SOFTWARE DEVELOPMENT AND PROGRAMING OF FERMENTER BATCH PROCESS REGULATOR, GUI & MMI

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 programming requirements to be applied to the Fermenter based process regulator system, GUI & HMI.
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 Programming of the software of PLC,GUI, MMI & hardware, commissioning assistance until successful handover to owner. The Fermenter based process regulator to be supplied for Fermentation plant Batch process regulator 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 is 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, GUI, MMI as mentioned specifically in the Factory Acceptance Test (FAT), Site Acceptance Test (SAT) .
Supplier shall program the necessary hardware, firmware, software and related accessories, assistance in pre commissioning and commissioning.

Supplier shall source software licenses for programming relevant to the hardware from same manufacturers who has supplied hardware for the batch regulatory system, GUI, MMI. The software must be Authorized software which will be used for programming

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 software shall comply with all the statutory requirements as required by law. Software development agency shall also provide appropriate operational and maintenance training on software 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.).

PROGRAMMING REQUIREMENTS OF FERMENTER BATCH PROCESS REGULATORY SYSTEM

1.03 System Acceptability.

The software developer shall be well acquainted with the Fermenter batch process regulatory system, Regulatory system hardware, GUI, MMI & their software. The software developed on Fermenter batch process system shall be designed and equipped to withstand to the maximum extent possible. The system architecture shall accept new technology as it becomes available, and future system enhancements shall be compatible with the equipment supplied so that extensive hardware and software retrofitting shall not be necessary.

The software developed for 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.
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 software designs that react to failures in a predictable and repeatable manner.

1.04 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 program to be developed to 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).

All program 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:

A Fermentation plant is a batch process to develop chemical product. The batch process regulatory system, GUI, MMI, Instrumentation system with all accessories, auxiliaries and associated equipments and cables for the safe, efficient and reliable operation include following systems.

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 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, GUI,MMI **include:**

3.01 The Fermenter based process regulator

The processor unit executes 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. 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.

h. 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.

i. 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.

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

I/O Requirements				
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 have capability of programming from Server station computer. 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

Following are the key points, the software agency to develop the software in line with the below requirements of equipment, design details of regulatory system & software.

a. The Agency shall develop 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.

q. 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 Communication System

The communication system of Fermenter batch process system, GUI & MMI have following features. The software agency to study the below key points of design of communication system & to develop the software in line with the requirements

5.01 The Communication System inside the plant 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.

6 Functions:

The regulatory functions required for system of Fermenter batch process system, GUI & MMI are listed below. The software agency to study the below key points of design of regulatory functions & to develop the software in line with the requirements

6.01 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 regulator able 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.

6.02 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

6.03 **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.

7 Alarm Functions

The Alarm functions required for Fermenter batch regulatory, GUI & MMI are listed below. The software agency to study the below key points of design of regulatory functions & to develop the software in line with the requirements

7.01 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.

7.02 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.

7.03 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 server station computer to display the alarms of that particular Process regulator system. All alarms shall be displayed on the server 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

The software agency to study the below key points of memory module & to develop the software in line with the requirements for the regulatory system of Fermenter batch process system,

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 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

11 Hardware

The software agency to study the below key points of hardware & to develop the software in line with the requirements for the regulatory system of Fermenter batch process system,

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

12 Accessories

The software agency to study the below key points of Time Synchronization Equipment & to develop the software in line with the requirements for the regulatory system of Fermenter batch process system.

12.01 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.

13 System Expansion capability

The software agency to study the below key points of spare capacity for further system expansion & to develop the software in line with the requirements for the regulatory system of Fermenter batch process system, GUI & MMI.
The software agency shall take into account the following installed but unused, spare capacity for further programing:

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 above. Programming agency shall develop the program for above system

14 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	GUI, MMI	Rockwell /Emerson /Yokogawa/Honeywell

PROGRAMMING REQUIREMENTS OF GRAPHICAL USER INTERFACE (GUI), MAN MACHINE INTERFACE (MMI)

1.0 Software

The software agency to study the below key points of software requirements of the GUI & HMI for the Fermenter regulatory system to develop the programming & 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 Regulatory logic, operator station displays / logs, 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. Industry standard operating system like WINDOWS--8 etc. to ensure openness and connectivity with other system in industry standard protocols (TCP-IP/ OPC etc.) shall be provided. The system shall have user oriented programming language & graphic user interface.

d. All system related software including Real Time Operating System, File management software, screen editor, database management software. On line diagnostics/debug software, peripheral drivers software and latest versions of standard PC-based software and latest WINDOWS based packages etc. and any other standard language offered shall be furnished as a minimum.

e. All application software for GUI & MMI system functioning like input scanning, data acquisition, conditioning processing, Regulatory and communication and software for operator interface of monitors, displays, trends, curves, bar charts etc. Historical storage and retrieval utility, and alarm functions and wireless interface drivers etc. shall be provided.

f. 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.

