BMS SYSTEM AND COMPONENTS TECHNICAL SPECIFICATIONS

1	16MAY2022	ISSUE FOR CONSTRUCTION AS PER NOTES	MAV	MAF	RSP
0	20AGO2021	ISSUE FOR CONTRUCTION	AAS	MAF	RSP
E	26JUL2021	90% DD ISSUE	AAS	MAF	RSP
D	24MAR2021	60% DD ISSUE	AAS	MAF	RSP
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B	28AUG2020	90% BD ISSUE	MAV	MAF	MSS
A	09JUL2020	50% BD ISSUE	MAV	MAF	MSS
REV	DATE	DESCRIPTION	EXEC	CHECK	APPROV.

INDEX

1. REVISION HISTORY

Rev.	Reason for change
A	50% BD ISSUE
B	90% BD ISSUE
C	FINAL BD ISSUE
D	• Included DOC NUMBER and rename CLIENT NUMBER (Former PRD-AIC-TS-014). • General review in index numbering because of the new table 1 (revision history) • New numbers of drawings and documents in items 6.1. and 6.2 • Inclusion of the Building 7F and W.W.T in item 3 (Scope) • Inclusion of the Building 7F and W.W.T in the table, item 7.1. • Updated item 8.4.5 • Updated item 8.4.6 • Updated item 8.4.7 • Updated item 8.4.8 • Updated item 8.4.9 • Updated item 8.4.13 • Updated item 8.4.14
E	• Document update to 90% phase • Attendance to comments if transmitter number 178 • Updated item 3 • Updated item 7.2.1 • Updated item 4 • Updated item 8.8.1 • Updated item 8.9
0	• Document update to 100% phase (ISSUE FOR CONSTRUCTION) • Attendance to comments if transmitter number 178.1 • Updated in all items • Updated in index and itemization of the all document

1	• Updated item 3.2, 3.3 • Moved item 3.5 • Updated item 6 • Updated item 7.2, 7.3 • Deleted item 8 – Quality Systems • Renumbered items from item 8. • Remake item 8 • Standardized sub-item letter • Added items 9.16, 9.17 and 9.18

2. PROJECT DESCRIPTION

2.1 Takeda has re-negotiated a licensing and tech transfer agreement (LTTA) with the Brazilian state- owned company Hemobrás (HB) to transfer the technology of Takeda's recombinant FVIII (rFVIII) product ADVATE from Takeda to Hemobrás. Hemobrás is planning to construct a vertically integrated facility for manufacturing of rFVIII at the Hemobrás owned site at Goiana, Pernambuco (PE), Brazil (Project Buriti).

2.2 The scope of Project Buriti is to design, build and qualify a new vertically integrated FVIII Manufacturing facility, and includes implementation of all needed support buildings and Systems on an existing brownfield site. It is expected that the new facility is completely self-contained and the existing Goiana site provides only basic utility supply (city water, gas, power) and logistics (access road, site security).

3. SCOPE

3.1 This Specification establishes minimum technical requirements that the Contractor/Vendor shall meet to procure, select, sizing, supply, install, configure, test (FAT and SAT), start up and guarantee the performance of Building Management System (BMS) and Components to be installed on the facilities of buildings B07A- Drug Product, B07B-Drug Substance, B07C-Boilers, B07F Generators and Wastewater Treatment (W.W.T).

3.2 The requirements listed do not release to the vendors/contractors of their responsibilities in design, reliability and safe operation of the systems supplied. Also, part of this scope is the integration of subsystems integrated to the BMS system (HVAC, Access control, CCTV, Fire alarm system, Electrical system).

3.2.1 HVAC – Monitoring and Control
3.2.2 Electrical system – Monitoring and Control
3.2.3 Access Control system - Monitoring
3.2.4 CCTV system - Monitoring
3.2.5 Fire Alarm system - Monitoring
3.2.6 Access Control system - Monitoring

3.3 A system compatible with the existing system on site, is required to use System Platform da AVEVA.

3.3.1 Deviations from this specification are not acceptable, unless writing approval by Takeda/Hemobrás, the contractor is responsible for engineering designs, material acquisition, manufacturing, inspection, verification, testing, certification, and delivery of all equipment listed in this specification. The integrations are described in their respective documents.

3.4 The intended scope of this document is to clearly and accurately define what the system should do. It should stop describing the required functions, and should not extend to attempts to provide design solutions. The document aims to provide a criterion for designing and implementing the necessary system functions.

4. ACRONYMS

For purposes of this document shows the following definitions and acronyms:

Word	Definitions
Hazardous Atmosphere	Mixture of air, gas, or vapor toxic or flammable that may cause harm or risk to health and the environment inherent in the process.
Bus	Physical environment where the data is from a source to a destination.
Must	Specification requirement means the obligation to comply with this requirement.
Takeda/Hemobrás	The owner and end user of the BMS & Process Control system.
Network	Set of computers, terminals, peripherals, control equipment, etc., through a physical or wireless.
ASCII	ANSI X3.4, Information Systems - Coded Character Sets - 7-Bit American National Standard Code for Information Interchange (7-Bit ASCII).
BACnet	ASHRAE 135, BACnet/Ethernet, Data Communication Protocol for Building Automation and Control Networks.
Distributed Control	System whereby control processing is decentralized and independent of central computer. Control system is built up as standalone controllers. Single controller failure shall not impact more than one system.
Ethernet	ISO/IEC 8802-3. The most common high performance peer-to-peer LAN protocol
Integration	Ability of control system components from different manufacturers to connect and provide coordinated control via real-time data exchange through common communications data exchange protocol. • Integration shall extend to operator's workstation software, which shall support user interaction with control system components • Methods of integration include industry standard protocols, such as: BACnet/Ethernet, LonMark/LonTalk, and OLE for Process Control OPC), or integrator interfaces between manufacturer's systems
Interoperability	Ability of equipment to communicate mutually
Master-Slave/Token-Passing (MS/TP)	One of the data link layers created specifically for use with BACnet/Ethernet messages
Network	• System of distributed control units that are linked together on communication highway. • Allows sharing of point information between control units. • Provides central monitoring and control of entire system from any distributed control unit location. • Primary networks provide peer-to-peer communications. • Secondary networks provide either peer-to-peer, master-slave, or supervised token-passing communications

Peripheral	Input/output equipment used to communicate with computer and make copies of system outputs. Peripherals include USB, printer, External Drive, and SSD drive.
PID (Proportional, Integral, and Derivative) Control Loop	Mathematical calculation used to evaluate control input and determine control output value required to maintain input value at set point. Shall have operator adjustable maximum rate of change, P and D gains, and loop response time delay. Loop shall be self-integrating, so no integral constant is required and not be subject to integral windup.
Transmission Control Protocol (TCP)	Connection-oriented protocol used to convey multiple related messages (e.g., file transfers, Web pages, etc.).

BIOS	Basic Input Output System.
BMS	Building Management System.
CPU	Central Processor Unit
IBM	International Business Machines, Inc.
DCS	Distributed Control System
EMI	Electromagnetic Interference
FAT	Factory Acceptance Test
FTA	Field Termination Assembly
HMI	Human Machine Interface
I / O	Input / Outputs
IP	Internet protocol
ISO	International Organization for Standardization
LAN	Local Area Network
LCD	Liquid Crystal Display
mA	Milliampere
Mbps	Megabit per Second
ms	Millisecond
MDC	Machine Data Collection
PC	Personal Computer
PCS	Process Control System
PID	Process Instrumentation Diagram
PLC	Programmable Logic Controller
PMS	Process Management Systems
RAM	Random Access Memory
RFI	Radio Frequency Interference
RH	Relative Humidity
ROM	Read Only Memory
SAT	Site Acceptance Test
SI	System International
SPC	Statistical Process Control
SQC	Statistical Quality Control
TCP/IP	Transmission Control Protocol/Internet Protocol
TUV	Technisher Überwashungs Verein
UPS	Uninterrupted Power Supply
UTP	Unshielded Twisted Pair
VAC	Volts Alternate Current
VDC	Volts Direct Current

OSI	Open System Interconnectivity
WDA	Weighing Dispensing Systems
SIL	Safety Integrity Level
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning

5. CODES, MANUALS AND STANDARDS

The Vendor shall consider the most recent issue of the applicable Codes and Standards issued by the associations and approval bodies listed in this Specification as part of the technical requirements for the equipment items to be supplied.

Codes and Standards to be observed include but are not limited to those listed below:

Electrical Instruments in hazardous atmospheres	ISA RP12.1
Hardware Testing of Digital Process Computers	ISA RP55.1
Compatibility of Analogue Signals for Electronic and Industrial Process Instruments.	ISA S50.1
Federal “Occupational Safety and Health Standard	OSHA
Functional Safety Instrumented Systems for the process industry sector	IEC 61511
National Fire Protection Association - National Electrical Code	NFPA 70-87
Guide to Fire Hazard Properties of Flammable Liquids, Gases and Volatile Solids	NFPA 325
Standard for Purged and Pressurized Enclosures for Electrical Equipment	NFPA 496
Electromagnetic Compatibility (EMC) Part 4.3: Testing and Measurement Techniques - radiated radio frequency electromagnetic field immunity test	IEC 61000.4.3
Ethernet - carrier sense multiple access with collision detection (CSMA/CD) access methods and physical layer specifications	IEEE 802.3
Electronic Industry Association interface	EIA-232/422/485
Limits of Electromagnetic Interference for Electrical Appliances and Equipment.	IEC/CISPR11
Electrical Apparatus for Potentially Explosive Atmospheres – General Requirements.	IEC 50014
Electrical Apparatus for Potentially Explosive Atmospheres – Increased	IEC 50019
Electrical Apparatus for Potentially Explosive Atmospheres – Intrinsic Safety	IEC 50020
Electrical Apparatus for Explosive Gas Atmospheres	IEC 60079

Electrical Installations	IEC 60364
Classification of Degrees of Protection Provided by Enclosures (IP Code)	IEC 60529
Electrical Installation Guide	IEC 61000
Programmable Controllers – Programming Languages	IEC 61131-3
EMC Generic Immunity Standard	EN 50 082-2
Verification Test for Electrical Noise	IEC 801-4,5
Surge Withstand	ANSI C37.90A
Level 3 Electrostatic Discharge (8KV)	IEC 801-2
EMC Generic Emission Standard	EN 50 081-1
Conducted and Radiated Emissions	EN 55 011
Electronic Records; Electronic Signature	21 CFR PART 11
A Risk-Based Approach to Compliant GxP Computerized System	GAMP5
Instalações Elétricas em Baixa Tensão	NBR 5410
Cabeamento estruturado para edifícios comerciais e Data Centers	NBR 14565
VSC Guide April 14, 2020	ANVISA
RDC 301/2019 and its associated normative instructions	ANVISA

6. PROJECT DELIVERABLES

Drawings and documents for conceptual design, that follow Hemobrás' requirements and standards.

Drawings will be issued in AutoCAD our Revit and Documents will be issued in Microsoft Office.

6.1 Drawings:

7A-I-0-7-04	BMS Network Architecture	Drug Product
7A-I-0-3-08	BMS Cabinet Arrangement	Drug Product
7A-I-0-3-12	BMS Wiring Diagram	Drug Product
7A-I-1-3-11	Ground floor- Autom. BMS	Drug Product
7A-I-2-3-21	First floor- Autom. BMS	Drug Product
7A-I-0-3-01	Walkable ceiling-Autom. BMS	Drug Product
7A-I-3-3-31	Second floor- Autom. BMS	Drug Product
7B-I-0-7-04	BMS Network Architecture	Drug Substance
7B-I-0-3-08	BMS Cabinet Arrangement	Drug Substance
7B-I-0-3-12	BMS Wiring Diagram	Drug Substance
7B-I-1-3-11	Ground floor- Autom. BMS	Drug Substance
7B-I-2-3-21	First floor- Autom. BMS	Drug Substance
7B-I-0-3-01	Walkable ceiling-Autom. BMS	Drug Substance
7B-I-3-3-31	Second floor- Autom. BMS	Drug Substance
7C-I-1-3-11	Ground floor- Autom. BMS	Boilers
7F-I-1-3-11	Ground floor- Autom. BMS	Generators
07-I-0-8-03	BMS Instrument Typic. Installation	General

6.2 Documents:

PRD-AIC-LIS-003 – BMS System – Drug Product – I/O List
PRD-AIC-LIS-006 – BMS System – Drug Substance – I/O List
PRD-AIC-LIS-008 – BMS System – Boilers – I/O List
PRD-AIC-LIS-014 – BMS System – BMS Instrument Index - Drug Product
PRD-AIC-LIS-015 – BMS System – BMS Instrument Index - Drug Substance
PRD-AIC-LIS-016 – BMS System – BMS Instrument Index - Boilers
PRD-AIC-LIS-017 – Automation Electrical Load List – Drug Product
PRD-AIC-LIS-018 – Automation Electrical Load List – Drug Substance
PRD-AIC-LIS-020 – BMS System – Equipment & Devices Schedule
PRD-AIC-LIS-035 – BMS Conduit and Cable Schedule – Drug Product
PRD-AIC-LIS-036 – BMS Conduit and Cable Schedule – Drug Substance
PRD-AIC-DSH-004 – BMS System – Drug Product – Instruments Data Sheet
PRD-AIC-LIS-043 - BMS System – Bill of materials

7. DOCUMENTATION

7.1 SYSTEM DOCUMENTATION

7.1.1 The system documentation package shall include functional and detailed design specification documentation, and drawings defining the functionality and/or operation of the system, general arrangement, and detailed design of the system and equipment, including mechanical, electrical, wiring, process flow, instrumentation, communication, and automation/controls.

7.1.2 The system documentation package shall include documentation (e.g., material certification data sheets and manuals) for all materials and devices.

7.1.3 The system documentation package shall include calibration certificates for all critical and/or calibrated instruments.

7.1.4 All final documentation shall reflect the final, delivered, as-built state of the system and equipment.

7.2 ACCEPTANCE TEST AND PROTOCOLS

7.2.1 The system documentation package shall include a Factory Acceptance Test (FAT) protocol, a Site Acceptance Test (SAT) protocol. Protocols shall be divided into installation requirements tests, and operational requirements tests. Successful execution of the protocols shall provide documented evidence that the equipment meets the requirements necessary.

7.2.2 All acceptance test protocol shall require pre-approval by Takeda / Baxalta prior to execution. Selection of Takeda / Baxalta approvers for each of the protocols shall be the sole discretion of Takeda / Baxalta.

7.2.3 The FAT shall be conducted at the Supplier's site with full participation by the Supplier throughout testing. One or more Takeda / Baxalta representatives shall be required to witness and participate in the FAT.

7.2.4 SAT shall be conducted at Takeda / Baxalta's site with full participation by the Supplier throughout testing. One or more Takeda / Baxalta representatives shall be required to witness and participate in the SAT.

7.3 INSTALLATION, OPERATION, AND MAINTENANCE

7.3.1 The system documentation package shall include Installation, Operation, and Maintenance Manuals and include one additional set in the Portuguese language.

7.3.2 Manuals shall include the following information at a minimum:

7.3.2.1 Installation Manual.

7.3.2.2 User Manual, operational and maintenance.

7.3.2.3 Alarm List

7.3.2.4 Spare Parts List

7.3.2.5 System Administrator Manual

7.4 DISASTER RECOVERY PLAN

7.4.1 The system documentation package shall include a Disaster Recovery (System Restoration) Plan. The plan shall detail a step-by-step plan for recovering individual components, subsystems, as well as the system from catastrophic failure. The plan and backup and restore procedure of the system shall indicate what, if any, backup files / equipment is required and / or available, and how they may be obtained from the system.

8. BUILDING MANAGEMENT SYSTEM (BMS)

8.1 Subject Areas Covered

The Building Management System (BMS) will be installed to allow the monitoring and control of HVAC system, Black Utilities systems (boilers, chillers, compressors, cooling towers, industrial water), Automation Subsystem (Fire Alarm System, Access Control, CCTV) and Electrical System that serve the buildings below:

BUILDING TAG	DESCRIPTION
B07A	DRUG PRODUCT (FDP)
B07B	SUBSTANCE PRODUCT (BDS)
B07C	BOILERS
B07F	GENERATORS
W.W.T	WASTEWATER TREATMENT

8.2 General specifications for BMS

8.2.1 Having a heating, ventilation, and air conditioning (HVAC), whose feature will be distributed in two controllers, which are interconnected through a control network and then concentrating the configuration and monitoring operations of a central computer system through ethernet industrial switches in the Automation room of building B07A and the Automation room of building B07B. Whenever possible third-party systems should have Ethernet TCP/IP interface for communication and compatible protocol with the AVEVA System Platform. With this new system is intended to ensure the required temperature conditions and air quality to provide adequate comfort for the staff working in the facility.

8.2.2 The BMS system is responsible for controlling the entire HVAC System, Black Utilities (Hot Water, Compressed Air, Cooling Water) and part of the Electrical System (cargo discharge system / main circuit break) and will consist of a DCS Controller, remote I/O distributed in the building B07A and other DCS Controller, remote I/O distributed in the building B07B and a supervision system with operating stations and local terminals devices. (see architecture BMS System).

8.2.3 The controller will communicate with the I/O Remotes via Ethernet TCP/IP network. The I/O Remotes must be allocated in panels that will be installed near the AHU machines, Air Handling Unit - (AHU), Chillers room and, Boilers room. The AHU I/O points should be connected via standard I/O and should allow control/operation of the HVAC system.

8.2.4 The BMS controllers shall communicate with the DCS Server through the Ethernet TCP/IP network. The physical means for BMS system communication between buildings B07A and, B07B shall be via fiber optics.

8.2.5 The BMS system of building B07 shall communicate with the existent BMS system of building B02 and B03 through the Ethernet TCP/IP network. The physical medium for BMS system communication between buildings shall be via fiber optics. Fiber optical cables and connections between buildings are in the scope.

8.2.6 The BMS system shall have a two Thin-Client operating station running the BMS Client application located in a utility supervision/maintenance room (A3002 and B1034 with two monitors full hd if the 24”) and allow control and operation of the BMS system. In room B3010 have a one Engineering Station for configuration of the BMS System. The others HMIs installed in the field must be full hd of the 24".

8.2.7 The BMS system shall have signal towers and sirens installed at strategic points in the production areas so that operators are immediately warned of the occurrence of critical alarms.

8.2.8 The BMS system communicate with the Black Utilities industrial generating systems and should control equipment such as chillers, cooling water towers, compressors and, boilers.

8.2.9 All skidded / packaged systems shall be supplied with a Siemens Programmable Logic Controller (PLC) and touch screen Operator Interface Panel (OIP) platform. Each Original Equipment Manufacturer (OEM) will deliver a standard approved Siemens Totally Integrated Automation (TIA) portal for integration to the BMS System.

8.2.10 The Black Utilities generation systems will be systems with embedded automation (PLC and HMI) supplied for Chillers, Compressors, Boilers and Potable Water packages. Whenever possible these systems should have Ethernet TCP/IP interface for communication and protocol OPC-UA with the DCS controller dedicated to the BMS system. If no network communication is possible, discrete signals will be used to exchange information between the DCS Controller and the Black Utilities Generation packages through Remote I/O.

8.2.11 The power monitoring system will be added to the BMS system to allow the visualization and storage of variables of the electrical system (current, voltage, active power, reactive power, power factor, winding temperature of transformers, thermal monitoring of MV panels, Main Switch Gears, etc.).

8.2.12 Physical redundant servers for B07 shall be provided by the BMS supplier to host all virtualized BMS infrastructure.

8.2.13 Virtualized Domain Control servers shall authenticate all BMS equipment / system users from existing Active Directory servers to be defined by Takeda / Baxalta in new Buildings 7A, 7B, 7C and 7F at the Goiana Site.

8.2.14 A virtualized Wonderware System Platform shall be implemented for the BMS Supervisory Control and Data Acquisition (SCADA) system to be compatible and integrated with the existing Wonderware system in Buildings 2 & 3 at the Goiana Site.

8.2.15 A virtualized Wonderware historian server will collect and store data from all packaged and non-packaged systems.

8.2.16 Quality Assurance requirements

8.2.16.1 Compatibility:

A. System shall have documented history of compatibility by design for minimum of 15 years.
B. Future compatibility shall be supported for no less than 10 years. Data Network System.

8.2.16.2 Compatibility shall be defined as:

A. Ability to upgrade existing microelectronic controllers to current level of technology and extend new microelectronic controllers on previously installed network.
B. Ability for any existing microelectronic controller microprocessor to be connected and directly communicate with new microelectronic controllers without bridges, routers, or protocol converters.

8.2.17 System Performance requirements

8.2.17.1 System shall conform to the following performance standards:

8.2.17.1.1 Graphic Display:

A. Minimum of 20 dynamic points.
B. Current data displayed within 20 seconds of request.

8.2.17.1.2 Graphic Refresh: System shall update dynamic points with current data within 30 seconds.

Object Command:

A. Maximum time between command of binary object by operator and reaction by device shall be 10 seconds.
B. Analog objects shall start to adjust within 10 seconds.

8.2.17.1.3 Object Scan: Changes of state and change of analog values shall be transmitted over high-speed network such that any data used or displayed at controller or workstation will be current, within prior 60 seconds.

8.2.17.1.4 Alarm Response Time: Maximum time from when object goes into alarm to when it is annunciated at workstation shall not exceed 20 seconds.

8.2.17.1.5 Program Execution Frequency: Custom and standard applications shall be capable of running as often as once every 5 seconds. Select execution times consistent with mechanical process under control.

8.2.17.1.6 Performance: Programmable Controllers shall be able to execute DDC PID control loops at selectable frequency from at least once every 5 seconds. Controller shall

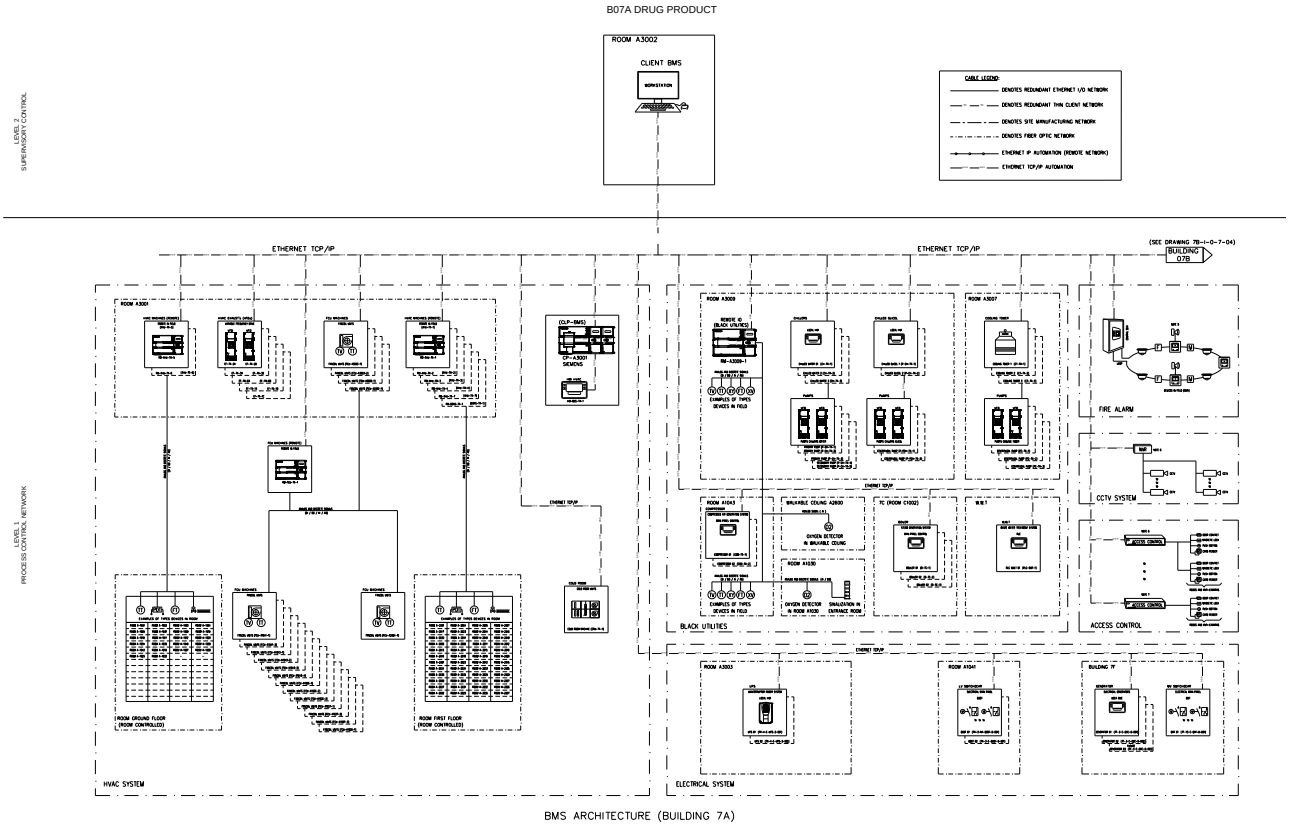
scan and update process value and output generated by this calculation at this same frequency.

8.2.17.1.7 Multiple Alarm Annunciations: Workstation on network shall receive alarms within 5 seconds of each other.

8.2.17.1.8 Reporting Accuracy: Table 1 lists minimum acceptable reporting accuracies for values reported by specified system.

Table I -- Reporting Accuracy	
Measured Variable	Reported Accuracy
Space temperature	±0.5°C
Ducted air	±1.0°C
Outside air	±1.0°C
Water temperature	±0.5°C
Delta-T	±0.15°C
Relative humidity	±5% RH
Water flow	±5% of full scale
Air flow (terminal)	±10% of reading *Note 1
Air flow (measuring stations)	±5% of reading
Air pressure (ducts)	±25 Pa
Air pressure (space)	±3 Pa
Water pressure	±2% of full scale *Note 2
Electrical Power	% of reading *Note 3
Carbon Monoxide (CO)	± 50 PPM
Carbon Dioxide (CO_2)	± 50 PPM
Note 1: (10%-100% of scale) (cannot read accurately below 10%)	
Note 2: for both absolute and differential pressure	
Note 3: not including utility company supplied meters	

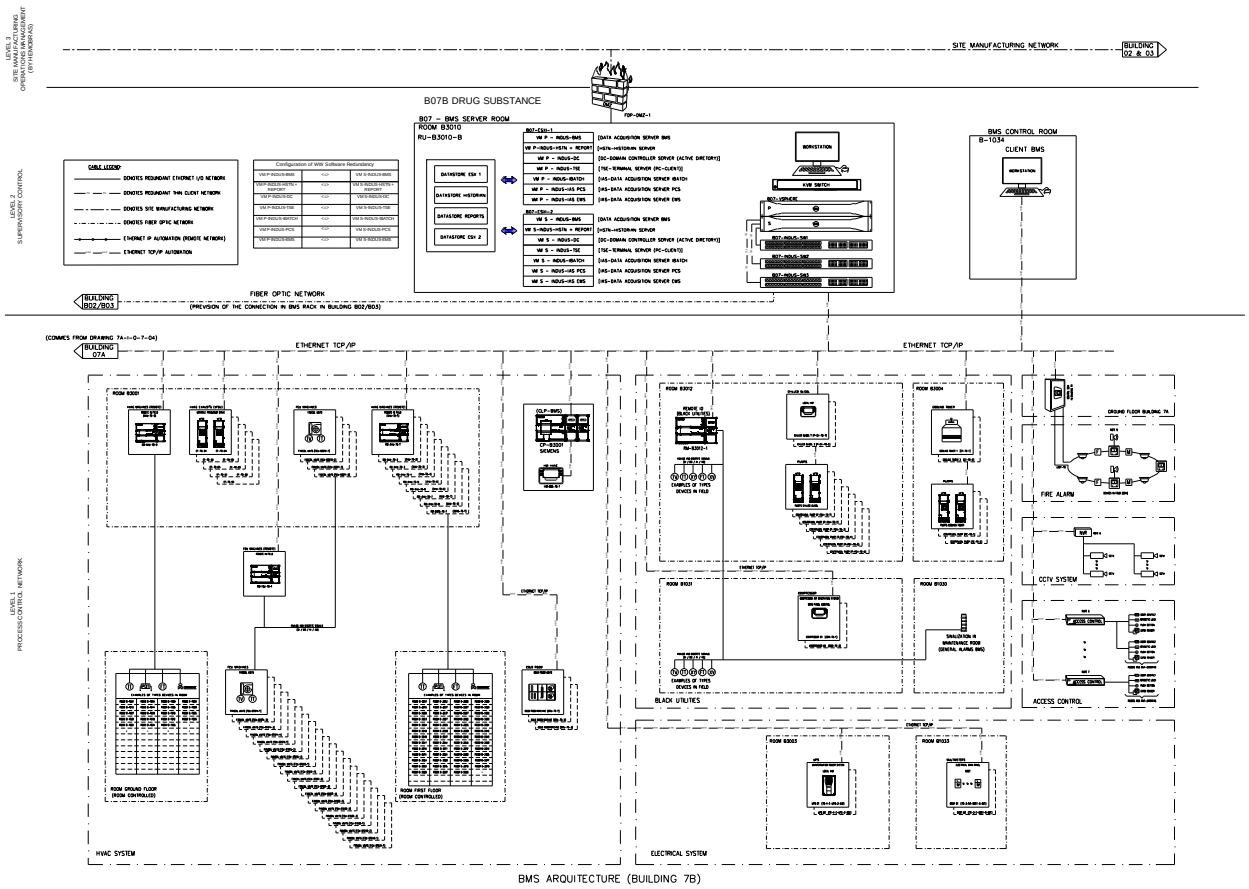
8.3 BULDING 7A (GENERAL ARQUITECTURE)



BMS ARCHITECTURE (BUILDING 7A)

Note: for general view of the BMS architecture see drawing 7A-I-0-7-04 sheet 1

8.4 BULDING 7B (GENERAL ARQUITECTURE)



BMS ARQUITECTURE (BUILDING 7B)

Note: for general view of the BMS architecture see drawing 7B-I-0-7-04 sheet 1

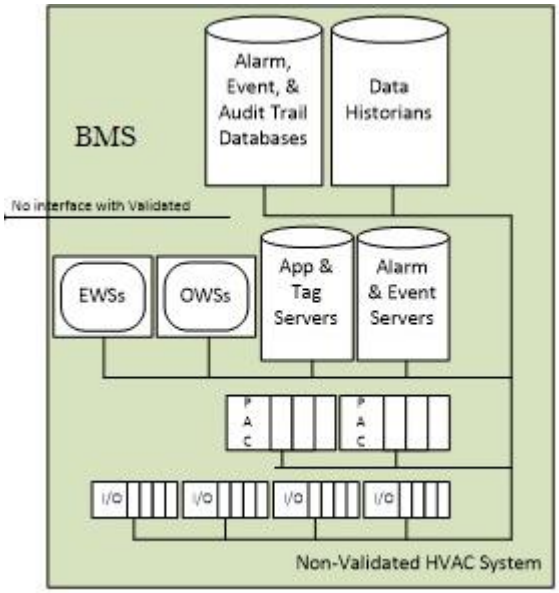
9. BMS - SUBSYSTEMS

9.1 The BMS HVAC system provides monitoring and control for HVAC systems throughout the facility in both GMP and non-GMP spaces. HVAC requirements include heating, cooling, ventilation, pressurization, air flow, temperature and humidity monitoring and control and filter status. The HVAC Control system shall monitor and control HVAC equipment and the rooms that the HVAC equipment services.

