC for up to 1 minute.

## Digital Outputs

* + - 1. Digital Outputs shall use either solid state or mechanical relays with each output having its own set of contacts. Mechanical relay contacts shall be dry (isolated from power and ground).
      2. For system powered digital outputs, individual fuses are required.
      3. In the event of loss of communication with controller, Digital Output modules shall be capable of providing a user selectable default option for each individual point.
      4. Digital solid state output modules shall meet or exceed the following:
         1. Output ratings shall be at least 0.5A
         2. Maximum off-state leakage current shall be less than 0.5 mA
         3. Outputs shall be zero voltage closing
         4. Outputs shall be protected against short circuits and over loads
         5. Outputs shall be provided with snubber or freewheeling diode
         6. Support up to 32 channels per module
      5. Digital relay output module characteristics shall meet or exceed the following:
         1. Output contact ratings shall be at least 3A
         2. Outputs shall be of normally open or normally closed type (Form A or Form B)
         3. Relay shall be expected to perform a minimum of 1,000,000 operations at rated load
         4. Outputs shall be provided with EMC protection components
         5. Vibration shall not affect relay performance
         6. Support up to 16 channels per module

## Pulse Inputs

* + 1. The Supplier’s pulse input module shall accept Sine and Square wave signals. If applicable, the Supplier shall provide means to control pulse counting through input gating, up/down, and quadrature modes.
    2. It shall be possible to present the measured value as either a pulse count or a frequency value.
    3. As a minimum, the digital and low frequency pulse input module characteristics shall include the following:
       1. Each pulse input shall be isolated at 700 VDC for 1 min.
       2. Each pulse input shall be system powered and capable of detecting status changes of at least 1000 ohms loop impedance (including contact resistance).
       3. CPAS field contact activation voltage shall be 24 VDC minimum.
       4. Low frequency pulse counter shall range between 0.25 Hz to 1.5 MHz.
       5. To filter out ‘process chatter,’ pulse inputs shall include a (selectable?) filter to prevent response to signals of less than 2 millisecond duration.
    4. If applicable, it shall be possible to set an output based on predefined count values.

## Sequence of Events (SOE) Inputs

* + 1. Supplier shall provide I/O module to monitor those digital inputs designated for SOE. SOE points shall be detected with a resolution of at least 1.0 ms.
    2. The SOE points shall be integrated with the system and configured using native engineering tools.
    3. SOE capability shall be a standard function integral to the system. Parallel wiring to an external SOE system is not an acceptable method of SOE detection. The SOE points shall be configured using native engineering tools and reported via standard system functions. If the Supplier's system does not include this capability, the Supplier shall take exception and describe how SOE data will be integrated with the CPAS system.

# FIELDBUS

## HART Protocol Device Usage

* + 1. Standard HART devices shall be wired point-to-point directly to standard I/O modules. Due to desire to perform Asset Management functionality, bus topology is not acceptable and no more than eight devices shall be assigned to one I/O module with integrated HART capabilities. For those systems that require additional multiplexer hardware, the Supplier shall identify additional requirements and its impact on system architecture and spare parts.
    2. Using WirelessHART devices shall be an option. Such devices shall be integrated into the CPAS using standard WirelessHART Gateway hardware and shall provide connectivity to the process controllers using ethernet based connectivity options like ModbusTCP or other. Availability of HART device data from wireless devices shall be the same as standard wired HART devices.
    3. The primary variable analog value shall be accessible within the CPAS. Other variables shall be accessible for system applications such as asset management, history, and field device management. The HART data and analog value shall be routed through the system and shall not require separate communication paths involving extra hardware like multiplexers. The support shall be provided in a manner that information required by system applications is available via non-propriety methods such as OPC.
    4. Power and status LED indicators shall be provided on each HART module. Indication shall be available on a module basis and on a HART channel basis.
    5. The HART modules shall support asset management applications. The support shall be provided in a manner that information required by the asset management application is available from information resident in the CPAS (no HART multiplexers) via non-propriety methods such as OPC.
    6. In order to monitor real-time performance, HART devices shall make information such as device status and on-board diagnostics accessible to CPAS Asset Management functions.
    7. For critical HART signals (as specified in Attachment 1), the HART interface module shall be provided with redundant back-up of same type.
    8. The HART module shall support local and remote installation options without affecting performance, hardware, or software configuration.
    9. The CPAS shall support HART device and module configuration, assignment, commissioning, and diagnostics through the system’s integrated engineering environment. A standalone engineering environment for HART device management is not acceptable. Use of integrated FDT technology with system supplier tested and approved DTMs is preferred.
    10. In its proposal, Supplier shall include the list of HART field devices by manufacturer and model that have been tested with the CPAS. Since new devices are commonplace, Supplier shall also describe the procedure in place to add a device that is not listed but is required by the project today or in the future.
    11. The CPAS shall support full HART7 capabilities including WirelessHART support.

## FOUNDATION Fieldbus (FF) Device Usage

* + 1. Using standard products, the Supplier shall support the entire FOUNDATION Fieldbus architecture including H1/HSE Linking Devices, HSE communication interface devices, and H1 power conditioners. HSE is required to support multi-controller access to individual FF segments and devices allowing geographic connectivity to devices independent of controller interfaces without peer-to-peer communications configuration. HSE is also required for the capability to configure field-level control functions across multiple FF segments if required.
    2. The FOUNDATION Fieldbus configuration environment shall allow for multiple engineers / technicians to edit, configure, commission, or troubleshoot the FF environment at the same time.
       1. Lock control or access to the FF environment should be allowed at various levels including segments, linking devices, or entire subnetworks as required for the conditions being modified or evaluated.
       2. Lock control / access shall prevent changes from one engineering session from overwriting or modifying configuration in other sections of the configuration.
    3. The CPAS shall support communication with Fieldbus Foundation via FOUNDATION Fieldbus H1, HSE, and OPC.
    4. The system shall support redundant H1 interfaces, HSE interfaces, and HSE communications. To power all field devices on each FOUNDATION Fieldbus H1 segment, redundant power supplies shall be provided.
    5. CPAS process controllers shall include a native interface to FF HSE without requiring gateways or scanners.
    6. Each FOUNDATION Fieldbus Linking Device module shall be capable of supporting a minimum of four H1 segments. At a minimum, each segment shall support 16 FF devices.
    7. To minimize H1 segment lengths and associated field cabling costs, it shall be possible to mount the Linking Device locally near the H1 fieldbus devices and remote from the process controller without affecting performance, hardware, or software configuration.
    8. All FOUNDATION Fieldbus H1 segments shall have a primary Link Active Scheduler (LAS) in the Linking Device module with back-up LAS’s in the field. Multiple back-up LAS’s shall be possible with the order in which they take over as primary properly defined.
    9. Power and status LED indicators shall be provided on each FOUNDATION Fieldbus Linking Device. Indication shall be available on a module basis and on an individual FF H1 segment basis.
    10. The Supplier’s FOUNDATION Fieldbus solution shall support system applications such as asset management, history, and device management. The support shall be provided in a manner that information required by system applications is available via non-propriety methods such as OPC. This preferred architecture prevents acyclic data from passing through the controller.
    11. In order to monitor real-time performance, the FF devices shall make information such as device status and on-board diagnostics accessible to the system’s Asset Management functions.
    12. The Supplier shall provide segment terminators for each end of the Foundation Fieldbus H1 segment.
    13. The CPAS shall provide FOUNDATION Fieldbus device and segment configuration, assignment, commissioning, and diagnostics through the system’s integrated engineering environment. A standalone fieldbus engineering environment is not acceptable.
    14. The CPAS shall, as a minimum, meet the requirements of the FOUNDATION Fieldbus HOST Certification test protocol 61a. The Supplier shall include documentation indicating successful completion of the Host Interoperability System Testing (HIST). At a minimum, the Supplier shall support the following features:
        1. Block Tag Configuration
        2. Block Instantiation
        3. Standard Blocks
        4. Enhanced Blocks
        5. Custom Blocks
        6. Function Block Linkage Configuration
        7. Device Description Services
        8. Capability Files
        9. Device Replacement
        10. EDDL information and diagnostics data representation.
    15. Since new devices are commonplace, Device Description Services and Capability Files are the preferred method of device integration. If this is not the Supplier’s method, Supplier shall describe its procedures to add new devices
    16. In its proposal, the Supplier shall include the list of FOUNDATION Fieldbus field devices by manufacturer and model that have been tested with the CPAS.
    17. The FOUNDATION Fieldbus configuration environment shall allow for bulk data configuration techniques to help reduce the overall engineering time to create or update the FF configuration.

## PROFIBUS Protocol Device Usage

* + 1. Each PROFIBUS module shall be capable of supporting one PROFIBUS DP segment. Each segment shall support up to 32 PROFIBUS devices without the use of repeaters, or up to 125 devices with repeaters.
    2. It shall be possible to add new Profibus devices on-line without affecting the communication of other segment devices.
    3. It shall be possible to configure PROFIBUS Remote I/O on-line without interrupting operation of the Remote I/O station.
    4. Power and status LED indicators shall be provided on each PROFIBUS module. Indication shall be available on a module basis and on an individual segment basis.
    5. The Supplier shall provide segment terminators for each end of the PROFIBUS segment.
    6. The PROFIBUS module shall support PROFIBUS DP-V0 cyclic communication and PROFIBUS DP-V1 acyclic communication.
    7. The Supplier’s PROFIBUS solution shall support asset management applications. The support shall be provided in a manner that information required by the asset management application is available from information resident in the CPAS (no external class 2 PROFIBUS Masters) via non-propriety methods such as OPC.
    8. For critical PROFIBUS signals (as specified in Attachment 1), the PROFIBUS DP master shall be provided with redundant back-up of same type. Additionally, PROFIBUS DP physical media (cable) shall be redundant. It shall be possible to connect PROFIBUS PA Linking Devices and non-redundant PA devices to a redundant PROFIBUS DP segment.
    9. The CPAS shall provide PROFIBUS device and segment configuration, assignment, commissioning, and diagnostics through the system’s integrated engineering environment. A standalone fieldbus engineering environment is not acceptable.
    10. Since new devices are commonplace, GSD format files are the preferred method of device integration. If this is not the Supplier’s method, Supplier shall describe its procedures to add new devices.
    11. In its proposal, the Supplier shall include the list of PROFIBUS field devices by manufacturer and model that have been tested with the CPAS.

## PROFINET IO Protocol Device Usage

* + 1. Each PROFINET IO module shall be capable of supporting one PROFINET IO sub-network. Each network shall support up to 248 direct device interfaces.
    2. It shall be possible to add new PROFINET IO slave devices on-line without affecting the communication of other segment devices.
    3. Power and status LED indicators shall be provided on each PROFINET IO module. Indication shall be available on a module basis and on a segment / subnet basis.
    4. The CPAS shall provide PROFINET IO device and segment configuration, assignment, commissioning, and diagnostics through the system’s integrated engineering environment. A standalone fieldbus engineering environment is not acceptable.

## ModbusTCP Protocol Device Usage

* + 1. Each ModbusTCP module shall be capable of supporting one ModbusTCP sub-network. Each network shall support 30 or more ModbusTCP slave devices.
    2. It shall be possible to add new ModbusTCP slave devices on-line without affecting the communication of other segment devices.
    3. Power and status LED indicators shall be provided on each ModbusTCP module. Indication shall be available on a module basis and on an individual segment basis.
    4. For critical ModbusTCP signals (as specified in Attachment 1), the ModbusTCP master shall be provided with redundant back-up of same type.

## The CPAS shall provide ModbusTCP device and segment configuration, assignment, commissioning, and diagnostics through the system’s integrated engineering environment. A standalone fieldbus engineering environment is not acceptable. Ethernet/IP Protocol Device Usage

* + 1. Ethernet/IP shall provide two simultaneous use cases. First to allow for distribution of Devicenet networks to remote locations, and second to utilize Ethernet/IP for direct device connectivity to Allen Bradley PLCs.
    2. Each Ethernet/IP master module shall be capable of supporting four DeviceNet sub-networks. Each network shall support 30 or more DeviceNet slave devices.
    3. It shall be possible to add new Ethernet/IP gateway devices or DeviceNet slave devices on-line without affecting the communication of other segment devices.
    4. Power and status LED indicators shall be provided on each Ethernet/IP master module. Indication shall be available on a module basis and on an individual segment basis.
    5. The CPAS shall provide Ethernet/IP gateway and DeviceNet device and segment configuration, assignment, commissioning, and diagnostics through the system’s integrated engineering environment. A standalone fieldbus engineering environment is not acceptable.
    6. Ethernet/IP communications modules shall be manufactured by, or shall be integrated, branded and supported by the supplier. Third party modules shall not be used.