1.01 Software Documentation and Software Listings

The software agency to study the below key points of **Software Documentation and Software Listings** requirements of the GUI & HMI for the Fermenter regulatory system to develop the programming & software

a. All technical manuals, reference manuals, user's guide etc., written in English those are required for modification/editing/addition/deletion of features in the software of the GUI & MMI System shall be furnished. The Bidder shall furnish a comprehensive list of all system/application software documentation after system finalisation for owner's review and approval.

b. All The software listings including source code for application software, All special-to-project data files etc. shall be submitted by the Bidder.

c. Software Licences: The Bidder shall provide software license for all software being used in GUI & MMI. The software licenses shall be provided for the owners and shall not be hardware/machine-specific. That is, if any hardware/machine is upgraded or changed, the same license shall hold good and it shall not be necessary for owner to seek a new license/renew license due to up gradation/change of hardware/machine in GUI & MMI. All licenses shall be valid for the continuous service life of the plant.

d. Software Upgrades: As a customer support, the Bidder shall periodically inform the designated engineering officer of the owner about the software upgrades/new releases that would be taking place after the system is commissioned so that if required, same can be procured & implemented at site. The up gradation software until the completion of last year of Annual Maintenance Contract (AMC) shall be under scope off supplier.

1.02 Databases

The software agency to study the below key points of **Database** requirements of the GUI & HMI for the Fermenter regulatory system to develop the programming & software

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 Regulatory 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.

A historian database shall be developed as a data acquisition system in GUI

1.03 System database

The software agency to study the below key points of **System database** of the GUI & HMI for the Fermenter regulatory system to develop the programming & software

The supplier shall provide a system database covering all system points and their attributes. The database organization shall be a standard database format, so that a point shall be stored as a file record and the attributes of that point shall be stored in the file as fields. Each point shall be supported by a set of parameters that represent the point properties. Typical point parameters shall include, but shall not be limited to, tag name functional point description, engineering units (analog points), state descriptions (digital points), scan rate, alarm limits, and value.

2.0 Regulatory and Information Display Functions as a supervisory function

The software agency to study the below key points of Regulatory and Information Display Functions of the GUI & HMI for the Fermenter regulatory system to develop the programming & software

The display functions shall be assignable by the operator to server station within the system. All system points including analog, digital, and calculated variables shall be capable of being displayed on the operator server station monitors. The use of colour on the displays shall serve to rapidly draw operator attention to important data. The colour of each item shall be as determined by the owner during the design phase of the system.

2.01 Trend Displays

The software agency to study the below key points of Trend Display of the GUI & HMI for the Fermenter regulatory system to develop the programming & software

Trend displays shall consist of a time plot of a minimum of five points concurrently. Each trace shall be in a unique colour. Alphanumeric information shall be overlaid on the same screen to identify points, scales, current value, and related information. The latest value shall be appearing at the right-hand side of the screen. Time shall be plotted on the horizontal axis. The operator shall be able to set the zero and full-scale values for each trended variable in any screen location. The system shall permit the operator to set the grid roll speed and the interval between time lines. The system shall provide standard trend displays with variable full-scale time ordinates. All trends shall be backward and forward scrollable from the trend start time. Selection of points to be trended shall be menu driven. The system shall allow any system variable to be trended, and shall allow points from short-term and long-term storage to be trended. The trend display period between points on trends using data from short-term and long-term data storage shall be the same as the storage frequency selected for those points. Trending resolution shall not be coarser than ±1/2 percent full scale.

The system shall also provide the capability to incorporate trend displays into any user created Regulatory or information display. Trend displays will be defined by the owner and shall be configured at the factory by the bidder.

2.02 Bar Chart Displays

The software agency to study the below key points of Bar chart Display of the GUI & HMI for the Fermenter regulatory system to develop the programming & software

The system shall display dynamic bar charts. The bar chart format shall consist of a series of separate display pages, each with a minimum of 20 vertical or horizontal bars. Each bar shall represent the value of a measurement. Alphanumeric information shall be overlaid on the same screen to identify points, scales, current value, and related information. Each point shall have high and low alarm limits values that shall be shown. Any bar in the group that traverses beyond its limits shall be identified by a change in colour. Bar chart displays will be defined by the owner and shall be configured at the factory by the supplier.

2.03 X-Y Plot Displays

The software agency to study the below key points of X-Y plot Displays of the GUI & HMI for the

Fermenter regulatory system to develop the programming & software

Upon operator request, the system shall graphically display the relationship between two analog points on X-Y plots. This display shall permit up to four points on the Y-axis to be plotted against a single point on the X-axis. The system shall have the capability to store curves (value of Y expressed as a function of X such as a pump curve) and impose the curves on the X-Y plots. Alphanumeric information shall be overlaid on the same screen to identify points, scales, current values, and related information. X-Y plot displays with static curves will be defined by the owner and shall be factory configured by the.

