ANNEXURE - II

TECHNICAL SPECIFICATION

FOR

HIGH FIDELITY OPERATOR TRAINING SIMULATOR

500 TPD METHANOL PLANT

ASSAM PETROCHEMICALS LIMITED

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1 Introduction

1.1 General

The purpose of this document is to provide a minimum specification for the High fidelity Operator Training Simulator (OTS) in sufficient detail to enable a simulator supplier (VENDOR) to develop detailed scope, prices and delivery schedule.

1.2 Objectives

Assam Petrochemicals Limited (APL) is planning to procure a Dynamic Plant Simulator (OTS) for the 500 TPD Methanol Plant at Namrup, Assam.

The OTS shall be suitable for long-term use throughout the life-cycle of the plant from early design to start-up and then throughout the operational life of the plant. For fulfilling the OTS Objective, the OTS should be capable of operation over the full range of:

- Normal operations
- Start-up and shutdown
- Turndown operations
- Equipment malfunctions and emergency conditions.

The OTS shall be of high accuracy for use both as operations and engineering tool and have the capability to allow APL (CLIENT) to:

- Train Panel operators to have better ability to handle panel operations in terms of various stages of the plant process namely:
    - Cold Startup
    - Warm Startup
    - Hot Shutdown
    - Normal Shutdown
    - Handling Operational changes – Pump Changeovers
    - Handling Emergencies
- Support all kind of operation conditions far from the design operation point
- Engineering Analysis – Doing analysis for changes such as equipment fouling predictions and effects etc.
- Conduct periodic refresher training and testing
- Certify operators for competence
- Perform control strategy tests - Pre-Commissioning and Post Commissioning strategy evaluation.
- Develop, verify and improve operating procedures
- Develop, verify and improve maintenance procedures
- Undertake studies into plant performance
- Conduct investigations into operating incidents
- Develop emergency response procedures

In view of above, the overall objectives of the simulator are to:

- Conduct dynamics studies into plant performance and operability
- Provide operator training
- Reduce start-up and shutdown time
- Increase plant on-stream time
- Reduce the risk of major operational incidents
- Reduce environmental impact
- Improve plant performance

1.3 OTS System Structure

The OTS systems may be installed in a dedicated room or hosted on the corporate network so that training session can be “flexible” in its design rather than dedicated in a single room (preferred option). Each system shall consist of the following major components:

- Trainee Operator Station
- Instructor Station
- Field Operator Station(functionalities to be included in Operator station)
- DCS Emulation software for the purpose of simulating as similar/as close as possible to that of the DCS including color schemes, flow schemes and the face plates.
- Simulation Computer (functionalities to be included in Instructor station)
- Simulation Software

Considering long term usage of OTS and for minimization of Hardware footprint it is required to host this system on APL (CLIENT) corporate network in such a way that all users can access this system from their desk computers connected to CLIENT network, thus making the training “flexible”. Users should be able to perform refresher trainings, preconfigured exercises and self-trainings remotely. More rigorous trainings involving instructor interventions may be conducted from dedicated training room.

1.4 Parties and Responsibilities

The OTS systems will be supplied by the selected VENDOR, who shall be responsible for provision of complete working systems in strict accordance with this specification.

VENDOR shall ensure that only OTS systems of proven capability are offered to meet the requirements set out in these specifications. Requirements which cannot be met or which are not available as standard features shall be clearly identified in VENDOR’s proposal together with any deviations or alternatives.

2. Definitions and Abbreviations

2.1 Definitions

CLIENT OR COMPANY means Assam Petrochemicals Limited

VENDOR - Supplier of Hardware and/or Software for OTS

Shall and Must - indicate a mandatory requirement

2.2 Abbreviations

APL – Assam Petrochemicals Limited

GUI – Graphic User Interface

DCS - Distributed Control System

ESD – Emergency Shutdown System

MAT – Model Acceptance Test

FAT - Factory Acceptance Test.

SAT – Site Acceptance Test

TPD – Tons Per Day

3 Applicable Documents

All specifications applicable to the Methanol project shall be complied. e.g. project specifications, drawings, codes & standards, etc.

4 Functional Specification

4.1 General Requirements

The proposed dynamic simulator (OTS) shall support the following applications.

4.1.1 Off-line Training:

Operator Training Exercises to ensure that operators can skillfully operate the plant to:

- Start-up and shut down the units safely and efficiently
- Identify and correct plant alarms, upsets and malfunctions
- Respond correctly and promptly to emergency situations and plant upsets
- Co-ordinate with field operations to ensure Smooth sequencing of field operations.