## IEC-61850 Substation Automation Protocol Device Usage

* + 1. CPAS controllers used for Electrical Substation automation shall be able to support up to 12 IEC 61850 master modules
       1. IEC 61850 master modules may be use individually (up to 12 subnets per CPAS controller)
       2. IEC 61850 master modules may be applied as redundant pairs (redundancy functionality provided by application, not direct hardware redundancy) for up to 6 subnets per CPAS
       3. Redundant and non-redundant IEC 61850 master modules may be used in combination on a CPAS controller.
       4. Each IEC-61850 master module (or redundant pair of modules) shall be capable of supporting one IEC-61850 sub-network. Each sub-network shall support up to 80 IEC-61850 IED slave devices with up to 150 GOOSE (Generic Object Oriented Substation Event) datasets per sub-network.
    2. CPAS controllers used for Electrical Substation automation shall retain their standard capability to perform normal process control. Increased functionality for Electrical Substation automation shall include electrical load shedding through command capabilities to IEC 61850 compliant protective relays. See requirement for GOOSE communications protocol below.
    3. It shall be possible to add new IEC-61850 slave devices on-line without affecting the communication of other segment devices.
    4. Power and status LED indicators shall be provided on each IEC-61850 module. Indication shall be available on a module basis and on an individual segment basis.
    5. The CPAS shall provide IEC-61850 subnet configuration, assignment, commissioning, and diagnostics through the system’s integrated engineering environment. The CPAS shall provide its own integrated toolkits for initial project configuration and for owner update and maintenance requirements.
    6. The IEC 61850 integration shall provide the following features as a minimum set of functionality:
       1. The CPAS system shall allow monitoring of at least 1280 electrical field devices.
       2. Communications to field electrical devices shall use either IEC 61850 or Modbus (ModbusTCP) over ethernet. These communications shall be native to the CPAS and not use third party hardware gateways as part of the communications path.
       3. Communications to electrical field devices shall be continuous and refresh or updates of information shall not exceed 5 seconds.
       4. A watchdog feature shall be provided to detect loss of communications to any electrical field device.
       5. Real-time monitoring of the connected power and energy measurements
       6. Status information on the I/O devices including status/position of circuit breakers and automatic transfer switches.
       7. Peer-to-peer control commands shall be executed using GOOSE message protocol for all medium voltage protection relays.
       8. Limit GOOSE messaging commands to medium voltage circuit breakers to simple “open” and “close” functions.
       9. Low voltage breaker control shall be limited to standard CPAS discrete logic connected via discrete relay I/O modules.
       10. OPC data servers shall provide vertical access to all electrical field device information
           1. OPC data server shall scan the compliant protective relays for the latest disturbances and recordings and upload new information into the OPC server.
           2. Optionally, once the data is uploaded from the device into the OPC server, the data may be deleted from the protective relay.
           3. A single IEC 61850 connection server shall be able to host up to four (4) instances of IEC 61850 OPC servers to limit system footprint and resource requirements.
           4. A single OPC data server instance shall support up to 80 electrical field devices

Each field device shall be allowed up to 80 data objects.

* + - * 1. A single OPC data server shall be able to collect and store data from up to sixteen (16) IEC 61850 subnets.
        2. Two OPC data servers may be applied to a single sub-network.
      1. Power quality analysis feature including:
         1. Harmonic measurement.
         2. Sag/swell monitoring.
         3. Transient disturbances.
         4. Waveform capture (and data storage feature) for capable devices .
      2. Execute simple control commands using relay logic.
      3. MMS support for the “Select Before Operate” (SBO) a functionality for both Normal Security and Enhanced Security operations as a means for the logic to “reserve” a device and prevent another source of command from interacting with the target device. Devices capable of SBO functionality shall include but not be limited to:
         1. Controllable single points.
         2. Controllable double points.
         3. Controllable integer status.
         4. Binary controlled step position information.
         5. Integer controlled step position information.
         6. Analogue set point.
      4. Utilize the CPAS common functions:
         1. Data logging.
         2. Alarming and alarm management.
         3. Reporting.
         4. Data historization.
         5. Trending.
         6. System security.
         7. User access control with inactivity log-out to limit open system access for long periods of time.
         8. Audit trail event tracking.
      5. Standard reporting features for power quality and power consumption.
      6. User authentication using User Identification and Password shall be required for control actions by operators and shall incorporate a waning message in prompt requesting verification of the requested action.
  1. User Defined Ethernet Protocol Device Usage (UDP/IP)
     1. The CPAS controllers shall provide a user definable protocol option supported by communications directly on the control network. In cases where standard interfaces may not be readily available, the owner requires the capability to use a standard library of communication functions to create a connection to ethernet based devices or subsystems. This option must be supported by both hardware and software.

# HUMAN SYSTEM INTERFACE

## General

* + 1. To reduce the quantity of system workstations and to provide flexibility during time of action, each system user interface shall be capable of performing process operations, engineering, and maintenance functions including batch management, asset management, historian, reporting, safety, and field device management. Access to various applications that are included shall be dependent on user login. The quantity and primary user function of each workstation shall be provided in accordance with Attachment 1.
    2. A workstation shall include mouse or trackball, user keyboard, and anti-glare monitor(s) of at least 1920 x 1080 resolution and 23” screen size (diagonal).
    3. If a workstation is to be placed outside of the control room environment, the Supplier shall include all necessary devices required to house, power, and cool workstation components.
    4. Licensing for workplaces shall include access to all system data (tags, trends, graphics, documentation, etc.) by default. Limiting access to objects or aspects shall be managed through security features, not licensing limitations or restrictions.

## Workplaces

* + 1. System workstations will be distributed throughout the plant. Regardless of physical location, each shall have identical functionality and system data access. Upon user log-in, the workstation shall be automatically personalized to a ‘workplace’ with specific user role and functions.
    2. Workplaces shall support multiple monitors (up to 4) in various arrangements (i.e. 4 across or in a square formation) where the cursor and displays shall have the ability to pass seamlessly from monitor to monitor.
    3. Workplaces shall include multiple areas that are each configurable to user preferences. It shall be possible to place areas at any location on the workplace. At a minimum, these areas shall include:
       1. Alarm Display that shall include alarm groups and a listing of most recent alarms. This area shall be located at the top or bottom of the workplace.
       2. Display Area that provides the main viewing area for process displays, faceplates, trends, documentation, and other operational views.
       3. Navigation Area that shall include search tools, selected tag shortcut tools with links to graphics, faceplates, trends and alarm/event lists, and user specific favorite links.
       4. Status Area that shall display the workplace status and diagnostics, current user login information, and operator specific messages.
       5. Each workplace shall include configurable filters to restrict access or refine information presentation.
       6. Workplaces shall be available in two modes:
          1. Operator mode shall create a stacking order of displays so that the most important displays will always be present and available. Also, no displays that are called up will fall behind the workplace when in ‘operator’ mode. When in ‘operator’ mode, the alarm area shall always be visible to the user. Opening a display shall not cause overlap and covering of the alarm area.
          2. Windows mode shall be available for users requiring access to other PC applications not available through the control system. In this mode, displays will not follow the stacking order.
    4. The system shall have a minimum of 3 default workplaces available centered around specific user roles:
       1. Operator
          1. Certain critical operations such as starting motors, changing set points, equipment trips, etc. shall, as a configurable option, be at least two-step actions by an operator.
          2. The system architecture shall be such that a component failure, which may cause unavailability of an operator workplace, does not prevent the operator from operation and control of the plant or an area of the plant. This means that the operator then shall have the ability to perform the same functions by logging into another workstation. Also, operator workplaces shall have identical capabilities, databases, and keyboards and be interchangeable for all functions including interactive graphics.
          3. Each Operator Workplace shall include 20% spare capacity for future expansion of graphics, displays, and alarms.
          4. The process graphic functions required to support the Operator Workplace are defined in Section 6.4.4.
          5. Faceplate requirements to support the Operator Workplace are defined in Section 6.4.5.
       2. Engineering
          1. Engineers require a system interface that provides the ability to perform process operations, engineering, and maintenance functions in an efficient manner. This shall be accomplished through an Engineering Each ModbusTCP module shall be capable of supporting one ModbusTCP sub-network. Each network shall support 30 or more ModbusTCP slave devices. Workplace that utilizes the intuitive, easy-to-use, common system interface for direct access to all plant objects.
          2. The Engineering Workplace shall include filters to refine presentation of system information for specific engineering roles including device configuration, control and safety configuration, display configuration, Workplace configuration, and history configuration.
          3. The Engineering Workplace shall provide context navigation to engineering only functions including I/O allocation, bulk data management tools, and controller functions.
          4. Plant and system information including system status, control architecture, device diagnostics, product instructions, control configuration, and P&ID drawings shall be readily available to engineering personnel through contextual navigation. A system that requires multiple environments and navigation schemes to access relevant engineering data is not acceptable.
          5. The Engineering functions required to support the Engineering Workplace are defined in Section 7.
       3. Maintenance
          1. Maintenance personnel require a system interface that organizes and arranges asset information in a way that is needed for efficient daily activities. This shall be accomplished through the Maintenance Workplace. It shall provide visualization of plant asset performance objectives, constraints, current behavior, and relationships with other plant assets.
          2. The Maintenance Workplace shall be the single interface for plant maintenance and asset management personnel..
          3. The Maintenance Workplace shall be configured as a fixed set of panes that provide the information to the user:

The primary pane shall present all of the plant assets to the user in a tree structure organized by asset type (field instruments, valves, motors, etc.). This pane shall be capable of displaying live status indication of each device according to the Namur NE107 standard.

A second pane will indicate the full set of asset conditions associated with a selected asset in the primary pane.

A third pane will show asset condition details for a single asset condition selected in the second pane including any probable causes and suggested solutions and actions to resolve the condition.

* + - * 1. The Maintenance Workplace shall support administrative functions to manage the monitoring functions for the plant assets.
        2. Asset performance alerts shall be reported to maintenance personnel via the system’s alarm and events functions.
        3. Asset information including field device diagnostics, product instructions, electronic documentation, CMMS data, Calibration data, and Standard Operating Procedures shall be readily available to maintenance personnel through contextual navigation. A system that requires different system environments and navigation schemes to access relevant asset information is not acceptable.
        4. The asset management functions required to support the Maintenance Workplace are defined in Section 9.
    1. In addition to these default workplaces, workstations shall be easily adaptable to other specific user roles and functions (i.e. Supervisor, Line or Plant Manager, Safety Engineer, etc.).
    2. The CPAS shall support the use of mobile workstations for any user role
       1. Mobile workstations shall be a standard offering of the system and the system supplier shall have a have a documented solution as part of the system offering.
       2. Mobile workstations should use Remote Desktop Services (RDS) as the preferred means of communicating with the system.
       3. Mobile workstations should support full functionality of the user type.
       4. Mobile workstations shall support display formats congruent with the device in use. If mobile workstations do not support the standard display resolution of the standard, fixed position clients, then the CPAS shall offer the capability to provide a user workplace environment configured to match the display capabilities of the mobile workstation hardware to avoid loss of visibility of information on the workplace required by panning or other display manipulation requirements.
       5. Mobile workstations require a well-designed wireless infrastructure to meet the reliability requirements of the system owner. If the system supplier can provide wireless networking hardware and services, the supplier should explain their capabilities in response to this specification item.

## Navigation

* + 1. To promote operation consistency and ease of use, navigation in the various workplaces shall be intuitive and similar to a web browser such as Microsoft’s Internet Explorer.
    2. Most selections shall be selectable with a single or double click of a mouse.
    3. There shall be options for the number of steps that users are required to perform in order to make changes.
       1. Single step
       2. Secondary confirmation step
       3. Re-authentication
       4. Supervisor authentication.
    4. Navigation tools shall be available for quick, intuitive access to relevant data and displays needed to properly control the process. The following shall be standard features and not customized solutions within graphic (mimic) displays:
       1. Favorite display menus
       2. Display folders with lists of pre-defined display menus
       3. Tag entry box with quick search function where quick search is automatically done after typing in letters and pausing.
       4. History menu with forward and back buttons shall be available that contains a list of previously accessed displays
       5. ‘Pin’ or ‘tack’ function that will protect a display or overlapping display from being replaced.
       6. Shortcut links shall be available for accessing various displays and other information.
       7. Function keys shall be programmable to bring up any displays with one operation action.
    5. Contextual Navigation
       1. With every plant entity that is represented by an object, a context menu allowing access to various, relevant information, properties, and configuration templates shall be available. This context menu shall be available via a right mouse click by the user and be filterable based on the individual’s job function as to remove any irrelevant, nuisance information.
       2. The context menu shall have the option to have ‘sub –trees’ to allow grouping of similar type displays in order to keep the list as small as possible for easy, intuitive navigation.
       3. The context menu shall contain links to displays such as, but limited to, the following:
          1. Graphic displays and elements
          2. Alarm and event lists
          3. Audit trail lists
          4. Trends
          5. Links to documentation
          6. Links to web displays
          7. Links to 3rd party applications
    6. Tabbed Navigation for displays
       1. The CPAS shall support a tabbed navigation system for commonly used operator displays that clearly identifies and simplifies access to appropriate plant areas and detailed content. This tabbed system of displays will be automatically configured according to the location of the displays within the functional configuration structure of the system database (i.e. high level plant area overviews will be the top level or primary tabs; tabs for detailed sublevels of each plant area will appear for the selected plant area; etc.).
       2. Display tabs at all levels shall provide indication of highest active alarm status present on the display and that indication shall roll-up to higher levels of the display hierarchy.
       3. Alarm status indication on a tab shall provide the option of indicating shelved alarms or hidden alarms that may be present on the graphic.