2.04 Process Regulatory Displays

The software agency to study the below key points of Process Regulatory Display of the GUI & HMI for the Fermenter regulatory system to develop the programming & software

The regulatory system shall include process regulatory displays designed to provide the means for the operator to monitor and Regulatory the plant equipment. Each process Regulatory display shall contain textual, geometric graphic, dynamic analog trending, dynamic bar chart, and alarm information representing plant systems, equipment, and other process information.
The process Regulatory displays shall be implemented on a high-resolution display system that, at a minimum, includes the following capabilities:

Each display shall allow selection of at least 256 colours from a colour palette of at least 65,536 colours. Alphanumeric characters shall be displayable in different sizes.

Dynamic numeric data linked to analog variables shall display the current numeric value of the variable, scaled as specified in the database, with engineering units.

The latest in pictorial abilities such as automation of symbols with three-dimensional effects applied to lines and symbols shall be available. Standard geometric shapes shall include, as a minimum, lines, polygons, rectangles, arcs, ellipses.

Standard geometric symbols (tanks, vessels, pipe, valves, etc.) and the ability to create new symbols using standard symbols and standard geometric shapes shall be included.

The capability to fill any closed geometric shape with any available colour shall be included. This capability shall allow fill in proportion to the value of an analog variable, and to select the fill colour in response to the analog variable or according to the status of a discrete variable.

The display system shall also include the following user selectable capabilities:

Creation, modification, and selection of colours in the colour library.

Definition of attributes of all textual and geometric graphic elements, such as colour, line weight, line type, blinking, and dynamic conditional linkage to system variables and attributes.

The system shall provide, at a minimum, the capability for any process Regulatory display to show 200 dynamic variables per screen (analog and digital) and/or geometric symbols, Regulatory 10 data entry points, and Regulatory 100 target points. Based on an operator clicking on or selecting a dynamic variable, the system shall provide the functionality to jump directly to its point detail display. Through operator entry of a value into a data entry point, the system shall provide the functionality to store and use that value for process and equipment Regulatory, for example, sending operation limits of the plant or other manually entered data to the dispatch

system via database points. By an operator clicking on or selecting a target point, the system shall, at a minimum, provide the following functionality:

Activation of a "pop-up" Regulatory station as defined below, to allow process and equipment Regulatory.

2.05 Activation of a display and/or trend

The software agency to study the below key points of Activation of a display of the GUI & HMI for the Fermenter regulatory system to develop the programming & software

The system shall be sized to store and display the quantity of process Regulatory displays to be specified. Process Regulatory displays shall be defined by the owner and shall be factory configured by the bidder.

2.06 Pop-up Regulatory stations

The software agency to study the below key points of Pop-up Regulatory stations of the GUI & HMI for the Fermenter regulatory system to develop the programming & software

The system shall include pop-up Regulatory stations that the operator can call up to operate the plant equipment. Each Regulatory station shall "pop up" on the current process Regulatory display when selected by the operator. The system shall not allow simultaneous display Operator Interface Displays/Logs of more than one pop-up Regulatory station on any process Regulatory display.
The system shall include a library of predefined pop-up Regulatory station templates that shall be used to create Regulatory stations for operator Regulatory of plant equipment. Templates provided shall include auto/manual analog Regulatory stations, bias stations, hand stations, ratio stations, motor Regulatory stations, valve/damper Regulatory stations, equipment tag-out stations, pulse accumulator Regulatory stations, and multiple measurement Regulatory stations. The system shall allow the user to add to or modify templates in the library as well as to create a unique user library.
Each Regulatory station template shall be available as many times as needed by defining the text and database point information specific to a particular piece of plant equipment. The system shall allow a Regulatory station for any plant device to be selected from as many process Regulatory displays as required for proper plant operation.

2.07 Text Displays

The software agency to study the below key points of Text Displays of the GUI & HMI for the Fermenter regulatory system to develop the programming & software.

The Regulatory system shall include text displays to provide information to aid in the operation of the plant and its equipment. Text displays shall include equipment permissive displays, help displays, equipment run time displays, and sequence displays.

Equipment permissive displays shall be provided to dynamically indicate the conditions that must be met for a designated piece of equipment to start or operate. Colour differentiation shall be used to inform the operator of the current status (allow or disallow operation) of each condition. Access to an equipment permissive display shall be by a single operator command once the equipment has been selected.

Help displays shall be static text displays that provide guidance messages on the operation of the Regulatory system or plant equipment. Access to a help display shall be by a single operator request once the operation or equipment has been selected.

Equipment run time displays shall be provided to dynamically indicate the accumulated running time in hours for selected plant equipment. The displays shall include the ability for the operator to individually reset the counter for each device.

Sequence displays shall provide dynamic indication of the status and progress of equipment, group, and unit level start up and shutdown sequences. The displays shall include static text for each step of the start-up, dynamic text to indicate process values or statuses, and links to other displays for individual equipment start up. The sequence displays shall include, for each step, an individual indication that confirms that each step has been completed. Sequence displays shall provide the operator with the ability to start, stop, step, hold, and set the mode of each sequence.