4.1.2 Off-line Engineering:

Engineers should be able to carry out the following functions using the dynamic simulator:

- What-if Scenarios
- Process De-bottlenecking
- Control Strategy Assessment
- Advanced Process Control preliminary assessment
- Operational procedure assessment and improvements
- Maintenance procedure assessment and improvements
- Steady State Process Simulation

4.1.3 Simulator Functional Requirements

When used for operator training, the trainee should be able to change parameters such as feed rates and qualities. The trainee should be able to upload particular scenarios and feed compositions to carry out the required training exercises.

DCS Emulation software for the purpose of simulating as similar/ as close as possible to that of the DCS including color schemes, flow schemes and the face plates. The regulatory control model must represent and support the parametric structure, connectivity, control modelling equations and sequences of the actual control function blocks supplied by the control system vendor. An emulation of the shutdown system must be provided. Logic must be simulated and it must be possible to change controller tuning constants.

The simulator must allow control room operators to be trained on various aspects of operations, including but not limited to the following:

- Normal operations
- Normal shutdown
- Normal ‘cold’ start-up
- Normal 'hot' start-up after a recent trip or shutdown
- Turndown operations
- Equipment malfunctions and emergency conditions
- Communication with field operators

It is planned that the OTS will be used to verify the process and control design, provided for stable and safe operation of the equipment and process through a variety of pre-determined process simulation runs. These simulations runs will be performed by APL and subject to the agreed limitations of the OTS. This will be achieved by carrying out studies for:

- Verification of consistency with steady-state operation (steady-state model)
- Investigate responses during start-up, shutdown and emergencies
- Investigate process and control design interaction to ensure stable operation during changes in throughput.
- Aid development of commissioning and operating procedures.

The OTS will also be used by Process Engineers and Control Engineers to evaluate plant modifications, control system changes, identify constraints etc., and must therefore be of sufficient engineering details that allows the user to change the configuration of plant, equipment and control strategy to evaluate changes without the need for excessive support from a vendor.

The VENDOR shall provide a complete description of the proposed hardware and software architecture in connection with the above simulator components.

5 OTS System Architecture

5.1 Simulator System

The OTS simulator computer system shall be a multi-user, multitasking with remote access capability over CLIENT Network. The simulator system shall be capable of synchronized operation of multiple computers and applications, which may be activated individually or on an integrated basis. The system shall permit easy extendibility of OTS simulation components by the instructor without reconfiguring the model. Increase of model scope/complexity will be possible by specifying which process model segments and simulation nodes will be loaded and available at runtime.

The VENDOR shall provide all computer software licenses to THE CLIENT for all installed computer vendor software.

The preferred computing environment is Windows 10 or later.

The VENDOR shall provide a complete description of the proposed hardware and software along with a system architecture diagram showing the interconnection.

Other than supplied hardware for instructor to conduct trainings OTS should have the following components which should be accessible from training room.

5.2 Instructor Station

The OTS features an Instructor Operation Panel that controls the training session to initiate, terminate the training session. The instructor station shall use an intuitive graphics user interface and be designed to provide easy-to-use training features, permitting quality operator training. It shall allow the instructor to call up displays and load models, insert malfunctions, and perform other tasks during a training session. Through easy-to use displays, the instructor shall be able to monitor the status of the models and directly control selected malfunctions and remote functions. Furthermore, the instructor shall be able to see all the process information available to the trainee, as well as certain key internal process variables.
The instructor station shall be driven by graphical user interface software that can be used by THE CLIENT's personnel to modify the standard displays and to add specific displays the instructor feels are necessary to enhance the training exercises.

The specific training features required in the instructor station are detailed in Section 6.2. The VENDOR shall include a complete description of the instructor station displays and capabilities in the proposal.

5.3 Engineering Station (include all these functionalities/features in the Instructor station)

All the functionalities of Engineering Station are to be configured within the Instruction Station.

The engineering station shall be designed to allow full access and flexibility to create or modify the malfunction and remote function displays, and allow modification and extension of process models through configuration of the simulation software.

The engineering station will also be used by process and control engineers to conduct studies into plant performance and improvement. The VENDOR shall detail facilities for generation of reports for study activities.

The VENDOR shall include a complete description of the engineering station displays and capabilities in the proposal.

5.4 Operator Stations

The operator station will be as similar/ as close as possible to that of the DCS including color schemes, flow schemes and the face plates. The OTS allows the operator console to be used by engineers, operators and trainees. The console used includes Operation displays (Graphics displays, Trend displays).

Trainees are able to perform the following functions:

- Start-up training
- Emergency shutdown training
- Normal operation, manipulate instrument action, set-point, alarm limits and control tuning parameters.

One Operator Station with single monitor shall be provided. The system shall include a high performance direct digital link between the simulation server, the instructor station and the stand-alone set of Operator Station.

The VENDOR shall fully describe the technical approach to be used including:

- Method of communication between the various components.
- Hardware and software required along with system configuration diagrams.
- Architecture to show the details of communication channels available to third party system.