9.2 The specific design of each system varies based on the application. Systems may utilize a single primary unit while others may utilize a primary-secondary air handler unit configuration. The BMS will control and monitor the conditions in each zone being serviced. The monitoring requirements for a room will vary based on the current function of that space.

9.3 The project shall present no validated systems (BMS HVAC). The BMS HVAC shall be provided in all classified areas and in controlled non-classified (CNC) production uniform areas.

9.4 The figure below illustrates that the non-validated HVAC.



Non-validated HVAC
{quantities and all identities of equipment are not intended to be shown}

9.5 In general, the BMS system will consist of a redundant, remote I/O controller distributed in buildings (7A and 7B) and a supervision system with operating stations and operating terminals. The PLC must communicate with remote I/O for industrial Ethernet network. The Remote I/O must be in panels that will be installed near the HVAC machines (AHU), most of which are located on the technical floor and walkable ceiling between-lining of the buildings.

9.6 The I/O points must be connected to AHU machines via standard I/O and should allow control/operation of the HVAC system. The physical means for the communication of the BMS system between the building 7A and building 7B should be via optical fiber, and server the BMS system should be virtualized.

9.7 This section defines general system requirements for the BMS HVAC system.

Item:	Description:
9.7.1	The BMS HVAC system shall monitor and control the critical primary air handlers. These units supply 100% preconditioned outside air to secondary air handling units in Manufacturing Areas, Manufacturing Support Areas, Material Transport Areas and Quality Control Operations.
9.7.2	The BMS HVAC system shall monitor and control the non-critical primary air handlers. These units supply air to Administrative, non-Process Rooms.
9.7.3	The BMS HVAC system shall monitor and control secondary air handlers. These air handlers receive make-up air from the critical primary air handlers and mix it with return air from occupied areas of the building.
9.7.4	The BMS HVAC system shall monitor and control the critical and non-critical exhaust fans. Critical exhaust fans serve systems supplied by critical air handlers. Non-critical exhaust fans serve systems supplied by non-critical air handlers.
9.7.5	The BMS HVAC system shall monitor the dehumidifier air handlers serving conditioning spaces. Dehumidification control is governed by the vendor provided packaged control system supplied with the unit.
9.7.6	The BMS HVAC system shall monitor and control the fan coil units. These units will serve technical areas. Fan coil units for classified cold rooms shall be tied to refrigeration systems that will have packaged control systems.
9.7.7	The BMS graphical displays for the HVAC systems shall segregate validated and non-validated systems.
9.7.8	The BMS shall provide normal and setback operating modes.
	A. The PID controllers shall receive different setpoint values based on the selected mode.
	B. Setback mode shall be event and time-of-day driven.
9.7.9	Air handlers must support multiple temperature zones. Each zone shall have independent temperature control.
9.7.10	The BMS HVAC system shall be capable of controlling and monitoring humidity in duct.
9.7.11	Duct smoke detectors shall be hardwired into Fire Alarm System and BMS HVAC controller.

Item:	Description:
9.7.12	The BMS shall be capable of performing the following calculations:
	C. Outside air enthalpy
	D. Return air enthalpy
9.7.13	Non-validated HVAC systems shall be required for areas listed as classified or CNC production uniform. These areas include:
	E. Local Protection
	F. Grade C
	G. Grade D
	H. CNC Production Uniform our unclassified
9.7.14	The BMS shall monitor and control non-validated HVAC systems in CNC plant uniform and non-controlled areas of the following buildings:
	A. Building 7A: Drug Product
	B. Building 7B: Drug Substance
	C. Building 7C: Boiler
9.7.15	The BMS shall monitor and control critical primary air handlers serving Manufacturing Areas, Manufacturing Support Areas, Material Transport Areas and Quality Control Operations; Critical primary air handling units consist of: A. G4/F9 Filter B. Cooling Coil C. Supply Fan D. Valves E. Dampers F. Door contact G. VFD H. Sensors (temperature, pressure, humidity, flow, differential pressure) I. Door contact
9.7.16	HVAC system equipment shall be interlocked when dangerous events are detected.
	A. Fire Detection and Alarm System, field devices are formed by analog addressable sensors of smoke, temperature, according to the particularities of each environment,
	B. Fire doors and doors with access control will be released to free access and keep the doors open. The elevator will be disabled if smoke is detected in the elevator lobby, or equipment room. The exception is for hazardous gas exhaust systems for smoke control.

9.8 PRIMARY AIR HANDLING UNITS (AHU AND DOAS)

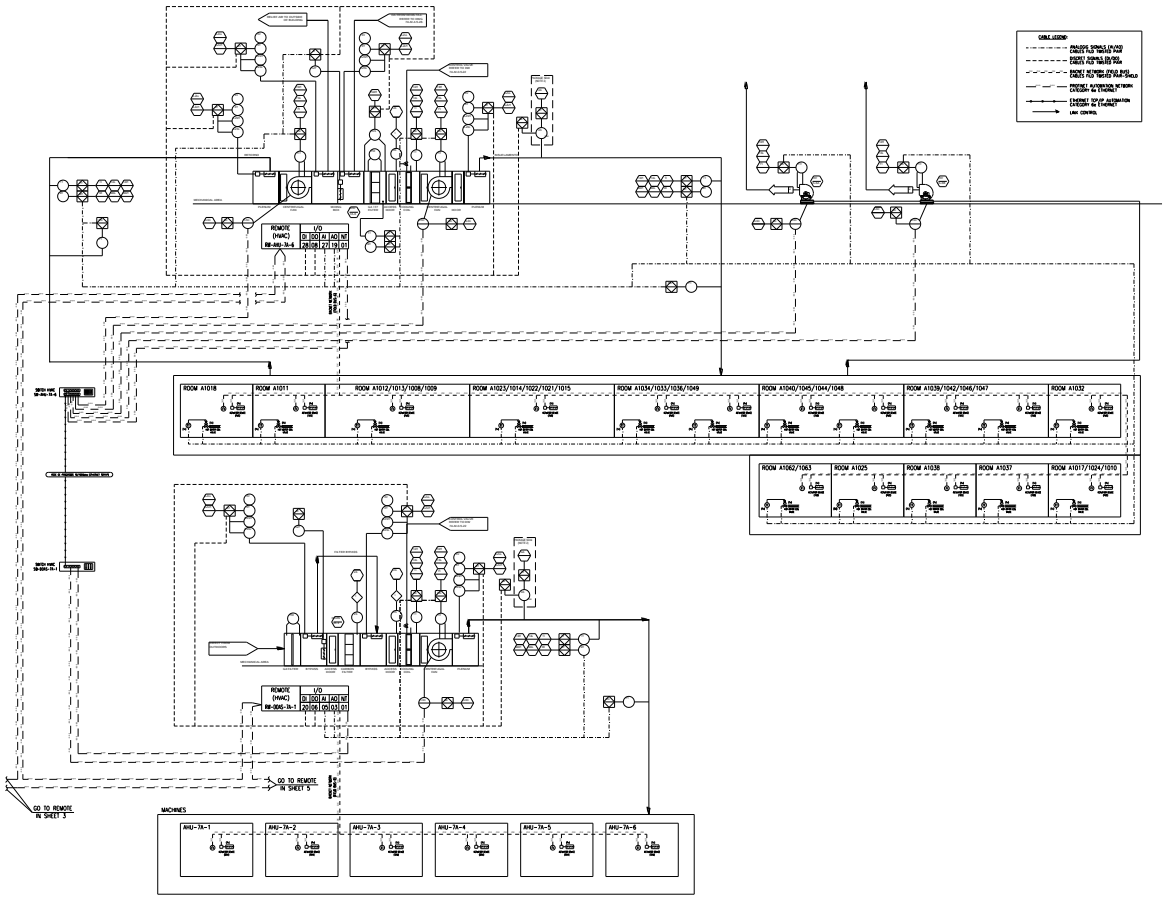
9.8.1 The BMS shall monitor and control primary air handlers serving Administrative, process Rooms and Technical Rooms.

9.8.1.1 Critical and Non-critical primary air handling units generally consist of:

A. Filter G4
B. Mixing Box
C. Door Contact
D. Cooling Coil
E. Supply Fan
F. Final Filter
G. Dampers actuator
H. Sensors (temperature, pressure, humidity, flow, differential pressure)
I. VFD

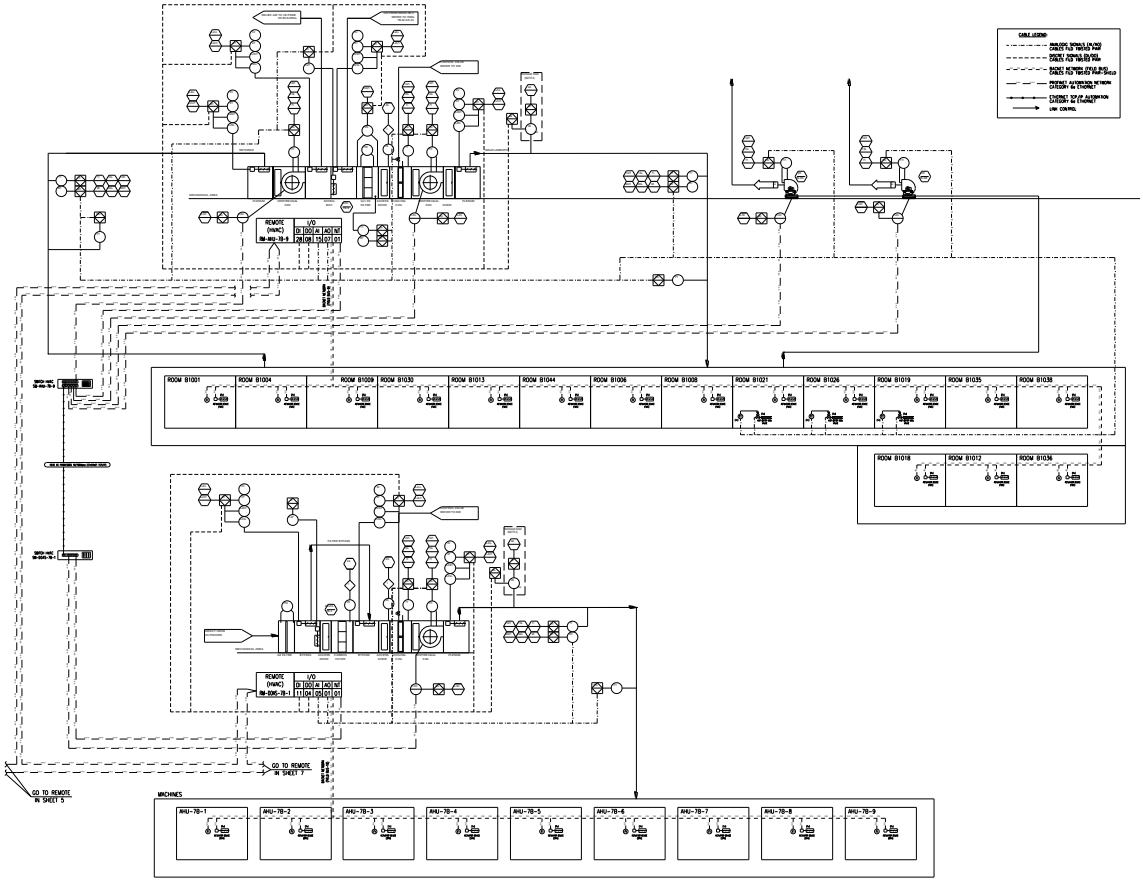
9.8.1.2 Refer to document 7A-M-4-5-28 and 7B-M-4-5-28 for a typical schematic drawing of this air handler.

9.8.2 Architecture subsystem (AHU and DOAS 7A).



Note: for general view of the sub-architecture see drawing 7A-I-0-7-04 sheet 2 at 5 for AHU and sheet 4 for DOAS

9.8.3 Architecture subsystem (AHU and DOAS 7B).



Note: for general view of the sub-architecture see drawing 7B-I-0-7-04 sheet 2 at 5 for AHU and sheet 6 for DOAS

9.9 SYSTEM START / STOP CONTROL – HVAC SUBSYSTEM

The BMS shall control the starting and stopping of each supply fan through VFD control if all safety interlocks are met. Safety interlocks will include but are not limited to, VFD fault or failure, supply duct over pressure, isolation damper closed status, smoke detection.
The BMS shall control the starting and stopping of primary air handling units as follows:

Item:	Description:
9.9.1	Supply fan shall be started/stopped by the BMS.
9.9.2	When the system is indexed to start and all safeties are within tolerance, valves shall be energized to open the supply and return air isolation dampers.

Item:	Description:
9.9.3	Once the supply and unit isolation dampers are proven open by the damper end switches, outside air intake damper shall open to their adjustable preset positions determined by the contractor and the fan shall start. These preset positions will be considered the default setpoints. These setpoints will be available within the BMS and can be accessed with the proper login.
9.9.4	When the supply fan is indexed to start, all interlocked fans shall start.

9.9.5 PID Control

The BMS shall perform the following PID control functions for critical and non-critical primary air handling units:

Item:	Description:
9.9.5.1	BMS shall modulate the cooling coil control valve to maintain the supply air temperature setpoint.
9.9.5.2	BMS shall modulate the Re-heat coil control valve to maintain the supply air temperature setpoint.
9.9.5.3	The outside air damper shall modulate open/close to maintain constant return air plenum pressure setpoint. The pressure sensor/transducer is located in the relief air part of the mixing box section. The BMS shall monitor and display this damper value.
9.9.5.4	Outside air flow shall be monitored through an airflow monitoring station via the BMS.
	A. If outside air flow is lower than minimum air flow, the relief air damper shall modulate open to maintain minimum flow set-point.
	B. A deviation from setpoint alarm shall be provided for the outside air flow.
	C. High and low alarms shall be provided for the outside air flow.
9.9.5.5	The BMS shall vary the supply and return fan speeds to maintain the duct static pressure set point in the supply and return ducts.
9.9.5.6	The BMS shall reset the supply static pressure setpoint by monitoring the most open flow control damper at the system terminal supply units. This applies to systems with EN and VAV boxes (for example).
	A. The BMS shall decrement the static pressure setpoint if the most open damper is less than a minimum position. The setpoint shall be decreased until the most closed damper approaches a set position.
	B. The BMS shall increment the static pressure setpoint if the most open control damper exceeds a maximum position. The setpoint shall be increased until the damper is less than a set position.
9.9.5.7	The BMS shall reset the return static pressure setpoint by monitoring the most open flow control damper at the system terminal return units.

Item:	Description:
	A. The BMS shall increment the static pressure setpoint if the most open damper is less than a minimum position. The setpoint shall be decreased until the most closed damper approaches a set position.
	B. The BMS shall decrement the static pressure setpoint if the most open control damper exceeds a maximum position, until the most open control damper is less than a set amount.

9.9.6 System Monitoring

The BMS shall monitor various points for non-critical primary air handling units. For example, VFD speed, filter pressure drop, unit pressure, damper position, temperature, etc.:

Item:	Description:
9.9.6.1	Differential Pressure transmitters across the pre-filters and across the final filters shall monitor the pressure drop at each filter section.
9.9.6.2	The BMS shall monitor the supply air: flow, temperature, humidity and pressure.
9.9.6.3	The BMS shall monitor the status and speed of each fan.
9.9.6.4	The BMS shall monitor the return air flow, temperature, humidity and pressure.
9.9.6.5	The BMS shall monitor status of the access door machine.

9.9.7 Alarming

The BMS HVAC shall alarm the following states and conditions for critical and non-critical primary air handling units:

Item:	Description:
9.9.7.1	Smoke Conditions
9.9.7.2	Supply Fan Failure (VFD)
9.9.7.3	Static Pressure – High-High, High, Low and Low-Low
9.9.7.4	Filter Pressure Differential – High (for each filter section)
9.9.7.5	Filter G4 Pressure Differential – High and Low
9.9.7.6	Position damper actuator – Fully Open and Fully Closed
9.9.7.7	Air Temperature Supply – High and Low
9.9.7.8	Relative Humidity Supply – High and Low
9.9.7.9	Mixing Box Pressure Differential – High

Item:	Description:
9.9.7.10	Make-Up Flow – High and Low
9.9.7.11	Access Door Machine – Open and Closed
9.9.7.12	Remote Shutdown

9.9.8 System Failures and Safety Shutdowns

The BMS shall implement the following system failure and safety shutdowns for critical and non-critical primary air handling units:

Item:	Description:
9.9.8.1	In the event of mechanical failure, as sensed by the duct static pressure sensors, fan status sensors or smoke detection, an alarm shall be indicated on the BMS. The supply fan, equipment shall be stopped. The unit outside air, isolation dampers, and any other associated dampers shall be closed.
9.9.8.2	Pressure indicating switches in the supply duct shall shutdown the supply fan respectively whenever high-limit or low-limit pressure setpoint is exceeded.
9.9.8.3	When smoke is detected in the supply duct, the fans shall be stopped and all dampers shall be closed.

9.10 SECONDARY AIR HANDLING UNITS

9.10.1 The BMS shall monitor and control secondary air handlers. These air handlers receive make-up air from primary air handlers and mix it with return air from occupied areas of the building.

9.10.2 Secondary AHUs consist of:

A. Return Fan
B. Mixing Box (consists of three dampers: relief damper, return damper and make-up air damper)
C. Filter G4, F9
D. Cooling Coil
E. Supply Fan
F. Door Contact

9.10.3 Refer to document 7A-M-4-5-21 to 7A-M-4-5-28 for Building 7A a typical schematic drawing of this air handler.

9.10.4 Refer to document 7B-M-4-5-21 to 7B-M-4-5-31 for Building 7B a typical schematic drawing of this air handler.

9.10.5 System Start / Stop Control

The BMS shall control the starting and stopping of each supply fan through VFD control if all safety interlocks are met. Safety interlocks will include but are not limited to, VFD fault or failure, supply duct over pressure, isolation damper closed status, smoke detection. The BMS shall control the starting and stopping of secondary air handling units as follows:

Item:	Description:
9.10.5.1	Supply fan and return fan shall be started/stopped by the BMS.
9.10.5.2	When the system is indexed to start and all safeties are within tolerance, valves shall be energized to open the supply and return air isolation dampers.
9.10.5.3	Once the supply and unit isolation dampers are proven open by the damper end switches, make-up air intake damper and return air damper shall open to their adjustable preset positions determined by the contractor and the fan shall start.
9.10.5.4	When the supply fan is indexed to start, all interlocked fans shall start.

9.10.6 PID Control

The BMS shall perform the following PID control functions for secondary air handling units:

Item:	Description:
9.10.6.1	BMS shall modulate the cooling coil control valve to maintain the supply air temperature setpoint.
9.10.6.2	BMS shall modulate the Re-heat coil control valve to maintain the supply air temperature setpoint.
9.10.6.3	The make-up air damper shall modulate open/close to maintain constant return air plenum pressure setpoint. The pressure sensor/transducer is located in the relief air part of the mixing box section. The BMS shall monitor and display this damper value.
9.10.6.4	Make-up air flow shall be monitored through an airflow monitoring station via the BMS.
	A. If make-up air flow is lower than minimum air flow, the relief air damper shall modulate open to maintain minimum flow set-point.
	B. A deviation from setpoint alarm shall be provided for the make-up air flow.
9.10.6.5	Return air damper shall modulate to maintain an UTA return air pressure setpoint. The pressure sensor/transducer is located in the intake part of the mixing box section. If one of the damper position switches is preventing the UTA from operating, an alarm shall be initiated at the BMS.
9.10.6.6	The BMS shall vary the supply and return fan speeds to maintain the duct static pressure set point in the supply and return ducts.
9.10.6.7	The BMS shall reset the supply static pressure setpoint by monitoring the most open flow control damper at the system terminal supply units.

Item:	Description:
	A. The BMS shall decrement the static pressure setpoint if the most open damper is less than a minimum position. The setpoint shall be decreased until the most closed damper approaches a set position.
	B. The BMS shall increment the static pressure setpoint if the most open control damper exceeds a maximum position. The setpoint shall be increased until the damper is less than a set position.
9.10.6.8	The BMS shall reset the return static pressure setpoint by monitoring the most open flow control damper at the system terminal return units.
	A. The BMS shall increment the static pressure setpoint if the most open damper is less than a minimum position. The setpoint shall be decreased until the most closed damper approaches a set position.
	B. The BMS shall decrement the static pressure setpoint if the most open control damper exceeds a maximum position, until the most open control damper is less than a set amount.

9.10.7 **System Monitoring**

The BMS shall monitor various points for secondary air handling units For example, VFD speed, filter pressure drop, unit pressure, damper position, temperature, etc.:

Item:	Description:
9.10.7.1	The BMS shall monitor the differential pressures across all AHU filters.
9.10.7.2	The BMS shall monitor the supply air: temperature, humidity and pressure.
9.10.7.3	The BMS shall monitor the return air: temperature, humidity and pressure.
9.10.7.4	The BMS shall monitor the status and speed of each fan.
9.10.7.5	The BMS shall monitor the status of the access door machine.

9.10.8 **Alarming**

The BMS HVAC shall alarm the following states and conditions for secondary air handling units:

Item:	Description:
9.10.8.1	Smoke Conditions
9.10.8.2	Supply Fan and Return Fan Failure
9.10.8.3	Static Pressure – High-High, High, Low and Low-Low
9.10.8.4	Filter Pressure Differential – High and Low (for each filter section)

Item:	Description:
9.10.8.5	Air Temperature – High and Low
9.10.8.6	Relative Humidity – High and Low
9.10.8.7	Mixing Box Pressure Differential – High
9.10.8.8	Make-Up Flow – High and Low
9.10.8.9	Status Access Door – Open and Closed
9.10.8.10	Remote Shutdown
9.10.8.11	Manual Shutdown

9.10.9 System Failures and Safety Shutdowns

The BMS shall implement the following system failure and safety shutdowns for secondary air handling units:

Item:	Description:
9.10.9.1	In the event of mechanical failure, as sensed by the duct static pressure sensors, fan status sensors or smoke detection, an alarm shall be indicated on the BMS. The supply fan, return fan equipment shall be stopped. The unit outside air, isolation dampers, and any other associated dampers shall be closed.
9.10.9.2	Pressure indicating switches in the supply duct shall shutdown the supply fans whenever high-limit pressure setpoint is exceeded.
9.10.9.3	When smoke is detected in the supply or return duct, the fans shall be stopped and supply and return dampers closed.
9.10.9.4	Additional safety interlocks and procedures shall be implemented as defined in the Safety Conditions, Interlock and Shutdown List(s) next point.

9.11 FAN COIL UNITS

9.11.1 The BMS shall monitor and control fan coil units that serve technical areas, utility equipment rooms and administrative areas. Note: Fan coil units for classified cold room areas are provided by packaged equipment control systems and not by the BMS.

