FERMENTER BATCH PROCESS REGULATOR

1.0 General Requirements:

1.01 It is not intent to cover all detail engineering for equipment design, manufacture, installation, tests and commissioning in this specification, but to cover the general and overall requirements to be applied to the Fermenter based process regulator system.
Any omissions in the specification shall not relieve the contractor from his obligation to provide a system compatible with the intent of the specification. All components shall be of a proven and reliable design and the highest possible uniformity and inter changeability of all parts shall be reached. Supplier shall accept full system responsibility for all supplied hardware and software and provide necessary training, supervision, and spares. They are fully responsible for Installation, start up and commissioning assistance until successful handover to owner. The Fermenter based process regulator to be supplied for Fermentation plant Batch process automation shall be from the proven for same type of application.

All technical services necessary to satisfy the various documentation and drawing requirements identified in this specification is included in a master drawing list.
The equipment, materials, and services to be furnished shall include, but not necessarily be limited to, the following major items

a. Ethernet switches
b. All cable (communication cable, prefabricated cable etc…)
c. Network accessories
d. Cable Termination Materials and accessories (Lugs, Glands, ferrules, Fittings, connectors (Ethernet) etc)
e. Required software
f. Other accessories as required by the system

1.02 Design criteria:

All components, sub-systems shall be designed to meet the following criteria:

Personnel Safety
A high level of system reliability
A high level of Process regulator performance
User-friendly human-machine interface
Ease of maintenance with self-diagnostic capability
Extensive flexibility and expandability
Economical Consideration

The design philosophy of the system shall encompass state-of-the-art technology and architecture, providing a cost effective installation.'

The total system and shall be configured with Architecture for high reliability. The system shall be fully operational with no degradation in performance for components. Only the listed manufacturers are recognized to maintaining the level of quality of workmanship required by the specification. Supplier shall conduct and demonstrate performance and availability tests for the ordered Process regulator system, as mentioned specifically in the Factory Acceptance Test (FAT), Site Acceptance Test (SAT) .
Supplier shall supply the necessary hardware, firmware, software and related accessories, certification of the hardware and software, marking / identification, transport to site and assistance in erection, pre commissioning and commissioning.

Supplier shall source and supply instruments and sub-equipments and all other accessories from reputed manufacturers who shall provide adequate service support for this plant in the Automation project.

The Supplier shall be responsible for any changes in Process regulator equipment or software that are required because of defective equipment, incorrect internal connections, incorrect programming, or incorrect selection of equipment.

A Fermentation plant is a batch process to develop chemical product. The Process regulator philosophy of the fermentation process must compile with ISA S88 batch process standard.

Alarms & event logging must be as per ISA S18.2 Standard. Batch Process must support Industry 4.0. digitization standard

The designed and offered system shall have latest hardware models & software versions and comply with all the statutory requirements as required by law. System supplier shall also provide appropriate operational and maintenance training to owner's identified personnel.

The definitions of the various terminologies in this specification are as below:

Sr. No.	Terminology	Description
1	Analog Point	Any analog input, analog output, or analog calculated variable.
2	Digital Point	Any digital input (digital output, relay output, or digital calculated variable.
3	Operator Interface Processor	An integral group of components used to execute operator interface functions, consisting of power supplies, computer processors, memory, and connection to the data highway communications network.
4	Modulating (Continuous) Process regulator	Analog Process regulator loops that produce an analog output that continuously positions the final Process regulator element (Process regulator valve, damper drive, etc.) between the full close and the full open position, and the associated digital Process regulator logic for the Process regulator element interlocks, permissive, runbacks, etc.
5	Discrete (Sequential) Process regulator	Digital Process regulator logic that produces a digital output that operates the Process regulatorled equipment (motor, dampers, valves, igniters, etc.) in discrete steps (on, off, open, close, etc.).

1.03 System Acceptability.

The proposed Process regulator must be in commercial operation in a minimum of Fermentor Automation treatment plants of scope and magnitude similar to that for which the equipment is proposed or provided as a part of this Contract. The system shall be compatible with the electromagnetic environment for which it is included, and shall not mis operate or sustain damage from the influence of radiated or cable conducted fields typically found in electromagnetic field of plants.

The system shall be designed and equipped to withstand, to the maximum extent possible, lightning surge by atmospheric electrical disturbance without damage or disruption. The system architecture shall accept new technology as it becomes available, and future system enhancements shall be compatible with the equipment supplied under this contract so that extensive hardware and software retrofitting shall not be necessary.

The Supplier shall not propose or provide equipment from any manufacturer that is expected to be superseded or outdated by a later generation of equipment prior to the commercial operation date. The plant Process regulator shall ensure maximum reliability during system operation, so that no single component failure, shall affect the Process regulator and data acquisition functions of the system. All equipment shall be new, unused, and of the highest quality available from the manufacturer.
The system shall be designed to detect failures by the use of continuously running diagnostic routines and bring them to the operator's attention & provide hardware and software designs that react to failures in a predictable and repeatable manner.

1.04 The Fermenter based process regulator shall be an embedded I/O design, with I/O expansion capability. A single chassis shall house CPU, memory, embedded I/O circuitry, communications, power supply.

The Fermenter based process regulator shall be designed to operate in an industrial environment with an ambient temperature of 0° to 55°C and with a relative humidity range of 5% to 95%, non-condensing. The Fermenter based process regulator shall be designed to operate in a free airflow environment (convection cooling only, no fans or other air moving devices shall be required, however the Process regulator panel shall be provided with cooling fan along with filter).
The Fermenter based process regulator shall be designed and tested to operate in high electrical noise environments.

The system shall support upto 12 expansion modules (input/output, discrete or analog) for a total of up to 256 discrete I/O. The expansion modules shall be front accessible. There shall be a proper Isolation between all internal logic and external circuits. Each input and output point shall have a visual indicator to display ON/OFF status. All user wiring to I/O modules shall be through a heavy-duty terminal strip. Pressure-type screw terminals shall be used to provide fast, secure wire connections.

1.05 System Timing:

The update rate, processing rate, and response time of all the data highway communications network, wireless network and of the overall system shall be sufficient to maintain Process regulator over the plant processes and equipment under all system operating conditions, including extreme upset conditions.

The **system response timings** shall be the time required for the exchange of command & status signals in the complete Process regulator network. The **Process regulator network** includes The Fermenter based process regulator, work stations, switch gears, field instruments.