## Displays

* + 1. General
       1. To ensure consistency throughout the system, the Supplier and Owner shall agree on graphic display format before development. All displays shall be developed in a consistent, logical approach.
       2. Graphic displays shall be high-resolution graphics. Completely user-configurable, graphic displays shall be built from a library of predefined symbols. It shall be possible to create project specific symbols and add them to the library.
       3. It shall be possible to move, minimize, resize, and print displays using a consistent, logical approach.
       4. Real-time data on active displays shall continuously update without requiring user interaction. The refresh rate of the data shall be configurable with a minimum refresh rate of once per second.
       5. As a minimum, the following display attributes shall be configurable:
          1. The location of the initial call-up of a display shall be configurable to be:

At the cursor;

Offset relative to a previously called up display;

Pre-defined X-Y coordinates.

* + - * 1. The size of the display upon initial call up.
        2. The stacking order to determine which displays are in front of other displays
        3. Whether the display is fixed in size or can be re-sized.
        4. Whether the display is pinned as to prevent it from being closed accidentally.
      1. For multi-monitor workplace arrangements, selected displays, including pop-up displays, shall be configurable to appear on a specified monitor.
      2. It shall be possible to add, modify, or delete a graphic without removing the workstation from service.
      3. Numeric data displays shall be individually configurable in any color and with five (5) digit fields available for display (not including decimal point or sign).
      4. It shall be possible to display numeric and text data in at least ten different font types and sizes. All font options (i.e. bold, italic, underscore, strikethrough) shall be available.
      5. Multi-state device shall have each state displayed with unique foreground / background color combinations.
      6. For easy interpretation, it shall be possible to display numerical data in configurable horizontal or vertical bar graphs.
    1. Process Graphic Displays
       1. Interactive, dynamic faceplates for controllable devices shall be available from the associated process graphic display.
       2. Graphical elements on the process graphic display shall indicate changes to data values through foreground color changes, background color changes, shape changes, or any combination of these (flashing).
       3. Each process graphic display shall be capable of handling a minimum of 200 dynamic display elements.
       4. There shall be no limitations to placement of dynamic and non-dynamic elements within the process graphic display.
       5. It shall be possible to display process information using a standard library of “high performance graphic elements” that provide improved operator information and effective situational response. In place of displaying traditional numeric data, these high performance elements will provide visual situation information. Some examples are:
          1. Radar plots with control limits clearly visible for multiple variable simultaneously,
          2. Gauge elements that show current value of single variable along with all alarm points clearly defined,
          3. Normalized trends to show relationship of several values at once including alarm limits,
          4. Alarm elements that represent alarm conditions both by color and by unique shape.
    2. Faceplate Displays
       1. Faceplate Displays for analog and digital control elements shall be available from any graphic or other type of display where the element is referenced. Additional elements for faceplate display shall include analog inputs, manual output stations, and digital inputs/outputs.
       2. Multiple faceplate views shall be available. Depending on user’s preference and job function, each view provides more or less information. At a minimum, the system shall support the following views:
          1. The Reduced View shall be optimized to be as small as possible while displaying relevant information and most used operator commands.
          2. The Faceplate View, or normal view, is larger than the reduced view and contains additional information and operator commands.
          3. Expanded view shall contain more information and functionality than the faceplate view displaying the maximum amount of information and is intended for engineers, technicians, and/or advanced operators.
       3. These faceplate views shall contain the following:
          1. Tag Name
          2. Tag Description
          3. Control Mode and set point input status
          4. Process input, set point and output values (described via bar graph and numerically).
          5. Loop diagnostics including set point and process variable status, high/low and deviation alarms, etc.
       4. ‘High’ and ‘Low’ process alarms shall be displayed on the faceplate. Upon return to normal, the faceplate shall indicate return to normal.
       5. For discrete multi-state devices, faceplates shall display graphical and text indication of control states.
       6. Based on user permissions, it shall be possible through either the keyboard or pointing devices to perform the following from a faceplate display in a single action:
          1. Change control mode and adjust outputs
          2. Change set point
          3. Change multi-state device positions
       7. Additionally, controller tuning parameters shall be optionally protected and only be visible and/or accessible with the right security and authentication from the workplace keyboard via password or key lock security.
       8. Group and detail displays shall be provided to show dynamic process and status information. These displays shall contain operator faceplates that allow an operator to change mode or control parameters of a control loop.
    3. Standard Displays
       1. For system alarms, status, and diagnostic information, standard displays shall be provided including:
          1. System status displays which present operational status of the communication network, communication devices, controllers, and associated I/O modules.
          2. Diagnostic displays which presents on-line and off-line diagnostics for major system components including hardware and software services.
       2. Supplier shall have the capability to perform remote diagnostic collection and analysis.
    4. Trend Displays
       1. Trend Displays shall present both run-time and historical data seamlessly regardless if data resides in short term or long-term data storage.
       2. To help in comparing two data sets, Trend Displays shall have the capability of having its traces be individually offset by duration of time.
       3. User shall have the capability to modify Trend Displays by adding or removing traces.
       4. It shall be possible to add a trace to a trend display by selecting the corresponding Tag on a graphic display and drag and drop it on the trend display.
       5. User shall have the capability to copy and paste Trend trace data into other applications such as MS Excel.
       6. Trend Displays shall have a feature that allows the user to ‘zoom’ into a specific section to increase the time resolution and provide more detailed information.
       7. Trend Displays shall be able to display two values as X/Y plots. Optionally, it shall be possible to use Bitmaps or similar for the background. This image shall be dynamically selected with up to two pictures.
       8. Trend display background colors shall be configurable.
    5. Group Displays
       1. For displays of a similar type, such as trends, faceplates, alarm lists, it shall be possible to cluster them in groups of various quantities and sizes. For example, 10 faceplates can be grouped in a 2x5 arrangement or 4 trends can be grouped in a 2x2 arrangement.
    6. Dynamic Documentation
       1. To lower lifecycle costs, it is critical for documentation to remain up-to-date, contextual navigation to dynamic, real-time system documentation shall be available from all system workplaces. This documentation shall be automatically updated based upon dynamic references to system objects and properties. For example, it shall be possible to create interactive operator procedures that show the instantaneous value of a tag and allows the operator to navigate directly from the value to its associated, process display, or faceplate. If requirement cannot be met, Supplier must take exception and describe how documentation will reflect changes made over the course of the system lifecycle.

## Alarm and Events

* + 1. Presentation
       1. The CPAS shall be the primary plant annunciation device. For any point in the system, real or calculated, alarm conditions shall be adequately indicated on the workplace monitor and a single step action shall call up as many as four (4) informational aspects related to the alarm (example: popup equipment display containing the point in alarm, the faceplate for the alarming device or loop, a trend containing the alarm tag and other key variables, and/or an alarm instruction document with specific information about possible causes of the alarm and potential actions to take based on the specific alarm.
       2. It shall be possible from each workstation to audibly annunciate each priority of alarm via a variable, configurable tone horn. In order to customize tones, the tone horn shall use standard sound files (i.e. .wav files).
       3. It shall be possible to access alarm displays from any other workplace display in no more than two user actions. Separate lists for alarms and events shall be available. It shall be possible to navigate through multi-page lists using forward or backward functions.
       4. Alarm and Event Lists shall be available on the plant, area, group, tag, and device levels.
       5. As a minimum, for analog points, the configurable triggers for process alarms shall include:
          1. Process variable high
          2. Process variable high high
          3. Process variable low
          4. Process variable low low
          5. Process variable rate-of-change high
          6. Process variable deviation from set point
          7. Process variable invalid value
       6. As a minimum, for digital points, the configurable triggers for process alarms shall include:
          1. Either state
          2. Change of state
       7. For use with intelligent alarm applications, it shall be possible to create soft alarms from the workplace level. These alarms shall be presented similar to the system’s controller-based alarms.
       8. It shall be possible to assign a priority to each alarm with the system accommodating at least 500 priority levels. The user shall have the ability to configure each level based on priority name, horn sound, and color annunciation.
       9. It shall be possible to assign alarm groups by process area, process location, asset type, and alarm priority.
       10. The alarm display format shall user configurable. However, the system shall provide a default alarm and event display that presents alarm and events in ascending order of time-based occurrence.
       11. The alarm displays referenced above shall have filtering capability to focus attention by priority, tag name, or other data fields presented to the operator.
       12. The system shall indicate process alarm state changes. As a minimum, these include:
           1. Unacknowledged alarm
           2. Unacknowledged alarms - returned to normal
           3. Acknowledged alarm
           4. Acknowledged alarms - returned to normal
       13. From any workplace in the system, it shall be possible with the proper authorization, to acknowledge alarm conditions in no more than two actions. Acknowledgement from one workplace shall update the alarm state on every other system workplace.
       14. It shall be possible to navigate from an individual alarm in the alarm list to any configured display or information attached to the Tag. A list with references to process displays where the alarming tag is represented shall be easily accessible.
       15. Alarm information shall be available in the following display formats:
           1. Active Alarm displays present a full window listing of all currently active alarms. From this display, it shall be possible to acknowledge alarms on an individual basis or a per page basis.
           2. Alarm History displays present a full window listing of the most recent alarm events. This includes all state changes.
           3. Alarm band displays present the most recent unacknowledged alarms in a dedicated area of the operator workplace. This display shall always be visible to the user. Opening a display shall not cause overlap and covering of the alarm area.
       16. The alarm displays shall include a one-line alarm message with the following information as a minimum:
           1. Alarm time stamp including date and time (hours / minutes /:seconds)
           2. Tag Name
           3. Tag Description
           4. Alarm Description
           5. Alarm Priority
           6. Alarm State
           7. Desired state and actual state (for discrete alarms)
           8. Alarm limit and actual value with engineering units (for analog alarms)
    2. Process Alarm Masking (Alarm Hiding)
       1. It shall be possible to mask alarms on a point-by-point or group basis. This can be accomplished by either:
          1. Automatically masking alarms upon the occurrence of another alarm, the equipment being out of service, or other defined conditional situations.
          2. Manually masking alarms. This manual function is based on user privileges.
       2. All masking functions shall be logged in the system audit trail. A list of hidden or masked alarms shall be available from the operator workplace.
    3. Process Alarm Shelving
       1. It shall be possible to shelve alarms on point-by-point or group basis.
          1. This shall be an action initiated by an operator.
          2. The action of shelving an alarm shall initiate an alarm shelving time-out timer that is either defaulted to a project standard, or with privilege, may be adjusted by the operator.
          3. There shall be a standard, on demand system report to show current shelved alarms.
    4. Process Alarm Analysis
       1. There shall be a system option to provide an alarm analysis feature.
       2. It is preferred that the alarm analysis features be fully integrated into the standard system software.
          1. If a third party software alarm analysis package is utilized, the supplier must detail how this feature is licensed and maintained as part of the suppliers total system responsibility.
          2. Also in the case of third party software, the supplier must provide details on how the alarm analysis package is kept current with new software versions of the CPAS.
       3. The alarm analysis feature is intended to provide information on key performance indicators (KPIs) associated with system alarming performance. These KPIs shall be available in real time, displayed in graphical formats, and made available in standard system reports. The measurements shall include but not be limited to:
          1. Number of active, unacknowledged, hidden, and shelved alarms
          2. Alarm rates and average and maximum number of alarms per hour
          3. Average time to acknowledge alarms
          4. Percentages of alarms above acceptability level (level must be user definable)
          5. Percentages of alarms above intense level (level must be user definable)
          6. 20 most frequent alarms
          7. 20 alarms that were active for the longest time
          8. 20 still active alarms that were active for the longest time
          9. Runtime distribution of alarm priorities
    5. Alarm Grouping Function
       1. It shall be possible to group alarms within the CPAS to provide a single alarm to the operator when several alarms are generated at the same time for a piece of equipment or within a common equipment grouping as defined by the system owner. The grouped alarm shall indicate the severity of the highest alarm priority within the group of individual alarms.
       2. It shall be possible for the operator to expand the single alarm to view details about any and all alarms within the grouping to obtain information about the abnormal situation and take appropriate action based on the active alarms within the group.
    6. The CPAS shall provide the option of supplying alarm help instructions from a managed database rather than from separately maintained documents.
       1. Rather than relying on a separate collection of alarm response documents, it is desired that a database of responses and a standard presentation format be offered to supply operators with recommended causes and actions for alarms.
       2. It shall be possible to populate the database from documents or other database tools (for example a HAZOP tool) to prevent mistakes made from manual entry of information into the database.
    7. Remote notification for alarms
       1. The system shall be capable of remote notification of key plant personnel of operating conditions. As a minimum, the following conditions shall be reported via SMS messaging system or similar functionality.
          1. Critical alarms
          2. Device asset alerts
          3. Control system status
          4. IT component status
          5. Calculated value alerts
          6. Key performance indicators
       2. SMS Messaging system shall have a means of scheduling and managing a list of recipients. For each recipient, the SMS Messaging system shall have multiple means of contacting including:
          1. Pagers
          2. Cell phones
          3. Emails
       3. The SMS message shall be derived from actual system alarm lists. The message shall be configurable by selecting pertinent alarm field information.
       4. For audit purposes, all SMS Messaging system actions and events shall be automatically entered in the system audit trail.
       5. The sending device shall use GSM technology.
       6. The SMS Messaging system shall be able to log a reply generated from the recipient’s phone that will automatically be entered into the system’s audit trail.