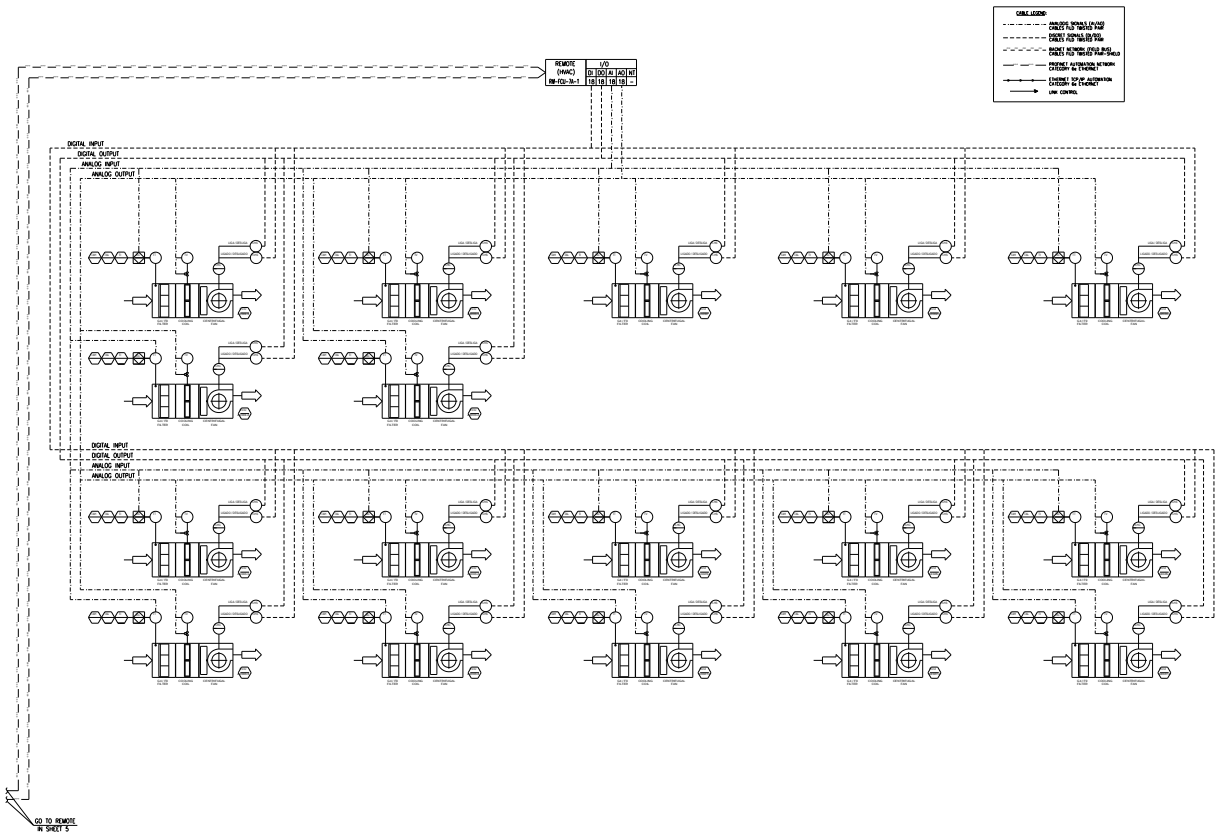
9.11.2 Fan coil units consist of:

A. Cooling Coil
B. Sensor temperature

9.11.3 Refer to document 7A-M-4-5-29 for Building 7A a typical schematic drawing of this fan coil units.

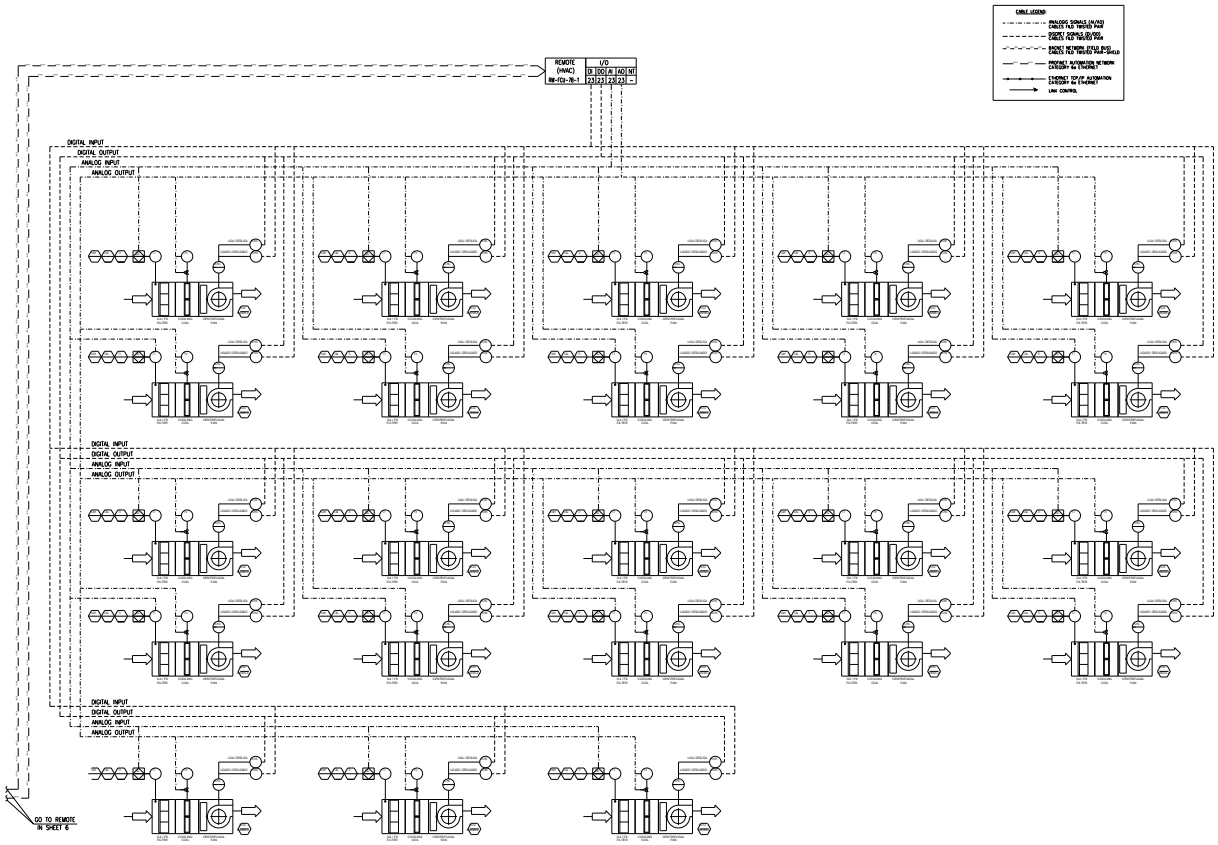
9.11.4 Refer to document 7B-M-4-5-31 for Building 7B a typical schematic drawing of this fan coil units.

9.11.5 Architecture subsystem (FAN COILS 7A).



Note: for general view of the sub-architecture see drawing 7A-I-0-7-04 sheet 6 for fan coils

9.11.6 Architecture subsystem (FAN COILS 7B).



Note: for general view of the sub-architecture see drawing 7B-I-0-7-04 sheet 7 for fancolis

9.11.7 System Start / Stop Control

The BMS not control the starting and stopping of each Fan Coil unit.

9.11.8 PID Control

The BMS shall perform the following PID control functions for fan coil units:

Item:	Description:
9.11.8.1	For systems with chilled water cooling coils, the BMS shall modulate the cooling coil control valve to maintain the space air temperature setpoint.

9.11.9 System Monitoring

The BMS shall monitor fan coil units:

Item:	Description:
9.11.9.1	The BMS shall monitor the status of the supply fan.
9.11.9.2	The BMS shall monitor temperature.

9.11.10 Alarming

The BMS HVAC shall alarm the following states and conditions for fan coil units:

Item:	Description:
9.11.10.1	Temperature High and low limits
9.11.10.2	Fan Failure

9.11.11 System Failures and Safety Shutdowns

The BMS not control failure in fan coil units:

9.12 EXHAUST FANS

The BMS shall monitor and control exhaust fans. References to equipment lists that contain exhaust fans can be found in next section.

9.12.1 System Start / Stop

The BMS shall control the starting and stopping of each Exhaust fan control if all safety interlocks are met. Safety interlocks will include but are not limited to, VFD fault or failure, Motor fault or failure, Room over pressure, smoke detection. The BMS shall control the starting and stopping of exhaust fans.

Item:	Description:
9.12.1.1	All exhaust fans shall operate 24 hours a day seven days a week.
9.12.1.2	When the associated air handling unit starts, the corresponding exhaust fans shall start. When the associated air handling unit stops, the corresponding exhaust fans shall stop.
9.12.1.3	The BMS shall start and stop the exhaust fan which shall also be capable of manual operation.
9.12.1.4	The BMS shall index the exhaust fan to the run position upon the opening of the isolation damper, as proven by the damper end switch.
9.12.1.5	Whenever an exhaust fan is indexed to stop or be de-energized, the BMS shall de-energize the exhaust fan and close its isolation damper.

9.12.2 PID Control

The BMS shall perform the following PID control functions for exhaust fans:

Item:	Description:
9.12.2.1	The exhaust fans shall maintain a constant duct air flow. The air volume shall be of sufficient value for proper operation as indicated by the testing, adjusting, & balancing contractor.
9.12.2.2	The BMS shall monitor the status of each exhaust fan through the status signal from the fan motor and will activate an alarm on a fan failure.

9.12.3 System Failures and Safety Shutdowns

The BMS shall implement the following system failure and safety shutdowns for exhaust fans:

Item:	Description:
9.12.3.1	Each exhaust fan shall be interlocked with its associated air handling unit. Starting and Stopping of each Exhaust fan control and associated air handling unit if all safety interlocks are met. Safety interlocks will include but are not limited to, Motor fault or failure, Room over pressure, smoke detection.
9.12.3.2	If an exhaust fan fails to start, the associated AHU shall continue to run and the BMS shall display an “Exhaust Fan Fault” alarm condition.
9.12.3.3	Upon activation of any building fire alarm, exhaust fans shall be de-energized and the BMS and building fire alarm system shall be in alarm.

9.13 ROOM CONTROLS

The HVAC systems shall serve multiple types of rooms throughout the facility. Spaces that will receive some type of PID control include but are not limited to: Classified, GMP Warehouse, Administrative areas with VAV supply, and CNC areas. References to documents that contain lists of rooms can be found in next section.

9.13.1 PID Control

The BMS shall perform the following PID control functions for room controls:

Item:	Description:
9.13.1.1	For the classified rooms, temperature transmitters and sensors located in the room or room’s return duct shall modulate their respective heating hot water reheat coil control valve to maintain temperature.
9.13.1.2	For the GMP Warehouses and big rooms, the average reading of the temperature transmitters and sensors located in the room’s return duct shall modulate the heating hot water reheat coil control valve to maintain temperature.

Item:	Description:
9.13.1.3	For the CNC rooms, the temperature transmitters and sensors shall modulate their respective heating hot water reheat coil control valve to maintain temperature. The pressure transmitters and sensors shall modulate their respective damper control valve to maintain differential pressure.
9.13.1.4	For the rooms with VAV supply, the pressure transmitters and sensors shall first modulate the damper, thus modulating the airflow of their respective VAV terminal box to maintain pressure. If the room temperature setpoint still has not been met the temperature transmitters and sensors shall modulate their respective heating hot water reheat coil control valve to maintain temperature.
9.13.1.5	For all classified rooms, the BMS shall maintain room pressurization.
	A. The BMS shall monitor the room pressure against a common reference point and modulate their respective return/exhaust terminal device to maintain the room pressure setpoint.
	B. When a door is open the BMS shall lock the return/exhaust in its current position. When the door is closed the BMS shall release the return/exhaust device to modulate to maintain the room pressure setpoint.
	C. If the pressure differential deviates from setpoint an alarm shall appear on the BMS.
9.13.1.6	The BMS shall monitor the differential pressure across every room and shall display alarms for rooms that are out of tolerance. These values will be determined by the room balancing vendor. These differential alarms will have delay timers associated with each room to allow access to each room without causing nuisance alarms.

9.13.2 System Monitoring

The BMS shall monitor following states and conditions for room controls:

Item:	Description:
9.13.2.1	For some classified and CNC rooms (see air flow HVAC) shall monitor the status
	A. Room Differential Pressure
	B. Room Temperature
	C. Room air flow

9.13.3 Alarming

The BMS shall alarm the following states and conditions for room controls:

Item:	Description:
9.13.3.1	For all classified rooms, the following shall alarm at the BMS:
	A. High/Low Room Differential Pressure
	B. High/Low Room Temperature

Item:	Description:
9.13.3.2	For GMP Warehouses, the following shall alarm at the BMS:
	A. High/Low Room Temperature
	B. High Room Humidity
9.13.3.3	For areas with VAV supply and CNC rooms (see air flow HVAC), the following shall alarms will be displayed at the BMS, but not limited to:
	A. High/Low Room Differential Pressure (if available for the room)
9.13.3.4	B. High/Low Temperature (if available for the room)
9.13.3.5	C. High/Low Humidity (if available for the room)

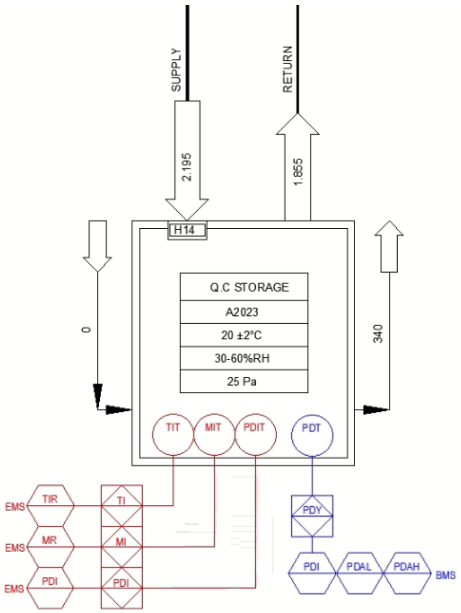
The Setpoints Room Alarms (temperature, humidity, pressure) are indicated in air flow engineering the HVAC System. Below is a template for one of the project room;

9.13.3.6 Room A2023 – Q.C STORAGE

A. Normal condition temperature 20°C +/- 2°C (alarm when equal to or above 24°C and alarm when equal to or below 15°C)

B. Normal condition humidity relative 30-60%RH [<55% is desirable] (alarm when equal to or above 61%RH and alarm when equal to or below 30%RH)

C. Normal condition internal pressure 25Pa (alarm when equal to or above 37Pa and alarm when equal to or below 12,5°Pa) - utilized timer delay of the 30 seconds.



9.13.3.7 The table below illustrates an example of values to be used according to the Classification of the room:

Rooms or Areas	Temp. Control RANGE (ºC)	Room Temp. Control (ºC)	Room Rel. Hum. Control (%)	Room Rel. Hum. Dehumidification (%)	Room Rel. Hum. Humidification (%)
Grade A, B & C	15-24	20 ± 2	30-60%	<55%	Uncontrolled
Grade D	15-24	20 ± 3	30-60%	<55%	Uncontrolled
Labs	15-24	22 ± 3	30-60%	<55%	Uncontrolled
Warehousing	15-24	22 ± 4	30-60%	<55%	Uncontrolled
Mechanical	15-30	20-26	<90%	<90%	Uncontrolled

In addition to the table indicated above, there are process environments with temperatures from 2ºC to 8ºC called cold rooms.

9.13.3.8 Filtering of Alarms

The alarm system shall provide filtering to control the behavior of the alarm display screens. The filtering attributes shall include but not be limited to:

A. Date
B. Time
C. Alarm class
D. Alarm type
E. Alarm priority
F. Status (in alarm, out of alarm, or acknowledged)
G. Tag name
H. Area

Note: the development of the graphic screens should follow the pattern of the Takeda

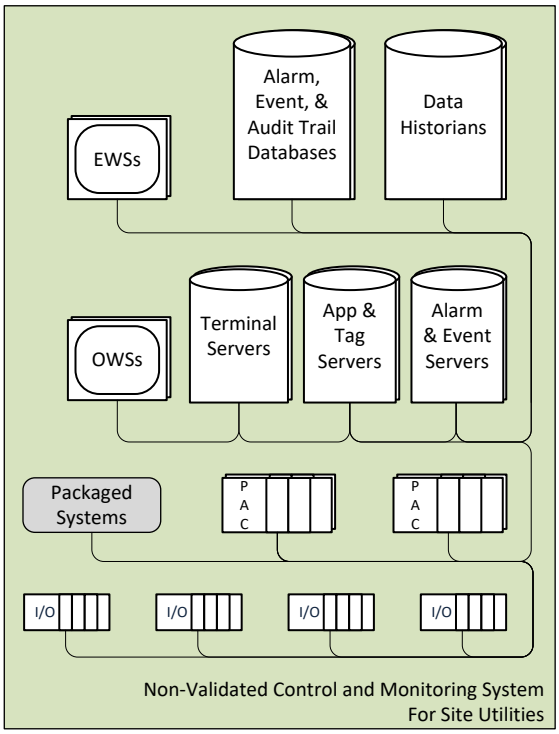
9.14 BMS SYSTEM DESCRIPTION FOR BLACK UTILITIES

9.14.1 The BMS Site Utilities system consists of the following utility systems: Chilled Water (chilled water and tower water); Generation Compressed Air; Boiller; Hot Water for HVAC; Hot Water for Showers and Plant Water. The Site Utilities system does not include Clean Utilities.

9.14.2 The central heating and cooling system for the site will use chilled water, cooling tower/condenser water, and plant steam generation and distribution systems. The Central Utility Plant (Building 7C) building has been designated to provide a central location for the generation of these site utilities. Chemical treatment occurs in the chilled water system and will be monitored by the BMS via a standalone control by the vendor providing chemical treatment services. Additionally, compressed air, boiler fuel, and plant water are standalone controls.

9.14.3 Utility generation equipment in the (Building 7C) shall be locally controlled by the equipment vendor control packages. The BMS shall only interface to generation control systems for monitoring purposes. Site utilities are then distributed to the buildings around the site (Building 7A and 7B). Distribution control shall be performed by packaged equipment control system.

9.14.4 The following figure gives an overview of the equipment that comprises the Black Utilities system inside of the BMS.



Black Utilities Basic Architecture
{quantities and all identities of equipment are not intended to be shown}

9.14.5 The Black Utilities system shall satisfy the general requirements listed below (General Requirements).

Item:	Description:
9.14.5.1	The BMS shall monitor site utility generation, storage and distribution.
	A. Utility systems shall include the utilities Chilled Water (chilled water and tower water); Generation Compressed Air; Boiller; Hot Water for HVAC; Hot Water for Showers and Plant Water.
9.14.5.2	The BMS shall monitor packaged control systems associated with Black Utilities systems.
	A. The BMS shall monitor equipment status information.
	B. The BMS shall monitor alarms.
	C. The BMS shall monitor process parameters.
9.14.5.3	The BMS shall provide visualization of Site Utilities systems.
	A. Utility generation and storage information shall be displayed under a common central utilities plant HMI navigation map.
	B. Utility distribution information shall be available on the basis of the utility being served or the building being serviced.
	i. The HMI design shall allow users to follow each utility from its generation source to all of its distribution locations.
	ii. The HMI design shall allow users to see summary information on all the black utilities systems located within a building.

9.14.6 **Chilled Water System**

9.14.6.1 Chilled water shall be used for HVAC cooling and for process cooling. The chilled water system consists of chillers, cooling towers, distribution pumps, and control valves. The system can be broken into two subsystems: cooling tower water / chilled water and chilled glycol. The chilled water loop can be further broken into primary and secondary pumping loops.

9.14.6.2 Cooling Tower: The chillers in the central utilities plant use water-cooled condensers for refrigerant heat rejection. Condenser water running through the condenser is cooled by cooling towers located on the roof.

9.14.6.3 Chilled Water: Chilled water flows through the evaporator side of the chillers and is used for HVAC and process cooling purposes throughout the facility. The chilled water subsystem shall use a variable-primary, distributed-secondary-pumping system. Primary loop pumps shall distribute the chilled water to each building; chilled water flow meters shall be provided at each building supply line to monitor and record chilled water

use; each building shall have dedicated variable flow secondary loop pumps matching the load demand.

9.14.6.4 Chilled Glycol: Chilled glycol flows piping the side of the chillers and is used for HVAC and process cooling purposes throughout the facility.

9.14.6.5 Chilled Water – Cooling Tower

9.14.6.5.1 The chillers utilize water-cooled condensers for refrigerant heat rejection. The condenser water is cooled by the cooling towers located on the roof of the Building 7A and 7B. The tower fans, condenser water pumps shall be controlled for BMS System. The chemical treatment and filtration skids shall be controlled by packaged control systems with perform monitoring only.

Item:	Description:
9.14.6.5.2	The BMS shall monitor the generation cooling water system (CAG) in utilities plant.
9.14.6.5.3	The cooling water subsystem shall connect to the following packaged control systems:
	A. Chilled Water Master Control system
	B. Chemical Treatment Skid
	C. Filtration Skid

9.14.6.6 System Start / Stop Control Chiller's and Tower's

The BMS shall control the starting and stopping of each pump through VFD control if all safety interlocks are met. Safety interlocks will include but are not limited to, VFD fault or failure, piping over pressure, isolation valves interlocks closed status, flow transmitters pressure transmitters and temperature transmitters out parameters. The BMS shall control the starting and stopping handling units as follows:

Item:	Description:
9.14.6.6.1	All Chiller's and Towers shall operate 24 hours a day seven days a week.
9.14.6.6.2	The BMS shall stop the Chiller's and Tower's which shall also be capable of manual operation
9.14.6.6.3	The BMS shall start the Chiller's which shall also be capable of manual operation
9.14.6.6.4	Turn on and turn off the units of the according to the hourly schedule, thermal and electrical demand
9.14.6.6.5	Command the opening/closing of motorized lock valves to isolate non-operating cooling units (Chiller);
9.14.6.6.6	Automatic relay of chillers and pumps, based on the number of hours worked in order to obtain a use of staggered service life between them;
9.14.6.6.7	Allow the totalization of the operating hours of each cooling unit and pumps;

Item:	Description:
9.14.6.6.8	BMS should stop chiller and tower's when there is not enough water in the system (interlock of the pumps too)
9.14.6.6.9	The BMS should stop the refrigerator and the tower when there is not enough electricity in place in the system (concessionaire). Selection electrical loads.
9.14.6.6.10	Control the operating capacity of each cooling unit, depending on the thermal demand managed by BMS;
9.14.6.6.11	Total operating hours/hours of stops for each unit

9.14.6.7 **PID Control**

The control logic of the Chillers and Tower's should be supplied together with the package equipment (PLC Master Control local Stand-Alone Controller).

9.14.6.8 **System Monitoring**

The BMS shall monitor various points for the cooling water system. For example, VFD speed, unit pressure, valves position, temperature, etc.:

Item:	Description:
9.14.6.8.1	Expansion Tanks (level)
9.14.6.8.2	Control Valves Stations (status open, closed, failure)
9.14.6.8.3	Chemical treatment skid equipment (process parameters, status equipment)
9.14.6.8.4	VFD speed (status on/off, failure)
9.14.6.8.5	Field Devices (temperature sensor, pressure sensor, flow switch)

9.14.6.9 **Alarming**

The BMS for Black Utilities shall alarm the following states and conditions for cooling water system handling units:

Item:	Description:
9.14.6.9.1	Pressure water in supply line – High High, High, Low and Low Low
9.14.6.9.2	Temperature water in supply line – High High, High
9.14.6.9.3	Flow water in supply line – Low and Low Low
9.14.6.9.4	VFD speed (failure)
9.14.6.9.5	Remote Shutdown
9.14.6.9.6	Manual Shutdown

Item:	Description:
9.14.6.9.7	Status Failure equipment (general alarm) in Chiller's
9.14.6.9.8	Status Failure equipment (general alarm) in Chemical treatment skid
9.14.6.9.9	Failure in communication (network data) PLC Master Control water cooling system
9.14.6.9.10	Failure in communication (network data) PLC Stand Alone Chemical treatment skid

9.14.7 Plant Steam – Generation

The primary system function of the steam generation systems is to supply pressure steam for process and HVAC building needs. Each boiler shall be controlled by its own individual local control panel. Similarly, the surge tank, deaerator and blow down tank shall be provided with their own control panels. A master control panel, separate of the BMS, shall provide staging of these systems.

Item:	Description:
9.14.7.1	The BMS shall monitor the steam generation system in the plant.
9.14.7.2	The BMS shall connect to the following packaged control systems associated with plant steam generation.
	A. Plant steam generation master control
9.14.7.3	The BMS shall monitor the following components from the packaged control systems:
	A. Each boiler
	B. Surge tank
	C. Deaerator
	D. Blow down tank
	E. Feedwater System
	F. Chemical Treatment
	G. Shutdown Alarms for components listed above
9.14.7.4	The list of data to be monitored shall be provided in tag lists from each packaged control system.

9.14.8 Hot Water Plant – Hot Water Distribution

Hot water flows through the pipes and is used for HVAC (Re-heat coil) and process heating purposes throughout the facility. Loop pumps shall distribute the hot water to each building; hot water flow meters shall be provided at each building supply line to monitor and record hot water use;

Item:	Description:
9.14.8.1	The BMS shall monitor the hot water temperature in the building main supply header.
9.14.8.2	The BMS shall monitor the hot water pressure in the building main supply header.

9.14.9 Reheat Hot Water

Reheat hot water shall be used mainly for reheat coils and showers within various buildings. Each building shall be provided with its own dedicated reheat hot water packaged skid. Reheat hot water shall be provided by a steam to hot water heat exchanger that is part of a package system. Skids include heat exchangers; pumps; air separator; expansion tank; and associated electrical and control panels.

9.14.10 Boiler Fuel

9.14.10.1 Each boiler shall be provided with dual fuel burners. The primary fuel source shall be natural gas, but diesel oil is provided as a secondary source (prevision). Natural gas usage shall be monitored.

9.14.10.2 Emergency diesel generators shall also use diesel oil. Diesel flow shall be metered at each group of equipment (emergency electric generators 1,2 and 3) for consumption monitoring and record.

9.14.10.3 Diesel oil discharge pumps shall be provided for oil transfer from tank trucks to stationary tanks (fill pumps). Diesel oil distribution pumps shall be provided to transfer diesel from the tank to emergency diesel generators. . The diesel oil tank fill pumps, and storage tank level control are controlled by packaged systems; the BMS performs monitoring only.

Item:	Description:
9.14.10.5	The BMS shall provide monitoring for natural gas.
9.14.10.6	The BMS shall connect to the following packaged control systems associated with the diesel oil system.
	A. Diesel oil transfer pumps skid
	B. Diesel oil fill pumps skid
	C. Diesel oil storage tank level control system
	D. Diesel oil intermediate tanks level control system
9.14.10.7	The BMS shall monitor the following components from the packaged control systems:
	A. Diesel oil transfer pumps
	B. Diesel oil fill pumps

Item:	Description:
	C. Diesel oil storage tank
	D. Diesel oil intermediate tanks
9.14.10.8	The list of data to be monitored shall be provided in tag lists from each packaged control system.
9.14.10.9	The BMS shall monitor Diesel Oil loop alarms.
9.14.10.10	The BMS shall monitor the grounding switch local (status) de transference system of the Diesel Oil.

9.14.11 **Compressed Air**

The purpose of the compressed air system is to supply compressed air to process and utility users. The compressed air shall be distributed to users through mains and branches. Each use point from the branches shall be regulated to an appropriate pressure required by the use point. Control and sequencing of the compressed air system is by the air compressor vendor. The BMS shall provide system status monitoring. Compressed Air flow shall be metered at each building for consumption monitoring and record.

Item:	Description:
9.14.11.1	The BMS shall monitor the compressed air utility system.
9.14.11.2	The BMS shall connect to the following packaged control systems associated with the compressed air system:
	A. Compressed air system master control
9.14.11.3	The PAS shall monitor the following components from the packaged control systems:
	A. Air compressors
	B. Condenser water valve
	C. Air Dryers
	D. Filters
	E. Reservoirs
9.14.11.4	The list of data to be monitored shall be provided in tag lists from each packaged control system.

9.14.12 Plant Water Monitoring (Only Industrial Water)

Industrial Water shall be metered at each building for recording and consumption monitoring by the flowmeter and BMS.

Water levels and loop pumps are controlled by their local control systems.

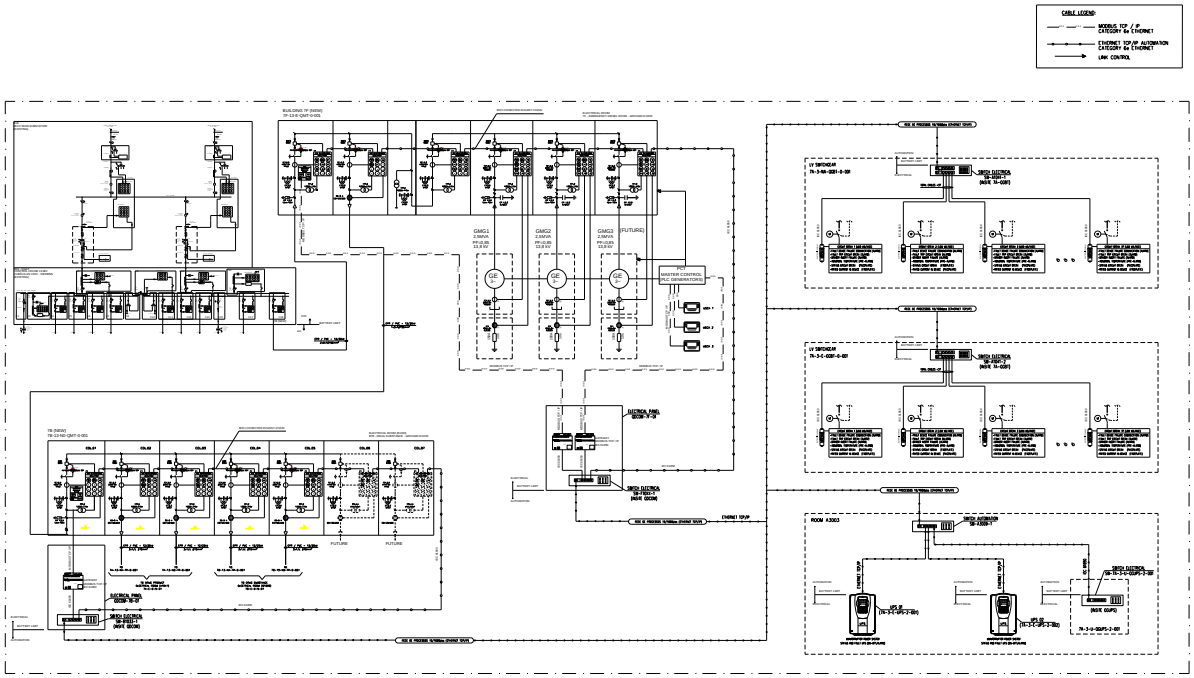
Item:	Description:
9.14.12.1	The BMS shall monitor plant water systems. (only new buildings)
	A. The BMS shall monitor the following water loops:
	i. Industrial water for cooling towers
	ii. Industrial water to the Spine
	iii. Fire protection water for hydrants (hold)
	iv. Fire protection water for sprinklers (hold)
	v. Potable water (hold)
	B. The BMS shall provide monitoring of industrial wastewater and wastewater treatment systems. (W.W.T)
9.14.12.2	The BMS shall connect to the following packaged control systems associated with the plant water monitoring:
	A. Water loop control systems
	B. Wastewater treatment control systems
9.14.12.4	The list of data to be monitored shall be provided in tag lists from each packaged control system.