VENDOR to identify any changes or modifications required to these configurations.

The CLIENT's intent is, where possible and cost effective, to replicate the full functionality of the actual DCS. The VENDOR shall clearly identify any limitations or exceptions to this in the proposal.

5.5 Field Operator Station (include all these field functionalities/features in the Operator station)

The VENDOR shall provide the capability for simulating remote functions such as starting/stopping pumps or opening/closing block valves. The VENDOR shall provide a means for easily operating the remote functions through the operator station, instructor station or a separate field station.
The VENDOR shall describe the simulation capability and interface for the remote functions.

5.6 Corporate Network Deployment Architecture – Flexible Training Room

To provide flexibility of training and ease of maintenance, the supplied OTS should be deployed on CLIENT’s corporate network. It should be possible to deploy the VENDOR’s software using a server-client architecture – one central server to store the master copy of the model and multiple client machines to under-go training. The VENDOR shall ensure the following capabilities for the OTS deployment:

1. Centralized storage of all CLIENT OTS models on the central server which can be virtualized.

2. On demand download of the OTS models on the trainee's client machine. The model download should be possible on any CLIENT machine as long as it's connected to the corporate network.

3. The transfer or download of the model should be through the TCP\IP protocol and not a mere copy-paste of the model.

4. Ability to store the OTS model temporary on the client machine. Whenever the master model is updated on the central server, it should automatically replace the model on the client machine. This is done to ensure that the latest model changes are available to all trainees at the same time.

5. Ability to send back training and evaluation reports to the central server at the end of the training exercise. The training reports should be stored based on trainee names and easily segregated.

6. The architecture should provide the flexibility to run multiple sessions of the same OTS on multiple trainee client machines. Vendor to quote one session design as a minimum, with a flexibility to increase additional sessions without any additional engineering on the OTS.

Vendor to explain how the above server-client architecture can be deployed using Vendor's software and without any dependency on 3rd party software.

6 Simulation Software

6.1 Overview

The simulation software shall run under the unmodified operating system (preferably Windows 10 or later) provided by the computer vendor.

The software should be compliant with Microsoft OPC DA Level 2v
(OLE for Process Control - Object Linking and Embedding) with the ability to:

- Build custom property packages
- Develop specialized unit operations
- Create Customized unit operation using interface such as Visual basic. etc.
- Create customized solutions and applications to address critical business issues using Excel and Visual Basic for Applications (VBA)

The simulation software shall provide the following functionally:

- Software that permits the simulator to be operated in training mode alone.
- Software that permits modifications to the process model, controls, instructor station and field operator displays for engineering applications and software maintenance purposes.

- Software that permits the use of the system for engineering studies.
- Software should support corporate network deployment capabilities using a server client architecture.
- Software should support running of at least two sessions of the same OTS – parallel training.

VENDOR shall specify the capability for THE CLIENT to modify the process models and/or create new models, as may be required.

The VENDOR shall fully describe:

- The functional capabilities of simulation software in the proposal.
- The facilities of the system to simulate the operation of multiple process units, both individually and as integrated units.
- The accuracy criteria of the simulation system, including details of calculation step size, data refresh rates to operator and instructor displays.

The software should be a network based licensed software with the ability to provide license availability in case of license server failure which would minimize the impact of non-availability of network server till it's rectified and restored. Dongles and other hardware based security keys are NOT acceptable. Simulation software along with necessary operator station and other software's be supplied with perpetual (99 Years term) development / maintenance / run-time license.

6.2 Summary of Training Features

The VENDOR shall include complete descriptions of the instructor user interface, training features and functional capabilities.

The software shall provide powerful training tools that improve exercise development, operator training and certification. These training tools are designed to satisfy the needs of an instructor by providing him with the tools necessary to set up training exercises and to monitor and evaluate the progress of a trainee. There shall be four basic functions

- **Common Functions** to all users types utilizing the simulator,
- **Training Functions**, in which an instructor is able to pre-configure training exercises to automate instructor-less training exercises,
- **Process Control Functions**, in which an instructor is able to monitor and control the process and its operation
- **Evaluation Functions**, in which an instructor is able to evaluate a trainee's performance during the course of the training exercise.

In order for CLIENT to prepare a curriculum for Operator Certification, the VENDOR shall include the following functional capabilities shall be available as a minimum requirement:

6.2.1 Common Functions

- Automatic Snapshots shall allow process conditions to be stored automatically at given intervals during the simulation session. These stored conditions can be saved as initial conditions files for reuse in future sessions.

- The conditions that exist at any point during a simulation session can be stored on demand as a future Initial Condition. They can be used repeatedly during future sessions.