At a minimum, the Process regulator shall respond to operator commands and system changes as follows:
Time to completely generate a display shall not exceed 1 seconds.
The indication of any variable, on all displays including alarm displays, shall be updated within 1 second of its value or status change.
The time to respond to any operator command shall not exceed 1 second.
The time to respond for Foreign device Interface (FDI) functions shall not exceed 1 second (response time will not include the time required for the foreign device to respond to the Process regulator system; only the actual bidirectional communication time shall be considered).

The bidder shall provide the sufficient spare capacity to accommodate any Process regulator and data acquisition functions that may be added to the system during the start up phase of the project and thereafter.

All equipment shall be designed for operation in plant areas with the environments defined in the specification.

1.06 System Reaction Time

The reaction time of the Fermenter based process regulator from input signals at the input cards to output of the associated signals or commands of the output card inclusive of programmed logic processing, comprising a mixture of logic gates, arithmetic operations and other internal operations shall be less than 250 milli seconds under the most difficult Process regulator operating conditions. However, for specific electrical applications, it shall be less than 100 milli seconds.

2.0 System Description:

Bidder shall provide complete and independent Fermenter based process regulator based Process regulator and Instrumentation system with all accessories, auxiliaries and associated equipments and cables for the safe, efficient and reliable operation of the following systems.

A Fermentation plant is a batch process to develop chemical product. It includes,

a. Fermentation process,
b. Harvester,
c. Distilled water tank,
d. Process water tank,
e. Cooling water tank,
f. Refrigeration plant,
g. Batch reactor,
h. Cooling water system and
i. Interface with steam generation plant

Field instruments like transmitters, switches, valves, Solenoid operated vales & motorized actuators on the process shall be electrically interfaced with the Fermenter based process regulator. The plant communication & communication with operating work station shall be sufficient enough to maintain the communication rate of 100 Mbps.

Type of communication protocol & distance between the various devices to be interfaced:

Sr. No.	Item	From	To	Distance in Meter	Remark
1		Fermenter based process regulator	HMI	Maximum 200	
2		Fermenter based process regulator	Workstation	Maximum 200	
3		Workstation	Mobile APP	Maximum 400	

3.0 The Fermenter based process regulator Based Process regulator requirement

3.01 The Fermenter based process regulator **Processor**

The processor unit shall be capable of executing the following functions:-

a. Receiving binary and analog signals from the field and operator initiated commands from operator Work Station (OWS)/ Process regulator panel/HMI

b. Implementing all logic functions for Process regulator, protection, data storage, developing alarms and annunciation of the equipment and systems.

c. Implementing modulating Process regulator function for certain application as specified elsewhere in the specification.

d. Issuing Process regulator commands.

e. Providing supervisory information for alarm, various types of displays, status information, trending, historical storage of data etc.

f. Performing self-monitoring and diagnostic functions.

g. The Fermenter based process regulator shall provide all basic functions of binary gate operations, modulating Process regulators, storage, counting, timing, logging, transfer operations and comparison functions. The Fermenter based process regulator shall have expansion capability and shall be able to interface with Human-Machine Interface (HMI) & SCADA functions, including display processing, data acquisition and display, data storage ,data history systems ,alarm processing, event recording, process reporting, Process regulator sequence configuration ,integrated database management and engineering maintenance utilities. The detailed functions are mentioned in EWS/OWS section.

h. At no time, The Fermenter based process regulator processor shall utilize more than 70 % of it's capacity during execution of the program. the processor utilization shall be always below that.

i. Bidder to provide the redundant power supply unit of suitable capacity specifically for the Fermenter based process regulator CPU powering. The power supply unit shall be separate from the Fermenter based process regulator input/output card power supply unit. Power supply failure indication to be provided on Process regulator panel.

3.02 The Fermenter based process regulator Memory

a. Each Fermenter based process regulator unit shall be provided with memories, the memory shall be field expandable & shall have sufficient capacity to execute the complete system operation. Memory shall have a capability for at least 30% expansion in future.

b. Programmed operating sequences and criteria shall be stored in non volatile semi conductor memories like EPROM. All dynamic memories shall be provided with buffer battery backup which shall be for at least 360 hours. The batteries shall be lithium or Ni-Cd type.

c. In Fermenter based process regulator, memory should exist as to where the sequence was aborted due to power supply failure so that further operation from that point can restart after power supply restoration. This restart after recovery of the power supply shall be through operator intervention so as to enable verification of readiness of other related equipments.
At no time, Fermenter based process regulator memory shall load more than 70 % of it's capacity, the memory loading shall be always below that.

d. The operating system firmware shall be contained in non volatile memory. An option shall be possible to store both the user program and system firmware in a removable non volatile memory for back-up/restore purposes.

e. The Fermenter based process regulator shall contain a minimum of 2 MB and maximum of 32 MB of user memory.

3.03 Input/ Output Modules

a. Input Output modules, shall be designed in the Process regulator for all type of field input signals (4-20 mA, discrete contact inputs etc.) and outputs from the Process regulator (discrete contact, 24/48 VDC output signals for energising interface relays and 4-20 mA output etc.) are to be provided by the bidder.

b. Electrical isolation of 1.5KV with optical couplers between the plant input/output and Process regulator shall be provided on the I/O cards. The isolation shall ensure that any unintentional voltage or voltage spikes shall not damage the internal processing equipment.

c. The Input/output system shall facilitate modular expansion in fixed stages. The individual input/output cards shall have LED indications on the module front panels for displaying individual signal status.

d. Individually fused output circuits with the fuse blown indication shall be provided. All input/output points shall be provided with status indicator. Input circuits shall be provided with fuses preferably for each input, alternatively suitable combination of inputs can be done and provided with fuses such that for any fault, fuse failure shall affect the particular drive system only without affecting other systems.

e. In a single chassis system, all system and signal power to The Fermenter based process regulator and support modules shall be distributed on a single backplane. No interconnecting wiring between these modules via plug-terminated jumpers shall be acceptable.

f. All input/output cards shall have quick disconnect terminations allowing for card replacement without disconnection of external wiring and without switching of power supply.

g. Bidder to provide the power supply unit of suitable capacity specifically for The Fermenter based process regulator input/output card powering. The power supply unit shall be separate from the Fermenter based process regulator CPU power supply unit.

h. The Bidder shall provide the minimum following monitoring features:

i. Power supply monitoring.

ii. Contact bounce filtering.

iii. Optical isolation between input and output signals with the internal circuits.

i. In case of power supply failure or hardware fault, the critical outputs shall be automatically switched to the fail-safe mode. The fail-safe mode shall be intimated by the bidder during detailed engineering.