## Point-of-Control Management

* + 1. The CPAS shall offer the option of a Point-of-Control feature to allow operator responsibility for individual control points or entire process areas to be safely managed by the appropriate person or site area. This feature shall provide for a designated individual or group of individuals within a control area to normally have sole control over the process points / area important to that area. Point-of-Control also provides the feature to transfer the responsibility for those points or the area to other individuals or a different control area.
    2. The mechanism for the transfer of responsibility should involve a software “dialogue” between the involved operators that is provided as part of the Point-of-Control CPAS service that make the transfer of responsibility obvious to the individuals involved when the responsibility is being changed.
    3. Each transfer of responsibility must be logged as part of the standard system audit trail feature.

## Live view of SFC logic

* + 1. There shall be a standard system feature that allows the operator to view Sequence Function Chart (SFC) logic from within the normal operator environment.
       1. These views need to reflect current, installed SFC logic at all times and should update automatically with any changes made to the SFC code within the control logic.
          1. Custom configured graphic displays to show SFC logic do not meet the intent of this requirement as they do not update automatically.
       2. Access to the SFC view should be available from appropriate operator tools such as faceplates and graphics via a graphical element (button) or contextual navigation.
    2. The SFC view feature shall not require that the operator station be configured as an engineering station, nor shall the feature require attachment of an engineering license to view the SFC.
    3. The operator shall not be able to edit the SFC from this view feature.
    4. The SFC view shall provide for drill-down capability to view the logic or code content of the SFC steps and transitions to enable debugging of operational problems associated with an SFC.
    5. The SFC view shall provide live indication of boolean (true or false) state of all logic for debugging purposes.
    6. The SFC view shall provide for contextual access to faceplates for elements of the logic for debugging purposes.
    7. The SFC view shall provide for operator capability to force SFC logic transitions when the logic may be stalled and conditions are safe (based on a judgment from the operator or supervision) to proceed.

# ENGINEERING

## General

* + 1. The Engineer Workplace shall provide a common environment and interface for configuring all system devices, control applications, and safety applications. A system that requires multiple environments and navigation schemes to access relevant engineering data is not acceptable.
    2. The Engineer Workplace shall be fully capable of graphics generation, database addition and editing, control configuration and revisioning, maintenance, diagnostic review and performing change management functions. All configuration changes made from the Engineer Workplace shall be traceable through a single audit trail.
    3. In addition to performing engineering functions, each Engineering Workplace shall include access rights to all system functions (including retrieval of historical and trended data). Access to various applications shall be dependent on user login. For example, engineer 1 has complete access to Unit 1 while engineer 2 has complete access to Unit 2.
    4. The engineering environment shall provide a method for performing offline, remote engineering. This method must support complete and selective synchronization of changes between the offline database and online production database configurations, generation of difference reports, and a mechanism for transporting changes to a disconnected system.
    5. The Engineering Workplace shall include the capability to change device configuration, control and safety configuration, display configuration, Workplace configuration, and history configuration. The changes shall be made via the communication network and shall not affect performance of plant operations or data acquisition. In addition, the workplace shall retrieve historical process data and trends, load process controllers, perform system and device diagnostics, and tune process loops.
    6. Without affecting control of the process, it shall be possible to download a modified application to the running process controller for the purpose of evaluation. The evaluation shall be performed in parallel with the existing application and utilize the live process inputs without directing the outputs to the final elements. When the evaluation is completed, an explicit command or action shall be required to replace the existing application with the modified application.
    7. The engineering environment shall provide the option for utilizing up to 20, concurrent licensed sessions to allow up to 20 individuals simultaneous access to the configuration database. The engineering environment shall also have built in safeguards to prevent the configuration of one engineering session from overwriting the content of another.
       1. Engineering workplace environments shall support the ability for remote users to access the system and perform engineering functions. This environment must be secure. The desired connectivity would be to use Remote Desktop Services (RDS) for this functionality.
    8. The engineering environment shall provide a standard mechanism for change management of the configuration database. This feature shall provide functionality for comparing and reporting differences in both control logic and operator graphics configurations between the current production configuration and stored historical configurations. The feature should be able to display the comparisons with complete information or filtered to view only the difference items. It shall be possible to save these comparisons in electronic format or print for hard copy storage. The change management system shall provide the following features as a minimum:
       1. Check in, check out, get latest and compare versions
       2. Baseline creation for the system database and roll back to an older baseline.
       3. Support different access control privilege levels (Owner, Member, Visitor, etc.)
       4. Support versioning at the individual object level of the database and retain multiple versions of system objects.
       5. Handle reservations of the system database to avoid overwrite conflicts
       6. Provide error reporting
       7. Allow connections to more than one engineering system at the same time.
    9. The engineering environment shall provide a tool to evaluate controller loading and distribution of controller tasks analyze for program conflicts that could lead to control task latency or controller overload situations. The tool shall provide features to allow adjustments to the controller program loading to eliminate or minimize the possible problem areas. The tool shall be capable of preventing a download that would result in task latency or overload.

## Control Configuration

* + 1. The workplace shall include the capability to download control configurations to the on-line process controllers without interruption of plant monitoring and control.
    2. The engineer workplace shall be capable of programming control applications in all five IEC 61131-3 programming languages:  
       1. Function Block Diagram
       2. Sequential Function Chart
       3. Ladder Diagram
       4. Structure Text
       5. Instruction List
    3. It shall be possible to program a single control application using a combination of the programming languages identified above.
    4. In addition, the Engineer Workplace shall include a programming framework that utilizes a library of pre-defined control and SIL- compliant functions. SIL-compliant functions and applications shall be clearly identified when compared to non-SIL functions and applications.
    5. In applications requiring SIL rated programming, to create a SIL2 or SIL 3 Safety Instrumented Function (SIF), the engineering environment shall include safeguards against non-SIL compliant configurations. Once identified as a safety critical control application, the engineering system shall automatically limit user configuration choices to SIL-compliant functions and shall prevent download if SIL requirements are not met.
    6. A search utility that allows the user to search for control parameters, such as tag name, variable, location, etc. shall be available from the Engineer Workplace. All matches to the search criteria shall be shown together with definitions of its usage and single click access to the occurrence.
    7. The Engineer Workplace shall include a verification feature that will ensure accurate documentation by comparing configuration drawings against the process controller’s executing configuration.
    8. The Engineer Workplace shall include an I/O force feature allowing the engineer to override an actual I/O value with user-selectable value. This feature shall be used during loop testing when actual I/O values are not available. This capability shall be restricted by user log-in.
    9. Configuration of peer-to-peer communications variables shall be done automatically when peer connections of programs or applications are identified.

## Graphical Loop Design

* + 1. The Engineer Workplace shall provide an interactive graphical loop design tool that can be used to create and modify the process functions (i.e. device, I/O channel, control algorithms) that make up the control strategy. The user shall build control programs by dragging control functions from a list into a diagram. When complete, these diagrams are compiled into control program configurations for download into the control processors, and serve as the control strategy documentation.
    2. At a minimum, the graphical loop design tool shall provide:
       1. Support creating type solutions that can be saved into the application or as library elements to be reused in other larger applications as well as creating individual, one-of-a-kind control logic diagrams.
       2. Support for connections between process functions including field devices, I/O channels, and controllers.
       3. Connection variables should be automatically defined by the graphical connection process of two entities. Support for the interconnection of IEC 61131-3 functions, function blocks, and other pre-defined control algorithms.
          1. It shall be possible to display Sequence Function Chart (SFC) and Structured Text (ST) logic blocks as part of the graphical diagram to aid in understanding the total logic flow.
          2. Content of SFC and ST code blocks shall be viewable within the presentation format of the graphical editor and not need to navigate away from the tool to view the code.
       4. Contextual navigation from each process function to all of its associated information. For example, for a control station, information available could include faceplate, trend displays, alarm lists, and loop documentation.
       5. A method for inserting graphic primitives, bitmaps images, and Active X components within the control loop diagram to enable creation of descriptive control strategy documentation is optional.
       6. The ability to include lower level diagrams (type solutions) within a parent diagram (i.e. nesting of a common interlock strategy). The lower level diagram (the interlock strategy) shall be represented as a single functional component with IN/OUT ports.
       7. On-line display (including status, i.e. forced, good or bad quality, etc.) and tuning of values for all connections and ports within a diagram.
       8. A method for displaying and tuning a user defined collection of system wide on-line values.
       9. System wide navigation to all functional areas from within a single control diagram or across multiple diagrams through the use of page and cross reference links
       10. An automated mechanism for creating and printing the complete control strategy configuration including page to page references, table of contents, signature fields, and customer specific data areas.
       11. Automatic generation of controller peer-to-peer communication.
       12. Graphical representations for conventional I/O channel assignments shall indicate the physical address of the controller, I/O module, and channel assignment on the diagram to facilitate quick referencing of information.

## Display Editor

* + 1. A display editor shall be provided to generate and modify displays that implement all the features as defined in this specification using an interactive (CAD-like) procedure.
    2. The display editor shall use current, supportable graphics technology (i.e. Windows Presentation Foundation [WPF] or similar). Outdated and unsupported technology like Microsoft Visual Basic is not an acceptable platform.
    3. The display editor shall provide a complete set of graphic primitives and symbols for use when developing process displays, and support the use of photos, bitmaps, or graphics from 3rd party systems that utilize Active- X technology.
    4. It shall be possible to create a display symbol generically on a tag type. In other words, if a flow control loop or tag is created as a generic solution to be re-used multiple times, the symbol and its references can be engineered in advance on the generic solution. By creating a new instance from the generic solution, the graphic element will be created automatically along with references to correctly animate the graphic element.
    5. It shall be possible to change a display symbol on a generic tag type and have it change the display symbol on each tag type instance automatically throughout all the process displays. In other words, if a flow control loop or tag is created as a generic solution that is to be re-used multiple times, the display symbol and its references can be modified on the generic solution and automatically update all of the instances created from that solution.
    6. The display editor shall include a design mode that allows displays to be built offline and a test function that allows the behavior of the display to be tested prior to being placed on-line.

## Device Management

* + 1. Field devices shall be configured using an integrated fieldbus management tool that utilizes a standardized, non-proprietary interface. The tool shall allow device access from the control room and eliminate costs such as separate service bus wiring costs, costs of handheld configuration devices, and configuration/documentation maintenance costs.
    2. The integrated fieldbus management tool shall include:
       1. Adding / moving / deleting / copying devices
       2. Fieldbus network topology planning from controller to device
       3. Device channel / address assignment
       4. Graphical interface for configuration and parameterization of device
       5. Graphical interface to view process variables and diagnostics
       6. Comparison of device on-line and off-line data
       7. Device upload, download, and commissioning
       8. Configuration of the fieldbus interface to system applications such as history and asset management.