NOTE: the proponent shall consult all drawings (P&ID) of the procedure discipline.

9.15 BMS SYSTEM DESCRIPTION FOR ELECTRICAL SYSTEM

9.15.1 The BMS for Electrical system consists of the following utility systems: Electrical Power Entrance, Generators (GMG), UPS and main distribution panels system.

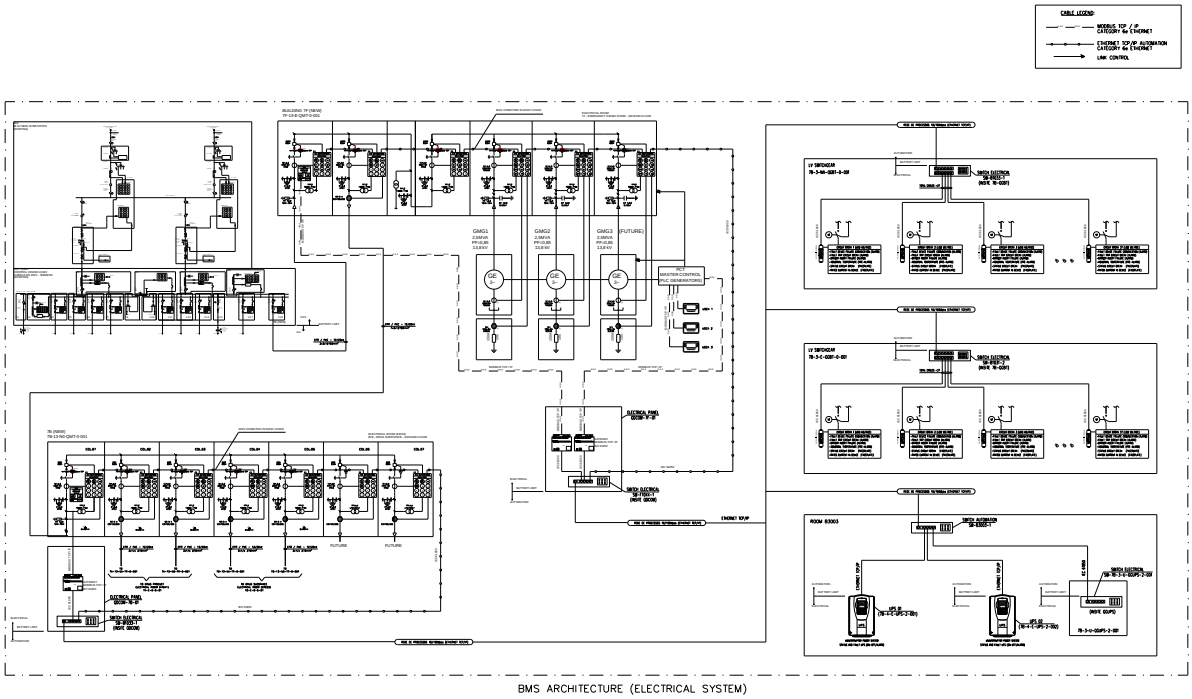
9.15.2 Architecture Electrical System (Building 7A).



BMS ARCHITECTURE (ELECTRICAL SYSTEM)

Note: for general view of the sub-architecture see drawing 7A-I-0-7-04 sheet 7 for electrical systems.

9.15.3 Architecture Electrical System (Building 7B).



BMS ARCHITECTURE (ELECTRICAL SYSTEM)

Note: for general view of the sub-architecture see drawing 7B-I-0-7-04 sheet 8 for electrical systems.

9.15.4 Currently the Takeda site already has a existing an electrical substation in medium voltage (69 KV Main Substation) localized in building B18. For the new facilities of building 7A and 7B will require the installation of a new cubicle.

9.15.5 A new building will be built named "Building 7F" which will house the generating motorcycle group (GMG), being two new equipment and one future.

9.15.6 As a premise, the BMS system should collect data from all field switches belonging to the electrical panels (LV Switchgear), using an industrial network of processes in TCP/IP ethernet.

9.15.7 In general, the BMS system should also alarm the operator in case of tendency to exceed the maximum value of electrical demand contracted.

9.15.8 Electrical Power Entrance

The BMS System shall monitor the following points:

A. Monitor the status of the mains circuit breaks and section lines.
B. Monitoring the status the line transition for measuring parameters electricals (tension, current, voltage in cada phases).
C. Monitoring of the alarms and actuation the circuit break protections.
D. Monitoring of the alarms of the temperature sensor of the transformers (winding).
E. Interligation with paralized unit (main concessionary).
F. Command of the mains circuit breaks and section lines.
G. The System will monitor the states of electronic reles (IED's) of the main panels using buss IEC 61850. These devices must be interconnected in daisy chaining.

9.15.9 Group Motors Generators (GMG)

9.15.9.1 The GMG set will be supplied with its own automation through a Stand-Alone type controller installed in the general generator control panel (PCT Master Control). The BMS system should monitor the information in this panel.

9.15.9.2 The System will monitor states through digital input points interface with USCA or by industrial communication protocol.

9.15.9.3 The PCT panel should be connected to the BMS system using Modbdus TCP/IP. A gateway (modbus TCP/IP - IEC61850) will be required for data acquisition in IEC 61850.

9.15.9.4 The BMS System shall monitor the following points;

A. Monitoring of the status the equipment (on/off).
B. Number of hours worked.
C. Monitoring of the status the main section / circuit break.
D. Monitoring of the general alarms of the equipment (temperature, faull, etc).
E. Status Stop Button (Alarm)
F. GMG operated in load charge
G. GMG operated in test
H. Low fuel level
I. Low tension battery
J. Monitoring the status the measuring parameters electricals (tension, current, voltage)
K. Monitoring the status the measuring parameters electricals of the potential generated (Kw, KVA, KVAr, KWh).
L. Monitoring of diesel tank levels.

9.15.10 Low Voltage switchgear

9.15.10.1 The BMS System shall monitor the following points the circuit breaks;

A. Fault device failure communication (Alarm).

B. Fault trip circuit break (Alarm).
C. Drawer insert failure (Alarm).
D. Abnormal temperature (pre-alarm).
E. Status circuit break (Faceplate).
F. Rated current in device (Faceplate).

9.15.10.2 It is part of the scope of the electrical panels supplier to supply the electrical switch for data acquisition by the BMS system. All interlocks between the circuit breakers are also part of the scope of the electrical panel's supplier.

9.15.11 Uninterruptable Power System (UPS)

9.15.11.1 The BMS system hardware must be powered by a 220VAC conditioned circuit provided by the uninterruptible power supply (UPS) of building 7 (Buriti project).

9.15.11.2 The UPS must have their own automation (bypass) and will be monitored by the BMS system.

9.15.11.3 The System will monitor states through points interface with Controlled or by industrial communication protocol. BMS should do data acquisition over ethernet TCP/IP.

9.15.11.4 The BMS System shall monitor the following points;

A. Monitoring of the status the equipment (on/off).
B. Number of hours worked.
C. Monitoring of the status the main section / circuit break.
D. Monitoring of the general alarms of the equipment (temperature, faull, etc).

9.16 BMS SYSTEM DESCRIPTION FOR ACCESS CONTROL

9.16.1 The access control system should be interfaced with the BMS to inform with a general alarm of an event that has occurred in the system. The operator must access the access control system to verify further details of the alarm that occurred.

9.16.2 The BMS system must provide an ACS system overview screen indicating the ACS controllers with their ON/OFF/FAILURE status.

9.16.3 An Ethernet communication network must be provided to interconnect the BMS system with the ACS system.

9.17 BMS SYSTEM DESCRIPTION FOR CCTV

9.17.1 The CCTV system should be interfaced with the BMS to inform with a general alarm of an event that has occurred in the system. The operator must access the CCTV system to verify further details of the alarm that occurred.

9.17.2 The BMS system must provide an CCTV system overview screen indicating the CCTV devices with their On line /Off line/ FAILURE status.

9.17.3 An Ethernet communication network must be provided to interconnect the BMS system with the CCTV system.

9.18 BMS SYSTEM DESCRIPTION FOR FIRE ALARM SYSTEM

9.18.1 The Fire Alarm system should be interfaced with the BMS to inform with a general alarm of an event that has occurred in the system. The operator must access the Fire Alarm Control Panel (FACP) to verify further details of the alarm that occurred.

9.18.2 The BMS system must provide an Fire Alarm system overview screen indicating the Fire Alarm devices with their Activated /Normal/ Fault status.

9.18.3 An Ethernet communication network (BACnet) must be provided to interconnect the BMS system with the Fire Alarm system.

10. HARDWARE AND SOFTWARE SPECIFICATIONS

10.1 HARDWARE AND SOFTWARE

10.1.1 Hardware and software must be for the most part scalable to fulfill the wide-ranging requirements.

10.1.2 The system should provide client-server architecture.

10.1.3 Vendor's proposal shall include supply, installation, testing, and commissioning of all hardware, furniture, electronic equipment, software, firmware and third party equipment involved. Training services for Operations personnel shall be included, facilities will be defined by client.

10.1.4 The system must comply with the following:

A. The system must provide common hardware and development tools for various solutions.
B. The system must offer integrated fail-safe features in runtime and engineering.
C. The system must support field bus devices from any manufacturer without additional certification.
D. The vendor system must contain a high-performance HMI product which is owned, developed, manufactured, and tested by the vendor.
E. The vendor system must support separation between the terminal and system bus.
F. Connection to an office bus may not lead to a problem.
G. The controllers of the system must allow operation without a fan.
H. The software shall be provided on the latest version of the software AVEVA System (former Wonderware)

10.1.5 BMS server, PLC, and Remote I/O

10.1.5.1 The Automation system for BMS shall include features traditionally associated with both a programmable logic controller (such as programming in ladder logic, and remote I/O architectures) and a distributed control system (such as continuous and complex control, advanced operator interfaces). These capabilities must seamlessly reside in one control system without the use of special gateways or interfaces. In addition, the system shall provide seamless integration of continuous, batch and safety protection control, including common software tools.

10.1.5.2 Horizontal Integration

10.1.5.2.1 The system shall provide integration of BMS control tasks and upstream and downstream discrete control tasks such as fire alarms of the automation system, permitting safety integration of all operations in any manufacturing and process environment.

10.1.5.3 Vertical Integration

10.1.5.3.1 The system shall support vertical integration by utilizing uniform data communication structures to support complete integration from the ERP, MES, and control and field levels.

10.1.5.4 Open System

10.1.5.4.1 The system shall be an open system composed of standards-based technology including PC platforms with a Windows operating system, Ethernet communications, TCP/IP, OPC for interconnectivity of multiple systems from different suppliers, field mountable control system, remote IO subsystem, and bus based serial communication with field devices over PROFINET, Foundation Field bus H1, HART, AS-I, and Modbus networks. The system software is resistant to third-party programs. It must be possible to install all system components. The use of virus scanners must be possible.

10.1.5.5 Licensing

10.1.5.5.1 Software licenses for engineering workstations and for operator interface consoles shall be independent of the type and mixture of I/O used (analog vs. discrete, input vs. output).

10.1.5.5.2 The software licenses (both runtime and engineering) shall be portable allowing the user to transfer licenses from one PC to another without requiring intervention from the vendor.

A. Written Explanation of Licensing Practices

To help minimize risk associated with changes in project scope, if software is licensed on a tag-by-tag basis the vendor shall supply in writing details on how the required software license would change under the following circumstances:

B. If the total number of system I/O was increased

C. Modifications to the set-up of I/O modules (e.g. converting 20% of the discrete inputs into analog inputs. This only applies when the vendor cannot fulfill the demands mentioned. It in no way implies dilution of the requirements described there.

D. If the user would like to pass real-time variables from his system to a 3rd party OPC Client.
E. Smart License Model

10.1.5.5.2.1 The vendor must offer a clearly delineated licensing model.

10.1.5.5.2.2 The vendor must offer a licensing procedure that is based on the number of process objects (PO) for OS and controller in the application.

10.1.5.5.2.3 The engineering system must control and count the process objects (PO) .

10.1.5.5.2.4 All computer operating system versions must be the most current operating system that is fully compatible with OEMs of all installed software contemplating all windows licenses or any corresponding/necessary licenses for the perfect and complete functioning of these systems and their interconnections with equipment/systems to be integrated/interconnected.

10.1.5.6 Use of Standard Products

10.1.5.6.1 The system shall be composed of manufacturer's standard hardware, systems software, and firmware that can be configured to meet the stated requirements.

10.1.5.6.2 The vendor's standard system operating software shall not be modified to meet any of the user's requirements.

10.1.5.6.3 Application software shall be designed in a manner that requires no modification to the system operating software.

10.1.5.6.4 Software design shall be such that future revisions or updates of the system operating software will not affect the successful operation of the system.

10.1.5.6.5 The vendor must offer the same platform for safety and non-safety applications.

10.1.5.7 Spare Capacity and Expansion

10.1.5.7.1 Each system shall be supplied with 10% spare capacity for each I/O type in the base system. The base system is defined as the quantity of hardware needed to meet the project requirements. Communication networks shall be designed to allow for system growth of at least ten percent (10%) based on the number of unused node addresses. System expansion shall be achievable without shutting down the controllers not directly involved with the expansion.

10.1.5.7.2 System Runtime and Engineering Software shall be capable of being expanded by the purchase of additional licensing units. There shall be no cost penalty for expansion.

10.1.5.8 Software Revision

10.1.5.8.1 Application software shall not require modifications to be able to run under new releases of the system operating software. Any new release of system software shall be backward compatible with files created using the previous software releases.

When a new release is installed, it must be possible to back up the user data since the manufacturer may change the data with the new release.

10.1.5.9 An emergency button is installed in each I/O Remote Panel to allow the shutdown of the equipment that serves from this I/O Remote and thus comply with NR-12.

10.2 ELECTRICAL REQUIREMENTS

10.2.1 Electrical Area Classification

Buildings containing the control equipment (servers, workstations) will be rated as electrically unclassified.

10.2.2 Electromagnetic Compatibility (CE Compliance)

Equipment shall meet all electromagnetic compatibility requirements of the IEC 61000-4-2, 61000-4-3, and 61000-4-4 standards.

10.2.3 Wiring and Cabling

PROFINET, Ethernet, and other communication cables shall maintain a minimum separation of 75 mm from any AC power cables. Fiber optic cables are excluded from this requirement. Vendor installed cables shall be designed and installed in such a way as to allow cable disconnection to service the equipment. Cables shall not interfere with circuit board removal. It should be possible to use safe connectors without short-circuit and the risk of missing connection.

10.2.4 Cabinet and Workstation Grounding

AC Safety ground and instrumentation circuit ground shall conform to the NBR 5410.

10.2.5 Circuit Boards

It shall not be necessary to remove power or field wiring to replace a control or input/output module.

10.3 CONTROLLERS

10.3.1 Multipurpose Controller

The controller shall be a multipurpose controller capable of executing fast PLC-type programs (discrete) and PCS-style applications (regulatory) allowing process and machinery control to be integrated in one device. Extremely short instruction processing times down to 10 msec. required for programmable logic control, and lower processing times required for process control, shall both be available. A minimum of 6 independent scan rates should be available for optimizing the execution time of the application program.

10.3.2 Large Capacity Controller

The vendor shall provide a large capacity controller capable of executing a minimum of 1000 standard PID Control loops with a 500 msec. scan rate to reduce the need for partitioning of the user application program. A controller of the upper performance class must be offered with the following performance specifications:

A. Execution time: 18ns
B. Memory: 30 MB
C. A firmware update must be possible for redundant systems during ongoing operation.
D. The vendor shall offer a controller in the upper performance range for more than 750 I/Os.
E. No connected engineering system containing required data in the controller must be necessary for a cold restart.
F. The vendor system shall not encounter high CPU load or memory requirements for saved texts in the controller. The variable length texts are to be stored in a text database.

10.3.3 Power Requirements of the Controller

10.3.3.1 Power Supply

There shall be a choice of a 24 VDC or 220 VAC 60 Hz power supply.

A. The manufacturer should consider in the control cabinet, the external power supply on individual circuit breaker of 220 VAC power supply to each load cells systems, flow transmitters and level switch, for example.

B. The manufacturer should consider in the control cabinet, individual circuit breaker of 24 VDC power supply to each solenoid panel.

10.3.3.2 Battery Backup

Controller configuration memory shall have a battery backup so that the controller maintains its configuration and state information in the event of an extended power outage. The program execution shall restart where it left off upon power restoration.

10.3.3.3 Response to Power Failures

10.3.3.3.1 In the event of an extended power failure the controller shall not require access to the engineering station to reload or redo any portion of its configuration.

10.3.3.3.2 The system must ensure that programs are not deleted if power fails. This should be ensured with battery backup.

10.3.4 Choice of Configuration Languages

10.3.4.1 Configuration languages shall be offered that are traditionally associated with both a DCS and a PLC programming environment. These shall include the following six programming languages including those described in standard IEC 61131:

A. Continuous Function Charts (CFC)

B. Sequential Function Charts (SFC)
C. Structured Control Language (SCL)
D. Relay Ladder Logic (R-LAD)
E. Instruction List (STL) and Function Block Diagram
F. Safety Matrix (for Safety System Configuration)

10.3.5 Closed-loop-control

10.3.5.1 Standard software algorithms shall be available to perform regulatory control functions, and these shall have easily configurable parameters.

10.3.5.2 It shall be possible to put any individual control loop in a manual; automatic, or cascade mode. In cascade, it shall be possible to configure remote set points from other regulatory controllers or from other control blocks.

10.3.5.3 There shall be bumpless, balance less transfer between all control modes, and windup protection shall be provided. Control blocks shall be able to perform automatic mode switching based on external or internal logic inputs.

10.3.6 Calculations

10.3.6.1 Algorithm calculations shall be performed in floating-point engineering units or other such equivalent methods that do not require scaling.

10.3.6.1.1 Input Functions

The following input functions shall be supplied as standard configurable items:

A. Square root extraction, for flow measurement
B. Linearization of type B, E, N, J, K, L, R, S, T, and U thermocouples
C. Linearization of RTDs
D. Digital input pulse totalization
E. Pulse input to frequency conversion

10.3.6.1.2 Computational Functions

The following computational functions shall be supplied as standard configurable items or simple algebraic instructions.

A. Addition / subtraction
B. Ramp generator
C. Lead lag
D. Integrator / Accumulator
E. Dead time
F. High/low select
G. Multiplication / Division
H. Time averaging
I. Signal selection switch

J. Exponential polynomial
K. Logarithms
L. Square root
M. Absolute value
N. Closing delay
O. Min/Max selection
P. Smoothing function
Q. Noise generator
R. Signal smoothing / low pass filter
S. Alarm delay

10.3.6.1.3 Continuous Control Functions

The following control functions shall be configurable items:

A. Proportional Integral Derivative (PID)
B. Auto/manual with bias control
C. Ratio control
D. Step Controller
E. Split Range Controller
F. Cascade Control
G. Override control
H. PID with feed-forward
I. PID with Smith predictor
J. PID with safety logic and control loop monitoring
K. PID with operating point-oriented parameter adaption
L. Model predictive control
M. Adaptive tuning (optional)
N. Fuzzy logic control (optional)
O. Multivariable Control (optional)

10.3.6.1.4 Control Loop Execution Frequency (Scan Rate)

It shall be possible to independently select the execution frequency of each device. Control strategy in the controller. Controller scan rates as fast as 100 times per second (10 ms) shall be possible.

10.3.6.1.5 Control Loop Output Functions

The following output functions shall be supplied as standard configurable items and shall be the same regardless of execution in the system controller:

A. Linear
B. Linear with clamping (high and low restricted)
C. Non-linear characterization

10.3.6.1.6 Setpoint Clamps

Upper and lower clamps on all set points shall be configurable.

10.3.6.1.7 Discrete Control

10.3.6.1.7.1. The following discrete control functions shall be supplied as standard configurable items:

A. Logic functions -- and, or, not, nand, nor, xor
B. Change of state detect
C. Set/reset flip-flops
D. Timers and counters
E. Comparison elements -- greater than, less than, equal to, not equal to
F. Multiplexer (selects one of up to 16 signals)
G. Positive, negative, and bi-directional edge trigger

10.3.6.1.7.2. The vendor system must be able to support wide-ranging technological modules (Controllers, positioners, counter etc.).

10.3.7 Sequential Control

10.3.7.1 Sequential Function Charts (SFC) shall be available. SFC is a structured, IEC-61131-3 compliant, high-level control programming language.

The SFC shall include the following features:

A. It shall provide the necessary facilities for real-time control of sequential processes.
B. It shall have access to process control and other database information.
C. It shall be possible to modify the program logic while other sequences are active.
D. It shall support execution of the chart in Manual or Automatic Mode
E. It shall be possible to configure multiple states within a single SFC container.

10.3.7.2 This allows for effective coordination of sequences which have more than one mode (e.g. Heating and Cooling) or that contain safe-state logic (e.g. Aborting or Holding Logic).

A. The ability to create master SFC elements which can be copied and used throughout the configuration just like a function block. Changes to a single instance of the SFC will result in automatic updates to all other instances in the Configuration.
B. The ability to automatically create displays for visualization and control of the SFC directly from the controller configuration.

C. The SFC editor shall include a test/debug mode which does not write to the outputs.
D. Manual adaptation following name changes in charts and their references should not be necessary.
E. Sequential charts in OS: It must be possible to monitor the sequencer of the vendor system and operators must be able to intervene if disturbances occur in the process.
F. It must be possible to perform actions in step transitions.

10.3.7.3 Sequential Functions

The following sequential functions shall be supplied as standard capabilities:

A. Hold sequence -Manual or preset time
B. Recycle to prior step
C. Skip one or more steps
D. Automatic Restart at beginning upon completion (Cyclic Operation)
E. Configuration of maximum or minimum execution times for steps and transitions
F. Ability to configure an optional operator confirmation for each individual transition condition

10.3.7.4 Step Control Modes

The way in which chart progresses from a transition condition to the next step can be controlled according to the following modes:

A. Transition – Control is governed solely by satisfying the transition condition
B. Confirmation – Control is governed solely by operator confirmation
C. Transition and Confirmation – Both the transition condition must be satisfied, and the operator confirmation must be entered before the sequence will proceed
D. Transition or Confirmation – Either the transition condition is satisfied or the operator confirmation is entered to allow the sequence to proceed

10.3.7.5 Phases of a Step

Each step of a chart shall support the following standard phases of step execution:

A. Initialization – For first-time execution of actions
B. Execution – For continuous execution of actions until transition condition is met
C. Termination – For post-processing to allow an action to be executed once after the transition condition has been met

10.3.7.6 Supported Operating States

The following 16 SFC operating states (per the ISA S88.01 standard) shall be supported natively by the system:

A. Ready

B. Starting
C. Active
D. Completing
E. Error (Completing)
F. Completed
G. Holding
H. Held
I. Resuming
J. Error
K. Held (error)
L. Resuming (error)
M. Aborting
N. Aborted
O. Stopping
P. Stopped

10.3.8 Supervisory Control

10.3.8.1 The vendor shall be able to supply standard supervisory control functions fully integrated with the regulatory control functions. The supervisory functions will include the ability to make set point adjustments to selected loops. It shall be possible for supervisory control applications to be scheduled, run on demand, or triggered by events. The supervisory system shall have access to the complete database, with privileges to change items such as controller mode and set point.

10.3.9 Auto Tuning

10.3.9.1 An integrated PID auto tuning facility shall be available from the Engineering Workstation:

A. Applicable to processes with slow and fast dynamics
B. Used with self-regulating and integrating processes
C. Immune to noise and process load disturbances
D. Can be used for standard and custom libraries
E. Can be accessed directly from the Engineering Workstation

10.3.9.2 The PID auto tuning facility shall employ an easy-to-use graphical interface with a setup “wizard“ (similar to Microsoft Excel) to assist engineers and technicians who are unfamiliar with the tool.

10.3.10 Fault Handling

10.3.10.1 Invalid value status shall be generated for inputs and calculated variables. A value shall be declared invalid if any of the following conditions are true:

A. If a value is out of range
B. If a value cannot be measured or calculated
C. If a value is declared invalid by an application program
D. If a value is declared invalid by the source instrument

10.3.10.2 Invalid value status (data quality) shall be propagated through control schemes and be available at the HMI.

10.3.10.3 It shall be possible to inhibit the detection and propagation of an invalid value status.

10.3.10.4 This selection shall be available on a per tag basis. It shall be possible for an invalid value status to be used as a logical input to initiate Control algorithm changes.

10.3.10.5 When a control algorithm's input is declared invalid, it shall be possible to configure the output to fail as follows:

A. Hold last good value
B. Zero output signal
C. User defined output value

10.3.10.6 In the event of communications subsystem failure, regulatory control algorithms shall continue operating with the last valid information.

10.3.11 Variable Scan Rates of Control Functions

10.3.11.1 The control execution rates for analog functions and discrete functions shall be individually configurable.

10.3.11.2 The minimum scan rate for discrete and analog control functions shall be 10 msec.

10.3.12 Cabinets

10.3.12.1 Control cabinets shall conform to CE standards for electromagnetic compatibility with the EMC standard (IEC 61000), and ensure protection against unauthorized access, mechanical influences, contamination, and other environmental influences.

10.3.12.2 The standard cabinet shall conform to IP40, and a cabinet upgrade to IP55 shall be available.

10.3.12.3 The controller and I/O modules shall not require the use of cooling fans.

10.3.12.4 The vendor must offer switches suitable for mounting in switchgear cabinets.

10.3.13 Controller Communication over System Bus

A. The system bus used for communication between controllers and up to the HMI Servers shall be capable of running at a minimum of 100 Mbps data rate.

B. Use of fiber optic cables shall be supported, allowing noise free communication between control and operator stations separated by large distances as required by many processing facilities.

C. ITP cable (Industrial Shielded Twisted Pair, Cat6) are to be used for distances up to 100 m.

D. The length of the system bus shall be expandable to 150 Km.

E. The system bus shall support from two to 1024 stations.

F. For maximum availability, the system bus shall support configuration in double redundant ring architecture, using either fiber or copper media.

10.3.14 Reserve CPU Capacity

10.3.14.1 To reserve CPU capacity for future growth and ensure rapid software response to process upsets, CPU execution of the configured software application shall not exceed 50 percent CPU time during the course of normal process monitoring and control.

10.4 INPUTS AND OUTPUTS

10.4.1 General Inputs and Outputs

10.4.1.1 Common mode rejection ratios of 60 dB or greater from DC to 60 Hz and normal mode rejection ratio of 30 dB or greater at 60 Hz are required.

10.4.1.2 Analog input and output modules shall provide pass through capability to exchange non-control data, both PROFIBUS, PROFINET and HART, with asset management applications, utilizing the infrastructure of the system.

10.4.1.2.1 The following configurable fail-safe options shall be available for output modules:

A. Drive to predetermined analog output, or de-energize for a digital output
B. Maintain the last good output value for an analog or hold for a digital output.

10.4.1.2.2 The fail-safe actions listed above shall be taken upon a processor halt, or power supply failure, or a communication failure between the controller and the I/O module, if so configured. It shall be possible to change modules in remote I/O racks while the rack is powered up w/o affecting communication to the other modules in the rack.

10.4.2 Support for Remote I/O Architectures

10.4.2.1 Remote I/O Capability shall be provided native to the system to minimize wiring costs and to eliminate the need for costly “home run” wiring – The system shall support the following remote I/O families:

A. Intrinsically Safe (EEx-i) - For installation directly in Hazardous Locations (per NEC Class 1 Div 2, Zone 1 / Zone 2)
B. Support of Fail-safe Applications
C. Integration of HART field devices
D. With Integrated Terminal Blocks
E. With special-purpose modules such as Motor Starters and Weigh scales
F. With various levels of diagnostics and resolution (number of bits)

10.4.2.2 To achieve flexibility in the placement of equipment, the vendor’s system shall support remote I/O installation whereby conventional I/O modules can be located large distances away (up to 6.0 miles / 9.6 km with copper cable or longer distance when fiber-optics are used) from their associated controller.

10.4.3 Non- proprietary Communication from Controller to I/O

10.4.3.1 Open standards should be used to communicate between a controller and its I/O modules to facilitate connectivity of 3rd party I/O with the same level of system support (diagnostics and engineering ease of use) as those offered by the vendor.

10.4.3.2 It shall not be acceptable to utilize proprietary communication between the I/O and the controller.

10.4.3.3 Communication between controller and I/O should be in accordance with IEC 61158 (Field bus communication).

10.4.4 Redundancy

10.4.4.1 The system shall support the use of I/O Redundancy whereby a single sensor or actuator is connected to two separate I/O modules. A redundant controller can utilize a mixture of redundant I/O and non-redundant I/O within the same system. To minimize the potential for common cause failures, redundant I/O Modules must be able to be located in physically separate racks. It is not permissible to share a common backplane.