The system shall be sized to store and display the text displays. Text displays shall be defined by the purchaser and shall be configured at the factory by the supplier in the quantity approved during detail engineering by consultant/owner. The quantity of each type of text display will be selected by the purchaser.

2.08 Group Displays

The software agency to study the below key points of Group Displays of the GUI & HMI for the Fermenter regulatory system to develop the programming & software.

The system shall allow the user to create and store text type displays that show the tag name and point description adjacent to the current value or status of selected groups of points. The user shall be able to create each display from a supplier programmed template that allows the user to enter the point tag name for at least 50 points in a column format. The system shall provide storage for 50 such groups for display by the operator.

2.09 Alarm Displays

The software agency to study the below key points of Alarm Displays of the GUI & HMI for the Fermenter regulatory system to develop the programming & software.

The text type alarm displays shall display all points (analog or digital) in the alarm state in the form of written messages with each message containing tag name, point description (refer to the digital point description requirements in Article 17101.2.5.2), time tag, point value or status, and alarm limit.

The alarms shall be displayed on the monitor in the order of occurrence. An alarm, when first output to the screen, shall be displayed on the top line of the screen. A newer alarm shall push all older alarm messages on the screen down by one line. All alarm messages pushed out of the screen shall be backlogged and organized in pages.

The system shall be capable of displaying the backlogged alarm pages on demand by the operator. When an alarm point has been returned to normal, the message shall disappear from the display after it is acknowledged. The system shall categorize all points in alarm into priority levels, and distinctions shall be made between high priority level and low priority level alarms when displayed on the monitors and printers.

The system shall allow the operator to filter the alarm display on any operator server station by priority or specific plant area (if the user has assigned plant areas). The filter shall be applied to the alarm display on that particular operator server station only.

A separate alarm history display shall be provided that displays the most recent 5,000 alarm occurrences in chronological order. The alarm history shall display alarms of all priorities, incremental alarms, and return to normal messages.

2.10 System Displays

The software agency to study the below key points of System Displays of the GUI & HMI for the Fermenter regulatory system to develop the programming & software.

The supplier shall provide a hierarchy of system displays that provides status and health information for the system and for all individual components (switches, server) within the system. These system status displays shall provide the user with a detailed view of the system as designed to indicate the status of each component along with an associated diagnostic summary for each component. Equipment status indication shall be distinctive so as to allow determination of health, trouble, or fault for each operator interface processor, Regulatory server, power supply, switch and associated memory used in the system. These system displays shall be in addition to the quantities of displays defined in Regulatory and Information display functions on the 17101 specification sheets.

2.11 Summaries

The software agency to study the below key points of Summaries of the GUI & HMI for the Fermenter regulatory system to develop the programming & software.

The system shall be configured to allow the operator to display on any 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.

2.12 GUI features:

The software agency to study the below key points of the GUI for the Fermenter regulatory system to develop the programming & software

a. Share data and integrate seamlessly with other software and Regulatory devices. It shall have a common service such as security, alarming and diagnostics. GUI shall have capability of accessing tag information in the Regulatory, eliminating the need to create MMI tags. A defining feature of view shall have an ability to “directly reference” live information from any vendors Regulatory system.

b. GUI shall have a common address book of factory resources so that changes at one place of the Regulatory system shall updated automatically across the entire Regulatory system.

c. GUI shall have an ability to provide a centralized security authority for all components in the system. The diagnostics shall make it easy to record information, warnings and errors generated by the system and users to a central location.

d. GUI shall be able to configure the application from anywhere on the network and easily make changes to a running system, with no need to copy graphics from a server to clients. It shall have a Multi-user configuration capability. It shall provide an audit trail of operator and alarm information in a centralized log database and shall have an ability of validating the user access with private and windows security options.

e. Provides the option of specifying a secondary or redundant, server to take over in case the primary server fails (native redundancy). Software shall have decreases development time and increases code consistency and increases display consistency.

3.0 System Data Reporting Functions

The software agency to study the below key points of System data Reporting functions of the GUI & HMI for the Fermenter regulatory system to develop the programming & software

The Regulatory system shall provide data reporting functions, all reports shall be made from stored data so that once a report is initiated, it can be completed without interruption. The system shall include major types of reports described below.

The system shall include a library of supplier-configured report formats as specified in the following articles. Supplier-configured reports shall include all required headers, footers, subheadings, column headings, and descriptive text.

The quantity of Supplier-configured reports shall be as specified on the specification sheets. All reports and summaries shall be configured and tested by the supplier prior to the factory acceptance test. The system tools shall allow the user to assign run time properties to any report format, such as specific point tag names, title, file name, execution time or event information, and destination. For each report, the user shall be able to define whether that report is sent to a printer, viewed on screen, or saved as a file with complete formatting information. Supported file types shall include, as a minimum, comma-delimited ASCII, comma-separated variable (CSV), XML, Microsoft Excel spreadsheet, and HTML file.

3.01 Periodic Reports.

The software agency to study the below key points of Periodic reports of the GUI & HMI for the Fermenter regulatory system to develop the programming & software.