j. Keying-in of individual wire connectors shall be provided to ensure that only the correct card is plugged on the I/O module. It shall be possible to remove I/O module without disconnecting wiring from field inputs or outputs. Over and above the system requirement, there shall be minimum 30% spare capacity available on input, output of total I/Os distributed in all I/O slots of that the Fermenter based process regulator. A spare capacity on power supply and memory modules shall be minimum 30 to 40% of normal consumption.

k. Binary Output modules shall be rated to switch ON/OFF coupling relays of approx. 3 VA at 24 VDC/48 VDC. Analog output modules shall be able to drive a load impedance of 600 Ohms minimum.

l. Output module shall be capable of switching ON/OFF inductive loads like solenoid valves, auxiliary relays, etc. without any extra hardware. However, bidder shall provide coupling relays with two changeover contact to interface with field devices & MCC for Process regulator and interlock requirement. The required multiplication, shall be done in Fermenter based process regulator system.

a. In case of loss of I/O communication link with the main processing unit, the I/O module shall be able to go to predetermined fail safe mode with proper annunciation (to be decided during detailed engineering).

b. Bidder shall provide for 20% spare I/O slots in each system cabinet to take care of any further addition.

c. The maximum number of inputs / outputs to be connected to each type of module shall be as follows :

I/O requirement				
Type of I/Os	**DI**	**DO**	**AI**	**AO**
Actual requirement	34	70	49	15
10 % spare	4	7	5	2
Total	38	77	54	17

3.04 Following are the major functions to be performed:

a. Processor of the Process regulator shall have capability of programming from work station. Programming shall be user friendly & shall not require special computer skills. Programming, self-diagnostics, testing of sequence, simulation and sequence modification shall be possible on the programming console.

b. Programming shall be possible in any of the following formats:

i. Block logic representing the instructions graphically.

ii. Ladder diagrams.

iii. Universally accepted latest technique

c. A NORMAL / TEST / PROGRAM / OFF lockable selector switch shall be programmed. In case of test mode of operation, all outputs shall be blocked.

d. Manual intervention shall be possible at any stage of operation. Protection commands shall have priority over manual commands and manual commands shall prevail over auto commands.

4.0 Software

a. The bidder shall provide entire set of software required by the system for meeting the functional and parametric requirements of the specification like implementation of Process regulator logic, storage & retrieval of program.

b. The software and programs shall include high level languages as far as possible. The bidder shall provide sufficient documentation and program listing in view of making modifications in program at a later date.

c. All application software for The Fermenter based process regulator system functioning like input scanning, data acquisition, conditioning processing, Process regulator and communication and software required for operator interface of monitors, displays, trends, curves, bar charts etc. retrieval utility, and alarm functions etc. shall be provided.

d. The software shall be password protected. The Bidder shall provide software locks and passwords to buyer's engineers nominated by the management authority at site for all operating & application software so that buyer's engineers can take backup of these software and shall be able to perform modifications at site.

4.01 Databases

An I/O list database will be developed to allow design information transmittal between the owner and the Supplier. A system database shall be developed that will allow access of the I/Os by the Process regulator system.
In the databases, a unique identifying code (tag name) shall be assigned to each analog, digital, calculated, data linked, or manually inserted point, by which the point may be referenced by both the operator and the system. The code shall consist of at least 14 alphanumeric characters. The code format shall be as determined by the purchaser and shall not be subject to any Supplier requirements.

4.02 I/O list database

The owner shall provide initial information, including the tag name, functional point description, and electrical characteristics for the process I/O, using a commercially available database program in an agreed upon format. After the initial I/O list database submittal by the owner, the supplier shall be responsible for maintenance of the database until the system is shipped to the project site.
Alarm priorities, data storage requirements, and similar information will be submitted by the owner during detailed design. The owner may, from time to time, provide other additions or revisions to the database that the Supplier shall incorporate into the master database. The additions or revisions may be in hard copy or electronic format. At the time of shipment, the Supplier shall furnish an as-shipped I/O list database to the owner. The as-shipped database shall be in the same format as the initial I/O list database provided by the owner. The Supplier shall use the I/O list database to generate the system database.

4.03 Diagnostic Programs

Diagnostic programs shall be provided for the following diagnostic tests:

a. Initiation checks.

The initiation checks shall be initiated each time power is applied to a Process regulator or operator interface processor. These checks shall monitor the start up sequences of the processor to ensure that the processor has been successfully powered up and in the proper working condition.

b. On-line diagnostics.

The on-line diagnostics shall be executed automatically during normal on-line operation of the Process regulator and operator interface processor, providing continuous monitoring of the processor functions, including, but not limited to, memory functions, and communications functions.
Data highway communications network, I/O bus communication network, RS-485 bus network, Process regulator, card, and error status information shall be available. The system shall present this information in English terms. Cross-referencing of numeric values to a diagnostic manual for initial problem determination is not acceptable.

Hardware diagnostic test software shall be provided for the following computer equipment. These diagnostics shall include fault analysis to the circuit board level:

i. Memories.
ii. Peripheral and display devices.
iii. All communications networks, etc
iv. Peripheral devices like Mass memories (disks, etc.), Multiplexing system, Printers

"Watchdog" diagnostics shall be provided which can periodically check the operation of all communications network nodes and alarm detected problems. Time synchronization between all nodes shall be periodically checked and set by the Process regulator network to prevent inaccurate timing of alarms

4.04 Programming Techniques

The programming format shall be IEC 61131-3 compliant ladder diagram (LD), function block diagram (FBD), sequential function chart (SFC), and structured text (ST) languages. The Fermenter based process regulator shall organize user applications as Tasks, which can be specified as continuous, periodic, or event based.

The programming techniques shall compliance with following features:

a. Periodic tasks shall run via an interrupt at a user-defined interval in minimum increments from 1 mS to 2000 S. The increment period will be decided and approved by consultant/owner during detail engineering. The interrupt mechanism of periodic and event tasks shall adhere to the IEC 61131-3 definition of pre-emptive multitasking.

b. The Fermenter based process regulator shall be able to accommodate a maximum of 32 individual tasks, of which one can be continuous. The periodic and event tasks shall have an associated, user-assignable priority from 1…15 (1 being the highest priority), which specifies that task's relative execution priority in the multitasking hierarchy.

c. Each task shall have a user-settable watchdog timeout, which is unique to that task. Each task can include a maximum of 100 programs, which can be prioritized for execution within the task. Each program shall be able to include routines that could be programmed in LD, FBD, SFC, or ST languages. One of the routines can be specified as the main routine and one can be specified as an optional fault routine. All routines shall be capable of being edited when online. The number of routines that can be contained in a program is limited only by memory.