## Bulk Data Management

* + 1. The Engineer Workplace shall provide tools that enable efficient bulk data handling through commercially available off the shelf applications (i.e. Microsoft Office Excel Add-in’s).
    2. Import of external data such as tag names, signal lists and assignments, and document links shall be supported.
    3. The bulk data handling utility shall support an iterative, step-wise design process that allows the user to read and write data (i.e. the step-wise project definition of tags, tag descriptions, properties and I/O assignments).

## Libraries

* + 1. The Engineer Workplace shall be provided with a comprehensive library of standard, reusable, predefined control and SIL-compliant functions that are sufficient to perform all control strategies required.
    2. These libraries shall include preconfigured faceplates, trends, graphic elements, alarm and event lists, and documentation links and incorporate both standard and specialized functions, ranging from simple tasks such as multiply/divide to complex tasks such as adaptive nonlinear controllers and controllers with internal logic and manual/auto capabilities.
    3. The Engineer Workplace shall support the creation and revisioning of user-defined libraries that contain “Best Practice” standards. These libraries can be transported from system to system through an import\export mechanism. Modification of these “Best Practice” standards shall be automatically propagated to all instances. Supplier shall provide details on how this is accomplished in their system.
    4. The Engineer Workplace shall provide a standard means of configuring connectivity to third party PLC devices on a library basis. The library shall support both a standard configuration format to connect to PLC OPC servers and a set of common graphical items for PLC data integration into the Operator Workplace.

## Engineering Design Tool Support

* + 1. The Buyer’s representative will use INtools© (use SmartPlant® Instrumentation when applicable) for engineering design. To streamline the system definition phase of the project, the Supplier shall support the exchange of engineering data with a graphical user interface via the Engineer Workplace.
       1. The interface shall support bi-directional data synchronization of basic engineering data including hardware structure, I/O Channel assignment, and dynamic links to INtools documentation. (use SmartPlant© documentation when applicable).
       2. The interface shall support the direct, automatic, transfer of INtools (use SmartPlant© when applicable) data into the control system database. Utilities that require manual manipulation of the engineering tool data will not be accepted.
       3. I/O module definition files to support the Supplier offering must be available for import into the INtools (use SmartPlant© when applicable) engineering database.

# BATCH MANAGEMENT

## General

* + 1. The CPAS shall include standard software functions to configure and control a fully automated batch process. The batch management software functions shall conform to the ANSI/ISA 88.00.01-2010 batch control standard. These functions shall supply a common methodology for configuration, runtime, maintenance and security that is consistent with the balance of the CPAS.
    2. The batch management software functions shall be supplied in a client/server configuration
    3. The batch management server function shall be redundant.
       1. The redundant batch server shall be installed in a separate physical node, different than the primary batch server. It shall not be permissible to substitute a single node, high available solution executing a single instance of the batch server execution engine and database application.
       2. The redundant batch server shall remain synchronized with the primary batch server and shall automatically assume the role of the primary in the event of hardware failure or software malfunction of the primary server.
    4. The batch client application shall be tightly integrated with the CPAS standard Human System Interface application. Batch functions shall be accessible from within the standard HSI application and have access to all system data points. It is not permissible to have the standard process control operator interface and the batch control operator interface as separate applications running on the same workstation.
    5. The security and access control for batch functions shall be integrated with overall CPAS security and access control configuration as described in Section 2. The batch functions shall be represented as an additional set of permissions that may be granted or denied to the appropriate user groups and/or individual users. It is not permissible to configure separate but equivalent access control, User ID’s, passwords, etc. for the batch system.

## Recipes and Procedures

* + 1. Recipe procedures shall support the levels as specified in the Procedural Model of the ANSI/ISA 88.01-1995 standard:
       1. Recipe Procedure
       2. Unit Procedure
       3. Operation
       4. Phase
    2. Procedures shall be configured using a graphical, object oriented design tool.
    3. It shall be possible to configure header information for any level procedure.
    4. It shall be possible to configure parameters for any level procedure that may be used to represent formulation data.
    5. Procedure parameters of the type floating point, string or list must be supported.
    6. It shall be possible to define a procedure parameter as an expression or variable that may have its value evaluated or assigned during procedure execution. This will provide the user with the functionality to define calculations within the recipe procedure. This will enable the configuration of dynamic recipe parameters.
    7. The procedure editor shall include an expression function wizard to assist the procedure developer in the configuration of an expression within the procedure.
    8. The available expression functions shall include:
       1. Arithmetic functions
       2. Trigonometric functions
       3. Comparison operations
       4. String handling functions
       5. Time functions
    9. The configured procedures shall be available for use as controlling and monitoring displays in runtime on the batch client workstations without additional configuration.
    10. The batch management software shall provide version control on all master procedures at all procedural levels.
    11. It shall be possible to compare any two revisions of a procedure with an explicit visual indication of the differences between the two revisions.
    12. The procedure editor shall allow the reuse of lower level procedures in an unlimited number of higher-level procedures.
    13. It shall be possible to configure monitors for undesirable product related process conditions with specific exception handling instructions at the procedure level.

## Batch Execution and Runtime

* + 1. The batch manager shall support operation in the following modes: Automatic, Semi-Automatic, and Manual.
       1. In automatic mode, procedural elements automatically execute sequentially through the procedure steps when the transition condition following the procedural element is satisfied.
       2. In semi-automatic mode, procedural elements execute per the sequence of the procedure, but the transition between the procedural elements requires that the transition condition is satisfied and the continue command is entered by the operator.
       3. In manual mode, procedural elements execute in the order specified by the operator and not the procedure.
    2. The batch manager shall allocate, reserve, and acquire required equipment for the procedure or phase as specified in the procedure. The batch manager shall support the dynamic selection of equipment at runtime according to preconfigured selection criteria.
    3. The batch manager shall allow the operator to override the automatic equipment allocation. The operator shall be able to redirect the assignment of a batch to different equipment. The operator shall be able to manually set the status of equipment (i.e. reserve, disable). The level of access granted to any operator (or other user group) shall be controlled by the system security and access configuration parameters.
    4. It shall be possible to edit any currently executing control recipe. It shall be possible to modify any procedural element within the control recipe subsequent to the currently active procedure block.
       1. The following modifications shall be supported:
          1. Modification of the procedure sequence
          2. Addition or deletion of procedure elements
          3. Modification of equipment assignments
          4. Modification of recipe procedure parameters.
       2. It shall be possible for the control recipe being edited to continue its execution if the affected procedure or sub-procedure has not been reached in the execution order.
       3. The performance of an online recipe procedure edit shall not affect the continuing execution of other active control recipes.
       4. The activation of a control recipe modified online shall not require the interruption of the continuing execution of active control recipes. It shall not be necessary to stop controller execution or processing for a download. It shall not be necessary to restart the batch manager.
    5. The batch manager shall communicate on the control network to all controllers that are configured with batch equipment phases.
    6. The batch manager shall include the ability to monitor and control batch execution in the Supplier’s prior generation process automation system. The level of support shall be similar as for the current controller generation. The Supplier shall describe how it supports earlier generations of its batch offerings.

## Operator Display and Interaction

* + 1. The operator shall be able to monitor the progression of the batch processing via a graphical flow view representing the control recipe.
    2. It shall be possible to navigate between standard process graphics and batch functions/views via contextual navigation. It is not permissible to have the standard process control operator interface and the batch control operator interface as separate applications running on the same workstation.
    3. The operator shall be able to modify the operating mode of the procedure or sub-procedure as allowed by the security and access control configuration.
    4. The operator shall be able to perform an online modification of any executing control recipe as allowed by the security and access control configuration.
    5. The system shall include default faceplate display elements for informational display and operator interaction purposes. At a minimum, faceplate display elements for Units and Phases shall be included.
    6. Batch messages and dialogs generated by the control recipe procedure should be presented to the operator for information and action. The system shall provide an alarm and/or visual indication of any batch message requiring operator attention.
    7. The operator shall be able to access any batch message requiring operator attention via contextual navigation.
    8. The CPAS shall provide standard graphical elements that can be embedded into process graphics to indicate batch status information as well as provide batch creation and scheduling capabilities.

## Batch Equipment and Equipment Phases

* + 1. The system shall support the configuration of batch equipment and resources as individual, distinct objects. It shall be possible to allocate and arbitrate batch equipment and resources as part of the overall batch control strategy.
    2. It shall be possible to define specific characteristics (attributes) for each equipment object. These attributes may include information about equipment capacity, materials, allowable operating conditions, etc. These attribute values shall be accessible for use in expressions developed as part of the procedure configuration.
    3. It shall be possible to organize equipment objects into equipment groups. This will facilitate the assignment of an equipment group to a procedure when the process is constructed in a manner to allow multiple equipment of a similar or identical type or class to fulfill the processing requirements.
    4. The system shall provide a standard status display of all batch equipment and resources configured for the application. This equipment status display shall provide an overview of the current state of each batch equipment and resource including the Batch ID of the current batch and equipment status (available, acquired, disabled, etc.). It shall be possible to select a single equipment or batch resource and access more detailed information via contextual navigation. This detailed information view shall also enable the operator to change equipment status and manipulate the batch reservation queue of the equipment as allowed by the security and access control configuration.
    5. It shall be possible to configure equipment phase logic for execution directly in the controller and coordination with the batch manager control recipe procedures executing at the batch server.
    6. A template shall be provided to enable the engineering of the executable code for each standard ISA 88.01 phase state to be supported by the application (i.e. Running, Holding, Restarting, etc.).
    7. The phase control module logic application shall be capable of being programmed in any of the five IEC 6-1131-3 programming languages.

## Scheduling and Dispatching

* + 1. The system shall provide a view to enable the scheduling and dispatching of new batches (batch overview). The ability to schedule a new batch is determined by the security and access control configuration.
    2. The batch overview shall provide an overview of all executing and scheduled batches. It shall be possible to select a single batch and access more detailed information about the batch.
    3. The system shall enable the organization and scheduling of multiple batches of the same master recipe as a campaign.
    4. The system shall ensure that the Batch ID for each batch is unique and does not duplicate a previously used Batch ID. The system shall enable the user to manually assign a Batch ID when scheduling the batch. The system shall also support the automatic generation of a Batch ID according to configured formula or pattern.
    5. The system shall offer, as an alternative to the standard scheduling features, a Microsoft Excel-based scheduling and formulation management interface that can be used directly within the CPAS by standard operator clients. This same interface shall be supported on general PCs with access to the system, but not configured as operational clients (example: Production Scheduler’s desktop/laptop PC).

## Batch Historical Data

* + 1. The batch software shall provide the capability to incorporate all alarms and events originating within the batch software in a batch report.
    2. It shall be possible to configure specific parameters within the procedures for inclusion in the batch report. This provides the flexibility to specify the capture of process values associated with a procedure or phase within the recipe. This may include amount of material charged, maximum temperature, or elapsed time in phase.
    3. It shall be possible to associate non-batch generated alarms and events within units acquired by the batch procedure for inclusion in batch reports.

## Interface with External Systems

* + 1. The batch system shall support a programmatic method to communicate data from and to external business systems such as ERP and scheduling applications.
       1. The interface shall be based upon XML and utilize published schema.
       2. The interface shall support, at a minimum, the reading of active batch details and the writing of batch scheduling information.
    2. In many batch applications it is common to find skid-based equipment already supplied with a programmable logic controller. The batch must be processed through this equipment. It is desired that the batch system have complete visibility and supervisory control of all batch processing steps, therefore the batch system shall include the facility to provide batch supervision to non-vendor supplied controllers. Supplier shall describe the methods used to provide supervision of batch applications resident in third party controllers.

# ASSET MANAGEMENT

## General

* + 1. The system software shall include real-time plant asset management (PAM) functions. These functions shall collect, aggregate, and analyze real-time plant asset information in order to provide warning of degrading asset performance and impending asset failures.
    2. The owner’s objective with its real-time PAM system is to reduce total plant maintenance costs; therefore the PAM system shall not be limited to field device assets. The PAM software shall be capable of supporting the maintenance of all plant assets including field devices, CPAS equipment, major plant equipment and processes, and IT assets. Specific asset types and quantity are identified in Attachment 1.
    3. PAM features shall be integrated with the CPAS and be available from any workstation in the system.
    4. Access to the PAM shall not require additional login, change of user, or other initiation of user credentials for an authorized user profile.