Periodic reports shall contain the current and averaged values of system variables collected during the period. The reports shall be printed out automatically at designated times and on demand by the operator. Each report shall be designed to collect data for a minimum of 100 points. The actual number of points contained in each report, the points to be collected, and the print times shall be user selectable.

3.02 Trend Reports

The software agency to study the below key points of Trend reports of the GUI & HMI for the Fermenter regulatory system to develop the programming & software.

Trend reports shall contain current and averaged values of system variables at predetermined intervals. The reports shall be printed out automatically at designated times, on demand by the operator, and automatically on the occurrence of a designated event. Each report shall be designed to collect data for a minimum of 100 points. The actual number of points contained in each report, the points to be collected, the print times, the length of the collection intervals, and the designated event shall be user selectable.

3.03 Post-Trip Review Report

The software agency to study the below key points of Post-Trip Review reports of the GUI & HMI for the Fermenter regulatory system to develop the programming & software.

The post-trip review report shall contain current values of system variables at predetermined intervals before and after a plant or major equipment trip. The report shall be printed out on demand by the operator. The report shall be designed to collect data for a minimum of 100 points. The actual number of points contained in the report, the points to be collected, the length of the collection intervals, and the number of collections before and after the trip shall be user selectable.

3.04 Maintenance Data Report

The software agency to study the below key points of Maintenance data reports of the GUI & HMI for the Fermenter regulatory system to develop the programming & software.

The maintenance data report shall calculate and display the number of starts and stops and the accumulated running time of all rotating equipment monitored by the system. The report shall be printed out automatically at designated times and on demand by the operator. The report shall be designed to collect data for a minimum of 100 pieces of equipment. The actual quantity of equipment contained in the report and the print times shall be user selectable.

3.05 Housekeeping Report

The software agency to study the below key points of Housekeeping reports of the GUI & HMI for the Fermenter regulatory system to develop the programming & software.

The housekeeping report shall contain a listing of all changes made to the system by operating and engineering personnel. The reports shall be printed out automatically at designated times and on demand by the operator. The print times shall be user selectable.

3.06 User Reports

The software agency to study the below key points of User reports of the GUI & HMI for the Fermenter regulatory system to develop the programming & software.

The system shall also include a report writer package that allows the user to create, edit, and store new reports and new report formats in addition to the supplier-configured reports defined above. The reporting package shall allow reports to be built in a flexible free-format environment like commercial spreadsheet software and shall provide the following features:

Real-time data and messages combined in flexible layouts to produce meaningful reports.

Information such as headers, footers, number of columns, column format, column headings, calculation equations and descriptive text defined and entered by user for each report.

Reports enhanced through the use of various formatting styles, colour to highlight information, and insertion of charts such as bar charts and pie charts.

User created templates and macros for frequently used formats.

The system shall provide storage for the quantity of user reports

Suitable displays and reports for Regulatory operation & monitoring shall be provided. The details shall be finalised during detailed engineering stage.

DOCUMENTS, DATASHEETS AND DRAWINGS

A complete engineering includes deliverables like engineering calculations, feasibility study reports, operation and control philosophy, guides and standards, drawings and documents. The documentation to be provided by the supplier is indicated in the various sections of the specification however, this section covers the general guideline on the type of drawings and documents to be provided by supplier as a part of this EPC contract for successful commissioning and operation of the plant.

The number of copies/prints/CD-ROMs/manuals to be furnished for various types of document is given in Annexure-II to this section.

Supplier shall submit a master document schedule including all project drawings, specification submission schedule within three weeks from the award of contract. The master document schedule/drawing list shall be reviewed by the consultant/owner and shall be finalized. During various stages of the project, supplier shall submit the drawings and documents based on the master document schedule/drawing list finalized by the consultant/owner. Supplier shall also furnish L1 & L2 schedule for EPC work for approval of the consultant/owner.

The documentation to be provided by the Supplier is indicated in the various sections of specification. This shall include but not be limited to the following:

1.0 Basic engineering documentation

Prior to commencement of the detailed engineering work, the Supplier shall furnish a Automation Definition Manual as per the agreed schedule. This manual shall contain the following as a minimum:

a. System description of the instrumentation, control system and data Acquisition.
b. Selection of appropriate technology / schemes for various field instruments, control system and communication system including techno-economic studies between various options.
c. Equipment performance optimisation studies.
d. Schemes and Process & Instrumentation diagrams for the various systems/ sub-system with functional write-ups.
e. Operation and the control philosophy of equipment control system
f. General Layout plan of the control room equipments and control panel, local mounted control panels, instrument location drawings and control equipment locations on plant layout drawing. This drawing shall also be furnished in the form of CDs to the incharge of the plant.
g. Documentation in respect of Quality Assurance System and List of documentation.