10.4.4.2 The system should offer optimal integration of redundant Remote I/O racks (RIOs), redundant I/Os and field bus (Profibus PA and DP for example), with both redundant and no redundant models. It must be possible to create two process tags (process variables) with the same process name and apply integrated redundancy functions without additional programming work.

10.4.5 Analog Inputs

10.4.5.1 The system shall be capable of supporting the following types of analog process input signals:

A. 4-20 mA DC, 0-20 mA DC, and ±20 mA DC, isolated and non-isolated inputs
B. 1-5 V DC, ±10 V DC, and ±1 V DC isolated and non-isolated inputs
C. Type B, E, J, K, L, R, S, T and U thermocouples
D. Platinum resistance temperature detector (RTD) – Pt100, Pt500, Pt1000, Ni100, Ni1000, Cu10 - per IEC 60751
E. High-speed Pulse input – 1, 10, 20, 100, 250, 500 kHz, @ 24 V

10.4.5.2 Temperature linearization and thermocouple cold junction compensation shall be provided.

10.4.5.3 Normal resolution shall be a minimum of 12-bits; special modules with 16-bit resolution shall be available.

10.4.5.4 Typical analog input modules shall operate at 25 □C with a basic error of no more than 0.25% of input range.

10.4.5.5 Input module with 8 inputs for RTD(Ohm) and TC - High Feature Fields of application;

A. Analog input module for the measurement types voltage,
B. resistance, thermo-resistance and thermocouple with channel-specific process alerts for exceeding the operational limit.

10.4.5.6 Range of values/measurement:

A. Voltage: +-50V, +-80mV, +-250mV, +-1V
B. Resistance 2-,3-,4-Wire: 150, 300, 600, 3000, 6000Ohm

C. Resistance 2-Wire: PTC
D. Temperature: Thermocouple, resistance therm.

10.4.5.7 System features;

A. Supply voltage 19,2 – 28,8 V DC
B. Nominal voltage (DC) 24V
C. Push-In terminals for tool-less wiring
D. Stationary wiring
E. Exchangeable terminal box
F. Flexible cables
G. Re-parametrizable during operation
H. Calibratable during operation
I. LED status display for channel-specific status information
J. LED diagnostics display on the device
K. Protection against short circuit on the sensor supply
L. Output type/range parametrizable by channel
M. Max. operational limit: +-0,1%

10.4.5.8 Diagnosis;

10.4.5.8.1 Parametrizable by module

A. Missing load voltage L+
B. Reference junction
C. Overflow
D. Underflow
E. Wire break

10.4.5.8.2 Functions;

A. Channel-specific monitoring of the Operational limit (2 upper / 2 lower)
B. Adjusting the range of measurement in order to increase the resolution

10.4.5.8.3 Technical Data;

A. Permissible input voltage: 30V
B. Temperature range for standard components:
C. Horizontal installation: from 0 to 60 degrees C
D. Vertical installation: from 0 to 50 degrees C

10.4.5.8.4 Max. cable length:

A. Shielded: 200m
B. Shielded for thermocouples: 50m
C. Reference model; Siemens / AI 8xRTD/TC 2-wire HF 6ES7134-6JF00-0CA1

10.4.6 Digital Inputs

10.4.6.1 The system shall be capable of supporting the following digital input types:

A. 24 VDC (capable of being time stamped to 1 msec accuracy)
B. 125 VDC
C. 24-48 VAC/DC, 60 Hz
D. 220 VAC, 60 Hz

10.4.6.2 Eight (8) digital inputs for 24V DC - High Feature Fields of application;

10.4.6.2.1 Input module for a bit-modular setup in order to adapt to an automation task, being suited for the connection of switches and 2-wire sensors according to IEC 61131 Type 1 and 3 with internal or external sensor supply.

10.4.6.3 System features;

A. Supply voltage 19,2 – 28,8 V DC
B. Push-In terminals for tool-less wiring

10.4.6.4 Stationary wiring.

Exchangeable terminal box suited for cable diameters (flexible cables)

10.4.6.5 Re-parametrizable during operation

10.4.6.6 LED status display for channel-specific status information

10.4.6.7 LED diagnostics display on the device

10.4.6.8 Protection against short circuit on the sensor supply

10.4.6.9 Input delay parametrizable by channel:

A. 0,05 ms to 20 ms

10.4.6.10 Diagnoses;

10.4.6.10.1 Parametrizable by channel

A. Missing load voltage L+
B. Short circuit to M
C. Wire break

10.4.6.11 Functions;

A. Parametrizable process alert (per channel)
B. Parametrizable extension of signal impulses
C. Access to inputs via multiple controllers (MSI)

10.4.6.12 Technical Data;

A. Permissible input voltage: -30 to 30V

10.4.6.13 Temperature range for standard components:

A. Horizontal installation: from 0 to 60 degrees C
B. Vertical installation: from 0 to 50 degrees C

10.4.6.14 Max. cable length:

A. Shielded current: 1000m
B. Shielded voltage: 600m
C. Reference model; Siemens / DI 8x24VDC/0,5A HF 6ES7131-6BF00-0CA0

10.4.7 Analog Outputs

10.4.7.1 The system shall support output types of 0-20 mA, 4-20 mA, ±10 V DC, 0-10 V DC, and 1-5 V DC.

10.4.7.2 Analog output modules shall operate with an error limit less than the following:

A. Voltage ±0.2% of output
B. Current ±0.3% of output

10.4.7.3 4 analog current and voltage outputs – Standard Fields of application;

Output module for a bit-modular setup in order to precisely adapt to the automation task, qualified for delivering current and voltage values to actuators

10.4.7.4 Range of values:

10.4.7.4.1 Output range for current output:

A. ± 20 mA
B. 0 to 20 mA
C. 4 to 20 mA

10.4.7.4.2 Output range for voltage output:

A. ± 10 V
B. ± 5 V
C. 0 to 10 V
D. 1 to 5 V

10.4.7.4.3 System features;

A. Supply voltage 19,2 – 28,8 V DC
B. Nominal value 24V DC
C. Push-In terminals for tool-less wiring
D. Stationary wiring

10.4.7.4.4 Exchangeable terminal box suited for cable diameters (flexible cables)

10.4.7.4.5 Re-parametrizable during operation

10.4.7.4.6 CPU runtime calibration

10.4.7.4.7 LED status display for channel-specific status information

10.4.7.4.8 LED diagnostics display on the device

10.4.7.4.9 Output type/range parametrizable by channel

10.4.7.4.10 Max. operational limit: 0,5% %

10.4.7.5 Diagnoses;

10.4.7.5.1 Parametrizable by module

A. Missing load voltage L+
B. Short circuit
C. Overflow
D. Underflow
E. Wire break

10.4.7.5.2 Technical Data;

A. Permissible output voltage: 0 to 30V

10.4.7.5.3 Temperature range for standard components:

A. Horizontal installation: from 0 to 60 degrees C
B. Vertical installation: from 0 to 50 degrees C

10.4.7.5.4 Max. cable length:

A. Shielded current: 1000m
B. Shielded voltage: 200m

10.4.7.5.5 Reference model; Siemens / AQ 4xU/I ST 6ES7135-6HD00-0BA1

10.4.8 Digital Outputs

10.4.8.1 The following solid state output ratings shall be available:

A. 24 V DC
B. 220 V AC, 60 Hz

10.4.8.2 Relay or solid-state output contacts that are free of voltage and ground shall be available.

10.4.8.3 Relay outputs with 24 VDC to 127 VDC, 48 VAC to 220 VAC, 5A rating shall be available.

10.4.8.4 Digital output module with actuator shutoff via low signal or high signal must be available.

10.4.8.5 -8 digital outputs for 24VDC 0,5A – Standard Fields of application;

10.4.8.5.1 Output module for a bit-modular setup in order to precisely adapt to the automation task.

10.4.8.5.2 Qualified for magnetic valves, DC contactors and signal lamps.

10.4.8.6 System features;

A. Supply voltage 19,2 – 28,8 V DC
B. Push-In terminals for tool-less wiring
C. Stationary wiring

10.4.8.7 Exchangeable terminal box suited for cable diameters (flexible cables)

10.4.8.8 Re-parametrizable during operation

10.4.8.9 LED status display for channel-specific status information

10.4.8.10 LED diagnostics display on the device

10.4.8.11 Protection against short circuit

10.4.8.12 Diagnoses;

10.4.8.12.1 Parametrizable by module

A. Missing load voltage L+
B. Short circuit to M
C. Short circuit to L+
D. Wire break

10.4.8.13 Functions;

A. Re-parametrizable substitute value for CPU STOP

10.4.8.14 Technical Data;

10.4.8.14.1 Outputs P-switching

10.4.8.14.2 Output switching capacity:

A. resistive load: 0,5A
B. lamp load: 5W

10.4.8.14.3 Output sum current:

A. per channel: 0,5A
B. per module: 4A

10.4.8.15 Temperature range for standard components:

A. Horizontal installation: from 0 to 60 degrees C
B. Vertical installation: from 0 to 50 degrees C

10.4.8.16 Max. cable length:

A. Shielded: 1000m
B. Unshielded: 600m

10.4.8.17 Reference model; Siemens / DQ 8x24VDC/0,5A ST 6ES7132-6BF01-0BA0

10.4.9 Module Interface

10.4.9.1 Profinet interface module for distributed I/Os – Standard Fields of application

10.4.9.2 Connection of up to 32 distributed I/O modules to a PLC via PROFINET

10.4.9.3 System features;

A. For ex areas zone 2
B. Supply voltage 19,2 – 28,8 V DC
C. Support of media redundancy processing MRP
D. LED for indicating diagnoses on secondary module errors
E. RUN with gaps possible
F. Module exchange under power (1 module)
G. Support of identification data I&M 0 to 3
H. Bus system PROFINET RT/IRT
I. Min. bus cycle: 250µs
J. Expansion of up to 32 IO-modules

10.4.9.4 Features;

A. Support of failsafe modules
B. Activating/deactivating configuration variants via data sets (option handling)
C. Multiple PLC run (Shared Device)
D. Support of PROFIenergy

10.4.9.5 Technical data

10.4.9.5.1 Max. address volume

A. per module: 256 Byte I/O
B. per station: 512 Byte I/O

10.4.9.6 Standard component temperature range:

A. Horizontal installation: from 0 to 60 degrees Celsius
B. Vertical installation: from 0 to 50 degrees Celsius

10.4.9.7 Reference model; Siemens / IM155-6PN ST 6ES7155-6AA00-0BN0

10.4.10 HART I/O

10.4.10.1 The system shall support HART inputs and outputs. The HART interface shall be a module on PROFIBUS, or the HART devices can be connected to conventional analog input/output modules.

10.4.10.2 All components shall have plug and play capability.

10.4.10.3 The engineering system shall be able to read all variables provided by the field device without the need for any additional wiring.

10.4.11 I/O, Instrumentation, and couples

A. The I/O Interfaces and couplers must be integrated in the alarm system of the control system.
B. The I/O Interfaces and couplers should optionally offer recording of events SOE (Sequence of Events).
C. The I/O interfaces should support high channel density (i.e. >320 discrete or >80 analog I/O).
D. The I/O interfaces / couplers shall support HART sensors.
E. The scan rate for all channels shall not be longer than 120 ms.
F. A 1 ms time stamp for DI must be available (SOE= Sequence of Event)
G. The system shall be capable of closed loop scan rates of 10 ms.

10.4.12 Marshalled Termination Assemblies

10.4.12.1 To reduce installation costs and startup time, the system shall offer a standard set of Marshalled Termination Assemblies (MTA) as a means of providing fast and easy connection to the field level while preventing wiring faults. These termination assemblies shall provide individual blown-fuse indication and redundant power connections. A common MTA shall support connection to a redundant or no redundant I/O configuration.

10.5 FIELD BUS INTEGRATION

10.5.1 General Requirements

10.5.1.1 The system shall be able to read all variables provided by the field device without the need for any additional wiring. Diagnostic information shall be available from the field devices, including device faults, configuration faults, operating mode, and maintenance requests.

10.5.1.2 Compatibility with 3rd Party Devices

10.5.1.3 The system shall support all field devices certified by the appropriate standards body for that field bus type and shall not require additional approvals by the vendor of the host system.

10.5.2 Process Automation Fieldbus Segment (H1) / Foundation Fieldbus (FF)

10.5.2.1 Communication rates with process field devices connected to the H1 field bus shall be 31.25 Kbps.

10.5.2.2 An H1 ring topology should be available such that a disconnect or cut in the ring will still allow communications to all field devices.

10.5.3 Interoperability

10.5.3.1 The system shall support the use of devices from multiple manufacturers on the same field bus.

10.5.4 Interchangeability

10.5.4.1 The system shall support the ability for a field device from a given manufacturer to be replaced by one of the same type (e.g. temperature measurement instrument) from a different manufacturer without loss of functionality. The configuration software shall support these features.

10.5.5 Minimize Wiring Costs

10.5.5.1 To minimize wiring costs it should not be necessary to run individual cables for each H1 segment from the field all the way back to the vicinity of the controller.

10.5.6 Number of Devices per H1 Segment

10.5.6.1 The H1 field bus segment shall support up to 31 devices in a general purpose area and up to 9 devices in an intrinsically safe (EEx-i) area. (Assuming an average 12 mA current draw per device).

10.5.7 Minimizing the number of Physical Devices

10.5.7.1 To minimize the potential points of failure in the system, no separate physical device connection should be required to provide power to field devices.

10.5.8 Integrated Bus Terminator

10.5.8.1 The system's H1 interface shall include a power conditioner and an integrated bus terminator to reduce the number of points of failure and to reduce the labor cost to wire the segment.

10.5.9 Redundant & Fault Tolerant Process Fieldbus

10.5.9.1 To make it practical for users with mission critical applications, the system shall support the creation of optional redundant / fault tolerant architectures at the H1 level for PROFINET.

10.5.10 High Availability through fault tolerance

10.5.10.1 To allow mission critical process instrumentation to keep running in the event of communication faults, the system shall be able to sustain the following types of faults without interruption:

A. Breakdown of the field bus Coupler
B. Short circuit or wire break on the field bus backbone
C. Short circuit or wire break on a field bus spur segment
D. Loss of / Missing terminator

10.5.10.2 Field Device Distribution Box

10.5.10.2.1 To decrease the costs of installation and maintenance, the system shall support the use of field distribution boxes for connection and termination of multiple smart field devices. The field distribution boxes shall provide the following capabilities:

A. Automatic monitoring of trunk line
B. Support connection of at least 4 instruments
C. Automatic bus termination
D. IP65 case, PG connectors
E. Short-circuit proof spurs
F. Temp. range: -25° to 60° C
G. Usage within zone 2 (Class 1 Div.2)
H. Diagnosis through LEDs

10.5.10.3 Online Configurability

10.5.10.3.1 The system shall support the making of online configuration changes such as repairs, extensions and modifications to trunk lines.

10.5.10.4 The vendor shall be able to integrate field devices connected via FOUNDATION Fieldbus into the control system architecture quoted.

10.5.10.4.1 The System shall have an interface that allows the user to connect FF devices to the system. The following functions should be supported:

A. Cyclic and acyclic data exchange
B. Diagnostics
C. Integration in the systems maintenance station
D. “Control In The Field”

10.5.11 AS-Interface I/O

10.5.11.1 Possibility of the system shall support AS-Interface inputs and outputs for discrete devices such as switches and solenoids. The AS-interface shall be a link module on PROFINET, communicating with the devices over the AS-Interface serial cable.

10.6 COMMUNICATIONS AND NETWORKING

A. The system shall utilize Industrial Ethernet on the System Bus for communication between controllers and HMI servers or single stations.
B. The system shall support the use of standard commercial, off-the-shelf networking components for the terminal bus to communicate between servers and clients.
C. The system shall support the use of Fiber Optic and Copper (Twisted Pair) media.
D. The system shall support communication at 10 Mbps and 100 Mbps on the system bus and up to 1000Mbps on the terminal bus network.
E. A project-spanning network view must be available.
F. Intelligent field devices (Profibus PA, HART, FF) shall be accessible via an integrated configuration tool.
G. The system shall be able to control and diagnose intelligent drives via the field bus
H. The system shall support WLAN wireless networks.
I. The following maximum network sizes shall be supported: Electrical – up to 1.5 km, Fiber Optic – up to 150 km, WAN – worldwide (incl. Web-client).
J. The vendor system should offer networking options and support hybrid applications and linking of package units.

10.6.1 Supported Architectures

A. The system shall support the following networking topologies for setup of the System Bus: Linear, Tree, Ring, Star, and Redundant.
B. The system shall support the following networking topologies for setup of the Terminal Bus: Linear or Redundant.

10.6.2 Industrialized Smart Switches

10.6.2.1 Optional smart switches shall be available for use with the system that are designed for use in industrial environments. These switches shall have the following characteristics:

A. Support for Fiber Optic or Copper Media
B. Built-in Digital Inputs that can be wired into the system to alert users of networking faults
C. Signaling contacts to alert users of port or power supply failure
D. Redundant power supplies
E. Built-in web-based networking management tools
F. High speed networking fail-over times of 300 msec or less
G. Fan less design
H. Extended temperature range - 0 degrees C to 55 degrees C

10.6.3 Event-Driven Communication

10.6.3.1 To minimize the communication load on the System Bus, change-based communication shall be used by the system for the communication of alarms and

events as well as for the communication of process data from the control system to the Operator Interface.

10.6.4 I/O Bus Redundancy

A. It must be possible to configure a redundant I/O bus.
B. The vendor shall provide coupler redundancy.
C. The vendor must provide a redundant ring structure of the I/O busses.
D. It must be possible to perform value acquisition from field devices as fail-safe (1oo2) and fault-tolerant (2oo3), the vendor must ensure this with his bus architecture.

10.6.5 I/O Bus Properties

10.6.5.1 The I/O bus must have the following properties:

A. Avoids unplanned plant down-time with increased availability
B. Automatic bus termination
C. Detailed diagnostic options
D. Changes to the configuration can be performed online. They also take into account repairs and add-ons including changes on the cable bus.

11. SYSTEM CONFIGURATION

11.1 This section specifies the engineering workstation and software tools that shall be available for the initial engineering, configuration, and long-term maintenance of the system.

11.1.1 General requirements

11.1.1.1 The engineering workstations shall employ standard PC technology with state-of the-art hardware based on a Windows operating system, and industrial Ethernet communications.

11.1.1.2 It shall be possible to install more than one engineering workstation in a system.

11.1.1.3 The engineering system shall be an open system allowing, for example, project data from Microsoft Excel or CAD/CAE tools to be imported. It must be possible to import/export messages to/from Excel and Access for simple manipulation. Removable storage media shall be provided at each engineering workstation. It shall be possible to save all database and configuration data on both removable and non-removable media for back up purposes without taking the system off-line.

11.1.1.4 It shall be possible to provide redundant storage media for configuration database.

11.1.1.5 The engineering software shall employ an intuitive MS Windows explorer style interface, which will allow the user to manage all aspects of the controller, HMI, network, hardware, and field device configuration. The use of differing, inconsistent user interfaces should be avoided as much as possible.

11.1.1.6 The system shall offer fast compile and download times.

11.1.1.7 The system must support archive marking for variables. Marked variables must automatically be archived.

11.1.1.8 The system must enable data communication with a CAx system. Support of engineering workflow is required.

11.1.1.9 The HMI level must be derived from the project created on the engineering station, automatically, to avoid duplicate input of information.

11.1.1.10 Multi-layer technology must be available for picture designing to enable clear engineering.

11.1.1.11 The engineering must be supported with graphical resources; pure programming is not acceptable.

11.1.1.12 The system must enable direct derivation of a picture tree in the OS from the technological/plant hierarchy.

11.1.1.13 The system shall support hierarchical CFC charts with graphical block type (chart in chart with compilation).

11.1.1.14 The system shall be able to detect errors in the configuration, test the connection between two different data types and reject them when applicable.

11.1.1.15 It must be possible to handle the system engineering even without in-depth knowledge of object-oriented programming.

11.1.1.16 It must be possible to automatically place and connect all process objects.

11.1.1.17 The vendor system must be able to display a sequential chart in the OS.

11.1.1.18 Block programming sources must be accessible to users.

11.1.1.19 The system must harmonize with SQL, SYBASE, X Window and TCP/IP.

11.1.1.20 Centralized engineering for all components including field devices must be possible.

11.1.2 Functions of the Central Engineering Workstation

11.1.2.1 Only one engineering workstation shall be necessary to perform all traditional configuration tasks (Control, HMI, Batch, and History), Fieldbus configuration (transmitters, drives, analyzers etc), database generation, and editing. However, it shall also be possible to use multiple engineering workstations simultaneously for this work. protection (requirement shall be all HMI messages / screens / alarms will have to be provided in Portuguese language).

11.1.2.1.1 The central engineering workstation shall be capable of supporting all of the following functions:

A. I/O configuration
B. DCS hardware configuration (controller, operator stations) Configuration of plant and field communication networks
C. Field bus instrument configuration and maintenance
D. Configuration of drives, weighing scales and motor management equipment
E. Configuration of continuous and sequential control operations
F. Configuration of the plant process structure / hierarchy, for example, compliant to S88.
G. Configuration of fail-safe (Safety System) Functions
H. HMI Graphics display generation and modification
I. Tag logging (archive) configuration
J. Configuration of historical and real-time trends
K. Management of alarm and event configuration
L. Report creation, generation, and modification
M. Configuration of user security and access privileges
N. Implementation of the FDA requirements (Food and Drug Administration)
O. Process object view with test mode
P. Data communication with a CAx system
Q. The operator shall be able to perform their desired picture assembly online.
R. Asset Management configuration
S. Access to external files and programs such as Excel
T. System Diagnostics
U. Servers, Clients and keyboard plant area assignments
V. A controller simulator tool to enable logic debugging and testing w/o requiring any hardware.
W. It should be possible to protect the engineering project via a user specific password.

11.1.3 Object Oriented Engineering Tools

11.1.3.1 Object-oriented configuration tools shall be provided to aid in system configuration. It shall be possible to configure both control and HMI aspects at the same time from this tool for one or multiple process objects. The tool shall include a Spread sheet style interface for configuration which supports ease-of-use with functions such as copy/paste, search and replace, sort by column, and connection with Excel/Access. The following parameters shall be configurable from this Interface:

A. Control: Loop identifier, Alarm limits, Tuning constants, Descriptors, Engineering Units, I/O assignment.
B. HMI: Alarm Priorities, Alarm Message Text, HMI Symbol assignment, tag Archive rates.

11.1.3.2 The engineering system shall have a uniform database ensuring that data, which has been entered once by the user, shall be available to all tools throughout the system, thus ensuring that there is a single point of entry for the system database.

11.1.4 Optimization of the Run Sequence

11.1.4.1 The system shall be capable of naming processing cycles or runtime groups for optimization of the run sequence / runtime group. It must be possible to change the processing sequence of the function blocks.

11.1.5 Bulk Engineering Capabilities

11.1.5.1 The system shall provide tools for bulk editing of the configuration and to facilitate easy duplication of standard control elements (those provided standard by the system or created custom by the user). The duplication tool shall support generation of instance-specific copies via an export / copy /import routine that utilizes a spread-sheet style tool for configuration. Duplication and instantiation of the following element types shall be supported:

A. Function Blocks
B. Function Block Charts (Control Modules)
C. An entire Unit of Equipment
D. An entire Process Area
E. SFCs

11.1.5.2 The tool shall support cloning of process control elements through the import of configuration data from an external file.

11.1.5.3 The tool shall also provide a menu-guided process for defining reproducible elements and for selecting instance-specific attributes (such as tag name or configuration area) of each individual element. A user interface like a spreadsheet shall be provided for cloning elements (such as motors, valves and PID controllers) and for the configuration of their Instance-specific properties.

11.1.6 Standard Process Automation Library for Controller and HMI

11.1.6.1 A library of standard prebuilt control algorithms for process control shall be available along with their associated HMI faceplates/symbols. Optional Industry specific libraries shall be available. The standard library shall consist of the following control strategies and pre-engineered symbols/faceplates at minimum:

A. Standard PID Controller
B. CASCADE PID Controller
C. Ratio Controller
D. Split Range Controller
E. Manual Loader
F. Totalizer for Solids and Liquids
G. Digital Value Monitoring with Alarming
H. Analog Value Monitoring with Alarming
I. Motor (Start / Stop) with Interlocks
J. Motor – Two Speed

K. Motor – Forward / Reversing
L. Valve (On/Off) with 1 or 2 Feedback Signals
M. Valve (On/Off) with Interlocks
N. Motorized Valve Control

11.1.7 Configuration Structure

11.1.7.1 The application shall be viewable and configurable in a hierarchy which groups configuration elements according to the plant or process structure. This plant hierarchy shall be capable of directly representing the process model and the physical layout of the process. It shall be used to automatically derive the display hierarchy in the operator interface and to generate the dynamic elements of process graphics.

11.1.7.2 For maximum flexibility in structuring the controller program, the system shall support the creation of a configuration hierarchy that is at least eight levels deep.

11.1.8 Copy / Paste

11.1.8.1 The system shall support copy and paste of all configuration elements contained within the hierarchical configuration structure including:

A. Control Modules (Function Blocks or Charts)
B. SFCs
C. Process Graphics

11.1.8.2 The system shall support the ability to copy and paste multiple levels of the hierarchy in a single step (Deep Copy) allowing entire process areas or units to be copied and modified with minimal engineering effort.

11.1.9 Concurrent Engineering

11.1.9.1 The system shall support concurrent engineering practices whereby multiple engineers can work on the same application via a networked environment or via a “check-in / check-out” style for configuration locally on different PCs.

11.1.10 Documenting the Configuration

11.1.10.1 Tools shall be available for automatically documenting the configuration and project data.

11.1.10.2 The system shall be able to display the connections between individual charts in the automatic documentation.

11.1.11 Online Configuration Changes

11.1.11.1 The system shall support making changes to the controller, I/O, HMI, Batch, and Communication network while online without interrupting operations.

11.1.12 Change Management (General)

11.1.12.1 The engineering station (ES) shall support versioning. Configuration additions, changes, and deletions shall automatically update all modules and tags affected by the change.

11.1.12.2 Configuration changes shall follow a prompt-validation sequence requiring a final acknowledgment step before the change is downloaded to the on-line system. An option shall be provided to allow the user to view a detailed report of changes as part of the download confirmation process.

11.1.12.3 When configuration data are compiled or downloaded to the system, invalid configuration entries shall be identified, and the parameters affected shall be indicated.

11.1.12.4 It shall be possible to change, delete, and add any independent loop in the controller without affecting the other loops.

11.1.12.5 In the multi-project mode, the system shall support updating of blocks from the master data library in libraries of the individual projects.

11.1.13 Multilingual Engineering Environment

11.1.13.1 At a minimum, the English, German, Spanish, Italian and French languages shall be supported by a single version of software. The user shall be able to toggle between the different supported languages in the Engineering and Operator Run time environment without having to recompile the program.

11.2 CONFIGURATION LANGUAGES

11.2.1 Choice of Configuration Languages

11.2.1.1 Configuration languages shall be offered that are traditionally associated with both a PLC and BMS programming environment. These shall include the following programming languages including those described in standard IEC 61131:

A. Continuous Function Charts (CFC)
B. Sequential Function Charts (SFC)
C. Structured Control Language (SCL)
D. Relay Ladder Logic (LAD)
E. Instruction List (STL)
F. Function Block Diagram (FBD)
G. Safety Matrix (for programming of Safety Systems)

11.2.2 Continuous Function Chart

11.2.2.1 A continuous function chart (CFC) tool conforming to IEC 61131-3, shall be available for graphical configuration and connection of function blocks. The CFC tool positions, parameterizes, and connects predefined function blocks using an auto routing and integral message configuring function. It shall be possible to embed a CFC inside another CFC for creation of unit- or equipment-control applications.

11.2.2.2 It shall be possible to embed CFC charts to a nesting depth of eight. (Support from macro functions)

11.2.2.3 Connections between function blocks shall require no more than two mouse clicks no matter where they are located, by using auto routing.

11.2.2.4 The auto routing function shall prevent wiring from falling on top of each other.

11.2.2.5 The tool shall support comprehensive syntax checking during configuration.

11.2.2.6 Double clicking a connection shall turn the wiring a different color and shall open the destination of the connection, for example, another CFC chart or the I/O module where the signal is connected.

11.2.2.7 The system shall support trend displays of up to 8 trends in the CFC. It must be possible to export the displayed values.