## Asset Condition Monitoring

* + 1. The PAM software shall monitor asset performance by using real-time plant information as inputs. Because of the high costs associated with scheduled and corrective maintenance, the Owner will implement predictive and proactive maintenance strategies as much as possible. The PAM system will be the enabler for these strategies and shall be capable of:
       1. Detecting asset health and performance conditions,
       2. Assisting in the diagnosis of the asset performance problem,
       3. Providing correction recommendations
    2. Condition Monitoring capabilities shall be flexible and vary in complexity from simply identifying status changes or deviation limit conditions in traditional field devices and leveraging advanced on-board diagnostics of intelligent field devices to identifying abnormal conditions using advanced process equipment condition monitoring techniques. The Supplier shall describe their field proven monitoring techniques for the assets listed in Attachment 1.
    3. Condition Monitoring capabilities shall include configurable prediction horizon for “Harris Index.”
    4. Asset Optimization must support virtualization
    5. The PAM condition monitoring capabilities shall extend to third party automation or condition monitoring systems. All information, including the data coming from third party components, shall be available and accessible from any CPAS workstation.
    6. Over the life of the system, the Owner may expand the scope of the assets maintained by the PAM. The Supplier shall describe how the proposed solution can be modified to support this expanded scope. The Supplier shall also describe how its solution will accommodate the exchange of vendor specific device types (i.e. replace Vendor A pressure transmitter for Vendor B pressure transmitter).
    7. The PAM shall support presentation of device asset status information according to NAMUR NE107 asset conditions (Normal or OK, Information, Maintenance Required, Off Specification, Function Check, and Device Failure).

## Asset Condition Reporting

* + 1. Asset performance alerts / alarms shall be communicated to plant personnel using the CPAS alarm and events features as described in the Alarm Management section of this specification (Section 6.5).
    2. To enhance response time, remote personnel shall be notified of critical asset alerts via mobile phone, e-mail account, or pager using the system’s standard SMS (Short Messaging Service) and e-mail messaging service. This requirement is described in Section 6.6 of this specification.
    3. Asset condition alerts shall be distinguished by condition severity level. The severity level for each condition shall be user configurable.
    4. Asset monitoring shall be hierarchical and described using an expanding tree structure. Higher-level plant assets may be composed of sub-assets. For these cases, the most severe performance conditions at the sub-asset level shall propagate up to the tree to the parent asset / group / unit, etc. At each level of the tree, it shall be possible to access detailed asset information through a single user action.
    5. To assist maintenance personnel with root cause analysis, each performance alert shall include current condition details, severity, and a description of the recommended maintenance action.
    6. Asset events and corresponding maintenance actions shall be included in the system’s audit trail.
    7. The PAM system shall provide summary reports to refine the current preventive maintenance schedules and assist in pro-active maintenance. As a minimum, these reports shall include:
       1. Asset condition history reports that identify critical assets with high failure rates (i.e. identify repeating asset condition offenders). This report shall assist by providing a detailed list of faults for a given asset over a specific time period.
       2. Device calibration reports shall summarize the current calibration state for each device (i.e. calibration due, work in progress, waiting for approval).
       3. Running time reports shall summarize an asset’s actual hours of operation (i.e. motors, pumps, agitators, turbines, etc.).

## Maintenance Management

* + 1. In an effort to streamline the maintenance workflow, the CPAS shall make information within the Owner’s Computerized Maintenance Management System (CMMS) transparently accessible to users in the process control and maintenance system environments. The Owner currently has a Maximo® system installed (use SAP PM® when applicable). Details of the Owner’s maintenance system are described in Attachment 1.
    2. It is not acceptable to use individual application programming interfaces to gather data from plant sources such as the Owner’s CMMS, Enterprise Resource Planning system (ERP), or calibration management system.
    3. For a given asset, it shall be possible to navigate directly to the related asset page within the CMMS environment without requiring additional login. CMMS user credentials/privileges shall be known upon CPAS user login to the system workstation.
    4. The user workplace shall provide single click context navigation to CMMS resident information for a given asset. At a minimum, the following CMMS asset data shall be available for quick reference:
       1. Active work orders
       2. Work order history
       3. Equipment status
       4. Maintenance schedule
    5. To eliminate paperwork, it shall be possible to initiate the maintenance work process by generating work orders from the system user interface and then electronically submitting these work order requests to the CMMS.
    6. The CPAS generated work order shall contain the information reported by the condition monitoring and reporting software described above (i.e. performance condition detected, time stamp, probable cause, recommended action, and submitter’s name). Upon assignment in CMMS system, the system shall receive receipt notification with CMMS assigned work order number. With consideration to an optimized maintenance workflow, it is the Owner’s desire to have this information automatically populated in the CMMS work order documentation, thereby eliminating the effort and errors associated with manual data entry. If this requirement cannot be met, the Supplier must take exception and describe alternate.
    7. Owner will add / delete / modify plant assets on a routine basis. Supplier shall describe the procedure in place to ensure synchronization of Maintenance Management functions when assets are modified in either of the two system environments.

# INFORMATION MANAGEMENT

## General

* + 1. The system software shall include services to provide information to operators, engineers and other systems. The system shall supply a common methodology for configuration, runtime, maintenance and security that is consistent with the balance of the CPAS.
    2. The information service shall be composed of the following basic components:
       1. History services
       2. Archival services
       3. Reporting services
       4. Data Access services
       5. Calculation services
    3. The architecture shall be scalable. Scalability shall range from a single node that is focused on a single process area or unit to multiple nodes focused on the entire enterprise. In a multi-node environment, it shall be possible to have historical storage, collection and applications execute in a distributed environment.
    4. In a multi-node configuration, the system shall provide common reporting tools to consolidate and distribute information.

## History services

* + 1. General
       1. History data for all system tags shall be available from all workstations though integrated trend and event displays.
       2. The Trend display shall be integrated with the system configuration and be available in the context of the process displays.
       3. Desktop PCs shall have access to history data via commercially available off the shelf applications (i.e. Microsoft Excel).
       4. The system shall supply a mechanism to configure and maintain the history service as it relates to process data, alarm and events, and production records collection. This mechanism shall facilitate configuration of multiple loops possessing common history collection requirements.
       5. All time stamps shall originate with the actual device that generated the data and shall be stored in the system using Universal Time Coordinate (UTC) format to provide the ability to combine data from multiple locations.
       6. History services shall provide a common data storage structure for process, alarm and event, and production data to provide a common data model for data reporting and analysis.
       7. In the event of a hardware failure or a requirement to change out hardware, it shall be possible to move a configuration and the associated runtime data from one set of computer hardware to another set of computer hardware.
       8. The Historian shall support redundancy and dual data collection for the following process data categories:
          1. Process signals
          2. Alarm and Events
          3. Production Data
       9. Interruption of redundant history services shall not compromise the availability of dual data. The data in each repository shall be merged and synchronized upon re-establishment of redundant operation. This allows each history service to have a continuous, uninterrupted history view.
       10. The hard disk mass storage media shall have the storage capacity of 200 Gigabyte or large enough to store 6 months of data assuming the average collection rate of every I/O point at 2 second resolution (whichever is greater).
    2. Process Data Collection and Storage  
       1. The system shall be capable of collecting continuous history for the quantities of tags as specified in Attachment 1.
       2. The system shall collect plant data from a number of sources, including plant control systems, lab information management systems, and networked plant business systems/computers. Manual entry of information or commands shall be supported.
       3. The following numeric process data types shall be supported:
          1. Single Precision Real Numbers
          2. Double Precision Real Numbers
          3. Integers (4 Byte)
          4. Integers (8 Byte)
          5. Strings
          6. Boolean or Binary values
       4. The system shall support OPC Data Acquisition (DA), Alarm and Event (AE), and Historical Data Acquisition (HDA) for data collection.
       5. It shall be possible to collect process signals on a cyclic basis.
       6. It shall be possible to configure each process signal with individual storage parameters including dead band and data compression. These storage parameters represent the minimum amount of on-line data that will be available.
       7. It shall be possible to collect process signals on event.
       8. In order to determine factors leading up to a process event (i.e. trip), it shall be possible to identify and store at a higher resolution relevant information leading up to a process event.
       9. It shall be possible to insert and update values in a historical log. To ensure data integrity, data manipulation shall require proper user credentials.
       10. It shall be possible to configure and store data in a hierarchical manner. For example, it shall be possible to store instantaneous values for a configurable period of time. It shall also be possible to store hourly averages, min, max, summations or other computable values from the raw signals. It shall be possible to reference each of these sets of data by a unique name.
       11. It shall be possible to configure the system and historical storage using bulk tools. It shall also be possible to create a generic configuration “template” which can be applied to a signal or a series of signals. This template can be reused for many different signal and signal types. The template should provide the basic configuration parameters for hierarchical templates, storage, archiving, compaction, and dead banding.
    3. Alarm and Events Data Collection and Storage
       1. The history service shall support alarm and event messages with time stamp and shall allow user entered messages. In addition to time stamp, each event message shall include tag name, descriptor, process value (or state), and the event type. In its proposal, the Supplier shall state the maximum number of the events that can be supported prior to archival to off-line media.
       2. All discrete process events including input state changes, and inputs entering and leaving alarm states shall automatically be stored in the history service.
       3. The history service shall automatically store all user actions that affect the process including set point, station mode, and control output mode changes or discrete state changes such as Start/Stop or Open/Close.
       4. The history service shall automatically store all user actions that affect the process control and monitoring configuration including, placing stations and devices on-line or off-line, changes to alarm set points, inhibiting/enabling alarms, and changes to tag parameters.
       5. The history service shall automatically store system events including failed process Input/Output modules, communication errors, program error messages, switchover between primary and backup, failed controller modules, and other function module failures.
       6. The history serviceshall support OPC Alarm and Event. It shall have the capability to subscribe to multiple OPC Alarm and Event Servers. In addition, it shall support alarms and events generated within other applications.
    4. Production Data Collection for Batch Systems
       1. It shall be possible to collect and store production data from various producers of production events. Production data is typically stored in a hierarchical structure and provides hooks to the other data structures, such as historical process data and alarm and event data. This is typically based on a production event that indicates some significant time period where the production information is extremely relevant. Based on occurrence of a production event, the system shall have the capability to modify the information collected and the collection requirements.
    5. Archive  
       1. To provide off-line storage of operating data for the plant, a mass data storage system shall be provided. Additionally, management of off-line storage process shall be integral to the CPAS system environment.
       2. For long-term storage of data, the system shall automatically archive accumulated data to removable media such as DVD, CD, jukeboxes, or remotely mounted disk when on-line storage nears capacity. In addition, archive to removable media shall occur at user-defined intervals. The system shall generate an alarm if the mass data storage system is not available.
       3. It shall be possible to retrieve data from on-line and archive sources to produce composite displays and reports.
       4. Once archived, it shall be possible to restore the archive based on time. Data retrieval from the data store on-line and data restored from an archive shall be seamless.
       5. In addition to archives that create time based restorable data snapshots, it must be possible to back up the following:
          1. Current running configuration and data
          2. Entire Plant Information Management (PIM) system functions
          3. It should also be possible to move a currently running configuration and the data from one computer to another computer.
       6. The archive service shall support the ability to configure how an archive occurs. It shall be possible to create an archive based on time, percentage full of the disk capacity, and an event.
       7. Once an archive is complete, it shall be possible to generate additional copies of the archived data for off-site storage.

## Reporting

* + 1. Simple reports shall be generated using Microsoft Excel using standard, easy to use functions. Complex reports shall be generated using commercially available 3rd party reporting tools such as Crystal Reports using Open Interface such as OLE/DB and ODBC.
    2. The reporting service shall support the ability to perform ad-hoc reports. Operators, engineers or other plant personnel shall initiate these reports from their user workplace.
    3. The reporting service shall support the ability to perform scheduled reports. Scheduled reports shall occur based on a system event or cyclic event.
    4. The reporting service shall provide a mechanism to organize reports for viewing as well as the ability to establish digital signatures for the completed reports.
    5. It shall be possible to save a report and retrieve a report from the history service secure data storage. It shall be possible for all reports to be displayed on a workplace screen as well as printed on a report or standard printer. It shall be possible to configure a report to be sent to multiple destinations, for example send a report to disk, e-mail and print.
    6. It shall be possible to configure a report in different output formats, including TEXT, RFT, PDF and HTML.
    7. It shall be possible to use any variable in the system in a report. Information includes:
       1. Process Signals
       2. Historical process signals
       3. Event Data
       4. Production Data
    8. It shall be possible to create standard queries using standard tools such as MS Query to get SQL type commands that include time stamps, signal names as well as other filters. It shall be possible to generate reports in different formats based on the capabilities of the reporting tool and execute reports as an integrated part of the system or via ad-hoc requests from a desktop. It shall be possible to configure a report to accept manually entered data for specified fields.
    9. It shall be possible to have several reports execute either in parallel or sequence based on cyclic or a system event. Hourly, daily, monthly, end-of-month, quarterly and yearly reports shall be supported. These reports shall be activated on the following basis:
       1. On demand (operator’s request)
       2. On schedule
       3. On event
    10. The CPAS shall provide a feature for creating standard, reusable snapshot reports
        1. The configuration of the reports shall be dialogue based.
        2. It shall be possible to select configured reports from a list and assign them as a characteristic to any appropriate item within the CPAS system.
        3. It shall be possible to group individual type snapshot reports into larger snapshot reports.
        4. It shall be possible to export snapshot reports to electronic or hard copy formats for retention.
        5. Snapshot reports should include functionality for common items such as:
           1. Loops in manual
           2. Forced I/O channels
           3. Items with shelved alarms / hidden alarms
           4. Etc.