- The software shall have the capability of starting the simulator at any one of several Initial Conditions. When the simulation model is originally built, it usually represents an empty and idle plant. By starting-up and operating the simulation model, a number of different operating conditions may be generated. At a specific point in time, an image of the process at that moment may be saved as an Initial Condition.

- The software shall be able to restore to a previous set of conditions saved during the current simulation session. Backtrack Conditions are created on demand or periodically within a given training session to quickly backtrack without leaving the training session and reloading these conditions. If any of the Backtrack Conditions are viewed to be valuable to future training sessions, they can be converted to Snapshots for Initial Conditions. When Backtrack is initiated, the simulator returns to a specified point in time and loads the same operating conditions, scenario steps and malfunctions saved at that instant.

- The simulator can be stopped or restarted at any time during the training session. Freeze allows the simulation to be stopped and all process-control simulation and training features are suspended. Unfreeze restarts the simulator.

- The simulation shall be able to vary the simulation speed: Real Time; Fast Time: To move slow moving transients faster when it is considered beneficial for operator training or other purposes. The simulation can be moved to and from Fast Time operation as required during the simulation session.; Slow Time: This operation slows down the simulation by a specified factor to permit a close look at rapid process dynamics allowing a more detailed review of operator-trainee errors and model transient behavior. The simulation can be moved to and from Slow Time operation as required during the simulation session; Step: Allows the simulation to freeze/unfreeze one (or a specified number of) frame(s) at a time to examine detailed operation of the process.; As-Fast-As-Possible: Remove any wait states of the simulation allowing it run as fast as the simulation engine can.

6.2.2 Training Functions

- The software shall allow the Instructor to combine an Initial Condition with a pre-configured Scenario (sequence of events) to provide an easy way to expose operators to many training Exercises for Instructor-Less training teaching styles.

- The software shall allow the Instructor to set up repeatable and consistent training Exercise for all trainees. In combination with the event monitoring feature, specific training exercises may be set up by the instructor before a training session. Once initiated, the exercise follows predefined procedures such as causing malfunctions to occur automatically at prescribed times. The following functions shall be invoke-able during the time-base sequence of operation include the control of:

    - Management of Training Performance functions
    - Activation and Regulation of Process Control Devices
    - Activation and Specification of Generic & Custom Process Upsets
    - Time Management Functions – freeze, real/fast-time
    - Snapshot Creation and Reports (files, printouts)
    - Sequence control following Boolean Logical States and Branching

- There shall be features to introduce Process upsets and disturbances with the simulation model. Active process upsets shall be displayed in a window for quick viewing by the Instructor. The software shall allow the configuration of any number of process upsets for any process disturbances.

- The following generic malfunctions shall be made available for all these type of equipments:

    - Transmitters (Malfunction in various ways by freezing the transmitter output at a constant value, adding an offset to the output over time or making the output unstable)
    - Pumps (Performance deterioration due to plugging or suction loss or overheating when the flow goes below a minimum “safe” flow rate)
    - Valves (Performance in the model may be malfunctioned in the following ways: Failure of the actuator; Inaccurate actuator calibration; Abnormal leakage through the valve when it is closed; Restricted flow through the valve due to plugging; Increased time delay responding to an actuator movement, Resistance to actuator movement and Oscillating actuator behavior).
    - Heat Exchangers (Performance in the model may be malfunctioned in the following ways: Performance Deterioration; Shell Fouling and Tube Fouling, Tube leakage).
    - Relief Valves (Performance in the model may be malfunctioned in the following ways: Actuator fail, Leakage, Pressure Drift)
    - Digital Switch and Valve Limit Switch (Performance in the model may be malfunctioned in the following ways: Outlet Signal and Set Point drift).

    - Filters (Performance deterioration due to filter clogging and flow restrictions).
    - Air Cooler (Performance may be malfunctioned in the following ways: Performance deterioration, Tube fouling and Fan Failures).

- It shall be possible for the Instructor to adjust certain parameters during the simulation session through pre-configured variables to allow changes such as feed, composition, pressure and temperature. These changes may occur instantaneously, over a period of time or within a preset range.

- A search tool shall be available for the user to search for occurrences of objects in the simulation model such as graphics, process upsets, scenarios, control devices and etc.

- The software should permit the ability to link with field operator training software either through panoramic or immersive training interfaces.

Training Exercises for Methanol Plant

The simulator shall be provided with a wide range of pre-programmed exercises to use in the training of operators. Some of these will include:

- Feed composition change
- Loss of Steam to Reformer
- Loss of Feed to Reformer
- Loss of Fuel to Reformer
- ID Fan failure/ Reformer furnace pressure high
- Loss of Combustion Air to Reformer
- Combustion Air Compressor trip
- Steam Drum Level low
- BFW pump trip
- DM water flow low / Deaerator level low
- Utilities (Power,CW,IA,N2)failure
- DCS/ESD failure

Some of these can be instigated by a standard library of malfunctions.