d. Tag naming convention shall adhere to specifications in IEC 61131-3. Tags may be created offline, online, and at the same time the routine logic is entered. The system shall have the capability to store user tag names in The Fermenter based process regulator. Tags shall be available to all tasks in The Fermenter based process regulator or limited in scope to the routines within a single program as defined by the user.

e. It shall be possible to program ladder diagram (LD) rungs with the following restrictions:

i. Series instruction count limited only by user memory
ii. Branch extensions limited only by user memory
iii. Branch nesting to six levels

It shall be possible to insert ladder diagram (LD) rungs anywhere in the program, even between existing rungs, so far as there is sufficient memory to accommodate these additions. A single program command or instruction shall suffice to delete an individual ladder diagram (LD) rung from memory. A clock/calendar feature shall be included within the CPU. Access to the time and date shall be from the programming terminal or user program.

f. Latch functions shall be internal and programmable. The system shall have the capability to address software timers and software counters in any combination and quantity up to the limit of available memory. All the operations of these instructions into memory shall be handled by the Process regulator. Instructions shall permit programming timers in the ON or OFF Delay modes. Timer programming shall also include the capability to interrupt timing without resetting the timers. Counters shall be programmable by using up-increment and down-increment. Timer instructions shall have a time base of 1.0 ms. The timing range of each timer shall be from 0… 2,147,483,648 increments. It shall be possible to program and display separately the timer's preset and accumulated values.

g. The Fermenter based process regulator shall store data in the following formats:

i. Boolean values (0 or 1).
ii. Short integer numbers ranging from -128…127.
iii. Integer numbers ranging from -32,768…32,767.
iv. Double integer numbers ranging from -2,147,483,648…2,147,483,647.
v. Floating point numbers consisting of eight significant digits. For numbers larger than eight digits, the CPU shall convert the number into exponential form with a range of ± 1.1754944 E -38 to ± 3.402823 E +38.
vi. Long integer numbers ranging from -9,223,372,036,854,775,808… 9,223,372,036,854,775,807.

h. The Fermenter based process regulator shall support for integer and floating point signed math functions consisting of addition, subtraction, multiplication, division, square root, negation, modulus, and absolute value. Trigonometric instructions supported must include Sine, Cosine, Tangent, Inverse Sine, Inverse Cosine, and Inverse Tangent. These instructions must fully support floating-point math. Additional floating point instructions supported must include Log 10, Natural Log, and Exponential.

i. It shall be possible to complete complex, combined calculations in a single instruction, such as flow totalizing or equations of the format ((A+((B-C)*D))|E).File function instructions supported shall also include Sort, Average, and Standard Deviation.

j. The Regulator shall support indexed addressing of array elements. Array element manipulation instructions, such as array copy (COP), array copy with data integrity (CSP), and array fill (FLL), array to array (MOV), element to array (FAL), array to element (FAL), and first in-first out (FIFO) shall be supported by the system. The four function and math instructions and instructions for performing logical OR, logical AND, exclusive OR, and comparison instructions, such as less than, greater than, and equal to shall be included within the system. All instructions shall execute on either single words or array elements.

k. The Fermenter based process regulator shall have a jump instruction that will allow the programmer to jump over portions of the user program to a portion marked by a matching label instruction.

l. The Fermenter based process regulator shall have an ability to provide a master system clock and the IEEE 1588 PTP version 2 CIP Sync object to allow time synchronization and transport and routing of a system clock to the Process regulator and communication system.

m. The program format shall display all instructions on a programming panel with appropriate mnemonics to define all data entered by the programmer. The system shall be capable of providing a HELP utility, which, when invoked by the programmer, will display a list of instructions and all data and keystrokes required to enter an instruction into the system memory on the programming panel.

n. The system shall have the capability to enter rung comments above ladder diagram (LD) rungs. These comments may be entered at the same time the ladder logic is entered. The capability shall exist for adding, removing, or modifying logic during program execution in routines of ladder diagram (LD), function block diagram (FBD), sequential function chart (SFC), and structured text (ST) languages. When changes to logic are made or new logic is added, it shall be possible to test the edits of such logic before removal of the prior logic occurs.

o. It shall be possible to manually set (force) all hardwired discrete input or output points to either ON or OFF from the programming panel. It shall also be possible to manually set (force) an analog input or output to a user-specified value. Removal of these forced I/O points shall be achieved either individually or totally through selected keystrokes. The programming terminal shall be able to display forced I/O points.

p. The Fermenter based process regulator shall have the ability to create Add-on Profiles, including generic profiles to provide open integration on third-party modules used in the The Fermenter based process regulator system. The Fermenter based process regulator files shall have the ability to be exported and edited in text or XML format.

4.5 Standards and Certificates

a. The Fermenter based process regulator processor shall be able to withstand conducted tests as outlined in the following:

Sr. No.	Environmental Test	Industrial Standard
1	Temperature	IEC 60068-2-1 IEC 60068-2-2 IEC 60068-2-14
2	Humidity	IEC 60068-2-30
3	Vibration	IEC 60068-2-6
4	Shock	IEC 60068-2-27 IEC 60068-2-32
5	Radiated Emissions	CISPR 11: Group 1, Class A
6	Conducted Emissions	CISPR 11/22: Group 1, Class A
7	Conducted Emissions - Telecomm	EN61000-6-4
8	ESD Immunity	IEC 61000-4-2
9	Radiated RF Immunity	IEC 61000-4-3
10	EFT/B Immunity	IEC 61000-4-4
11	Surge Immunity	IEC 61000-4-5
12	Conducted RF Immunity	IEC 61000-4-6
13	Magnetic field Immunity	IEC 61000-4-8
14	AC Voltage Variation	IEC 61000-4-11

15	DC Voltage Variation	IEC 61000-4-29
16	Oscillatory Waves	IEC 61000-4-18

b. The Fermenter based process regulator Process regulator shall be certified by:

Sr. No.	Certification Description
a	c-UL-us (certified for US and Canada)
b	UL Listed for Class I, Division 2 Group A,B,C,D Hazardous Locations
c	CE (European Union 2004/108/EC EMC Directive), compliant with: • EN 61326-1; Meas./Process regulator/Lab., Industrial Requirements • EN 61000-6-2; Industrial Immunity • EN 61000-6-4; Industrial Emissions • EN 61131-2; Programmable Process regulatorlers (Clause 8, Zone A & B)
d	Ex European Union 94/9/EC ATEX Directive, compliant with: • EN 60079-15; Potentially Explosive Atmospheres, Protection 'n' • EN 60079-0; General Requirements • II3 G Ex nA IIC T5X