## Data Access

* + 1. A configurable trend package shall be provided to fulfill the following real time and historical trending requirements:
       1. Accumulation of process variables to provide historical trending
       2. Capability to store information for the number of variables specified in Attachment 1, each with 1 second resolution
       3. Data, which is unavailable, shall be marked and distinguished based on status (i.e. good data quality, suspect data quality, and data not available).
    2. All user workplaces shall be capable of displaying real time and historical trends. It shall be possible to call up real time trend displays for any process point.
    3. Each trend display shall consist of the plotted trend graph and a table presenting trend parameters. For each point, the table shall list the tag name, descriptor, engineering units, and minimum and maximum scale values.
    4. Interpolation method used to connect consecutive trend data points shall be configurable (i.e. straight line, step, etc.).
    5. It shall be possible to trend at least six points simultaneously on one trend display with adjustable time period and scale. Each shall be represented by a different color.
    6. Both ad-hoc and pre-configured trend displays shall be available from any workstation. User login shall determine which pre-defined trend displays are available to a user.
    7. A user shall be able to trend all points in the system from any workstation with immediate access to the most recent values for selected trend points. The user shall be able view both on-line and archive data on a single trend display.
    8. Information Services shall support desktop applications. Desktop applications are those that execute on a non-CPAS workstation computer. Typically, these are computers that are based in the office area and are subject to the Buyer’s standards for Operating Systems, Service Packs, Web navigational tools and other standard desktop applications.
    9. Desktop applications shall provide a secure view of the information and include the following features:
       1. Process mimics
       2. Trend Viewers
       3. ODBC and OLE/DB interfaces
       4. Tools to provide easy access to information, specifically alarm and event and production data.
       5. Easy spreadsheets access to information for example plug-ins
       6. Web capable components to allow integration into other applications
       7. Viewing reports
       8. Simple data browsing tools

## Calculation Services

* + 1. The information service shall include a standard calculation package. The calculation package provides a common way to create reusable solutions. The calculation package shall hide all of the issues required to access data and allow the developer to concentrate on the specifics of the calculation. Data shall be available when the calculation executes. Calculations must have the ability to execute on cycle or event. The Calculation programming language shall be based on Microsoft COM technologies to provide the greatest flexibility to integrate 3rd party libraries. It shall be possible to move calculations from system to system as reusable software.
    2. It shall be possible to create signals that are not connected to a data source. The calculation service shall drive these signals and produce alarms and/or events. These soft points are stored in the same manner as a true process alarm/event.

# VIDEO INTEGRATION REQUIREMENTS

## A fully integrated CPAS video environment shall be provided.

* + 1. The video system shall support both newly installed IP camera hardware as well as integrating existing IP and CCTV hardware currently installed within the facility. A listing of the current hardware is provided in Attachment 1.
    2. The display of video to an operator shall be part of the normal operator workplace environment and shall not require separate video monitors unless specified in the detailed design.
    3. Where camera technology supports operational controls (pan, zoom, etc.), the integrated video system shall be capable of controlling those functions.
    4. It shall be possible to have video appear to the operator by the following means:
       1. Pop-up window accessed from an object context menu,
       2. This includes access from an alarm entry on an alarm list.
       3. Embedded into an operator graphic,
       4. As part of a tab of an object faceplate.
    5. The integrated video system should use a separate ethernet network from the control network or, where VLANs are used with high throughput fiber infrastructure, separate subnet addressing from the control network to avoid overloading the control network with video content.

# SYSTEM REQUIREMENTS

## Applicable Documents, Codes, and Standards

* + 1. All system equipment covered by this specification shall be designed, manufactured, assembled, and tested in accordance with applicable codes and standards.
    2. The Supplier shall be certified under the International Standards Organization (ISO 9001) quality guidelines. All system equipment shall comply with the Directives and Standards required for CE Marking and shall be CE Marked.

## Environmental Conditions

* + 1. Control and data acquisition equipment shall be housed in enclosures and be able to withstand the following conditions:
       1. Temperature: +5 to +55 oC
       2. Relative Humidity: 5 to 95% non-condensing
    2. Control room equipment shall be designed to the following conditions:
       1. Temperature: +5 to +60 oC
       2. Relative Humidity: 40 to 80%

## Enclosures and Power Systems

* + 1. Enclosures
       1. The general purpose enclosure shall be flexible in design to accommodate standard DIN-mounting rails according to EN50022 NS 35/7.5. The enclosures shall be able to accommodate either top or bottom cable entry and front access for installation and maintenance of power systems and mounting assemblies.
       2. If required, the Supplier shall provide enclosures designed to NEMA 4 / IP56 standards. The enclosures shall use gaskets to provide protection against dust and moisture (i.e. rain and hose directed water).
    2. Power Systems
       1. CPAS power supplies shall provide redundant 24 VDC power to the process controllers and I/O modules. The power system shall be designed with options to operate on 115 to 230 VAC, 50 / 60 Hz (nominal) and 240 VDC (nominal).
       2. Power shall be supplied in such a manner that a failure of one power supply shall not cause loss of operation of any module. Failed power supplies shall be able to be removed without removing power from the system or affecting control. The status of the power supplies shall be indicated by local LEDs.
       3. No user action shall be required for restart of the process controllers following a power failure. Recovery of process control units after power failure shall be automatic with control loops and sequence control placed in specific modes of operation.
       4. Each enclosure shall include a solid copper ground bus bar solidly connected to enclosure structure. To eliminate potential for ground loops, power conditioning and isolation shall be performed at each module.
    3. Spare Parts
       1. The Supplier will provide an itemized list of recommended spare parts for two (2) years of operation.
    4. Documentation
       1. Drawings submitted for approval shall be of sufficient scope and detail to permit comment and input by the Owner. The documentation shall indicate the arrangement of wiring, accessibility for maintenance work, capacity for future connections, and general appearance, as required by the specifications.
       2. Quantity, size, type, and delivery schedule of drawings shall conform to the requirements of the specification. The final documentation will reflect the “as Shipped” status of the system.
       3. The Supplier shall furnish the following engineering documents for record purposes:
          1. Equipment outline drawing, dimension drawing, service description, mounting details, weight, heat load, and power requirements
          2. Enclosure arrangement drawings
          3. Power distribution drawings
          4. Hardware product specifications
          5. Databases
          6. Equipment lists
          7. Program listings
          8. CAD drawings
          9. Cable list
          10. Log and graphic display format
          11. Test plans
          12. Site preparation and installation manuals
          13. Shipping preparation procedures
       4. (use if supplying the field instrumentation) The information contained in data sheets shall include:
          1. All primary elements and transducer design data, including manufacturer and model number, owner’s tag number, material of construction, range of input and output signals, power supply, accuracy and repeatability, sensitivity, and type of enclosure.
          2. Transmitter design data, including manufacturer and model number, owner’s tag number, range, accuracy of transmitted signal, type of actuation (bourdon, manometer, bellows, etc.), actuator material, type of compensation (if any), and pressure rating.
          3. Control drive data, including manufacturer and model number, torque produced, range and type of operating signal, direction and angle of rotation, type of enclosure, shaft material (mounting and overall dimensions including drive level and connecting linkage), and tag number.
          4. Additional information may be furnished, provided that the information is conveniently arranged, assembled in a package, and complete, particularly with regard to calibration details.

## Software License and Support

* + 1. This section describes the contract’s Terms and Conditions as it relates to the purchase and service of the CPAS software through the support period.
    2. The Supplier shall provide the Buyer and Owner with a list summarizing all system delivered hardware, documentation, and software revisions. Before and up to the shipment date, it shall be possible for the Buyer or Owner to obtain the latest available system revisions at no cost.
    3. The Supplier shall provide a one year software support agreement as part of the project. This support agreement shall automatically renew each year unless terminated by the Buyer or Supplier. The agreement shall include the following:
       1. Access to Supplier’s on-line knowledge base and phone-in support center.
       2. Support for the version of software initially provided by the Supplier, including:
          1. Normal updates and correction of mission-critical defects
          2. Any updates to Supplier embedded third-party software required as part of the system
          3. Verification and disposition of Microsoft OS related security updates
    4. During the support agreement period, the Buyer shall have the option to upgrade to a new release of Supplier’s software. Per the support agreement, the new software license shall be supplied at no charge. However, the Buyer will pay for Supplier's representative field service fees (at agreed rate) to install and verify field installation and upgrade.
    5. The Supplier’s support agreement shall provide the Buyer the option to stay on a given software version for five years with support (as defined above). The Supplier must commit to the following Life-Cycle format if the Buyer wishes to stay on a given release and not upgrade:
       1. Initial release supported at standard rate for 18 months minimum.
       2. Up to 4 additional years support at higher rates.

## Computer Operating Systems

* + 1. The operating systems for computers used within the CPAS as either servers or workstations shall be the latest software available in the Microsoft suite of products. Either Windows Server 2008 or Windows 7 shall be used as appropriate to allow for the easiest selection of current computer hardware.

## Virtual Machine Installation Environment

* + 1. The system owner desires to use virtual machine environments instead of physical PC hardware for each individual server and workstation to reduce system physical footprint, reduce power and air conditioning loadings, centralize software management, and reduce overall system administration lifecycle costs.
    2. The CPAS shall allow system installation using virtual machines for all system servers using VMware® vSphere products so that system owner may take advantage of lifecycle software management tools such as vSphere vMotion for live migration of virtual machines.
       1. The use of the virtual machine environment shall be a standard feature of the CPAS and shall have full supporting documentation for installation and use of the virtual environment
    3. The CPAS shall allow client workstations to be created using the virtual machine environment based on VMware® vSphere products so that the system owner may take advantage of lifecycle management tools such as vSphere vMotion for live migration of virtual machines.
       1. The use of a virtual machine environment for clients must be a standard feature of the CPAS and shall have full supporting documentation for installation and use of the virtual environment for clients.
       2. The CPAS virtual client environment shall support both full clients (individual VMs installed running the client application) and remote clients (single VM installed as Terminal Server supporting multiple clients).
       3. The virtual client environment shall support user interface hardware of either standard PCs running Remote Desktop Services (RDS) or embedded OS terminals running RDS
          1. User interface hardware for virtual machine clients shall support up to 4 monitors.

# MULTI-SYSTEM OVERSIGHT REQUIREMENTS

## Centralized control

* + 1. The system owner has identified a future need for a centralize control and operations area that will oversee two or more satellite process control areas, each with their own separate control system. The owner desires to have this central zone be able to access all critical control information from any of the satellite control systems.
    2. The integration of the central system to the satellite systems shall be done at the control system database level and not through client connectivity by using direct satellite system clients or remote desktop client connectivity between the satellite and the central systems.
    3. The centralized systems shall be able to control critical sections of the satellite processes.
       1. All critical process data including subsystems such as FOUNDATION Fieldbus and Electrical Systems, history, and critical asset data shall be visible to the central system.
       2. Transfer of control to and from the central system using the same Point-of-Control features identified in Section 6 above.
    4. The centralized system shall have the capability of performing the master control functions for a process plant it may be connected to.

# SYSTEM SERVICES

## General

* + 1. The Supplier shall include System Services in support of the delivery of a completely assembled and operational system. As a minimum, the following shall be provided:
       1. Project Management Services
       2. System Engineering Services
       3. Factory Acceptance Tests
       4. Field Services
       5. Training Services
    2. Quality testing and inspection of finished components, parts, and systems shall ensure that the highest level of manufacturing quality is achieved. The Supplier (and its sub-suppliers) shall be certified under the International Standards Organization (ISO9001) quality guidelines. In addition, as part of its proposal, the Supplier shall include its Quality Assurance Procedures for review.

## Project Management Services

* + 1. The Supplier’ proposal shall include the services of an experienced project manager (PM) to provide overall coordination during the course of the project. The project manager shall have overall responsibility for coordination of the work in the phases of the system design, hardware procurement, hardware assembly, and system test.
    2. The Supplier’s PM shall be responsible for the cost, schedule, and performance of the Supplier’s team including all sub-suppliers and subcontractors.
    3. The Supplier’s PM shall act as the liaison for all communications between the Supplier and Buyer. The PM shall provide the Buyer with project schedules and progress reports and shall assist the Buyer’s inspectors and engineers during the Factory Acceptance Tests.