11.2.2.8 The vendor system shall enable drag-and-drop across charts in the CFC with tracking of the interconnections.

11.2.3 Sequential Function Chart (SFC)

11.2.3.1 A sequential function chart (SFC) tool shall be available for graphical configuration of sequential and batch processes per IEC 61131-3. Steps and transitions shall be graphically configured using a convenient editing function. The tool shall support comprehensive syntax checking during configuration.

11.2.3.2 Connections to continuous control functions shall be available using simple actions such as Browse, Drag and drop and Fill in the blanks.

11.2.3.3 The operator's visualization display shall be automatically created, including dynamic step/transition boxes, overview, navigation display, and list boxes.

11.2.3.4 To minimize configuration time, the system shall automatically connect SFC steps and transitions during configuration, based on their placement in the SFC chart, without requiring the user to manually connect them.

11.2.3.5 The SFC tool shall provide a standard interface for configuration of the three phases of execution of a step (Initialization, Execution and Termination).

11.2.3.6 The vendor system must be able to display multiple SFC groups with their current states in a picture in tabular form.

11.2.4 Structured Control Language

11.2.4.1 A structured control language (SCL) shall be available which utilizes a high-level text-based language whose global language definition conforms to IEC 61131-3.

11.2.4.2 This language, which is similar to PASCAL, shall be capable of being used to program calculations, complex optimization algorithms, define HMI attributes / behavior and to call other function blocks directly from within the program. It shall support the use of a subroutine style of programming to maximize modularity and reuse. Function Blocks

created using SCL can be used throughout the program like standard function blocks in the CFC Editor.

11.2.5 Ladder Logic

11.2.5.1 The system shall support programming in Ladder Logic using syntax similar to a relay ladder logic circuit diagram. The elements of a circuit diagram can include normally open contacts, normally closed contacts; function blocks etc which can be combined to form networks per IEC 61131-3.

11.2.6 Instruction List

11.2.6.1 The system shall support the use of a Statement List Programming Language (STL) which utilizes a structure similar to machine code. Each statement shall represent a program processing operation of the CPU. Multiple statements shall be capable of being linked to form networks IEC 61131-3.

11.2.7 Function Block

11.2.7.1 The system shall support configuration using function blocks according to IEC 61131-3.

11.2.7.2 The user shall be able to modify the appearance and behavior of function blocks by simple modification of an object's property sheet.

11.2.7.3 Function blocks shall have integrated startup characteristics which govern their behavior during cold start, warm start and hot start conditions.

11.2.8 Safety Matrix

11.2.8.1 The system shall support the configuration of Safety System programs using a cause and effect matrix, which allows the user to easily relate process events (inputs or causes) to shutdown devices (outputs or effects) by listing all possible causes on one axis and all effects on the other. The relation of causes to effects is defined by marking the appropriate box (intersection) in the matrix.

11.2.8.2 Configuration of matrix should be simple and intuitive by employing familiar Windows point and click, drag and drop, and dialog box style editing.

11.2.9 Custom Function Blocks

11.2.9.1 The system shall allow users to create their own custom function blocks from scratch using ladder logic, structured control language or other. These custom function blocks should be able to be added to the application library for reuse through all the project.

11.2.9.2 Custom function blocks shall be used in the application just like a standard function block (for example they can be embedded in CFCs or connected to standard function blocks) Custom function blocks shall have the capability of being password protected so that access to proprietary intellectual property may be protected in the field.

11.2.9.3 There shall be no practical limit to the number of custom objects that that a user can create, and download is only limited by the memory capacity of the target controller.

11.2.10 Interconnection of Function Blocks and Control Modules

11.2.10.1 All parameters contained in a control module (composite of multiple function blocks) shall be able to be directly connected to another control module without the need for additional parameter function blocks.

11.2.10.2 The system shall support auto routing which allows function blocks which are located anywhere in the configuration to be connected quickly by two mouse clicks.

11.2.10.3 The system shall prevent the user from connecting function block parameters which have different types (real, Boolean, string, etc.).

11.2.11 Process and Equipment Interlocks

11.2.11.1 For ease of use and to minimize engineering costs, it shall be possible to configure device interlocks graphically via simple point and click operations between function blocks. It shall not be acceptable to require the user to program the interlocks using a text-based script-editor.

11.2.12 Testing and Commissioning

11.2.12.1 All configuration tools shall have test and commissioning functions, for example, it shall be possible to display and modify the value of a function block input or output parameter during operation, and with SFCs, to display step conditions and transitions during operation. it is requirement that the supplier provide all documentation tests and perform the tests for commissioning and SAT.

11.2.12.2 From the engineering environment, the user shall be able to create a Dynamic Display List to view and manipulate selected real-time input and output values from the control strategy within a spreadsheet-style view.

11.2.12.3 The user shall be able to create Dynamic Trend Displays from the engineering environment to monitor selected real-time input and output values from the control strategy.

11.2.12.4 It shall be possible to disable the execution of a configured module or force specific values (i.e. hardwired I/O signals) to override the actual signal, all without affecting other modules that may be running in the same controller.

11.2.13 Configuration / Change Management

A. Change tracking of Function Blocks

Each function block or chart shall have a unique Date/Time stamp which indicates when it was last modified. This information shall be displayable as an object property so that it is viewable directly from the engineering tool.
Function blocks / Charts shall support the assignment of a unique version number and author. This information shall be displayable as an object property so that it is viewable directly from the engineering tool.

B. Comparison Tool (Version Cross Manager)

An optional tool shall be available to perform a detailed comparison of two applications or versions of an application. This tool shall use a MS Windows Explorer-like interface to graphically highlight what elements of a configuration are different (CFCs, SFCs, Function Block types, Scan Rate Order etc). By selecting a “flagged” element, the user can dive deeper to determine exactly what is different (such as an Alarm Limit or Tuning Parameter).

11.2.13.1 The comparison tool should be able to identify differences in the following elements at minimum:

i. Application Program (Function Blocks, Charts, SFC, hierarchy / layout)
ii. Hardware Configuration
iii. Communication / Network Configuration
iv. Alarms
v. SFC details (Steps, Transitions and Properties)

A. Project-Specific Libraries

The system shall support creation of a project-specific library which contains only those standard function blocks, charts, and custom function blocks developed by the user that have been approved for use on the project. During configuration all other system libraries can be hidden to ensure that the project team uses only the “project-approved” elements during the application development phase.

B. Central Management of SFCs

The system shall support central management of SFCs by providing “SFC Types”, which allow a single sequential function chart (e.g. Reactor Heat Phase) to be copied and reused throughout an application. Making a change to one instance of the SFC shall result in the automatic update of all other instances in the configuration, thus saving engineering time and minimizing the chance of creating inconsistencies in the application.

C. Change Log

An optional tool shall be available for use on the Engineering workstation to enforce user access control for execution of protected actions (such as downloading a configuration change to the controller) and to allow recording of comments (detailed reason for change). Information will be recorded in a change log file, which shall be continuously updated with each new change. The change log shall be capable of being reviewed at a later point in time.

D. Read/Edit Protection of Function Blocks

The system shall support the locking of user-created custom function blocks. This ensures that the contents of the custom block cannot be viewed or edited, allowing users such as OEMs to securely protect their intellectual property.

11.2.14 Integrated ANVISA Functionalities (non-validated item)

11.2.14.1 The vendor shall offer wide-ranging ANVISA functionalities in his system, including features listed in the following:

A. System Logon
B. User administration and access control
C. Staged permission levels
D. Change log: recording of all changes during the production
E. Automation system: program download, changes in test mode for CFC/SFC, download of hardware and communication configuration
F. OS: program download
G. Change log: changes in projects and libraries, logons/logoffs, opening and closing projects and libraries, changes to settings
H. Version management (version trail): versioning of projects, libraries, multiprojects, recipes
I. Comparing/updating projects (Version Cross Manager): CFC/SFC, hardware configuration, communication configuration, OS alarms, plant hierarchy, SFC details (step, transitions, properties etc.)

11.2.15 General

11.2.15.1 A driver wizard shall be available to generate all blocks required for the diagnostics of I/O modules and field devices.

11.2.15.2 Object naming shall support at least 16 alphanumeric characters, and users shall be able to change an object's tag name without deleting and re-adding the object or any references to it, for example, SFC charts, process pictures or tag logging archives.

11.2.16 Database Reporting and Modification Utilities

A. Global Search Utility

Utilities shall be provided for global searching of the database. These utilities shall be under system access control.

B. Cross Reference Data Listings

The system shall be capable of generating listings containing the following fields:

B.1. Tag ID
B.2. Tag descriptor
B.3. Point type
B.4. Hardware address
B.5. It shall be possible to perform the following functions on the above list:
B.5.1. Sort alphanumerically by any field
B.5.2. Filter by any field
B.5.3. Print, display and store to media
B.5.4. Export Data

C. The above listings shall be available for all devices in the system.

12. CONFIGURATION AND MANAGEMENT OF FIELD DEVICES

12.1 A field device management tool shall be available to configure, parameterize, commission, and view diagnostics for intelligent field devices remotely (via a local station in the field), or from a central engineering station.

12.2 This single tool shall provide a uniform display of device parameters and functions for all supported devices regardless of their communication link, for example PROFINET, the HART protocol and Foundation Fieldbus H1.

12.3 in Buruti project was adopted / defined the level 1, in terms of hardware field, shall be SIEMENS (PLC's and Remote Controls). In level 2 in terms of software, shall be AVEVA™ System Platform.

12.4 The tool shall support the online addition of field devices to the network without interrupting operation of the system.

12.5 The management tool shall support configuration and management of devices from 3rd party manufacturers as well as those from the system vendor.

12.6 The system shall offer the option to connect modules that are outside the standard range.

12.7 The system shall offer the option to connect fail-safe field bus instruments.

12.8 The system offers ready solutions for controlling and diagnosing drives via the field bus.

12.9 The vendor system must provide a stable power supply for HART modules. It must be possible to configure interlocks without a programming language.

12.9.1 Centralized Engineering, Maintenance & Diagnostics

12.9.1.1 The field device management tool shall have the capability of communicating with remote field devices from a central location using routing. The routing functionality shall allow communication to pass between different networks or subnets of the system transparently, so that the user can communicate with remote devices without having to connect locally to them in the field.

12.9.2 Communication modes

12.9.2.1 The field device management tool shall support the following modes of communication at a minimum:

A. PROFINET interface
B. HART Interface
C. HART Multiplexer
D. HART Modem
E. Foundation Fieldbus Interface.

12.9.3 Functions of the Field Device Management Tool

12.9.3.1 The tool shall provide the following main functions:

A. Assignment / Configuration of Slave (network) addresses
B. Device adjustment and modification
C. Device comparison
D. Plausibility testing
E. Simulation, including a choice of predefined simulation routines such as ramp up, down, randomize, etc.
F. Automatic diagnostics
G. Management and commissioning
H. Online monitoring of selected values, alarms, and status signals
I. Life list for the automatic detection of existing field devices with the ability to:
   I.1 Open a device configuration screen directly from the life list
   I.2 Add devices from the life list to the application
   I.3 Configuration of field instrumentation from the life list (for field bus and for HART devices)
J. The vendor system shall support HART instruments in the life list
K. Import/Export capability for field device data exchange with other projects or other tools.
L. Export of device status information
M. Document management to allow online access to up to 10 documents per device
N. Change log

12.9.4 Field Device Management Display

12.9.4.1 The tool shall have a graphical user interface supporting several different views of the field devices:

A. Hardware project view
B. Process device network view – Displays device information, including diagnostic status, grouped according to the network topology
C. Process device plant view – Displays device information, including diagnostic status, for all devices in the system from all configured networks
D. Field device parameter view – Displays detailed device parameter information in a tabular format. This view shall support display of the following parameter information: Parameter Name, Value, Unit, and Status (Initial Value, Changed, or Invalid)

12.9.5 Comparison of Online and Offline Device Data

12.9.5.1 The tool shall support the ability to do a direct comparison of the online and offline device data. The comparison shall be displayed in a side-by-side format with the differences highlighted automatically by the tool.

12.9.6 Updating Device Profiles and Adding New Devices

12.9.6.1 The device management tool shall support the easy integration of new field devices and device driver updates of existing devices purchased from the system manufacturer or from 3rd party manufacturers. The device description files and drivers required for updating the management tool can be downloaded from the manufacturer's internet site. Device description files will utilize the Electronic Device Description Language (EDDL) format.

12.9.7 Device Diagnostic States

12.9.7.1 The management tool shall support the determination and display of the following diagnostic states at a minimum:

12.9.7.2 Communication States: Unchecked, Fault, Good Device Status: Unchecked, Configuration Error, Fault, Maintenance Required, Maintenance Recommended, Simulation or Manual Operation, Process Error, Good.

12.9.8 Role-based User Access & Security

12.9.8.1 The tool shall provide at least two different sets of user access and authorization privileges. At minimum the following users and sets of access privileges shall be provided

12.9.8.2 Maintenance Engineer – Can modify only operational data (parameter changes)

12.9.8.3 Specialist - Can modify all configurable data. Includes the optional definition of a password for access protection

12.9.9 Logging Tool

12.9.9.1 For troubleshooting purposes, the device management tool shall provide an integrated logging function. The log shall provide the ability to activate and choose which types of messages are displayed within the tool and to be saved to file for later review.

12.9.9.2 The following types of messages (selectable) shall be recorded as part of the logging function:

A. Errors
B. Warnings
C. Communication Messages
D. Details

13. CONFIGURATION OF THE OPERATOR INTERFACE

13.1 The workstation for Human Machine Interface (HMI) shall provide an object-based process graphics engine, which can provide process visualization and control. A standard utility shall be provided that is able to generate and modify user-defined color graphics. It shall use the same tag IDs that are used in the process database to access real-time variables from any database. It shall be subject to system access protection (requirement shall be all HMI messages / screens / alarms will have to be provided in Portuguese language). The development of the graphic screens should follow the pattern of the Takeda

13.2 The vendor system shall offer a wireless, mobile input medium.

13.3 The number of simultaneously opened windows may not be limited.

13.4 Capabilities of the Graphics Development Tools

13.5 The workstation shall include easy to use drawing tools, graphic palettes, and standard graphic object libraries.

13.6 The graphics system should provide Wizards to help the user with multi-step configuration operations including but not limited to: exiting the HMI application and/or Windows, dynamic language switching, screen navigation, calling up an external application, faceplate call-up, and connecting a symbol to a process object.

13.7 The dynamic properties of each graphic object, including fill level, fill color, text, shall be easily modifiable by assignment on the object's property sheet.

13.8 The graphics system shall support configuration of separate scan / refresh rates for individual graphical elements (symbol, process value etc) to allow for optimizing the system load.

13.9 The workstation shall provide support for standard Windows functionality such as: cut, copy and paste, drag and drop, grouping, ungrouping, and layering of objects.

13.10 The cut, copy, and paste functionality shall allow the user to include windows clipboard content.

13.11 The graphics system shall include a selectable grid to align objects vertically, horizontally, left, right, top, bottom, and automatically space objects with equal horizontal or vertical distance between them. Tools shall also be provided to rotate and flip objects horizontally and vertically.

13.12 The graphics subsystem shall provide up to 32 graphical layers which can be individually enabled/disabled (like a CAD Drawing Package) to facilitate the drawing of complex pictures. The following layering capabilities shall be provided:

A. Ability to promote / demote objects between layers
B. Zoom functionality while creating pictures, including the ability to rubber-band specific areas of interest
C. Maximum desktop size of 27", 1920 x 1080 pixels

13.13 Standard Graphic Elements provided by the System

13.13.1.1 Standard graphic elements provided by the system should include but not be limited to: Lines, polygon curves, polylines, circles, arcs, ellipses, rectangles, polygons, static text, OLE objects, ActiveX objects, input and output fields, bars, graphic picture objects (bitmap BMP, Windows Meta File WMF, and Enhanced Windows Meta File EMF), status displays, text lists, 3D bars, buttons, check boxes, radio boxes, and sliders.

13.13.1.2 The system shall provide pre-configured smart control objects to represent clocks, gauges, tables, application windows, alarm windows, and trend windows.

13.13.1.3 The workstation shall be supplied with a full library of process-oriented objects for the development of process graphics including but not limited to pipes, motors, valves, pumps, tanks, fans, indicators, sensors, conveyors, and electrical symbols.

13.13.1.4 These objects shall be provided in various formats (static, capable of being dynamically linked to the control strategy, 2-D, and 3-D).

13.13.2 Dynamic HMI Symbols for the Control Library

13.13.2.1 Pre-engineered graphics symbols shall be provided for all process control elements in the standard control library (PID Controller, Valves, Motors, etc). These pre-engineered symbols shall be designed to call up their associated faceplate and to represent the dynamic behaviors of the underlying control element, without requiring any additional configuration effort.

13.13.2.2 The workstation shall allow the user to create libraries of custom and composite symbols. Library management shall be an integral part of the system.

13.13.2.3 The system shall allow identical handling of all safety- and non-safety-related process tags (process variables) in the OS (visualization, operator control, monitoring, etc.).

13.13.3 Global HMI Symbols

13.13.3.1 The system shall support the creation of global HMI symbols for representation of process control elements. Edits to one instance of a global symbol shall be propagated automatically via a wizard to all other instances of the symbol in the application without manual reconfiguration.

13.13.4 HMI Faceplates

13.13.4.1 Faceplates shall be generated automatically by the system for each function block / chart provided in the process control library (PID Controller, Motor etc).

13.13.4.2 The User shall not be required to individually configure a faceplate detail display for each instance of a process object or control module.

13.13.4.3 Faceplates shall be linked to a corresponding HMI symbol such as a motor or valve. The symbol shall be programmed automatically by the system to call-up the appropriate faceplate without requiring any manual engineering steps.

13.13.4.4 A Faceplate list (Tag List) shall be created automatically by the system. This tag list will allow an operator to call up a faceplate by selecting it from a list of tag names.

13.13.4.5 The system shall provide a dedicated Faceplate Designer utility to facilitate easy creation of custom faceplates.

13.13.4.6 It must be possible to simultaneously open 3 faceplate instances on the OS (operator station).

13.13.5 SFC Visualization

13.13.5.1 To minimize engineering costs, the system shall be capable of automatically generating HMI representations of SFCs (aka SFC Visualization) directly from the control strategy, without additional engineering. These screens shall allow operators to monitor the status and interact with an SFC directly from an operator console.

13.13.6 SFC Status Displays

13.13.6.1 The system shall provide a standard SFC Status display object which will provide an overview of the status of the area-relevant SFCs. Additional information including the SFC Visualization faceplate shall be accessible from this status display.

13.13.7 Automatic Creation of Process Graphics

13.13.7.1 HMI displays, including the dynamic elements used to represent function blocks (such as motors, valves and PID Controllers), shall be generated automatically from the controller configuration. No manual engineering shall be required to place the dynamic elements on the displays or to link them to the controller configuration. The user interface should support automatic creation of static process pictures with MS Excel and Visual Basic.

13.13.8 Automatic Creation of Display Navigation

13.13.8.1 A hierarchical navigation scheme (like folders in Windows Explorer) shall be created automatically by the system for operator call-up of process pictures.

13.13.9 Change Management

13.13.9.1 To simplify change management and limit configuration errors to a minimum, the system must support automatic updating of all references to changes (Change Management) in a function block (including process graphics, faceplates, archives and scripts), for example, by changing the instance name of the function block.

13.13.10 HMI Scripting

13.13.10.1 The HMI development environment shall support the ability to customize the application using powerful scripting languages. The system shall support the following languages:

A. ANSI C
B. Visual Basic Script (VBS)

C. Visual Basic for Applications (VBA)
D. The programming environment shall support the following functions:
E. Ability to access properties and methods of all Active-X controls included with the application or provided by a 3rd party
F. Ability to easily establish connections to other applications / databases (such as Microsoft Excel and SQL databases)
G. To execute system functions such as initiating a report or generating an operator message
H. To define custom menu entries or configuration dialogs
I. User friendly editor with debugging support
J. Search and replace function to facilitate text modifications
K. A windows tree / list view presentation techniques to facilitate the display, creation, and editing of program scripts
L. Ability to have multiple functions or actions open simultaneously, and be able to drag and drop code between them. The programming environment shall permit user developed functions and/or libraries to be easily loaded and called.

13.13.11 HMI Database

13.13.11.1 The database system shall support both internal (computational) and external tags (real world). The database system shall support the following tag types/storage formats: binary, signed 8-bit, unsigned 8-bit, signed 16-bit, unsigned 16-bit, signed 32-bit, unsigned 32-bit, 32-bit IEEE 754 floating point, 64-bit IEEE 754 floating point, 8-bit character text, 16-bit character text, raw (user definable) and structured (template) tags.

13.13.11.2 Tag IDs shall be unique throughout the system and access to all tag parameters for configuration shall be available directly by tag ID.

13.13.11.3 The system shall provide the capability to define free-format alphanumeric descriptors for each state of a multi-state device, for example, open, closed, travel, and fault for a motor operated valve (MOV).

13.13.11.4 Configuration and archive data shall be stored in a relational database, which can be read using ODBC (open database connectivity) and Standard Query Language (SQL).

13.13.11.5 The vendor system shall provide consistent archives following a system failure.

13.13.11.6 The project archive shall contain all HMI segments. Additional work steps are not accepted.

13.13.12 HMI Text Library

13.13.12.1 To support localization of multilingual applications the system shall provide a text library of terminology which can be configured to contain translations for any number of languages defined by the user. This text library shall be accessible by the operator interface during runtime to allow messages and text strings to be

presented in the local language. The text library shall be capable of being exported and imported to facilitate easy configuration using Microsoft Excel.

14. OPERATOR INTERFACE ARCHITECTURE AND HARDWARE

14.1 Architecture
The Operator Interface shall be flexible to cover all possible applications from single user system (single station) to distributed client / server architectures. The architecture shall promote the use of multiple server and multiple client configurations.

14.2 The system shall be scalable, enabling the user to expand an existing installation by a simple license upgrade.

14.3 The system shall allow multiple clients to access up to 12 servers or 12 redundant pairs of servers.

14.4 Each server or pair of servers shall be able to communicate with up to 32 clients.

14.5 Any server computer shall be able to be dedicated to specific process functionality (i.e. Alarm Service, Historical Data Collection, etc.) Archiving of process variables should be possible on single stations, OS Servers and a dedicated Central Archive Server.

14.6 In general, it should be possible to add a redundant OS Server or Central Archive Server to a non redundant structure at any time.

14.7 All clients shall have complete visibility to all servers and the central archive server, and all servers shall have visibility at the peer level.

14.8 The software shall promote portability of applications between computers without any redevelopment or modification.

14.9 It shall be possible for the user to monitor and control the process from client or server. This includes but is not limited to:

A. View the same or different displays simultaneously
B. Make process adjustments and acknowledge alarms
C. View alarms, events, trends, and reports

14.10 The development and runtime environments shall be decoupled allowing the user to configure run-time only clients without any development capabilities.

14.11 For small systems it should be possible to combine all system engineering functions, the Operator Interface, Archiving, Batch and Controller on one PC.

14.12 PC Platforms

14.12.1.1 The Operator Interface consoles shall utilize standard PC technology with state-of the-art hardware based on a Windows operating system, and industrial Ethernet communications.

14.12.1.2 The system shall support the Window operating systems Windows 10. It shall be possible to swap out the complete project data onto external disks for long-term data storage.

14.13 Monitors

Monitors for operator stations shall be as follows or better:

A. Diagonal measurement 27 inches nominal
B. 1920 x 1080 resolution
C. 32,000 colors

14.14 Multi Monitor operation

14.14.1.1 The system shall support quad graphics cards with a resolution of up to 1920x1080 pixels. If multi-VGA cards are used, each OS client shall be able to drive between two to four monitors, but with a corresponding reduction in the number of clients per server. The multi-monitor workstation shall allow user configurable layouts. It shall be possible to dedicate either one or both monitors to the operator interface.

14.14.1.2 Additionally, it shall be possible to use the second monitor to view other applications without interfering with the viewing of operator process graphics and displays.

14.15 Printers

14.15.1 Display Hardcopy

A. The OS shall be able to generate a electronic copy, pdf file, of any active display.
B. The system shall support both full color and black and white copies for all displays.
C. The system shall support local or networked printers.
D. The printer driver should enable data reports to be generated as needed in electronic formats (pdf, excel, etc).

14.16 Time Synchronization with Control System

14.16.1 The Operator Interface shall be capable of synchronizing its time with the control system so that there is no more than a 20 msec deviation between input/output events in the field and events occurring and being time stamped at the HMI level.

14.16.2 System time will be based on UTC. However, means shall be provided to display time based on the local time zone setting within the Windows Operating System.

14.16.3 The System shall support connection to a highly accurate time source such as GPS (Global Positioning System) or DCF77 which can be used as the time master for the system.

14.16.4 Date and time synchronization shall be possible anywhere in the world using a satellite source such as GPS (Global Positioning System).

14.17 Web / Thin Client HMI Architecture

14.17.1 The system shall support web-based HMI functionality from an Internet Explorer Browser window via an Intranet/Internet or TCP/IP connection to the system's HMI Web server.

A. HMI Web Server

The HMI Web server shall be capable of supporting access for up to 50 web clients simultaneously.

B. HMI Web Client

Web Clients shall not require a full installation of HMI software, but should be operational simply by loading Internet Explorer in combination with selected plug-ins. Plug-ins shall be loadable over the internet.

C. Creating HMI Displays for Web /Thin Client Operation

HMI graphics for display on a Web client shall be automatically created by “publication” of the application into a form suitable for presentation by Internet Explorer.

D. Web / Thin Client Operation

The Web client will utilize operator graphics similar to those on the main control system with access privileges based on security/login information used in the main control system.

14.17.2 Based on password access, web client users will be able to perform the following standard operator actions at a minimum:

A. Set point changes
B. Automatic/manual loop status changes
C. Alarm acknowledgement.

14.17.3 Security of the main Operator Station Web server is maintained by end user limiting access by firewall and password authorization to their plant/corporate network.

15. OPERATOR INTERFACE FOR PROCESS CONTROL AND MONITORING

15.1 General

15.1.1 All displays and graphics that show real time data shall be automatically updated when the display or graphic is on a screen. Updates shall not require operator initiation.

15.1.2 Operators shall be able to easily access specific displays and graphics by pressing dedicated function keys or overview buttons, selecting from a hierarchical list of displays in directories or menus, or by selecting from an alphabetical listing of all displays.

15.1.3 It shall be possible to move between related displays and graphics of different detail levels or of the same detail level with a maximum of two operator actions.

15.1.4 Special indication shall be used to indicate that a value is invalid.

15.1.5 The system shall provide an overview of the alarm status of all areas to which the operator has access, no matter which graphic is displayed.

15.1.6 The vendor system must provide information regarding the violation of performance limits (memory, cycle time) during download. It must be possible to modify operation enable for each instance (relating to parameter type).

15.1.7 The system shall allow plant operation and data communication via the Intranet/Internet (use of Internet browsers) based on the configuration.

15.1.8 Graphics Subsystem

15.1.8.1 The graphics subsystem shall allow the operator to trigger a control action based on one or two user inputs. At a minimum, the control action will be triggered upon:

A. Mouse button press
B. Mouse button release
C. Keystroke event

15.1.8.2 The operator shall enter data by either:

A. Direct data entry
B. Use of up/down keys
C. A scrollbar or slider

15.1.8.3 The operator can browse in the picture hierarchy at the top of the screen to bring up the desired display.

15.1.8.4 User configurable buttons or screen targets to select operational functions or displays with a single entry shall be provided. Popup displays shall be movable and expandable by the operator.

15.1.8.5 All operator triggered control actions shall be logged within the message archive system.

15.1.8.6 It shall be possible to change control assignments to allow control of any plant area from any operator workstation by using the appropriate access password.

15.1.8.7 An SFC visualization display shall be available showing the step and transition displays with step comments or the dynamic step conditions.

15.1.8.8 For safety systems that have been configured using the Safety Matrix, a Visualization screen shall be available to view the status of the cause and effects matrix online.

15.1.9 Faceplates

15.1.9.1 Faceplates shall be provided with the system to allow for control and monitoring of both regulatory and discrete control algorithms.

15.1.9.2 Faceplates shall support the display of the following information as applicable:

A. Tag ID.
B. Tag descriptor.
C. Process input, set point, and output values displayed numerically with engineering units.
D. Process input, set point, and output in bar graph representation.
E. Auto/manual mode and remote/local set point status.
F. Visual indication for alarm status.
G. Symbolic and alphanumeric indication of discrete states both for two state devices and multi-state devices.
H. Faceplates shall be defined to pop-up when the appropriate location on a process graphic (such as a symbol) is selected with the mouse.