5 The Communication System

5.01 The Communication System inside the plant shall have following minimum features:

a. Regulator shall be provided to handle the communication between I/O Modules and Fermenter based process regulator and between The Fermenter based process regulators and operator work station. During normal operation 50% loading and during worst case only 70% loading of the communication throughput shall be utilized.

b. The design shall be such as to minimise interruption of signals. It shall ensure that a single failure anywhere in the media shall cause not more than a single message to be disrupted and that message shall automatically be retransmitted. Any failure or physical removal of any station/module connected to the system bus shall not result in loss of any communication function to and from any other station/module.

c. Built-in diagnostics features shall be provided for easy fault detection. Communication error detection and correction facility shall be provided at all levels of communication which shall be suitably alarmed/ logged.

d. The design and installation of the system bus shall take care of the environmental conditions as applicable.

e. Data transmitting speed shall be sufficient to meet the responses of the system in terms of

displays, Process regulator etc. plus 25% spare capacity shall be available for future expansion.

f. All Ethernet based communication networks shall use Category 5e (or better) unshielded twisted pair UTP for cables run inside the Process regulator room and single-mode, 8 core fiber optic cable for cables run outside the Process regulator room or between buildings. Twisted pair cable networks shall conform with ISO 8802.3 100BASE-TX or 1000BASE-T or newer requirements. Fiber-optic cable networks shall conform with ISO 8802.3 100BASE- FX or 1000BASE-SX or newer requirements. The network shall be designed for maximum speed through the use of Gigabit (or faster) components where possible. Ethernet communications networks shall include all necessary hubs, switches, connectors, patch panels, fan out kits, taps, repeaters, cables, terminators and any other components required for a complete communications system. The entire communication network shall be redundant.

5.02 The communication system hardware shall meet the following requirements:

a. Industrial switcher shall be with modular design, flexible configuration and shall support operating temperature -20 º C ~ +85 º C, for fan less design

b. Anti-electromagnetic interference performance is more than four level; support trouble-free communication, with zero packet loss technology

c. Support VLAN (Virtual LAN) sub-network, support port security (port MAC address binding, port access Process regulator), safe isolated industrial Process regulator data

d. Ring network self-healing recovery time <5ms / switches to ensure network security

e. To ensure the equipment working stability in harsh operating environment the Protection grade shall be IP40

f. Switch shall have a five-years warranty

g. Failure of any system or component connected with the communication system shall not fail the communication system or any other system or component.

h. The communication network shall be redundant, including redundant highway interface modules & all related accessories. Both the redundant data highways shall be active simultaneously at all times.

i. All stations interfaced on the highways shall have access to data on the highway and may send data to the highway.

j. The data communication system shall be designed to be loaded not more than 40 percent for Ethernet and 60 percent for Token-net under worst case conditions to allow for future expansion. The method of examination and calculation should be submitted by the contractor.

k. The data Highway speed and access time shall be such that the operator action must be executed in 1 second or less under upset as well as steady state conditions. The Contractor shall confirm his guaranteed response time under all operating conditions.

l. The data communication system’s protocol shall include such a codes as CRC (Cycle Redundant Check) , parity error, etc, to detect errors and take protective action to assure a high degree of transmission reliability.

m. Information about “communication protocol” (e.g. massage structure, addressing and direction of transmission, format of data block length, modulation and transmission medium), diagnosis

functions and equipment, automatic recovery for failed stations and access time per station, etc., shall be described and submitted in detail by the contractor in his proposal.

n. In case any error is occurred the data communication system shall be smart enough to automatically request the data to be retransmitted or the hardware must simply notify the software and the latter must decide what action to be taken. If there are still errors in the data transfer after several attempts, an automatic meaningful safe reaction shall be performed. (e.g. switching off defective components or switching to redundancy, etc).

o. All the communication highways shall be protected from any kind of abrasion, mechanical vibration, moisture, corrosion cause of communication failure.

p. Data communications system shall be in accordance with international standards and recommended requirements, such as IEC, IEEE and so on. The most important is that the anti-noise interference of all systems should meet IEC60255-4 specification, or IEEE recommended requirements.

q. The communication interface shall monitor and report whether the equipment is in normal working condition or not. In addition to process information, the Process regulator shall also access the Process regulator fault diagnosis information through the communication interface.

r. When failure occurs in the Process regulator system, operator can get information at operation station LCD.

s. All necessary communication interface equipment includes network interface cards, drivers, network communication cables and complete interface software.

5.03 Third party Interfaces(TPI)

a. The Supplier shall provide all hardware and drivers to communicate with owner-furnished foreign devices, such as personal computers and programmable logic Process regulator (Fermenter based process regulator) as defined. The communications medium shall be twisted shielded copper conductors for indoor locations and those areas not subjected to induced signal noise. For communications networks routed outdoors or in areas where induced signal noise is probable, fibre-optic cable shall be provided.

b. The Supplier shall furnish line drivers or short-haul modems for both ends of all interfaces. The Supplier shall also furnish line drivers or short-haul modems for both ends where the Supplier's equipment design recommends their use for isolation or other requirements.

c. The interfaces shall permit the data generated in the foreign devices to be used in any process Process regulator, displayed on any operator work station, or used in any report. The interface shall also allow the configuration of push buttons and Process regulator stations on the Process regulator station operator work station, which can be further used to start and stop motors, open or close valves, etc., that are Process regulated by the Fermenter based process regulators as foreign device.

6 Summaries

The system shall be configured to allow the operator to display on operator work station monitor and print the following summaries:

Summary of all points in alarm.

Summary of all existing "bad" quality points.

Summary of all existing points with substituted (forced) values.

Summary of all existing points not being scanned or alarm limit checked.

Summary of all existing analog and digital inputs and outputs with point specifications such as ranges, limits, etc.

Summary of all points in tag-out.

7 Functions:

7.01 Modulating (Continuous) Process regulator Functions

The analog Process regulator loop Process regulator stations shall simulate conventional hand/auto stations, allowing the operator to select a mode and to provide manual interface commands, and shall provide a display of all relevant variables associated with the Process regulator loops including the set point, the feedback signal, the Process regulator signals, and the status of the loop.

The required modes of operation and operator Process regulatorable parameters shall be as follows:

Automatic Mode: This mode shall permit full automatic operation of the system with no intervention on the part of the operator except for the functions designated as operator adjustable, such as set point adjustment and biasing of Process regulator signals.