## System Engineering Services

* + 1. The Supplier’s proposal shall include the services of a Lead System Engineer who shall be responsible for the technical coordination of the work in engineering, design, and testing phases.
    2. The Supplier shall have full responsibility for control, logic, monitoring and database design and configuration of the complete CPAS. It shall assume process control system design responsibility by applying their expertise to the development of a control system structure and implementation details to satisfy all functional and applicable code requirements compatible with the Owner’s operating requirements.
    3. In support of the Supplier’s engineering responsibilities, the Owner shall supply, as a minimum, the following:
       1. Piping and Instrument Flow Diagrams – mechanical process flow diagrams depicting process equipment, interconnecting pipe work or ducting and in-line or process connected instrumentation
       2. Field instrumentation database including tag names, descriptions, ranges, engineering units, and set-points
       3. Control and/or Logic Diagrams – control or logic diagrams in SAMA, simplified flow diagrams, ISA like or Boolean format defining inputs to and outputs from the control or logic functions associated with a control loop or device.
       4. Graphic display sketches and standards – The Owner’s graphic display standard will be provided to the Supplier for reference. The Supplier shall be responsible for all screen configuration and implementation per the specification. For specific areas, the Owner may supply sketches of control screens, indicating standard symbols, colors, text styles, screen content, control methods, paging schemes, I/O tags, etc.

## Factory Acceptance Tests

* + 1. General
       1. All equipment supplied by the Supplier shall be subject to Factory Acceptance Tests (FATs) as described here. The Owner reserves the right to witness and approve all Factory Acceptance Tests prior to shipment.
       2. The FAT shall be performed in accordance with the Supplier’s approved standards, and, in addition, any tests specified in the Contract by the Owner. The FAT shall include hardware and software configuration testing to ensure that the equipment provided fulfills the requirement of the purchase agreement specifications.
       3. The system shall not be shipped to Site until completion of a successful FAT and all associated documentation is completed and approved by the Owner. Completion shall normally include correction of all deficiencies, with exceptions subject to the Owner’s approval.
       4. Due to the requirement for delivery of some system areas in advance of others, it may be necessary to conduct the FAT on an incremental basis.
       5. The Supplier shall provide a brief description of FATs proposed as part of its base bid price and shall state how many days are allocated for Owner witnessed tests. The Supplier shall also describe and provide technical details of how functional tests are to be accomplished.
       6. The Supplier shall make provision for Owner’s witnesses of the FATs at any given time and shall include office space (such as conference room) complete with tables/desks and telephones.
    2. Hardware
       1. The Supplier shall conduct a functional test on each node. This may be part of the normal test procedure but as a minimum should include checks that verify the following:
          1. All I/O points are functioning correctly, are addressable, and are confirmed to be correctly displayed on the Human System Interface
          2. Watchdog function (as specified) type tests
          3. Any other diagnostic checks of the CPU, power supplies, and memory as are deemed appropriate to supplement the above checks and ensure 100% functionality of the node prior to shipment
          4. Redundancy for all component functions (as specified) type tests
    3. System
       1. The system FAT shall consist of, but not limited to the following:
          1. Power-up and loss of power test
          2. Verification of processing unit loading, spare capacity, installed spares.
          3. Verification of completed programming, configuration, and documentation
          4. Verification of system operation without performance degradation when one of the data highways (redundant) is disconnected
          5. Verification of subsystems operation without performance degradation when both data highways (redundant) of other subsystems are disconnected at an isolation hub
          6. Verification of correct communication system response to a node which has become defective (cannot communicate) and subsequent repair
          7. Demonstration of correct functioning, by simulation, of sequential logic
          8. Demonstration of correct functioning, by simulation, of modulating controls
          9. Verification of system response times
          10. Demonstration of completed programming and configuration of human system interfaces, including but not limited to graphic displays, menu/paging/hierarchy system, alarm management, operator control functions, update times, etc.
          11. Point to point wiring check.
       2. All tests shall be demonstrated using the Owner’s system and witnessed by the Owner as an option.
       3. The Supplier shall perform FATs for various subsystems, the timing of which will depend on delivery requirements. Testing of the CPAS as an entire system may not be possible as an FAT, but shall be part of the CPAS equipment commissioning. The Supplier shall be responsible for the complete installation and integration of all subsystems and for delivering a complete fully operational system.

## Field Services

* + 1. The Supplier shall provide XX man days of field support for start-up and commissioning services. These services will be performed by a qualified field service engineer and shall include system installation guidance, calibration of all CPAS supplied instrumentation, power and grounding checks, loop checks, and initial loop tuning. A daily rate for additional services shall be supplied with the Supplier’s proposal.

## Training Services

* + 1. The Supplier’s bid shall include training for Buyer’s designated personnel, including engineers, operators, maintenance personnel, and system administrator. Training shall be provided at Supplier’s facility nearest to the job site.
    2. For each type of training, the Supplier shall specify the following:
       1. The course location
       2. Course duration
       3. Course outline
       4. Maximum number of participants for one course
       5. Course availability
       6. Course price
    3. Supplier shall provide optional price for on-site training of operator and maintenance personnel.

# Focus on Future Development

## General

* + 1. The Supplier needs to demonstrate a focus on evolving the product to remain current with new standards important to the owners industry. Examples of such standards include, but are not limited to, NEMUR 107 for alarm management, ISA106 for sequential control of continuous processes, WirelessHART and more. The supplier should provide evidence of their current development programs related to these standards and any other important standard that the supplier thinks may be important to the owner.

**ATTACHMENT 1**

Attachment 1 defines all project specific details, including:

System block diagram (topology, # workstations / location / primary function, # control units / location, etc.)

Process Critical Loops (i.e. those requiring SIL 2 functionality)

I/O (count, type, location, spare capacity, redundancy requirements)

Fieldbus I/O (count, type, location, spare capacity)

I/O special requirements (i.e. SIL ratings, IS requirements, redundancy, isolation, spare capacity, etc.)

Third party control system interfaces (protocol, point count, etc.)

Asset Management Project Requirements (assets to be monitored, spare capacity, devices requiring calibration)

Historian (# / type of points to be collected and stored, spare capacity)

Here are the specific spec paragraphs that reference Attachment 1:

* Architecture (System Topology) – 2.4.1  
  The system architecture is summarized in the attached CPAS System Overview Diagram in Attachment 1. *(must create a conceptual diagram to fit specific project requirements)*
* Architecture (Availability and Reliability) – 2.5.3  
  The following system areas shall be made redundant:
* Process critical I/O modules (as identified in Attachment 1)
* Process Controllers (Safety Critical Control Functions) – 3.3.1  
  On this project, several process applications are designated as Safety Critical (as specified in Attachment 1). For these applications, the host controller and the corresponding safety critical control algorithms shall satisfy the Safety Integrity requirements for level 2 (SIL2) according to IEC 61508 Edition 2 and IEC 61511. The host controller is designated as a Safety controller.
* I/O Modules (General) – 4.1.1  
  I/O shall be modular, with each module supporting a specific signal type with a set amount of I/O channels. It shall be possible to intermix I/O modules of different types together in I/O clusters. Project I/O type, quantity, and location is tabulated in Attachment 1.
* I/O Modules (General) – 4.1.4  
  I/O modules shall be “hot swappable,” allowing the I/O module to be removed and replaced under power without damage to themselves, disruption to other modules, or to the system itself. For critical I/O, as specified in Attachment 1, it shall be possible to repair a channel fault without affecting operation of the neighboring channels.
* I/O Modules (General) – 4.1.7  
  The Supplier shall have the option to provide I/O modules for mounting in Class 1, Division 2 and Class 1, Division 1 hazardous areas as well as Zone 1 and Zone 2 classified areas (for I/O specified in Attachment 1).
* I/O Modules (General) – 4.1.8  
  The Supplier shall provide I/O modules for mounting in Class 1, Division 2 and Class 1, Division 1 hazardous areas as well as Zone 1 and Zone 2 classified areas (for I/O specified in Attachment 1). If the Supplier's system does not include this capability, the Supplier shall provide clarification and describe the intrinsic safety equipment and necessary interfacing software or hardware required between this equipment and the balance of the CPAS.
* I/O Modules (General) – 4.1.9  
  For safety critical I/O (as specified in Attachment 1), the Supplier shall provide SIL 3 certified I/O modules per IEC 61508 Edition 2. It shall be possible to install these I/O modules in combination with other I/O module types and configured natively from the system’s engineering tool. If the Supplier’s system does not include this capability, the Supplier shall provide clarification and describe the SIL 3 certified I/O equipment and any necessary interfacing software or hardware required between this equipment and the balance of the CPAS.
* I/O Modules (Analog Inputs) – 4.2.1.7  
  For critical Analog Inputs as specified in Attachment 1, galvanic isolation of inputs is required (channel to channel and channel to ground). Isolation shall be 250 VDC continuous and able to withstand voltage surge of 1900 VDC for up to 1 minute.
* I/O Modules (Analog Outputs) – 4.2.4.7  
  For critical Analog Outputs as specified in Attachment 1, galvanic isolation of outputs shall be provided.
* I/O Modules (Digital Inputs) – 4.3.1.4  
  For critical Digital Inputs as specified in Attachment 1, isolation of inputs is required (channel to channel and channel to ground). Isolation shall be 250 VDC continuous and able to withstand voltage surge of 1900 VDC for up to 1 minute.
* Fieldbus (HART Modules) – 5.1.6  
  For critical HART signals (as specified in Attachment 1), the HART interface module shall be provided with redundant back-up of same type.
* Fieldbus (PROFIBUS Modules) – 5.3.8  
  For critical Profibus signals (as specified in Attachment 1), the Profibus DP master shall be provided with redundant back-up of same type. Additionally, Profibus DP physical media (cable) shall be redundant. It shall be possible to connect PROFIBUS PA Linking Devices and non-redundant PA devices to a redundant PROFIBUS DP segment.
* Fieldbus (ModbusTCP Modules) – 5.6.5

For critical ModbusTCP signals (as specified in Attachment 1), the Ethernet/IP master shall be provided with redundant back-up of same type

* Human System Interface (General) – 6.1.1  
  To reduce the quantity of system workstations and to provide flexibility during time of action, each system user interface shall be capable of performing process operations, engineering, and maintenance functions including batch management, asset management, historian, reporting, safety, and field device management. Access to various applications that are included shall be dependent on user login. The quantity and primary user function of each workstation shall be provided in accordance with Attachment 1.
* Asset Management (General) – 9.1.2  
  The owner’s objective with its real-time PAM system is to reduce total plant maintenance costs; therefore the PAM system shall not be limited to field device assets. The PAM software shall be capable of supporting the maintenance of all plant assets including field devices, CPAS equipment, major plant equipment and processes, and IT assets. Specific asset types and quantity are identified in Attachment 1.
* Asset Management (Asset Condition Monitoring) – 9.2.2  
  Condition Monitoring capabilities shall be flexible and vary in complexity from simply identifying status changes or deviation limit conditions in traditional field devices and leveraging advanced on-board diagnostics of intelligent field devices to identifying abnormal conditions using advanced process equipment condition monitoring techniques. The Supplier shall describe their field proven monitoring techniques for the assets listed in Attachment 1.
* Asset Management (Maintenance Management) – 9.4.1  
  In an effort to streamline the maintenance workflow, the CPAS shall make information within the Owner’s Computerized Maintenance Management System (CMMS) transparently accessible to users in the process control and maintenance system environments. The Owner currently has a Maximo® system installed (use SAP PM® when applicable). Details of the Owner’s maintenance system are described in Attachment 1.
* .
* Information Management (Process Data Collection and Storage) – 10.2.2.1  
  The system shall be capable of collecting continuous history for the quantities of tags as specified in Attachment 1.
* Information Management (Data Access) – 10.4.1  
  A configurable trend package shall be provided to fulfill the following real time and historical trending requirements:

1. Capability to store information for the number of variables specified in Attachment 1, each with 1 second resolution

* Video Integration Requirements – 11.1.1

The video system shall support both newly installed IP camera hardware as well as integrating existing IP and CCTV hardware currently installed within the facility. A listing of the current hardware is provided in Attachment 1.

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| Revision History | | | |
| Date | Version Identification | Editor | Description |
| 2006-03-14 | 3BUS094313 | Mark Bitto | Original document release |
| 2009-12-09 | 3BUS094313 A en | David Huffman | Updates for System 800xA SV5.0 SP2 |
| 2011-04-04 | 3BUS094313 B en | Lisa Molitoris | Updates for System 800xA SV5.1/0 release |
| 2013-08-28 | 3BUS094313 C en | David Huffman | Updates for System 800xA SV5.1 FP4 |
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