15.1.9.3 Regulatory Control

Faceplates shall show dynamic process and status information about a single control loop. It shall be possible to perform the following control actions from a faceplate:

A. Change control block mode.
B. Change set point and other operator settable parameters.
C. Adjust outputs in manual mode

15.1.9.4 Discrete Control

Single faceplates shall be provided for control and indication of multi-state devices. For example, a motor operated valve shall indicate open, closed, intermediate position, and fault. An operator shall be able to operate the device (start, stop, open, close) from the faceplate.

15.1.10 Process Graphic Displays

15.1.10.1 It shall be possible to place a new graphic in service without interrupting an operator's ability to control the plant.

15.1.10.2 All control, monitoring, and status attributes of any tag shall be displayable on graphics. For analog points, this requirement includes measurement, set point, alarm limits, and output. For digital points, this requirement includes input and output status. Status information includes alarm status, control mode, and control status.

15.1.10.3 Numeric data shall be configurable on an individual basis. If the decimal point is not used, it shall be suppressed.

15.1.10.4 It shall be possible for each state of a multi-state device to be indicated by a unique foreground/background color combination.

15.1.10.5 It shall be possible for inactive alarm or status messages to be invisible to the operator.

15.1.10.6 Symbolic representation of data on the graphics shall be performed by color changes (foreground and background independently), and flashing in any combination.

15.1.10.7 The system shall support programming of tooltips which will display a configurable text message to an operator when he hovers over the element with his mouse.

15.1.10.8 It shall be possible to configure an area on the screen that calls up other displays.

15.1.10.9 It shall be possible for the operator to zoom in and out during runtime.

15.1.11 Screen Composition Favorites

15.1.11.1 The system shall support the operator’s ability to save specific screen compositions or layouts for call up at a future time. A favorite screen composition can consist of a process graphic with any number of specific device faceplates, trends etc. overlaid on the screen and positioned in specific locations of the display.

15.1.12 Dynamics Languages Switching

15.1.12.1 The Operator Interface shall provide the user with the capability to easily switch between languages and international character sets while online, how requirement shall be all HMI messages / screens / alarms will have to be provided in Portuguese language. Conversion between English, French, Spanish, Italian and German should optionally be supported. Re-programming, recompilation, or reconfiguration of the HMI software application shall not be necessary to achieve this functionality.

15.1.13 Security

15.1.13.1 The system must permit following virus scanners compatible to MS Windows (or most current) on the real-time computers:

A. Checkpoint Antivirus solution
B. Fortinet Antivirus solution

15.1.13.2 The system security shall be modeled after Windows 10 but configurable in a manner appropriate for control operations.

15.1.13.3 The system security configuration tool shall provide an easy to use, simple interface, which offers full support for standard Windows techniques such as copy, cut and paste, as well as drag and drop.

15.1.13.4 The system shall allow an individual's authorization to be programmatically modified and/or verified as part of the Control Logic/Scripting requirements.

15.1.13.5 The system security shall allow the configuration of authorization groups whereby individual users can be assigned to permission groups.

15.1.13.6 The system security shall allow the configuration of process area specific security for up to 256 different process areas.

15.1.13.7 The system shall support the configuration of custom security and access authorization levels up to a total of 999.

15.1.13.8 Default Security Levels

15.1.13.8.1 The OS system security shall provide different security levels to allow the access and interaction with the process to be controlled. At a minimum the following access levels should be pre-defined:

A. User Administration
B. Operation Supervision group
C. Ability to View alarms and call-up Displays from a particular area of the plant
D. Ability to Navigate through the system
E. Process Monitor - Ability to view the process in Monitor Only mode
F. Process Control (Basic) - Ability to Control the Process by sending commands, acknowledging alarms, and changing set points etc.
G. Process Control (Advanced) - Ability to modify alarm limits, PID tuning coefficients etc.
H. Ability to trigger reports
I. Ability to control archiving / storage

15.1.13.9 Advanced Access Control

15.1.13.9.1 The Operator Interface shall support the optional use of a chip card readers or a fingerprint mouse (biometric signature) to ensure unique user identification.

15.1.13.10 Global Security

15.1.13.10.1 The system shall support an optional common security system whereby the same login / password is used for the Windows operating system, the engineering environment, the HMI and for the Batch system.

15.1.14 Expandability and Extensibility

15.1.14.1 The system shall be able to collect data from multiple data servers, including other OPC-UA enabled process and control systems.

15.1.14.2 It shall be possible to exchange system data with other third party software that are compatible with the Microsoft operating system.

15.1.14.3 The OS system shall be based on an open architecture and support extensibility thorough the use of:

A. COM/DCOM
B. ODBC (Open Database Connectivity)
C. OCX / ActiveX Controls
D. OLE (Object Linking and Embedding)
E. OPC (OLE for Process Control) Data Access Protocol (DA)
F. OPC Historical Data Access Protocol (HDA)
G. OPC Alarms & Events Protocol (AE)
H. OPC Historical Alarms & Events (HAE)

15.1.14.4 The OS system functionality shall be expandable via the optional add-ons including, but not limited to:

A. User programmed ActiveX objects
B. Automatic event driven email messaging of real-time information
C. Event triggered display of live process images
D. Long term historical media-based data storage
E. Configurable messenger functions such as SMS, E-mail, Pager

15.2 ALARMS, EVENTS, AND MESSAGES

15.2.1 General

15.2.1.1 The alarm system shall provide complete alarm and event management with a user definable message structure.

15.2.1.2 The alarm system shall support definition of up to 16 message sub-classes and 16 message types.

15.2.1.3 Alarms must be assigned a time stamp based on the execution cycle in the controller.

15.2.1.4 The vendor system shall support a time stamp resolution of 1 ms for binary inputs.

15.2.1.5 The alarm system shall alarm any change of state that the system detects including:

A. Any violation of limits
B. Any change of state of a device connected to the system including all of its peripherals
C. The failure of any communications channel used by the system
D. The failure of system's hardware, which results in an automatic fail-over of the system's functions from the active to standby device.

15.2.1.6 The alarm system shall display alarm messages in a manner to facilitate easy interpretation of the current alarm status including but not limited to:

A. Different text color and background color for those points that are in alarm, those that have been acknowledged, and those that are no longer in alarm
B. Flashing of the current alarm message(s) in the alarm list
C. Alarms that have been automatically hidden by the system or manually by the operator
D. The system shall provide the option of displaying alarms in ascending or descending temporal order.

15.2.1.7 The vendor system shall provide a configurable, OS-spanning horn design.

15.2.1.8 The vendor system shall provide automatic alarm in the plant overview, without additional configuration.

15.2.1.9 The vendor system shall support more than 4 alarm priorities and more than 5 permission levels.

15.2.1.10 Alarm Acknowledgement

15.2.1.10.1 The alarm system shall provide capability to acknowledge an alarm message when a data point enters and / or exits alarm state. The system shall permit alarm acknowledgement including but not limited to:

A. For an individual alarm from the overview
B. For a filtered grouping of alarms from a summary list

C. From the device faceplate
D. From a process display (screen acknowledge)

15.2.1.11 Alarm acknowledgement from one operator station shall be automatically synchronized to other stations to provide global acknowledgement capability.

15.2.1.12 The operator name shall be saved when alarms are acknowledged.

15.2.1.13 The system shall offer the option to disable or enable messages via a second set of keys.

15.2.2 Filtering of Alarms

15.2.2.1 The alarm system shall provide filtering to control the behavior of the alarm display screens. The filtering attributes shall include but not be limited to:

A. Date
B. Time
C. Alarm class
D. Alarm type
E. Alarm priority
F. Status (in alarm, out of alarm, or acknowledged)
G. Tag name
H. Area

15.2.3 Alarm Status Symbols

15.2.3.1 The alarm system shall provide the ability to condense and present system alarming status in the form of a standard alarm status symbol (i.e. alarm group display). The group display shall be capable of indicating the status of an individual device or of an entire process area. When used to represent the status of a process area, the group display shall form a logical together of the alarm states from all devices in the process area.

15.2.3.2 The group display shall include the following standard alarm categories at minimum, which will each be represented in the symbol with a different color and text representation:

A. Alarm
B. Warning
C. System alarm
D. Operator message (operator action required)
E. Suppressed alarm state

15.2.4 Alarm Priorities

To allow for segregation of alarms based on criticality, the system shall support the assignment of individual alarm conditions to one of at least 16 different alarm priorities.

15.2.5 Categorizing Alarms and Messages

15.2.5.1 Process and designated system alarms shall be annunciated, displayed and stored in history files.

15.2.5.2 Normal plant operator actions, events and normal system actions and events shall not be alarmed; however, they shall be stored in centralized history files.

15.2.5.3 Alarms and messages shall be grouped to allow the user to readily identify and respond to alarms and conditions (e.g., in priority sequence) in his area of responsibility.

15.2.5.4 For any process alarm, it shall be possible, by no more than one operator action, for an operator to access a display from which he may take corrective action.

15.2.5.5 The system shall support the ability to display the highest priority, most recent, alarm all the time.

A. Operator Actions

The system shall automatically store all operator actions that affect process control parameters or alarm acknowledgment in centralized history files, including:

A.1. Enable/disable/acknowledge/suppress/lock/shelve alarms
A.2. Change mode of controllers
A.3. Change set point of controllers
A.4. Changes to alarm limits.
A.5. Changes to tuning parameters

B. Engineer Actions

The system shall provide the ability for Engineering actions that change the control and monitoring of the process to be stored in a log file along with a comment.

These actions shall include the following:

B.1. Download of controller configuration
B.2. Online/Test Mode
B.3. Download of Batch / Operator Station Configuration

15.2.6 Process Alarm Initiation

15.2.6.1 It shall be possible to initiate process alarms by configuring alarm attributes of any process I/O point or any calculated point.

15.2.6.2 For analog tags, the configurable triggers for process alarms shall include:

A. Process variable high limit exceeded
B. Process variable high-high limit exceeded

C. Process variable low limit exceeded
D. Process variable low-low limit exceeded
E. Process variable deviation from set point
F. Process variable invalid value (bad quality)
G. Process variable change value x / for value y

15.2.6.3 For digital tags, the configurable triggers for process alarms shall include

A. Specific state (0 or 1)

15.2.7 Alarm Suppression / Disablement

15.2.7.1 The system shall provide the ability to disable or suppress alarms at the following levels:

A. For each individual alarm condition
B. For all alarm conditions associated with a device or point
C. For all alarm conditions associated with an alarm group, process area or displayed on a process graphic

15.2.8 Minimizing Nuisance Alarms

To minimize the occurrence and effect of nuisance alarms on an operator, the system shall provide the following capabilities for identifying, managing and preventing them.

15.2.9 Alarm Dead bands & Chatter Suppression

15.2.9.1 To minimize analog input chattering (a point going in and out of an alarm condition rapidly) there shall be configurable dead band parameters, on an individual tag basis.

15.2.9.2 To minimize the occurrence of nuisance alarms during startup / shutdown scenarios the system shall support alarm chatter suppression at the controller level. This feature shall ensure that alarms are not retriggered at the HMI until they have been acknowledged.

15.2.10 HMI Displays for Identifying Nuisance Alarms

To help plant personnel identify nuisance alarms, the system shall provide standard capability to perform and display an alarm frequency analysis which identifies those alarms that have occurred most frequently over a given period of time.

15.2.11 System Alarm Initiation

15.2.11.1 Failures of individual components of the system shall result in the generation of an alarm message.

15.2.11.2 A system alarm shall be generated in the event of a failure for the following components at minimum:

A. Field device

B. Individual I/O channel
C. I/O module
D. I/O rack
E. Communication modules (bus and network)
F. Power supplies
G. Communication network
H. Controller
I. Server/clients
J. Central archive server
K. Time synchronization

15.2.11.3 All devices connected to the system communication network shall be monitored for failures. A system alarm shall be generated for each failure detected.

15.2.12 Process and System Alarms History Retention

15.2.12.1 All alarms shall be stored in history files with the capability to archive these to removable media.

15.2.12.2 Capability shall be provided to recall these alarms in visible display lists and printed lists according to selectable filtering options.

15.2.13 Alarm Annunciation

15.2.13.1 The system shall be capable of annunciating process and system alarms in ways including but not limited to:

A. Activation of an external audible alarm or light
B. Activation of the internal PC sound card (playing of .wav files)
C. Updating an alarm display with the current alarm
D. Updating an alarm overview screen to indicate the occurrence of an alarm in a specific process area / display
E. Printing the alarm message on an alarm printer
F. Any graphic object associated with the alarm point will change color, shape, appear, disappear, etc. as configured.

15.2.14 Audible Alarm Annunciation

15.2.14.1 All alarms for a process area may be assigned to any operator station at configuration time.

15.2.14.2 All alarms shall be displayed on the operator station(s) designated.

15.2.14.3 The audible alarm system shall be user configurable for different tones or patterns. A unique tone or pattern shall be capable of being generated based on alarm priority, message class or process area.

15.2.14.4 The system shall use global alarm acknowledgement allowing a single acknowledgement from any workstation to acknowledge that alarm on all stations and to silence the audible alarm.

15.2.15 Visible Alarm Annunciation

Alarms shall cause visible display annunciation at, and only at, an operator station configured for those alarms. The annunciation shall occur within 3 seconds of detecting the initiating event. It shall be possible to acknowledge process alarms only from an operator station configured for those alarms. It shall be possible for an operator to acknowledge any alarm configured at his station by no more than two actions.

15.2.16 Alarm Summary Display Lists

15.2.16.1 The system shall provide the following alarm summary display list capability at a minimum:

A. Active Process Alarms
B. Cleared Process Alarms
C. Acknowledged Process Alarms
D. Active System Alarms
E. Cleared System Alarms
F. Acknowledged System Alarms
G. Journal (Alarm History)
H. Operator Action List
I. Suppressed (Locked) Alarm List
J. Shelved (Hidden) Alarm List
K. Alarm Frequency Display (Hit) List

15.2.16.2 Accessing an alarm summary display from any other display shall require no more than one operator action.

15.2.16.3 Visible display of any alarm shall not clear unless the alarm is acknowledged; and the item initiating the alarm has returned to normal condition.

15.2.16.4 Multi-page displays may be used. If so, it shall be possible to page forward or backward by a single operator action. The display shall list alarms in tabular format in order of occurrence with the most recent at the top. It shall be possible to assign alarms to separate areas of the plant so that arriving alarms are entered in area message lists to create an area-related view.

15.2.17 “Smart” Alarming / Alarm Hiding

To minimize the alarm load on the operator and the presentation of alarms which are meaningless in context, the system shall support “smart” alarming whereby certain alarms can be automatically hidden from the operator based on the occurrence of specific process or plant conditions.

15.2.17.1 Determination of Plant State or Process Condition

The system shall provide a standard function block for determining / signaling changes in plant state or process condition from within the control strategy. This function block shall be capable of being combined with user-defined logic.

15.2.17.2 Configuration of Smart Alarming

The system shall provide tools and capability for easy configuration of which alarms will be “hidden” based on plant state or process condition. The configuration interface shall be a standard part of the Engineering system. It shall provide a spreadsheet style interface where alarms can be configured to be hidden / not hidden based on a simple checkbox.

15.2.17.3 Recording and Display of Hidden Alarms

Hidden alarms shall not be presented to the operator on the standard alarm displays or on process graphics, but their occurrence shall be recorded in the alarm history (journal). A “hidden alarm” display will be provided which lists all of the alarms that are currently hidden from the operator.

15.2.18 Alarm Shelving / Manual Alarm Hiding

15.2.18.1 To help plant personnel respond effectively to nuisance alarms or during plant upset conditions (alarm floods), the system shall provide the capability for the operator to manually hide individual alarms or groups of alarms on a temporary basis.

15.2.18.2 A central configurable timer shall monitor how long the alarm has been “on the shelf” and will place it back in the operator’s view when the time has elapsed.

15.2.18.3 A comprehensive display listing “hidden alarms” shall provide to show alarms that have been hidden automatically based on smart alarm hiding techniques and manually based on operator shelving.

15.2.19 Alarm Management and Performance Monitoring

To monitor and optimize the performance of the operator in conjunction with the alarm system, the following capabilities shall be provided by the system as a standard.

15.2.20 Configuration of Troubleshooting information and Corrective Action

15.2.20.1 The system shall support the configuration of an information text message for each alarm state.

15.2.20.2 This information text message can be used to display the probable cause of an alarm or the recommended corrective action. Information text messages shall be viewable from the standard alarm display list.

15.2.21 Recording of Alarm Comments

15.2.21.1 The system shall support operator entry of a comment upon acknowledgement of an alarm. The comment shall be stored in the alarm history where it shall be associated with the event. Comments shall be viewable at a later point in time from within the alarm history.

15.2.21.2 To make it easy to locate alarms that have been commented, the alarm history display shall indicate which alarms have received comments and support quick identification by sorting and/or filtering.

15.2.22 Alarm Frequency Displays

To help plant personnel identify nuisance alarms, the system shall provide standard capability to perform and display an alarm frequency analysis which identifies those alarms that have occurred most frequently over a given period of time.

15.2.23 Alarm Message Duration / Time to Acknowledge Displays

To help plant personnel continuously improve operator response to alarms and to minimize the number of standing alarms, the system shall provide a display indicating the amount of time each alarm was active along with the amount of time that elapsed before it was acknowledged.

15.3 INDUSTRIAL / CYBER SECURITY

15.3.1 In order to protect the process automation system from the danger of hacker attacks, viruses etc., the vendor / system shall provide comprehensive industrial / cyber security capabilities consisting of products and procedures (best practices), in according with ISO/IEC 27032:2012 and ISA/IEC 62443. An DMZ dedicated to the BMS System must be provided or the existing DMZ should be reused.

15.3.2 Use of “Defense in Depth” Architectures

The system shall support the use of a “Defense in Depth” strategy as recommended by the US Dept of Homeland Security. “Defense in Depth” advocates the creation of nested security architecture by division of the plant into secure and closed security cells / segments with clearly defined and monitored access points.

15.3.3 Rules for Creation of Security Cells and Segments

The following rules shall be followed to ensure the creation of secure and fully functional security cells and segments:

A. Each segment must form a self-sufficient “zone” that can be operated for a certain amount of time without connection to other segments; thus a segment must be capable of operating autonomously for a period of time.
B. All components contained in a segment and involved in its function should be connected to one another (not through leased lines)
C. Units that cause high network and computer load when connected from the outside via a complex security mechanism should be integrated directly in the segment

D. Access to a security cell should take place only after the user's identity has been verified and logged and only under supervision of authorized persons, for example, physical access by operators.

E. All connections to the Control System LAN should be routed through a firewall, with no connections circumventing it.

15.3.4 Securing network access points

15.3.4.1 The system shall allow clear demarcation between the protected internal network (control system LAN) and unprotected or entrusted external networks.

A. Use of Firewalls

The system shall support the use of firewalls to block selective (filter) traffic between network zones (subnets) or from a network to a device. To provide maximum protection, firewalls must allow for rules to be created which allow only necessary access by employing one or more of the following techniques:

A.1. Packet filtering
A.2. Circuit level gateways
A.3. Proxy gateways

B. Supported Firewalls

The following firewalls shall be supported at a minimum:

B.1. Windows 10 Personal Firewall
B.2. Microsoft ISA Server 2004

C. Security Modules for Industrial Environments

The vendor shall supply rugged, industrial-rated security modules as required, meeting the following characteristics:

C.1. Integrated firewall capable of Filtering on IP-, MAC addresses and ports
C.2. Capable of providing the following additional functions: NAT, DHCP Server, Data encryption
C.3. IP 30 Protection
C.4. Operating Temperature Range: 0°C to +60°C
C.5. Capable of accepting Redundant Power input
C.6. Can be configured / setup without expert security knowledge

D. Creation of Demilitarized Zones (DMZ)

The system shall support the ability to segment the network by use of demilitarized zones (DMZ).The DMZ shall contain file servers, historians, and databases. Data within this level shall be used for plant-wide reporting, business level application access, and backups.

15.3.4.2 The DMZ level shall contain non-validated relational database server(s) which have been consolidated from the non-validated systems in the BMS levels.

15.3.4.3 The DMZ level shall contain a non-validated, redundant enterprise historian which is used to aggregated and consolidate data from non-validated BMS level historians. Records shall be kept, at a minimum, for the shelf-life of the product plus one year.

15.3.4.4 DMZ database servers and historians shall have the ability to archive older data to durable media.

15.3.4.5 DMZ database servers and historians shall have the ability to reintroduce archived data for retrieval.

15.3.4.6 All DMZ database servers, historians, and file servers shall be part of a backup strategy for daily incremental backups and weekly full backups.

15.3.4.7 DMZ database servers shall be installed and configured for redundancy to ensure data integrity and high availability.

15.3.4.8 Data from DMZ database server(s) and historian(s) shall be available to business level users and processes or other systems users

15.3.4.9 DMZs shall be used to provide a secure access point for the following types of control system connections:

A. Data Historian (when it communicates outside the control network)
B. Web servers
C. Security servers
D. SUS Servers

15.4 DATA HISTORIAN

15.4.1 This low section outlines the major equipment components that comprise the Data Management and Historian systems. Final component selection shall be determined by the Seller. The Data Management and Historian system utilizes automation equipment detailed, including software and licenses. A minimum of two workstations shall be supplied by the Seller enabling the end user to visualize the historian data. Additional guidance on screen maps and navigation can be found in the relevant FS document(s) for that subsystem, and/or will be developed during the execution phase of the project.

15.4.2 BMS database servers and historians shall store data collected directly from devices, controllers, HMIs, Relational databases, File Servers, and other servers. BMS file servers shall store files generated by application servers.

15.4.3 Individual validated and non-validated process historians shall exist at the BMS level 2, with all data gathered on Level 1.

15.4.4 These data file servers shall contain items such as but not limited to, operator instruction data, alarm instruction data, recipe data, and report configuration data. Files shall be segregated on file servers into secure directories and shares by application or process area.

15.4.5 Where appropriate, validated relational databases shall be combined on dedicated validated database servers to reduce system footprint. Records within relational database servers shall be accessible through standard SQL-based queries.

15.4.6 Each BMS database server, historian, and file server shall be configured for redundancy and high-availability. Servers shall be sized and licensed to handle simultaneous queries from multiple applications.

15.4.7 User Management and Access Control

15.4.7.1 Central User Management

The system shall provide the capability of the central management of users within domains or workgroups providing the following specific capabilities:

A. Create, delete, lock-out users
B. Ensure IDs are unique
C. Two-level ID (username + password) or Login Device (e.g. Card Reader)

15.4.7.2 Password Security

To ensure the security of the passwords used for accessing the system, the following capabilities shall be available:

A. Specification of password properties (min. length ...)
B. Limited time for password validity
C. Expired passwords excluded for the next “n” generations
D. Forced password change after first Log-On
E. Auto – log-off after “n” minutes of inactivity
F. Lock-out of users after “n” failed attempts to log-in.

15.4.7.3 Role-based Access Control (RBAC)

The system shall provide for user accounts with configurable access and permissions associated with the defined user role. The system shall support the implementation of the principle of minimal rights whereby users and computers can be configured with the minimum set of access rights necessary to perform their function.

15.4.7.4 Single Sign On

The system shall provide the ability for Single Sign On (SSO) authentication whereby a single login / password allows a user to have access to all programs (PC / Desktop Access, Engineering Tools, HMI, Batch Management) without requiring re-authentication for each application. The Single Sign on capability shall be capable of being used with Role-based Access Control (RBAC)

15.4.8 Software Security Patch Management & Testing

15.4.8.1 Continuous and immediate testing of new software security patches is critical to maintaining a secure network infrastructure.

Support for Immediate Installation of Microsoft Security Patches
If deemed necessary by the user, it shall be permissible to load the following new MS Security Patches on the system as soon as they are released from Microsoft:

A. Windows operating system
B. Internet Explorer
C. SQL Server

15.4.8.1.1 Testing of Microsoft Security Patches

To ensure that the latest Microsoft Security patches have been tested for compatibility with the system, the vendor shall test new Microsoft security patches immediately upon their release.
Results of the testing shall be communicated to end users so that they can choose when / if to update.

15.4.8.1.2 Software Update Service

The system shall support the use of the Windows Software Update Service (SUS) from Microsoft as a means to quickly and effectively implement automatic deployment of software updates and security patches on all PCs connected to the control network. The SUS Server shall allow viewing of all available updates so that they can be released as required in a procedure determined by the end user.

15.4.9 Use of Virus Scanners & Malware Detection

The system shall support the installation of Virus Scanners on all PCs attached to the control network. The following Virus Scanners shall be supported at minimum:

A. Checkpoint Antivirus solution
B. Fortinet Antivirus solution

15.4.9.1.1 Minimizing Impact on System Performance

To ensure that virus scanners do not have a negative impact on system performance, the vendor shall provide guidance on malware detection settings for use with their system based on the results of system compatibility testing.

15.4.9.1.2 Updates and Testing of New Signature Files

To ensure that virus scanners are able to be continuously updated to prevent new malware threats, the vendor shall test new virus signature files immediately upon their release. Results of the testing shall be communicated to end users so that they can choose when / if to update.

15.4.9.1.3 Installation and Operation of Virus Scanners

The Installation and Operation of Virus Scanners shall comply with the following:

A. Engineering Stations and all other PCs where engineered data can be introduced to the Control System Network: Virus scanners shall be operated in a real-time mode with continuous scanning of all incoming traffic and shall support manual and periodic scans while offline (Runtime and Engineering)
B. Operator Stations: Virus scanners shall be operated in real-time mode with continuous scanning of all incoming traffic (Runtime)

15.4.10 Auto Configuration of System Security Settings

To minimize the chance of error during the configuration of security settings, the system shall support the automatic configuration of Windows firewalls and registry entries.

15.4.11 Securing Access for Remote Maintenance /Troubleshooting

The system shall be capable of providing a secure connection for remote maintenance and troubleshooting. This access point shall be securable through use of local firewalls and virus scanning software at a minimum. The following methods shall be supported:

A. Authentication and Encryption with IP Security (IPsec)
B. Authentication and Encryption with Secure Sockets Layer (ssl and https)
C. Use of VPN (Virtual Private Network) tunneling and Network Access Quarantine Control for Secure Support Access

15.4.12 Testing for Security Vulnerabilities

The system shall support the end user or designate testing for vulnerabilities using the Microsoft Baseline Security Analyzer (MBSA) or equivalent. Testing shall be able to identify the following conditions at a minimum:

A. Open ports and protocols in use
B. Missing Microsoft security patches

15.5 DIAGNOSTICS AND TROUBLESHOOTING

15.5.1 On-line and off-line diagnostics shall be provided to assist in system maintenance and troubleshooting. Diagnostics shall be provided for every major system component and peripheral, including controllers, clients, servers, and communication devices. If diagnostics do not exist for particular peripheral devices such as printers and terminals, the system must detect and provide an error indication for the failure of these devices. It shall be possible to monitor and troubleshoot PROFIBUS devices, HART and Ethernet/IP devices from the control room without having to go out into the field.

15.5.2 The system shall be capable of storing calibration information and device status history for each field device. It shall also be possible for the system to upload field device configuration changes implemented in the field.

15.5.3 Once the configuration information is stored in the system, it shall be possible to download it to any other similar device, whether a new or replacement device.

15.5.4 The system shall provide the capability of communication channel problem/error diagnosis.

15.5.5 The Operator Interface shall provide a heartbeat function to monitor the state of all the controllers and HMI components, and generate a message when a change is detected.

15.5.6 If a failure is detected in any backup equipment, the operator shall be notified, and the failure shall be logged.

15.5.7 Events

15.5.7.1 All events generated by the system shall be captured and logged electronically in a to the event database, in chronological fashion, on a hard disk on one or more servers or single stations.

15.5.7.2 It shall be possible to retrieve and sort events by time (ascending or descending order) or by type.

15.5.7.3 All system events shall be time stamped at the point of origin. Events generated in the controller shall be time-stamped in the controller. Those generated in the workstation shall be time stamped in the workstation.

15.5.7.4 System events shall be defined to include the following at minimum:

A. Intelligent Field Device Change in Status (e.g. Fault, Maintenance Required)
B. Channel Failure (e.g. Wire Break)
C. I/O Module Failure (e.g. Module External Failure detected)
D. I/O Rack Failure
E. Communication Module Failure
F. Power Supply Failure (e.g. Battery Failure, Failure in 24V Source)
G. Communication Network Failure (e.g. System Bus Failure)
H. Controller Failure (e.g. Failover events)
I. Server Failure (e.g. Loss of Redundancy)

J. Condition & Performance Monitoring

15.5.8 Smart Event Suppression

The system shall provide smart event suppression whereby only the highest order error is reported to the Operator Interface. For example failure of an entire I/O Rack will result in the presentation of an I/O Rack error message, but not in an error message for each individual module located in the rack or from each individual channel of each module.