2.0 Detailed engineering documents

a. General layout plan of the control system.
b. Layouts, general arrangements, elevations and cross- sections drawings for all the instruments, devices, panels and facilities to be supplied by supplier.
c. Process & Instrumentation Diagrams
d. Instrument installation drawing including Bill of material along with the instrument hardware specifications.
e. Purchase specification / technical data sheets for all bought out and manufactured items.
f. Detailed design calculations, sizing calculation.
g. Pressure drop in the present process piping due to mounting of flow meters & other field instruments.
h. Characteristic Curves/ Performance Correction Curves.
i. Comprehensive list of all terminal points which interface with plant facilities giving details of location, terminal pressure, temperature, fluid handled & end connection details, forces, moments etc.
j. Power supply single line diagram, wiring diagram block logics, SAMA logics, control schematics, electrical schematics, loop drawings, etc.
k. Interconnection diagram between Fermenter batch regulatory systems and existing switchgear panel, electrical wiring drawing of motorized Actuators mounted on various valves
l. Protection system diagrams and relay settings.
m. Interconnection diagrams & cable schedule, Junction Box schedule.
n. Cable routing plan and routing diagrams along with Bill of material
o. Instrument schedule, measuring point list, I/O list, Interconnection & wiring diagram, functional write-ups, installation drawings for field mounted instruments, logic diagrams, control schematics, wiring and tubing diagrams of panels and enclosures etc. Drawings for open loop and close loop controls (both hardware and software). Motor list and valve schedule including type of actuator etc.
p. Alarm and annunciation/list of alarms & trip set points.
q. Sequence and protection interlock schemes.
r. Type test reports and Fermenter process stability study report.
s. Control system configuration diagrams, panel drawings, card circuit diagrams and maintenance details.
t. Detailed software manuals & source software listing. Detailed flow chart for digital control system.
u. Mimic diagram layout. Ladder logic prepared based on the SAMA logic. A soft and hard copy in various sets
v. Specification of regulatory system, control panel switchgears, cable,

cable hardware, instrument piping and hardware.

w. Civil, structural and architectural drawings and documents for all structures, facilities, foundations, underground and over ground.

x. Functional & guarantee test procedures and test reports(Supplier to provide the list of test reports for consultant /owner approval)

y. Documentation in respect of Quality Assurance System as listed out elsewhere in this specification. (Supplier to provide the list of Quality Assurance System for consultant /owner approval)

z. Documentation in respect of commissioning as listed out elsewhere in this specification.

The Supplier's shall mark on each copy of 'submission reference letter' along with the date vide which the submissions are made, while submitting the above documents / drawings for approval / reference documents as the case may be.

3.0 Instruction manuals

The supplier shall submit to the consultant/ plant in charge, draft Instruction Manuals for all the components of system, communication system covered under the contract as per agreed schedule. The Instruction manuals shall contain full details required for erection, commissioning, operation and maintenance of each equipment. The manual shall be specifically compiled for this project. Modifications / changes carried out during commissioning shall be incorporated in the final O&M manual to be submitted before conductance of the performance Test. After finalisation and approval of the plant incharge the Instruction Manuals shall be submitted as a final document. The contract shall not be considered to be completed for purposes of taking over until the final Instructions manuals have been supplied to the plant incharge. The Instruction Manuals shall comprise of the following.

3.01 Erection manuals

The erection manuals shall be submitted as per agreed schedule prior to the commencement of erection activities of particular instrument, control system, device. The erection manual shall contain the following as a minimum.

a. Erection strategy
b. Sequence of erection
c. Erection instructions
d. Critical checks and permissible deviation/tolerances
e. List of tool, tackles, heavy equipments like cranes, dozers, etc.
f. Bill of Materials
g. Procedure for erection
h. General safety procedures to be followed during erection/installation
i. Procedure for initial checking after erection
j. Procedure for testing and acceptance norms
k. Procedure / Check list for pre-commissioning activities
l. Procedure / Check list for commissioning of the system
m. Safety precautions to be followed in electrical supply distribution during erection

3.02 Operation & maintenance manuals

a. The operating and maintenance instructions together with drawings (other than shop drawings) of the instrument, control system, devices as completed,

shall be in sufficient detail to enable the plant incharge to operate, maintain, dismantle, reassemble and adjust all parts of the equipment/instrument/system. They shall give a step by step procedure for all operations likely to be carried out during the life of the Fermenter system including, operation, maintenance, dismantling and repair. Each manual shall also include a complete set of drawings together with performance of the equipment/instrument/system and test certificates wherever applicable. The contract shall not be considered to be completed for purposes for taking over until these manuals have been supplied to the plant incharge.

b. If after the commissioning and initial operation of the plant, the manuals require any modification / additions / changes, the same shall be incorporated and the updated. The final instruction manuals shall be submitted to the plant incharge for records.

c. A separate section of the manual shall be provided for detailed description of construction and operation, together with all relevant pamphlets and drawings.

d. The manuals shall include the following:

i. List of spare parts along with their drawing and catalogues and procedure for ordering spares.
ii. Maintenance Schedule including charts showing lubrication checking, testing and replacement procedure to be carried out daily, weekly, monthly & at longer intervals to ensure trouble free operation.