Manual Mode. This mode shall permit manual "Raise" and "Lower" of system demand signals. Operator interface for analog Process regulator loops shall also include one, two, three, and four vertical bar indicating stations for indication of analog values. Each vertical bar on the station shall also display a short description of that point, and the point's process value and engineering units. The multiple measurement loop Process regulator stations shall allow the operator to select the multiple measurement mode, and shall provide a vertical bar and analog value display for each of the analog inputs and for the multiple measurement loop output. The station shall also display the multiple measurement mode and quality of each analog value.

The pulse accumulator loop Process regulator stations shall allow the operator to reset and hold pulse accumulation, and shall provide an analog value display of the accumulated total.
All operator interface command functions, except screen paging, shall be designed for two-step operation. The operator shall be required to make one keyboard or touch screen action to select the function to be performed and a second keyboard or touch screen action to execute the function. For example, the operator must select the "Auto" button for a device and then execute the auto function to prevent accidental touch screen or keyboard activation of Process regulator commands.

Operator interface functions shall include interface to the analog Process regulator loops, multiple measurement loops, and pulse accumulator loops, by the operator, from faceplates on the operator work station monitors.

7.02 Discrete (Sequential) Process regulatory Functions

Discrete Process regulator Functions:

The sequential OR discrete Process regulator functions shall be configured for the following applications, which shall include, but not necessarily be limited to, the following:

a. Start/Stop of Raw water & Pure water pump motors in sequential form

b. Open/Close/Stop of motor-operated valves

c. Filter bed sequential operation in manual /auto mode

7.03 Operator Interface Functions. Operator interface functions shall include mode selection and initiation of manual commands, made by the operator from Process regulator stations on the operator work station monitors. The Process regulator stations shall provide Process regulator functions, including, but not necessarily limited to, the following:

Start, stop, open, close, auto, manual, reset, and trip commands.

Maintained push buttons.

Momentary push buttons (with adjustable pulse duration).

Status indication for motor running/stopped/tripped and valve open/closed.

Indication for equipment mode, permissive condition, failure condition, first-out indication, and operational sequence status.

All operator interface functions, except screen paging functions, shall be designed for two-step operation. The operator shall be required to make one keyboard or touch screen action to select the function to be performed and a second keyboard or touch screen action to execute the function. The system shall provide system displays for the on-line monitoring of Process regulator logic signal flow on operator work station. These displays shall use colour and other unique symbols or nomenclature to indicate on-state, off-state, and signal flow path for all logic blocks, contacts, coils, and associated connections.

8 Alarm Functions

8.01 Analog Alarm Functions

The system shall perform comparison of limit functions on any or all analog points, as determined during detailed design. The system shall allow the user to selectively activate or deactivate these alarms. Each analog input variable, or calculation result, shall have an individual set of alarm limits. These limits shall be either manually set, calculated as functions of other variables, or rates of change with time. Violations of these limits shall initiate alarms and/or initiate execution of special software programs.
The analog alarm functions shall be on a per analog point basis, and shall include, but not be limited to, the following:
Provision to assign high and low transducer range limits for quality determination.

Provision for analog points to be deleted from and restored to alarm status by the user or automatically from internally generated variables.

Provision to assign high and low alarm limits, and at least one level of incremental alarm limits, either fixed or as a function of another system point.

Provision to assign an alarm dead band.

Provision to assign rate of change alarm limits and dead band.

Provision to impose alarm cut out (masking) conditions as a function of another system point.

A copy of the comprehensive alarm list which includes all I/O generated and internally calculated alarms shall be submitted to the Purchaser for review.

8.02 Digital Alarm Functions

The system shall compare the status of any or all digital points against the user selectable alarm state of these points, as determined during detailed design. The system shall allow the user to selectively activate or deactivate these alarms. Digital points entering the alarm state shall initiate alarms and/or initiate execution of special software programs. The digital alarm functions shall be on a per digital point basis, and shall include, but not be limited to, the following:

Provision for digital points to be deleted from and restored to alarm status by the user or automatically from internally generated variables.

Provision to alarm on a digital point status of "1" (on) or "0" (off).

Provision to alarm digital points on any change of state.

Provision to impose alarm cut out (masking) conditions as a function of another system point.

Description for a point that is to be alarmed, the alarm message text displayed to the operator shall be similar to the input point description, with the words "NOT", “NO” or other negative text omitted. The bidder shall be responsible for programming the alarm message text in a manner that does not use the words “Not”, “No” or other negative text in the alarm message text.

8.03 System Alarms

The system shall provide alarms for system failure conditions including, but not limited to, the following:

Loss of any server power supply.

Battery low (many hours before deterioration to the extent that it cannot maintain the functions of the equipment it supplies).

Failure of any Server.

Server history function failure.

Server synchronization failure.

Failure of Data historian data retrieval.

Failure of any operator interface processor.

Failure of any Foreign Device Interface (FDI)

Failure of any communications network.

Diagnostic programs shall have routines to generate component status alarms. These alarms shall include, but not be limited to, the following:

operator interface processor failure.

Server Hard disk failure.

Communications failure.

Disk read/write error.

8.04 Fermenter based process regulator system shall be capable for generating Alarm Annunciation System per below specifications

a. The system shall allow the operator/engineering work station to display the alarms of that particular Process regulator system. All alarms shall be displayed on the work station monitor in a dedicated alarm management window and/or distributed eight line alarm strips (as specified by the owner). The system shall also include an audible alarm that shall have adjustable volume Process regulator. The audible alarm shall be user configurable for different tones or patterns to distinguish between a minimum of four alarm priority levels. The system shall use global alarm acknowledgment, allowing a single acknowledgment from the dedicated work station.

b. The system shall record all alarm events to a storage file in chronological order The printer designated to the Process regulator shall automatically print out each alarm event and alarm reset as it occurs or shall print alarm event and alarm reset reports on demand.

c. Bidder shall provide annunciation system as integral part of the Fermenter based process regulator system. Field contacts shall be acquired through the Fermenter based process regulator only. The annunciation sequence logics shall be implemented as a part of the Fermenter based process regulator. OWS based alarm system shall be provided with audio alarm facility (beep/tone generator). Hooters are also to be provided.

d. Window based annunciation shall be provided wherever required which can be discussed during detail engineering. The annunciation window lamps mounted on Process regulator panel shall be driven through contact output modules of the Fermenter based process regulator. It shall be preferable to have each window as mosaic compatible. The lamp box shall have removable impact polystyrene window shall be 50 mm x 50 mm or 48mm x 48mm with 5 mm size inscription in black lettering on white background.

e. Each annunciation window shall be back lighted with two long life LED lamps The changing of lamps shall be conveniently done from the front by single removal of window. Redundant audible devices for alarms shall be cone type or metallic horn type and shall be driven by electronic tone generator of adjustable width and sound level. The trip alarm audible & ring back audible shall be differentiated from other alarms.

f. The annunciator sequence shall conform to ISA sequence ISA-2A. The number of annunciation facia windows and the provision for original input will be on as required basis. However, the minimum number of facia windows, signal input to the annunciation system shall be 25 nos

9 Memory

a. The program storage medium shall be a solid-state, non-volatile type.