15.5.9 System and Diagnostic Displays

15.5.9.1 On-line displays shall indicate the results of self-diagnostic tests. Failure diagnosis shall be sufficiently specific to indicate which components, modules or devices are at fault. The displays shall be designed to help maintenance and engineering personnel diagnose faults in the system and communications paths. Each category of diagnostic display shall be organized logically to reflect its location in the system hardware architecture.

15.5.9.2 Within the Operator Interface, a display shall be available showing all controllers and HMI Components with their status.

15.5.10 Online Changes

The system shall support the ability to make the following changes online without interrupting operations:

A. Changing the parameters of an I/O Channel
B. Adding or Removing an I/O Module
C. Adding or Removing a Rack of I/O
D. Adding or Removing a PROFINET Field Device
E. Adding new connections to Industrial Ethernet networks
F. Modifying the range of an analog point
G. Modifying a Process Graphic
H. Adding a new tag to the Historian (Archive) database
I. Adding a new Control Loop to the Configuration

15.6 MAINTENANCE AND ASSET-MANAGEMENT

15.6.1 Core Functions

The maintenance system shall provide the following core functions:

A. Monitoring of the control system components
B. Monitoring of technological components (e.g. heat exchangers, valves)
C. Monitoring of plant components
D. Acquisition of the asset identities
E. Condition monitoring
F. Acquisition of detail diagnostics
G. Interface to specialist tools
H. Generation of maintenance requests (including predictive ones)
I. Provision of maintenance data for all assets in uniform structure and form for subsequent processing stages
J. Commissioning support
K. Logging of events and maintenance measures
L. Controller load analysis: load, tasks, alarm capabilities when configurable load limits are violated.
M. Status of the terminal and system bus redundancy
N. Status of inputs/outputs redundancy, channel-based
O. Hit list for asset alarms
P. Comprehensive asset comments are displayed on the OS
Q. Up to 10 documents can be assigned to one field instrument
R. Performance and load analysis must be possible without additional hardware costs
S. The system shall support diagnostics and parameter assignment channel-by channel.
T. Diagnostic information on network (bus load, bursts, data frame loss etc.)

15.6.2 Required Properties

15.6.2.1 The maintenance system shall fulfill the following properties:

A. Industry sector neutral package
B. Integrated in the process control system
C. Link to engineering data with no additional configuration or engineering needed.
D. Uniform and plant-wide representation of the diagnostics and maintenance state (using uniform symbols or icons).
E. Integration of field devices from all manufacturers.
F. Separate evaluation of maintenance and process-relevant information.
G. Visualization of all plant sections in uniform fashion.
H. OS (HMI) "look and feel" in conformity with that of the process system.
I. Workflow optimization from diagnostics to completion of the maintenance. It must be possible to minimize production losses and down-time.

J. Comprehensive support of condition/state-based maintenance.

15.6.2.2 The system should be based on the following recommendations:

A. Requirements for plant oriented Asset Management
B. Requirements for Integration of fieldbus connected instruments in Engineering Tools for Field Devices
C. Self-test and Diagnostics of Field Devices

15.6.2.3 The vendor system shall provide component-spanning and automatic system diagnostics & help functions as well as role-based asset processing (read, write, maintenance personnel, specialists).

15.6.2.4 The system shall provide tools and capabilities which enable preventative and predictive maintenance techniques to be employed for all of the critical assets in a plant including but not limited to motors, pumps, analyzers, transmitters and valve positioners.

15.6.3 Maintenance Station

15.6.3.1 The system shall support the creation of a dedicated and integrated maintenance station which can provide comprehensive maintenance information for all plant assets.

15.6.3.2 It shall provide the same HMI interface (look and feel) as a standard operator HMI display that would be used for viewing the process.

15.6.3.3 The basic diagnostic data for all assets will be displayed on a uniform set of faceplates. Detailed diagnostic displays can also be called up representing the following:

A. An online view of the hardware configuration
B. Online view of a smart field device through the field device management tool

15.6.4 Integrated Plant Asset Management System

Integrated plant asset management capabilities should be provided by the system for all of the following assets:

A. Transmitters & Valve Positioners
B. Motors, Pumps and Drives
C. Analyzers
D. PC's (Servers, Clients, Historians, etc.)
E. BMS Hardware (controllers, I/O modules, etc.)
F. Networking Equipment (switches, etc.)
G. Plant equipment assets (User definable)

15.6.5 Auto Generation of Asset Management Database & Visualization

15.6.5.1 The system shall automatically populate the asset management database directly from the application program and hardware configuration. No additional entry of basic information for the asset management configuration shall be required.

15.6.5.2 Faceplates and symbols will be automatically created within the HMI to allow plant personnel to easily visualize and monitor the asset's operating performance.

15.6.5.3 Special summary displays are provided for viewing of asset alarms.

15.6.6 Integration of Motor Control Centers (MCC)

15.6.6.1 The system shall support the direct integration of Motor Control centers via PROFINET network. This will allow information on the motor's operating condition to be sent directly to the system via a digital field bus.

15.6.6.2 Optional pre-engineered libraries of function blocks and faceplates shall be available to support easy integration of MCCs into the controller and HMI applications.

15.6.7 Condition and Performance Monitoring

It is often necessary to consider certain process, chemical and mechanical conditions in the context of a maintenance concept for a plant. As such the system shall support Condition Monitoring whereby the user can be automatically notified before the operating conditions of critical equipment (such as pumps and bearings) goes beyond acceptable levels.

15.6.8 Standard Function Block for Monitoring of User Defined Assets and Conditions

15.6.8.1 The system shall provide a standard set of function blocks and faceplates that can be used to monitor the condition and performance of user-defined plant equipment assets. The system shall allow user-defined logic to be combined with the values already measured by the system, in order to monitor the performance of critical assets such as heat exchangers (fouling) and pumps (power consumption, deviations from characteristic curves for example)

15.6.8.2 The status of user-defined assets shall be displayed within the maintenance station along with those created automatically by the asset management system. Information and status displays will be displayed using a common set of faceplates and summary display lists.

15.6.9 Document Management

15.6.9.1 The system shall include document management capability allowing the storage and display of up to 10 different files (DOC, PDF, MPG, AVI etc.) for each device.

15.6.9.2 This allows information such as standard operating procedures, wiring diagrams, P&IDs or help files, to be called up from the central maintenance station.

15.7 PROCESS SIMULATION

15.7.1 The system shall support various levels of tools for simulation of processes.

15.7.2 The simulation system shall be able to run on a PC-based system with Windows 10.

15.7.3 The system shall allow commissioning in a virtual plant.

15.7.4 The system shall support training for plant personnel. It shall be possible to import existing architecture information into the system to avoid duplicate data input and the associated error source.

15.7.5 A fully graphic user interface should simplify operation. The available know-how of a process engineer or automation engineer should be sufficient for fast, comprehensive training. Special knowledge about simulation should not be necessary.

15.7.6 Controller Simulation

A controller simulation tool shall be available which shall allow simulation of field inputs and outputs within the control logic and to facilitate testing and troubleshooting of the controller program. It shall require no control or I/O hardware and shall be capable of being used to simulate both Batch and Continuous processes. It shall not require special modifications of the actual controller program to be able to be run in simulation mode.

15.7.7 Simulation of Remote I/O and PROFINET Devices BACNET Devices

15.7.7.1 The system shall support the use of cards which can simulate the actual electrical signals and responses of remote I/O and PROFINET field devices to an actual controller.

15.7.7.2 The system shall support the use of cards which can simulate the actual electrical signals and responses of remote I/O and BACNET field devices to an actual controller. (Network VAV's for example).

15.7.7.3 It must be possible to import the field devices to be simulated, from the hardware configuration of the plant.

15.7.7.4 The simulation of the PROFINET or BACNET nodes must be performed without reaction by the controller, i.e. the controller shall not distinguish between real and simulated field devices communicating on the bus.

15.7.7.5 The system shall allow error simulation on the PROFINET or BACNET. This includes:

A. Stations failure
B. Module failure
C. Channel and cable diagnostics

15.7.7.6 The system must offer simulation of aggregates using prefabricated libraries and editable software functions (sequencers, interlocks, redundancy).

15.7.7.7 The simulation must allow testing of virtual field devices without mechanical stress or danger to the real installation.

15.7.8 Process Modeling

15.7.8.1 The system shall support the use of higher order Process Simulation programs that are capable of modeling the process dynamics. These programs shall be capable of making use of the actual control program or database extracted from the control program for the development of the model (maximizing reuse), including export /import of the hardware configuration data.

15.7.8.2 The controller simulation shall be able to communicate with various communication interfaces (OPC, OPC_UA etc.). The vendor shall provide prefabricated, freely-programmable libraries for this.

15.7.8.3 The simulation shall allow modeling of process engineering factors with scalable detail precision and support the following functions:

A. Drag-and-Drop modeling through a graphic interface
B. Integrated mathematics
C. Component libraries with definable properties
D. Equation-based modeling
E. Macro components
F. Model sectors
G. Dynamic graphics and animations

15.7.8.4 The system shall allow running real-time simulation. Real-time synchronization must be possible.

15.7.8.5 It must be possible to save and reuse modeled scenarios. The reuse should be facilitated by integrated management.

15.7.8.6 The simulation system shall support the connection of process visualization. It must be possible to visualize and animate the simulation.

15.7.8.7 The system shall support simulation analysis with logs, trends and messages.

15.7.8.8 It must be possible to test software changes independent of the real plant.

15.7.8.9 The simulation must run on the process level, device level and signal level.

15.8 HISTORICAL DATA HANDLING

15.8.1 The Operator Interface shall provide a complete historical (archiving) subsystem providing the user the capability to capture and analyze historical data.

15.8.2 A high-performance central archive server shall be provided for handling (long term) archives. The system shall allow selection of any point in the system to be added and configured for archiving.

15.8.3 The archiving system shall utilize a Microsoft SQL real-time relational database for storage of all process related data. Flat file or internal proprietary databases will not be accepted.

15.8.4 The archiving system shall be configured using standard tools provided by the system to facilitate the display and editing of archive rates, archive types, etc. from graphical and tabular data displays.

15.8.5 The system shall support the online addition of new tags to the historical database without interrupting operations.

15.8.6 The historical subsystem shall promote the visualization of historical data in both tabular and graphical form. This includes the capability to view historical data via a web-enabled interface.

15.8.7 Archiving Capability

15.8.7.1 The historical subsystem shall provide the ability to define archiving rates in increments of milliseconds, seconds, minutes, hours, or days.

15.8.7.2 The historical system shall allow an individual archive rate to be programmatically modified and/or utilized as part of the Control Logic/Scripting requirements specified above.

15.8.7.3 The historical subsystem shall include the capability to archive values per analog point including but not limited to:

A. actual value
B. maximum
C. minimum
D. sum
E. mean

15.8.7.4 The historical subsystem shall include the capability to archive digital values on either a rising or falling edge.

15.8.7.5 A data compression algorithm shall be available to minimize the storage space required by the archives.

15.8.8 Backing Up the Database

15.8.8.1 The system shall supply tools for automatically backing up the database to removable media or to an alternate storage location. The backup utility shall execute the database backups automatically based on either of the following configurable criteria:

A. Time-based (e.g. every 24 hours)
B. Based on the size of the database (e.g. after the size reaches 1 MB)

15.8.9 Redundancy

15.8.9.1 The system shall support the use of redundant historical archives and storage of archive databases on separate PCs.

15.8.9.2 Redundant historical archives will be automatically synchronized when the partner is returned to service.

15.9 TREND DISPLAYS

15.9.1 Every operator workstation shall provide viewing for real-time and historical trend information.

15.9.2 Data collected in any historian package shall be available to all workstations. The system must support a centralized approach to historical data collection.

15.9.3 The system shall support user defined sets of trends so that commonly viewed historical information can be defined in trends once and easily accessed by selecting a pre-configured screen target incorporated in the graphic display. There should be no practical limit to the number of trends that can be defined. Each trend screen shall support up to 8 separate pens. Selection of points to be trended shall be menu driven.

15.9.4 Historical trends shall support seamless integration of both real-time and historical data within a single trend window, with seamless movement between the two. In the event that the screen is scrolled to the left, then historical values will be recalled from historical data files. Scrolling the trend far enough to the right will result in current real-time data being displayed as it is collected.

15.9.5 Zoom in/out and moving forwards and backwards in time shall be possible with no more than two operator actions. A mechanism for selecting a location on the trend, such as a hairline cursor and reading the numeric values of the trends at that point in time shall be provided.

15.9.6 It shall be possible to call up new historic trends and configure them online from the Operator Interface.

15.9.7 Pre-configured real-time trends shall be available from a faceplate. It shall be possible to export data associated with a currently displayed trend to a.csv file for viewing in MS Excel.

15.10 REPORTING

15.10.1 The Operator Interface shall provide an integral reporting subsystem used to report both current and archived data.

15.10.2 The reporting subsystem shall utilize standard Windows tree / list view presentation techniques for management and administration of reports.

15.10.3 The reporting subsystem shall provide the capability to define reports for both visualization and printed format. Report templates shall be supplied which can be modified or used as is.

15.10.4 The reporting subsystem shall allow individual reports to be programmatically modified and/or utilized as part of the Control Logic/Scripting requirements.

15.10.5 The reporting subsystem shall provide the capability to define both the dynamic and static properties reports, including but not limited to:

A. Inclusion of archived data, alarm data or event data,
B. Customization of the format, layout, and graphical images included on a report.
C. Configuration of automatic report generation, including frequency, destination of the report, and a prioritized list of alternate system resources should problems be encountered during automatic production.

15.10.6 The reporting subsystem shall not impose limits on the number of reports that can be configured.

15.10.7 The system shall support the use of optional third party applications (i.e. Excel, Crystal Reports) for generation of reports.

15.10.8 Report Generation

15.10.8.1 It shall be possible for all reports to be displayed on a workstation screen as well as printed on a report printer. Hourly, daily, monthly, end-of-month, quarterly and yearly reports shall be supported.

15.10.8.2 Reports shall be printed and/or saved to disk when a process event occurs. It shall be possible to activate a report in any of the following manners:

A. Upon demand (operator request)
B. Scheduled (shift, daily and monthly)
C. Upon event occurrence

15.10.9 Preconfigured Report Templates

The reporting subsystem shall be supplied with pre-configured reports including but not limited to:

A. Graphic display documentation
B. Historical archiving
C. Alarm archiving

15.11 RELIABILITY

15.11.1 A single failure anywhere in the system shall not result in the loss of regulatory control to more control loops than those associated with a single process input/output card. Failure of any single device shall not affect the ability of the system to communicate with other devices in the system.

15.11.1.1 Switchover shall not disrupt any system functions.

15.11.2 Redundancy

15.11.2.1 Redundancy shall be available over all levels of the automation system, including controllers, power supplies, networks, I/O racks, Clients, and HMI servers, Batch servers and Historians.

15.11.2.2 Redundant equipment and software shall be continuously monitored for errors. All modules shall be diagnosed on-line. Errors shall be alarmed with an error message identifying the failed module.

15.11.2.3 To maximize data availability and integrity, the Operator Interface shall provide the ability for configuration of system redundancy. This shall in no way limit or restrict the use of the client/server configuration and/or architecture.

15.11.2.4 Clients shall automatically failover to the backup or redundant server. This operation shall not require any application reprogramming or reconfiguration.

15.11.2.5 System redundancy shall be configurable on a server by server.

15.11.2.6 Once a failed server becomes available, the active server shall checkpoint data missing data to the previously failed server. This operation shall occur in the background, and shall not affect the operation of the on-line server.

15.12 SAFETY

15.12.1 The vendor of the process control system shall offer integrated control and safety functions that provide the following advantages:

15.12.2 Control and Safety functions are integrated in the vendor system, meaning less hardware is required, less personnel training is necessary, and the system is easier to operate.

15.12.3 Highest availability due to architecture with multiple fault tolerance

15.12.4 Highest flexibility since safety and standard application is possible in a single CPU and PROFIsafe can be used simultaneously on PROFINET.

A. Integrated safety field bus.
B. Less wiring, prepared for safe process instrumentation.
C. Safe life cycle engineering with safety matrix.
D. No additional communication busses needed for fail-safe technology.
E. No additional controller needed for fail-safe technology.
F. The system shall support safety programming with CFC and other fail-safe tools.

15.12.5 Support of Safety Systems

15.12.5.1 Execution of Safety Programs

The controller shall support the optional execution of safety programs up to SIL 3, according to IEC 61508.

15.12.6 Configuration of Safety Systems

The configuration of fail-safe systems shall automatically supplement user-specific CFCs with functions required for error detection and reaction. The configuration off fail-safe systems shall be performed with the same tools used for the non-fail-safe application.

15.12.7 Support for Safety Communication

The system shall support the use of PROFIsafe for communication to and from smart instruments even in a redundant / fault tolerant architecture. The PROFIsafe protocol ensures that reliable and fail-safe communication (up to SIL 3) takes place between smart field devices and their controller over PROFINET.

15.12.8 Optional Library for Fail-safe Controllers

The system shall support the optional addition of a specific library of fail-safe function blocks. These function blocks must be certified by technical inspectorate and easy to distinguish from those used for non-fail-safe applications. It must be possible to link and configure the blocks with the CFC tool:

15.12.9 Use of Shared Hardware

To minimize spare parts requirements the system shall support shared use of hardware (CPU, power supply, backplane bus and communication modules) for both safety-related and non-safety-related applications.

15.13 REMOTE ACCESS AND LINKS TO OTHER SYSTEMS

15.13.1 Support for third party connectivity

The system shall be capable of communicating with third party control systems by using of the following interfaces and protocols:

A. OPC
B. PROFINET
C. Foundation Fieldbus (FF)
D. Ethernet (Modbus TCP/IP, BACnet)
E. Serial Interface (e.g. Modbus RTU), RK512, 3964R

15.13.2 Serial Interface

The following capabilities shall be available for communicating to auxiliary systems:

A. RS-232C, RS-422, and RS-485 with full and half-duplex operation and selectable baud rates (19200, 38400, 57600, and 115200)
B. IEEE 802.3 Ethernet protocol at 10 or 100 MBPS, with TCP/IP
C. Modbus configured in a master-slave relationship, with the system as the master and the auxiliary system as the slave.

15.13.3 OPC Interface

15.13.3.1 The system shall be able to communicate bi-directionally with auxiliary systems using OPC. The OPC interface shall be configured in a client-server relationship and as such the system shall be able to act as either the OPC Client or OPC Server as required.

15.13.3.2 The vendor system shall provide access to alarms and events via OPC standard interfaces UA, DA, HDA, AE, and HAE. There shall be no need to write any custom code to set up the OPC interface.

15.13.3.3 Configuring the OPC shall be done using drag and-drop functionality to link the data source and target.

15.13.3.4 At a minimum, the OPC interface shall support scan rates of 500 ms and 1 second.

15.13.3.5 The Interface should be capable of handling a Data throughput rate of 10,000 tags/ sec.

15.13.4 Remote Access

15.13.4.1 It shall be possible to remotely access the system by modem (DSL or ISDN) for troubleshooting purposes.

15.13.4.2 The user shall have the capability to disable this feature without disconnecting the modem.

15.13.5 Safety with Network Components

15.13.5.1 The vendor shall ensure maximum security for remote access to ES or AS via LAN.

15.13.5.2 The data traffic between the internal and external network must be controlled by a special network component (SCALANCE S).

15.13.5.3 A Virtual Private Network (VPN) Tunnel is required for increased transmission security and transparency.

15.13.5.4 Encrypted data traffic is required between security modules.

15.13.5.5 The system network shall offer high performance and standby redundancy. A Gigabit backbone is required. (ARUBA 2930F)

15.14 EXPLOSION PROTECTION

15.14.1 The vendor shall offer future-proof distributed solutions for automation system in hazardous areas.

15.14.2 It should be possible to integrate these solutions quickly and easily in every controller via the system bus.

15.14.3 Distributed Hardware

15.14.3.1 The system shall provide intrinsically safe interfaces / couplers for the distributed I/O, field devices.

15.14.3.2 They should be designed modular and flexible and satisfy rugged design norms.

15.14.3.3 It should be easy to perform the installation using rails and integrated connectors.

15.14.3.4 It should be possible to connect the sensors and actuators via the bus system.

15.14.3.5 It should be possible to hot swap interfaces in the Ex area.

15.14.3.6 “Permanent wiring“ shall be possible, to make it easier to exchange modules without removing the wiring.

15.14.3.7 It should be possible to perform replacement during ongoing operation (hot swapping)

15.14.3.8 It should be possible to also use the I/O Interfaces and couplers in hazardous areas. (Ex areas)

15.14.3.9 Capability for use in Zones 2 and 1 is a requirement. It should also be possible to operate actuators and sensors in Zones 0/20.

15.14.3.10 All devices are certified according to guideline 94/9/EC.

15.14.3.11 The system shall be compatible for universal I/O cards, to avoid high storage costs.

15.14.4 Configuration and Diagnostics

15.14.4.1 The configuration and diagnostic capability shall be available locally or centrally via the configuration of the vendor system.

15.14.4.2 Full online expandability shall be possible.

15.14.5 Hardware Specification and Limits

15.14.5.1 The vendor system shall offer distributed solutions providing at least 3 of the requirements listed below.

15.14.5.2 Requirement 1 also fulfills requirements 2 and 3

15.14.5.3 Requirement 2 also fulfills requirement 3

	Requirement 1	Requirement 2	Requirement 3
CENELEC	II 2 G (1) GD EEx de [ia/ib] IIC/IIB T4	II 3 G EEx nA II T4/T5	II 3 G EEx nA II T4/T5
FM	IS, Class I Zone 1 EEx ib [ia] IIC, T4 Class I, II, III Division 2 Groups A, B, C, D, E, F, G, T4	Class I Division 2 Groups A, B, C, D, T4/T5 Class I Zone 2 IIC, T4/T5	Class I Division 2 Groups A, B, C, D, T4/T5 Class I Zone 2 IIC, T4/T5
Temperature	–20º C to +70º C	0º C to +60º C	0º C to +60º C

16. ENGINEERING DOCUMENTATION COMPLEMENTARY

Vendor shall include a plan whit all steps for develop software application with related document and information needed for each step.

16.1 Proposal phase

Vendor shall submit one hard copy and one electronic copy of the following documents, in this phase to review proposal.

A. System Architecture.
B. I/O Manuals.
C. Controller Manual.
D. Equipment List (with quantities).
E. SIL certificate

16.2 Approval phase

Once the proposal is approved, Vendor shall submit one hard copy and one electronic copy of the following documents, in this phase for approval.

A. Start-up Manual or Procedure.
B. Backup or Backup Procedure.
C. Operation and Maintenance Manual.
D. Configuration Manual.
E. Equipment List.
F. Application software List.
G. Graphical Displays.
H. System Architecture.
I. Wiring and Connection Diagrams.
J. Graphic Library.
K. Software for Hardware Diagnostic.
L. BMS Installation and test reports (SAT, FAT, etc.).
M. I/O List.
N. Panel Layout.
O. Modbus Database (if required).
P. License details for the used software and updates.
Q. Redundancy level.
R. Power load consumption Calculation.
S. Controller Process capacity.
T. Controller Saturation Capacity.
U. SIL certificate.

16.3 Dossier

Vendor shall submit two hard copies and three electronic copies of the following documents, at engineering detail phase and at construction phase.

A. Start-up Manual or Procedure.
B. Backup or Backup Procedure.
C. Operation and Maintenance Manual.
D. Configuration Manual.
E. Equipment List.
F. Application software List.
G. Graphical Displays.
H. System Architecture.
I. Wiring and Connection Diagrams.
J. Graphic Library.
K. Software for Hardware Diagnostic.
L. BMS Installation and test reports (SAT, FAT, etc.).
M. I/O List.
N. Panel Layout.
O. Field Bus necessary (if required).
P. License details for the used software and updates.
Q. Redundancy level.
R. Power load consumption Calculation.
S. Controller Process capacity.
T. Controller Saturation Capacity
U. SIL certification.
V. Cause-Effect Matrix.
W. Safety Instrument Function.

17. WARRANTY

17.1 Vendor must guarantee that all equipment and accessories (including software) are new and free of defects in design, materials and hand made.

17.2 A written warranty of non-obsolescence in the industry, of the system proposed, for a period of 10 years from the commissioning date.

17.3 The respective certificates by the international regulatory agencies must be presented, to approve equipment for the required application.

17.4 A written warranty of one year after the acceptance of the system must be submitted. It will cover equipment, accessories, materials, and services, including handmade, even those made by third parties but are part of the system.

17.5 The warranty period shall cover not less than twelve (12) months after starting-up of the system or eighteen (18) months after delivery of the systems or thirty six (36) months after Sales service.

17.6 During the warranty period, it will be vendor's responsibility to repair, replace or perform the necessary works to correct malfunctions or defective works that are part of the installation, to maintain the complete functionality of the system.

17.7 The contractor must include spare parts for commissioning of the system and must include a list of spare parts for two years.

18. TRAINING

18.1 Training courses for the personnel must be included, so they can achieve the correct and safe operation and management of the system.

18.2 The courses shall include didactic materials and the required reference manuals in Portuguese.

18.3 Courses for Operators, for Operation Engineers and for Maintenance Engineers must be implemented.

18.4 The courses shall cover the following areas:

A. Operation.
B. Maintenance.
C. Configuration.
D. Administration.

18.5 Contend and duration of the courses must be sent to the client for approval.

18.6 Place will be designated by the client, 10 persons per course must be at least considered.

19. MAINTENANCE

19.1 The maintenance contract shall guarantee the system is working correctly.

19.2 Maintenance contract must include a maintenance program and maintenance claim indicating an adequate response time and vendor's responsibility.

19.3 Contract must include delivery of recommended spare parts for maintenance purposes.

19.4 The system will be designed to allow that any failure can be eliminated quickly. The repair procedure must be based on the replacement of modules or subsystems.

20. TESTING

20.1 Vendor will be sent for approval, the protocols of acceptance tests. These protocols must be sent to Takeda/Hemobrás at least one month prior to the scheduled start date of the respective tests.

20.2 Protocols not previously approved by Takeda/Hemobrás will not be accepted.

20.3 Each type of test shall be described, indicating the purpose and method to perform the test and to record the results obtained.

20.4 Is the requirement for the supplier to provide all testing documentation AND perform the tests for commissioning and SAT.

20.5 Material, documentation, and equipment to be used in each test shall be described.

20.6 Takeda/Baxalta may reserve the rights to witness and participate in the tests and request special tests.

20.7 Testing to the following equipment's must be done:

A. Hardware.
B. Software
C. Communications.
D. Configurations/Settings.

20.8 The tests to be considered are:

A. Factory Acceptance Test (FAT) documentation and test.
B. Acceptance test on site (SAT).

20.9 Tests of entire equipment and materials may only be scheduled when assembly, connection, identification, etc. are completed.

20.10 Acceptance tests should consider the following:

A. Must be done with the system fully connected.
B. All cards and devices must be tested individually.

C. All inputs, outputs and control circuits must be individually and completely tested.
D. All software modules must be checked.
E. All communication channels must be checked.
F. The logic configured in base of cause and effect matrix must be tested.
G. All infrastructure must be certified (FO cables, UTP cables, connectors)

20.11 System will be received by the client once is fully tested and its operation is approved.

21. VENDOR SERVICES

21.1 Vendor system shall present a proposal including installation, configuration, programming, testing, commissioning, repair and service to the entire system, and must also include training services for operation and maintenance personnel.

21.2 Any detail omitted in this document does not relieve the vendor of his obligation to provide a complete system operating satisfactorily.

21.3 The contractor is responsible to complete pending work.

21.4 Full service shall comply with all aspects of Takeda/Baxalta EHS.

22. EQUIPMENT STORAGE AND HANDLING

22.1 Vendor is fully responsible for the packaging of each component of the BMS. Vendor is also responsible for using the appropriate materials and components in the packages to ensure protection against impacts, vibrations, damages due to atmospheric conditions and / or humidity.

22.2 Lifting points in the Package must be perfectly identified.

22.3 All packaging must be identified including general data of the project, manufacturer name and equipment description.

22.4 Devices sensitive to electrostatic charges must use appropriate package to prevent electrostatic damages.

22.5 Vendor must store and protect the equipment at the site.

22.6 Prior the system is accepted; vendor is responsible for safekeeping and administration of all materials and equipment including software.

23. EQUIPMENT DOCUMENTATION, WARRANTY, AND CERTIFICATIONS

23.1 All included equipment, components, hardware, software, cables, third party equipment are supplied with operating manuals, maintenance manuals, passwords, licenses, programming keys, warranties, assistance times and manufacturer-certified documentation.

23.2 All hard copy generated and electronic documents, will be incorporated into Technical Memories for the BMS, at the end of the construction phase and the client reception.