6.2.3 Process Control and Monitoring Functions

- The Instructor shall be able to monitor alarms and the operator performance with typical alarm management functions like audible alarm annunciation and acknowledgement function.
- Simulated events may be configured to trigger video clips that can be played on the Instructor station or spawned to run in another machine.
- Simulated events may be configured to trigger pre-scripted messages.
- To quickly review the process performance, the software shall provide multi-variable trend displays of any simulated variables for viewing, reporting and record keeping.

6.2.4 Trainee Performance Monitoring and Evaluation Functions

- The software shall be able to capture the trainee's ability to control key production variables within their target operating window. It shall be able to record the trainee's ability to maintain a process within a specified operating limit, bring a variable to a specific target and maintain an ideal trajectory within a defined envelope.
- The Instructor shall be able to get an overview of the current status of key variables in relation to their target, or ideal values.
- The software shall provide the instructor with a tool for reviewing the training session in order to confirm that the trainee responded quickly and correctly under upset conditions. The tool shall monitor, capture and report all simulation events, alarms and trainee's response actions during a simulation session. These captured events may be replayed at a training session at a later date in a scenario to examine what went wrong in a training exercise.
- The software should allow Trainee to be accessed and graded on the plant's Standard Operating Procedure (SOP) including subjective evaluations like team communications.
- The software should provide a repository for domain knowledge and experiences; teaches and evaluates "what if" reflexes and diagnostic abilities.
- Software should include customizable competency model that aligns and assists in improving critical requisite skills and behaviors; tracks operator progress.
- The simulation server shall provide a centralized operator performance management feature with the following support:

    - Models Repository over a server and client architecture
    - Centralized Training Records & Reporting
    - On-demand training module access
    - Scalable classroom style multi training on independent models
    - SCORM V1.2 Interface to 3rd Party Learning Management Systems

6.3 Engineering Features

The OTS software shall have a model development and execution environment to enable CLIENT to modify existing process models and to conduct engineering studies. The following engineering features and functions shall be provided as a minimum:

- GUI based modeling tool that is available for modifying the process model in build and runtime modes.
- Rigorous first principle based unit operations.
- Rigorous thermodynamic models
- Process, control and logic libraries
- Model modification and enhancement capabilities (of the delivered process model)
- Ability to protect the process models with password.
- Support Steady-State simulation and Dynamic Simulation
- Instructor Interface configuration, modification and development capabilities
- Runtime interface to reporting facilities for engineering studies via OPC DA Level 2.0 (or equivalent)
- Process modeling tool should be compliant with CAPE-OPEN standards.

VENDOR shall have libraries of dynamic model algorithms for common process equipment and control functions and that this library would be expanded if additional functions are needed.

The Engineering terminal shall comprise of facilities to enable model modification and enhancements. CLIENT expects that changing the performance of items of process equipment shall be achieved by simple modification of the parameters associated with a specific algorithm. For example a valve characteristic will be modified by changing the value of the CV within the corresponding "valve" algorithm.

Facilities shall enable development and testing of new or improved control strategies, operating procedures or maintenance procedures associated with the processes modelled as part of the OTS Systems. This requirement will enable proposed changes to be tested prior to implementation on the actual process unit control system. The VENDOR shall explain how this requirement will be met.

The OTS should be capable of storing and retrieving additional versions of the main or custom model in order to enable process and control engineers to experiment with process and control strategies without destruction of the base model version which is used for training. The VENDOR shall state the capacity of its system for such model duplication.

Thermodynamics and Multiple Component Slates

Good Thermodynamics is the heart of every process dynamic simulation. The Simulator should calculate process thermodynamics at each time-step throughout the entire process simulation. The Simulator should also allow multiple component slates to be used in the same flowsheet.

It is expected that the simulator shall use structured and proven thermodynamic and property prediction methods for the Methanol process. The simulation vendor shall state the methods used, their applicability and highlight the experience of use to validate the methods. Vendor shall indicate their past experience in this regard.

7 Custom Plant Models

7.1 General

The CLIENT requires the OTS system to simulate in detail those parts of the process containing process materials and utilities and to include all of the DCS points and the shutdown system logic as required such that the operator sees minimal differences between the simulation and actual process. Non DCS Controls such as local PLC based controls for main process areas should be considered in scope of the modeling.
For the exercises covered by the training plan it will be possible for the operator to perform the same activities on the simulator as it is carried out on the DCS stations in the main control room. Any simplifications or assumptions shall be clearly outlined.