4.0 Plant handbook and project completion report

4.01 Plant handbook

The supplier shall submit to the Consultant/plant incharge a preliminary plant hand book which shall contain the design and performance data of various equipment/instrument/system covering the complete project including

a. K
ey points of troubleshooting
b. P
rocess & Instrumentation diagrams. Single line diagrams
c. S
equence & Protection Interlock Schemes. Alarm and trip values.
d. C
ontrol philosophy

The plant handbook shall be submitted as per agreed schedule. After the incorporation of Plant incharge comments, the final plant handbook complete in all respects shall be submitted as per agreed schedule before start-up and commissioning activities.

4.02 Project completion report

The Supplier shall submit a Project Completion Report at the time of handing over the project.

5.0 Drawing details and As Built Drawings

5.01 Drawings

a. All the regulatory panel, junction box, plant layouts indicating the regulatory panel locations in the plant, control room locations in the plant, control room architecture and layouts shall be made in computerised 3D modelling system. The consultant/ plant incharge reserves the right to review the 3D model at different stages during the progress of engineering. The layout drawings submitted for plant incharge review shall be fully dimensioned and extracted from 3D model after interference check.

b. All the plant layouts shall be made in computerised 3D modelling system. The consultant/ plant incharge reserves the right to review the 3D model at different stages during the progress of engineering. The layout drawings submitted to plant incharge review shall be fully dimensioned and extracted from 3D model after interference check.

c. All documents submitted by the supplier to plant incharge, it's review shall be in electronic form (soft copies) along with the desired number of hard copies as mentioned in the drawing list. The soft copies to be supplied shall be either in CDs or through direct transfer via E-mail, etc. The drawings submitted for approval shall be in the Image form. Final copies of the approved drawings shall be submitted on CD-ROM along with the requisite number of hard copies as mentioned in the drawing list.

d. The completed plant documentation including data sheets, P&ID, BOQ, schematics, logic diagrams, test reports and quality plan, etc. attached to the respective equipments / systems in the 3D model shall be furnished to consultant/ plant incharge, along with the design software (on which model has been made so that same can be used for modification and updation). This software shall be loaded on suitable hardware (server and work station). The software shall include facility for obtaining hard copies of all the drawings/documents on standard plotter/printer. The requisite hardware and software shall be supplied and commissioned by the Supplier at as per mutually agreed schedule.

e. All documents/text information shall be in MS Word (Latest).All drawings submitted by the supplier including those submitted at the time of bid shall be in sufficient detail indicating the type, size, arrangement, weight of each component for packing and shipment, the external connection, fixing arrangement required, the dimensions required for installation and interconnections with other equipments and materials, clearance and spaces required between various portions of equipment and any other information specifically requested in the drawing schedules.

f. Each drawing submitted by the supplier (including those of subvendors) shall bear a title block at the right hand bottom corner with clear mention of the name of the Consultant/Plant incharge, the system designation, the specifications title, the specification number, the name of the Project, drawing number and revisions. If standard catalogue pages are submitted the applicable items shall be indicated therein. All titles, notings, markings and writings on the drawing shall be in English. All the dimensions shall be in metric units.

g. The drawings submitted by the supplier (or their subvendors) shall bear Plant incharge drawing number in addition to Supplier's (their sub- vendor's) own drawing number. Plant incharge drawing numbering system shall be made available to the supplier so as to enable

him to assign drawing numbers to the drawings to be submitted by him during the course of execution of the project.

h. The supplier shall also furnish a "Master Drawing List" which shall be a comprehensive list of all drawings/ documents/ calculations envisaged to be furnished by him during the detailed engineering to the Plant incharge. Such list shall clearly indicate the purpose of submission of these drawings i.e. "FOR APPROVAL" or "FOR INFORMATION ONLY". Similarly, all the drawings/ documents submitted by the Supplier during detailed engineering stage shall be stamped "FOR APPROVAL" or "FOR INFORMATION" prior to submission.

i. The drawing list shall be in line with the drawings mentioned in the section "**Typical documents"** attached below. The "Master Drawing List" shall be Reviewed/approved by the consultant/Owner prior to finalization.

j. The furnishing of detailed engineering data and drawings by the supplier shall be in accordance with the time schedule for the project. The review of these documents/ data/ drawings by the consultant/Plant incharge shall cover only general conformance of the data/ drawings/ documents to the specifications and contract, with the process equipments, interfaces between various regulatory systems, external connections & dimensions which might affect plant layout. The review by the consultant/Plant incharge shall not be construed to be a thorough review of all dimensions, quantities and details of the equipments, materials, any devices or items indicated or the accuracy of the information submitted. The review and/ or approval by the consultant/Plant incharge shall not relieve the supplier of any of his responsibilities and liabilities under this contract.

k. After the approval of the drawings, further work by the supplier shall be in strict accordance with these approved drawings and no deviation shall be permitted without the written approval of the consultant/Plant incharge.

l. All manufacturing and execution of work in connection with the regulatory system, prior to the approval of the drawings, shall be at the Supplier's risk. The Supplier is expected not to make any changes in the design of the equipment /system, once they are approved by the consultant/ Plant incharge. However, if some changes are necessitated in the design of the regulatory system at a later date, the supplier may do so, but such changes shall promptly be brought to the notice of the consultant/Plant incharge indicating the reasons for the change and get the revised drawing approved again in strict conformance to the provisions of the Technical Specification.