The Fermenter based process regulator shall be able to address up to a minimum of 32K data words, where each word shall be comprised of 16 data bits. User memory shall consist of a minimum of 32K words of program and data.

b. Non-volatile memory shall store the operating system, user program and all user data to protect against memory loss in case of power loss or system shutdown.

c. The memory module shall have an ability to selectively protect multiple areas of user data from being overwritten in case data download takes place. Whenever power is ON the program shall download automatically.

d. Memory shall have an ability to detect if a fault is present during the power-up sequence and, if a fault is present. Memory shall be able to download the program that is in the memory module and enter the RUN mode. If a fault is not present, the Process regulator shall proceed normally without memory module intervention.

10 I/O Circuitry

a. The manufacturer shall have available a variety of I/O options for the Fermenter based process regulator that include:

Sr. No.	Type	Description
1	Inputs	120VAC, 240VAC, 24VDC, DC sink, DC source, 4-20mA Analog, 0-10V Analog, RTD and Thermocouple.
2	Outputs	Relay (some of which must have individual isolation), 24VDC, DC source, 4-20mA Analog, 0-10V Analog and TRIAC.

Relay outputs for DC devices which operate with 1 amp continuous current capacity.
Relay outputs for AC devices which operate with 2.5 amp continuous current capacity.

b. Inputs shall have adjustable filter time constants to improve input performance in high-speed applications, and to limit the effects of voltage transients.

c. A minimum of 4 isolated digital input groups, 1 isolated analog input group, 6 isolated digital output groups and 1 isolated analog output group shall be located on the self-contained Process regulatorler. At least 4 relays shall be individually isolated.

10.01 Program Environment

a. The programming port shall be RS-232/RS-422/USB/Ethernet

b. The programming software shall run on Windows 8 environment and shall be IEC-61131 compliant ladder logic:

i. Ladder – Project Tree navigation and simultaneous multiple rung editing
ii. Online Editing
iii. Data Logging
iv. Drag-and-Drop Editing
v. Diagnostics
vi. Database Editing

10.02 Power Supply

The Fermenter based process regulator shall operate in compliance with following:

240VAC, single phase at 50 Hz power supply OR 24VDC

a. All AC powered The Fermenter based process regulator with 24VDC inputs shall be capable of supplying a minimum of 24VDC at 250mA. This can be used to provide external 24VDC power for input devices (sensors, switches, etc.).

b. The onboard power supply shall be capable of supplying power to all subsystems includes CPU, memory, local I/O, expansion I/O modules, without external wiring.

c. The power supply shall provide surge protection, isolation and power outage carryover of at least 1 cycle of the AC line. In cases where the AC line is especially unstable or subject to unusual variations. The AC power shall be made available from UPS dedicated for the system. At the time of power-up, the power supply shall inhibit operation of the processor and I/O modules until the DC voltages are within specifications.

11 Tests and Standards

The Fermenter based process regulator shall be able to withstand the susceptibility tests conducted as outlined in:

a. ESD Immunity EN 61000-4-2
4kV contact, 8kV air

b. Radiated RF Immunity EN 61000-4-3
10V/m with 1 kHz sine-wave 80% AM from 80 to 1000 MHz
3 V/m with 1 kHz sine-wave 80% AM from 1.4 to 2.0 GHz
1 V/m with 1 kHz sine-wave 80% AM from 2.0 to 2.7 GHz

c. Fast Transient Immunity EN 61000-4-4
Power Supply, I/O: 2 kV, 5 kHz
Communications Cable: 1 kV, 5 kHz

d. Surge Transient Immunity EN 61000-4-5
±1 kV line-line (DM) and ±2 kV line-earth (CM) on AC power ports
±1 kV line-line (DM) and ±2 kV line-earth (CM) on signal ports
±1 kV line-earth (CM) on communication ports

e. Conducted RF Immunity EN 61000-4-6
10V, 150 kHz to 80 MHz

f. Line Related Tests EN 61000-4-11
60% dip for 10 periods on AC supply ports
30% dip for 25 periods at 0x and 180x on AC supply ports
100% dip for 250 periods at 0x and 180x on AC supply ports

100% dip for 0.5 period, arbitrary angle, on AC supply ports

12 Hardware

Enclosure	Extruded Aluminium with DIN and panel mount
Size	Manufacturers standard
Serial Data Port	Minimum DB9, RS-232, RS-422 / RS-485 300 bps to 230 kbps
Configuration Port	DB9, RS-232
Antenna Ports	One, Manufacturers standard

13 Environmental

Operating Temperature	-20°C to +75°C
Humidity	5% to 95% relative humidity, without condensation
Vibration	IEC 60068-2-6 - 20g, 3-axis
Shock	IEC 60068-2-27 - 5g, 10 to 150 Hz
External Power	9 to 48 VDC
Power Consumption	Maximum 12 W peak

14 Accessories

14.01 Time Synchronization Equipment.

A GPS synchronized timing receiver with all accessories shall be supplied & commissioned by the supplier. The Fermenter based process regulator based SCADA systems shall synchronize with the system clock to within 0.001 second of a time signal received from a GPS synchronized timing receiver. The system may also use Network Time Protocol (NTP), Simple Network Management Protocol (SNMP), or TCP/IP. All, software, and cables shall be provided to support a fully functional time synchronization system. The system shall be fully configured at the site by the Supplier.

14.02 Power Distribution.

The Supplier shall furnish and install terminal blocks in the cabinets to receive the incoming power source from section UPS. The power distribution for the each operator console or item of equipment furnished by the Supplier shall be provided with circuit breakers. Breakers shall be provided by the Supplier and mounted in a central location providing convenient access for replacement. The proper coordination of branch circuit protective devices shall be the Supplier's responsibility. A fault on a single branch circuit will disable only that circuit; it shall not cause the

failure or tripping of any other devices. It is the supplier responsibility to distribute the power for his components. The Supplier's equipment shall impose no grounds on any ac power source unless specifically permitted by the owner. If ground connections are required by design of the Supplier's equipment, the Supplier shall provide isolation transformers to prevent transmitting these grounds to any ac power source provided by the owner. The owner's ac power sources will be equipped with neutral grounding at the source. If the Supplier's system requires source ground isolation, the Supplier shall provide the required isolation transformers.