The simulator shall be capable of performing:

- Start-up from cold conditions
- Restart from tripped conditions
- Shutdown, both normal and emergency
- Turndown operating conditions
- Various normal operating conditions around design
- Emergency conditions

7.2 Process Definition

The Methanol Plant scope to be considered in the simulation model is providedin the Process Description and Process Flow Diagrams (PFDs) which are included in Appendix A& B attached.

The Methanol Plant OTS will include all ISBL Process areas as follows:

- Feed Purification
- Reforming (refer note no. 1)
- Process Gas cooling
- Methanol Synthesis (refer note no. 2)
- Methanol Distillation
- Steam Production

Notes:

1. Vendor shall advise whether the temperature profile of the flue gas through the reformer box shall be reproduced based on the standard/typical information provided by licensors. Vendor shall also advise whether the temperature profile can be reproduced using operating data.

2. Vendor shall confirm the interaction of principally three elements - the hydraulics, the heat transfer and the reaction kinetics. Mechanical data sheet and drawings shall be made available to determine the geometry and heat transfer. Vendor shall confirm regarding their experience with regard to kinetic modelling and tuning of the same to match the heat and mass balance in the absence of specific catalyst input from the licensor.

For the above system, failure / non availability shall be simulated.

Utilities Scope

Typically, the cooling water systems are modeled as boundaries to the process. The instructor will have the ability to control the state of the cooling water systems. If the systems are set in running state, water will be supplied to the users based upon the control system requirements. If the systems are set in not running state, then no cooling water will be supplied to the users. The instructor will also have the capability to modify the temperature, pressure of these systems and delivery.

Other utilities such as nitrogen that are brought in from off-site will be included in a similar manner to the cooling water systems with the instructor having the capability to set the availability of these utilities as well as vary the temperature and pressure.

In this way, the operators can be trained on the impact of upsets or disturbances to these utility systems on the main process and can be trained in how to manage these upsets and so return the plant to a safe operating condition.

While the electrical systems will not be modeled in detail, it will be possible to simulate loss of different power levels, which will shut down only the equipment connected to and driven by that electrical power level.

Instrument air system will not be modeled in detail but it will be possible for the instructor to simulate a failure of this system at which point all instrument air driven valves will move to their air failure position.

Compressor lube or seal oil systems will be modeled in a simplified manner, provided the lube oil or seal oil pumps are turned on by the operators. It will be assumed that these systems are operating as designed and any startup interlocks will be cleared. If the pumps are not turned on, then the startup interlocks will not be cleared and it will not be possible to progress the compressor start sequence.

VENDOR shall clearly outline any simplifications and shall specify the accuracy.

7.3 Modelling Philosophy & Criteria

VENDOR shall provide detailed information on the approaches adopted in modelling the process. The solution shall be based on first principles engineering models and make use of rigorous thermodynamics. VENDOR shall detail how key process items (e.g. Reactors) are to be modelled and the number of chemical components used to represent streams in the model.

The VENDOR shall be fully responsible for specifying the individual data and information requirements. The model data and information requirement shall be specified by the VENDOR together with the date by which it is required. CLIENT shall be responsible for the provision of the said data as required by the VENDOR’s representative during an onsite data collection period. The VENDOR shall include this data collection period within its project schedule.

The steady-state and dynamic precision of the Process Model responses should be such that operators and process engineers will gain a quantitative as well as qualitative process knowledge from the simulation package. In essence, the objectives of the individual Custom Model(s) shall be to provide the trainees with a realistic representation of the actual process unit, in such a manner that he will see no significant difference between operating at the simulator or the actual process unit.

The Custom Models shall be hi-fidelity and shall be based, for the purposes of tender, on the documentation, drawings and data provided in the Appendices to this Specification Document.

As a minimum the process modeling software should have rigorous first principle-based thermodynamics with the ability to use Drag and drop features.

Some of the key requirements include:

7.3.1 Multi-Flowsheet

An unlimited number of flowsheets should be installed within a simulation. Information contained in any flowsheet should be always accessible.

7.3.2 Sub-Flowsheets

Each flowsheet should have their own PFD, Workbook and fluid package (components, property method, reactions, etc.).

7.3.3 Unit operations:

List of standard unit operations should have following Unit operations as minimum

- Vessels: Two Phase Separator, Three Phase Separator, Tank
- Heat Transfer: Heat Exchanger, Plate-fin, Condenser, Reboiler, Furnaces
- Piping: Pipe segment, Valve, Ejector
- Rotating Equipment: Pump, Compressor, Expander, Turbines
- Distillation Columns, Reactors
- Miscellaneous: Spreadsheet, Flare system
- Instrumentation: Flow, Pressure, Temperature Controllers, Logic Operations, Signal Selector, Transfer Function

Vendor should define the feature of each of the unit operations in their technical proposal.