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5.02 As Built Drawings

a. After final acceptance of individual instruments/control systems by the consultant/Plant incharge, the supplier shall update all original drawings and documents of the instruments/control system to "as built" conditions. Supplier shall submit as built 3D model along with the software on which the model is made. Drawings must be checked by the supplier in terms of its completeness, data adequacy and relevance with respect to Engineering schedule prior to submission to the consultant/Plant incharge. In case drawings are found to be submitted without proper endorsement for checking by the supplier, the same shall not be reviewed and returned to the supplier for re-submission. The

supplier shall do the complete engineering including interfacing and integration of all his regulatory system & facilities within his scope of work as well as interface engineering & integration of systems, facilities, equipment & works under Plant incharge scope and submit all necessary drawings/documents for the same.

b. The supplier shall submit adequate prints of drawing/data/document for consultant/Plant incharge review and approval. The consultant/Plant incharge shall review the drawings and return one (1) copy to the supplier authorizing either to proceed with manufacture or fabrication, or marked to show changes desired. When changes are required, drawings shall be re-submitted promptly, with revisions clearly marked, for final review. Any delays arising out of the failure of the supplier to submit/rectify and resubmit in time shall not be accepted as a reason for delay in the contract schedule.

c. All engineering data submitted by the supplier after final process including review and approval by the consultant/Plant incharge shall form part of the final contract documents and the entire works covered under these specification shall be performed in strict conformity with technical specifications and approved drawings.

5.03 Typical documents

Supplier shall furnish all required information/data sheet/drawing/document required to facilitate full appreciation of bid which shall include but not limited to following :-

a. Detailed regulatery architecture drawing (also indicating interconnection of different C&I Sub-System) vis-a-vis a comprehensive write-up on the C&I System offered.
b. Filled up Technical Particular Sheets/Schedules.
c. Suggested closed Loop and open Loop regulatory Schemes along with write-up.
d. Details of regulatory System offered for each plants and subsystems & their Operational Philosophy.
e. Description and write-up of regulatory and interlocking system
f. Complete layout diagrams with foundations details of all panels, desks and consoles.
g. Details of hardwired controls and indication (if any).
h. Lists of spares (erection/ commissioning & recommended), special tools and tackle.
i. List of deviation from Specification document.
j. Interconnection blocks schematics and architecture drawing for complete control & Instrumentation system.
k. Interconnection & wiring schematics between various instruments and sub-assemblies.
l. Detail wiring diagrams of all panel desk, control consoles, system cabinets etc.
m. Proposed displays and logs with menu and format. List of typical Dashboards and their formats
n. Flow chart for auto regulatory loops. Logic flow sheets/Boolean diagram for open loop controls.
o. Network drawing, network architecture, specifications & bandwidth of various protocol and accessories used in the communication.
p. Complete Instrument Schedule.
q. Calibration test & quality assurance test procedure and test certificates.
r. Shop and site Test Records.
s. Regulatory system documentation Manuals & technical literature for other equipments.
t. Cable Schedule and interconnection diagram, cable layout and tray drawing.
u. Power supply arrangement for field mounted instruments/panels/sub systems.
v. 'As built' status drawings

NUMBER OF COPIES OF DRAWINGS AND DOCUMENTS

Sr. No.	Description	Prints in nos.	CD-ROMs/sets in nos.	Manuals in nos.
1	Plant definition manual	-	-	-
a	"FOR APPROVAL"	4	4	
b	"FOR INFORMATION"	4	4	
c	"FINAL DRAWING"	-	-	-
d	"AS BUILT"	6	6	
2	Data Sheets, design calculations, purchase specifications, etc. and Other type of documents	-	-	-
a	"FOR APPROVAL"	-	-	-
b	"FINAL"	-	-	-
3	Erection manual "DRAFT"	-	-	-
	Erection manual "FINAL"	-	-	-
4	Operation & Maintenance manual "DRAFT"	-		4
	Operation & Maintenance manual "FINAL"	-	6	6
5	Plant Handbook for Automation "DRAFT"	-		4
	Plant Handbook for Automation "FINAL"	-	6	6
6	Commissioning and Performance Procedure manual "DRAFT"	-	-	4
	Commissioning and Performance Procedure manual "FINAL"	-	6	6
7	Performance and Functional Guarantees test report	6	6	
8	QA programme including Organisation for implementation and QA system manual (with revision servicing)	6	6	-
9	Programming QPs, Field QPs and their reference documents like test procedures, etc.	6	6	-
10	Progress Reports per month	2	2	-
11	Project completion report	6	6	-