14.03 Process regulator & Power Supply Scheme

a. For Fermenter based process regulator system, 24 V DC power supply shall be provided for the Fermenter based process regulator CPU power The Fermenter based process regulator I/O shall be powered from separate powers supply unit. 3-phase incomers to be provided by Purchaser at the input terminals of Power supply cabinets.

b. For separately mounted I/O racks, separate power supplies shall be provided. Power supply module shall be of sufficient capacity to supply all modules. In addition 30 % spare capacity for future shall be provided. All the drives shall be switched ON/OFF through 24V DC coupling relays to be provided in HT/LT SWGR panels.

c. Power supply distribution from Bidder’s power supply cabinets shall be in the scope of Bidder. The exact power supply scheme shall be as approved by Purchaser during detailed Engineering stage.

14.4 System Grounding.

The Supplier's electrical system or logic ground shall be designed for grounding to the station ground mat at a single connection point. The system cabinets shall be equipped to accept the insulated ground cables, which at this point will be isolated from the building ground. Any internal component grounds or commons shall be connected to the system ground, which shall be kept isolated from the building ground.

Any required electrical ground or common from components not mounted in the system cabinets shall be brought to a terminal block connection within that component. This terminal block connection shall be located with the other terminals within the component and shall be available for connection through the shield of the field wiring to the system ground bus within the associated system cabinet. Isolation between building ground and system ground shall be inherent in the component design.

Each cabinet structure will be safety grounded to building steel. The Supplier shall provide separate connection points within each cabinet for attachment of owner-furnished cables to the building ground.

At least 600 volt isolation shall be provided between the electrical system or logic grounding bus bar and cabinet or building ground for all system components.

When shielded terminations are required in cabinets furnished under these specifications, suitable terminals and supports shall be furnished adjacent to input terminals. Cabinet wiring by the Supplier shall include connection of the shield terminals to the grounding bus bar. The Supplier's shields shall be provided with insulating sleeves to prevent contact of the shields with the metallic structure.

The Supplier shall submit detail earthing requirements of their system for the purchaser approval. The Supplier shall provide connectors in each cabinet for connection of the system ground and the safety ground. The connectors shall be sized to allow connection of 2 AWG field ground conductors.

15 Process regulator Cabinets / Panels / Desks

a. The cabinets shall be IP-52 protection class. The Bidder shall ensure that the packaging density of equipment in these cabinets is not excessive and ab- normal temperature rise, above the cabinet temperature during normal operation or air-conditioning failure, is prevented by careful design. This shall be demonstrated to the Purchaser during the factory testing of the system.

b. The Bidder shall ensure that the temperature rise is limited to 10 deg. C above ambient and is well within the safe limits for system components even under the worst condition.

c. Ventilation blowers shall be furnished as required by the equipment design and shall be sound proof to the maximum feasible extent. If blowers are required for satisfactory system operation, dual blowers with blower failure alarm shall be provided in each cabinet with proper enclosure and details shall be furnished with proposal. Suitable louvers with wire mesh shall be provided on the cabinet.

d. The cabinets shall be designed for front access to system modules and rear access to wiring. The panel cable entry shall be decided during detailed engineering.

e. The cabinets shall be totally enclosed, free standing type and shall be constructed with minimum 2 mm thick steel plate frame and 1.6 mm thick CRCA steel sheet or as per supplier's standard practice for similar applications, preferred height of the Fermenter based process regulator cabinet is 2200 mm. The cabinets shall be equipped with full height front and rear doors. The floor mounting arrangement for other cabinets shall be as required by the owner and shall be furnished by the Bidder during detailed engineering.

f. Cabinet doors shall be hinged and shall have turned back edges and additional braking where required ensuring rigidity. Hinges shall be of concealed type. Door latches shall be of three-point type to assure tight closing. Detachable lifting eyes or angles shall be furnished at the top of each separately shipped section and all necessary provisions shall be made to facilitate handling without damage. Front and rear doors shall be provided with locking arrangements with a master key for all cabinets. If width of a cabinet is more than 800 mm, double doors shall be provided.

g. Two spray coats of inhibitive epoxy primer-surface shall be applied to all exterior and interior surfaces. A minimum of 2 spray coats of final finish colour shall be applied to all surfaces. The final finished thickness of paint film on steel shall not be less than 65-75 micron for sheet thickness of 2 mm and 50 microns for sheet thickness of 1.6 mm. The finish colours for exterior and interior surfaces shall conform to following shades:

Exterior surface:
As per RAL 7032 or as finalised and specified during detailed engineering.

Interior surface:
As per RAL 7032 or as finalised and specified during detailed engineering.

h. Cabinets shall be designed for a grounded installation on the building structure. Any isolation from the building ground which is required by equipment design shall be provided internal to

the cabinet.

16 System Expansion capability

The bidder shall take into account the following installed but unused, spare capacity for further system expansion:

a. 30% spare I/Os wired up to terminals for each type of I/O module in each cabinet. (at least one module shall be provide even if calculated capacity is less than one module). 20% spare I/O module slots shall be provided in each cabinet. All spare slots shall provide with necessary hardware such as: backboard, connecting cables, terminal, etc. The completeness of hardware shall ensure that the I/O slot shall come into operation as long as module is insert in the slot.

b. The engineering cum operating station processing capacity shall have minimum 40% spare margin. The spare margin capacity shall be maintained even if in the "peak condition" also.

c. The Fermenter based process regulator memory shall have minimum 30% spare capacity & power supply capacity 40%.

d. Network communication bus load shall not be more than 70% (share type Ethernet communications is not more than 20%).

e. Inside cabinets, the bidder shall provide the right amount of back-up relays.

f. The typical expansions & spare capacity shall be as below:

- Fermenter based process regulator processor loading: ≤ 70 %
- The Fermenter based process regulator memory expansion capacity :30 %
- Spare I/Os wired up to terminal block: 30%
- Spare I/O slots: 20%
- Spare power supply spare: 30%~40%
- Communication load: ≤ 40%~60%
- Storage spare: 50%
- Memory load: ≤ 70%

Note: The Fermenter based process regulator specification written above is based on the I/Os mentioned below. Supplier shall size the Process regulator for minimum but not limited to the I/O count mentioned below.

16.01 List of Approved Make:

Sr. No.	Instrument	Approved Make
1	Fermenter based process regulator	Rockwell /Emerson /Yokogawa/Honeywell
2	Communication Accessories	CISCO/D-link
3	Power supply unit in Fermenter based process regulator	A.B. Enterprise / NHP / Emerson