7.4 Model Fidelity:

The Process Models shall simulate throughputs from zero percent (0%) to one hundred and ten percent (110%) of the design rate. It shall be capable of accepting real-time changes in feed composition of any individual components.

The OTS should be capable of predicting plus or, minus two percent (+/- 2 %) of the process variables, displayed within the DCS for the steady state design conditions and other conditions stated in section 7.1.
Dynamic responses shall be directionally correct in all cases and shall occur within the expected durations of time.

The Process Models should operate in a stable manner up to a value of one hundred and ten percent (110%) of the design case. In this situation all process variables and indicators should display realistic and relatively stable values, bottle necks should be observed.

The process equipment / control algorithms must be valid in a range from zero (cold start-up of the process) to a reasonable degree above the process safety limits, i.e., one hundred and ten percent (110%), in order to allow training through all possible circumstances.

Pressure drops in all unit operations should be calculated for different throughputs, and it must be calculated rigorously through k-value. Reverse flow should be simulated as default in all process streams without adding a second process stream for the back flow.

The Custom Models stability shall remain consistent with any given operating condition.

The individual Custom Model execution and calculation shall remain valid for all operating conditions, from start-up to the normal design case operation.

The VENDOR shall state the modelling approach to be adopted, on all named process equipment detailed in the individual Process Model scope, as detailed in this Enquiry Specification Document.

VENDOR shall describe the methods, assumptions, limitations and basis of the model.

VENDOR shall confirm equipment listings for the Process Model.

The OTS shall use actual process unit instrument and equipment tag names based on the actual DCS configuration and shall include point type, loop configuration, graphics, etc.

The Custom Model shall include important local instrumentation as instructor readable data, for example pump discharge pressure gauges, vessel pressure gauges, level gauges, etc.

Instructor Functions, Remote Functions and Malfunctions for all relevant items of equipment within the Process Models will be defined in detail during the Kick off meeting.

7.5 Malfunctions

VENDOR shall describe its standard malfunctions. The simulator should respond realistically to all operator actions during these malfunctions. The following are possible options for customized malfunctions. VENDOR shall comment on their relevance to this simulator development and also suggest any additional malfunctions.

This will be used by the CLIENT to firm up the list at the functional design stage.

- Spurious trip of major rotating equipment such as the blowers, pumps and compressors.
- Fouling of certain heat exchangers; each will have a variable fouling input by the instructor
- Total and partial power failure
- Main equipment power failure
- Loss of steam pressure control
- Cooling water failure
- Instrument air failure
- Independent failure of certain control valves; each will fail to a specified position
- Independent drift of certain transmitters; each will have a variable percentage drift input by the instructor

Any field operated or non-DCS operated devices such as, but not limited to, pump start / stop switches, block valves, by-pass valves, local valves, and pilot burners which are required to perform the simulated operations during start-up, shutdown, malfunctions or normal operations, will be provided as remote functions operable by the instructor at a field operator station/operator station.

The VENDOR should allow for up to 25 custom malfunctions for OTS system.

VENDOR shall describe the typical malfunctions to be included.

7.6 Field Operator Duties (FODs)

Any field operated or non-DCS operated devices such as but not limited to pump start/stop switches, block valves, bypass valves, local valves, and pilot burners which are required to perform the simulated operations during start-up, shutdown, malfunctions or normal operations, will be provided as remote functions operable by the instructor at a field operator station/operator station.

7.7 Process Data

VENDOR shall also identify, the specific process information required to develop a high fidelity process model and when the specific data is required as part of their project milestone schedule. The VENDOR shall also clearly define all technical support required from the technology owner or process group, or other parties, which may be necessary to understand, develop, test, and verify the model.

8 Project Services

8.1 Project Management and Coordination

The VENDOR shall form a dedicated project team led by a project manager to assure THE CLIENT of regular project reporting and timely delivery of a high quality product meeting the simulator requirements.

The project team shall be composed of highly qualified individuals with extensive experience in the design and building of process simulators.

The VENDOR shall provide a project organization chart and CVs for key personnel, with the proposal.

The VENDOR shall state the location, at which the project will be undertaken, which should permit efficient co-ordination between CLIENT and VENDOR.

The VENDOR shall state the quality standards that are applicable to its work.

8.2Detailed Design Document

VENDOR must develop a comprehensive Detailed Functional Specification document, which will be reviewed and approved by the CLIENT.

8.3 Acceptance Tests

The acceptance tests shall consist of a Model Acceptance Test (MAT), a Factory Acceptance Test (FAT) and a Site Acceptance Test (SAT).

The VENDOR and THE CLIENT.s process engineers shall jointly conduct a MAT at the VENDOR.s site to verify the scope and performance of the process model.

Following integration of the process model with the control and logics, the VENDOR and THECLIENT.s process engineers and/or instructors and/or experienced operators shall jointly conduct a FAT at the VENDOR.s site based upon mutually-agreed Acceptance Test Procedures (ATP). The ATP shall include all inspection and system tests to demonstrate compliance with contractual requirements.

The Acceptance Test Procedures shall include; simulator hardware and equipment tests, and simulation performance.

The simulation performance test shall include, but not be limited to:

- Process start-up and shutdown
- Dynamic conditions
- Selected malfunctions
- Instructor station functionality

Following the FAT the VENDOR shall remedy any agreed deficiencies identified in the FAT exception reports.

The VENDOR shall also perform a SAT to assure operational integrity following shipment. The SAT shall include:

- Verification that the simulator operates as it did during the FAT
- Demonstrates all the agreed corrections have been made following FAT

8.4 Training

The VENDOR shall provide training courses to enable THE CLIENT.s training personnel and engineering staff to effectively implement the Operator Training Simulator Program.

The training courses shall include:

- Simulation Engineering Course
- Simulator Instructor’s Course

The VENDOR shall provide a simulation overview course to familiarize the CLIENT.s process engineers and instructors with the principles of the simulator in preparation for the testing. This course shall be run at VENDOR.s facility. The VENDOR shall provide an instructor’s course to teach THE CLIENT’s instructors how to use the simulator as a tool to train process operators in their plant. This course shall be run at site / VENDOR.s facility.

The VENDOR shall recommend any other courses or training that may be appropriate.

The VENDOR shall detail, as an option, its services for the development of training exercises based on the simulator.

8.5 Documentation

In addition to the project documentation identified, the VENDOR shall also provide electronic copies along with three sets of the documentation that THE CLIENT needs to use and maintain the simulation system. These documents shall include:

- Custom Model Manual
- Instructor Manual
- Systems Administration Manual
- Hardware Manuals

8.6 Site Services

The VENDOR shall provide site services for the installation and commissioning of the OTS systems. VENDOR shall provide details of the specific site services to be provided.

8.7 Project Schedule

The VENDOR shall provide a detailed project schedule with the proposal indicating the key project milestones for hardware, software development, process data requirements, model acceptance test, factory acceptance test, site acceptance test, training and other services. Overall project schedule shall not exceed four months from the date of award.

8.8 Client Duties

The VENDOR shall provide clear details of the duties that VENDOR expects to be fulfilled by the CLIENT, including provision of data, attendance at meetings, acceptance testing etc.

8.9Quality Assurance

VENDOR shall be certified to ISO 9001 or equivalent, and shall provide details of its certification. VENDOR shall include for providing a Quality Assurance plan for the project.

8.10 Project Management Team

VENDOR’s Project Management Teams shall be led by experienced project management and shall provide details of the similar execution project references in their CV. VENDOR shall include for providing a Project Management plan for the project.

8.11 Project Technical Support

The VENDOR shall clearly define all technical support required from the process licensor or other parties which may be necessary to understand, develop, test, and verify the simulator.

8.12 Warranty

The VENDOR shall specify the warranties for both the simulator hardware and software. Warranty periods on hardware, software and services shall be at least twelve (12) months from the date of completion of the Site Acceptance Test. The VENDOR shall outline its options for provision of long-term support of the OTS systems, including local support facilities.

9 Bill of Material

Sr.No	Particulars	Quantity
1	Instructor Station	One
2	Engineering Station (All functionalities to be included in Instructor Station)	
3	OTS Simulation Software with Perpetual (99 Years term)run-time license and model Development / Maintenance capability	One Set
4	Steady State Design Software for engineering analysis	One Set
5	Operator Station	One
6	Field Operator Station (All functionalities to be included in Operator Station)	
7	Network Switch	One
8	Model Implementation Services including Warranty as defined in Section	1 Lot
9	Training Services as defined in Section 8.4	1 Lot

10 Vendor Response

The VENDOR shall prepare and submit a proposal with separate technical and commercial sections. The proposal shall be fully responsive to and compliant with this bid specification, any deviations or exceptions shall be clearly identified according to the following example compliance table:

Heading
Compliance
(C=Comply, D=Deviate, E=Except)
Notes

The technical descriptions shall be of sufficient detail to enable THE CLIENT to make a full evaluation of the approach proposed by the VENDOR.

11 Price

The commercial section shall include itemized pricing of the simulation computer and peripherals, simulation software, simulation models, training, licenses, and options.
Prices shall be quoted in Indian Rupees, valid for a period of three (3) months from the due date, and shall be firm and fixed for the duration of the contract

12 Simulator References

The VENDOR shall submit full details its simulation experience in Haldor Topsoe Technology, provide C.V. for key project staff and shall make particular reference to the installations relevant to the proposed application.