



Exploration & Production

GENERAL SPECIFICATION

FIELD OPERATION

GS EP EXP 157

Operator Training Simulator

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1. Scope

The purpose of this specification is to define the requirements for the design of an Operator Training Simulator.

Generic training simulators are not impacted.

2. Reference documents

The reference documents listed below form an integral part of this General Specification. Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the EFFECTIVE DATE of the CONTRACT.

Standards

Reference	Title
Not applicable	

Professional Documents

Reference	Title
Not applicable	

Regulations

Reference	Title
Not applicable	

Codes

Reference	Title
Not applicable	

Other documents

Reference	Title
Not applicable	

Total General Specifications

Reference	Title
Not applicable	



3. General

A custom Operator Training Simulator is a site specific training system designed for initial training and retraining of operators (control room, field operators ...).

The OTS shall be based on:

- A dynamic process model
- A model for control and safety logics
- An operator interface
- An instructor interface

4. OTS architecture and hardware

OTS servers and workstations shall never be connected to the ICSS network.

Antivirus software shall be installed on all workstations and servers. The configuration activity of the antivirus software is the responsibility of OTS vendor. It shall be described in the OTS maintenance manual.

In case of connection to the SIE (Enterprise Information System), OTS servers and workstations shall comply with the SIE policy.

5. Scope of simulation

5.1 Battery limits

Simulated systems and battery limits are defined in the project OTS specification.

5.2 Operating conditions and scenario

The operating range for the simulator shall be identical to the site.

The simulator shall be capable of performing transient operations such as:

- Start-up from cold conditions
- Restart from tripped conditions
- Change between various steady states
- Shutdown, both normal and emergency
- Blow down
- Downgraded situations that are defined in the project OTS specification
- Specific operations that are defined in the project OTS specification

6. Requirement for real time calculation

It is mandatory that the OTS can be executed at least in real time whatever the encountered operating conditions.

The OTS shall also be capable to simulate at speed other than real-time, depending on the simulation speed decided by the instructor.

OTS vendor shall ensure that the transient answer of the simulated systems is independent of the acceleration speed.

7. Dynamic process model

The dynamic process model shall be based on marked-up P&ID's.

7.1 Methodology

The dynamic process model shall be developed with a user friendly engineering interface.

The dynamic process software shall be object-oriented, thus allowing unit models to be developed independently and easily set up in the dynamic process model. The equipment malfunctions shall also be coded directly within the unit model. As a consequence the list of malfunctions is identical for all instances of the same unit model (e.g. instructor can introduce a malfunction on a pressure transmitter, on a sand detector).

The dynamic process model shall be designed according to the following rules:

- Unit models (well, pipelines, separator, valve, motor, pump, PID controller, transmitter,...) shall be connected with material streams (reflecting a piping), or information streams (reflecting sensor output, actuator command, digital output ...)
- The software shall have the capacity to carry multiphase flow in the material streams, depending on the stream thermodynamic conditions. In the streams, detailed multiphase flow calculation is not requested.
- Unit models shall be configured with equipment vendor data sheet (e.g. valve Cv, pump head / flow curve, weir height, ...)

Unit models configuration parameters and OTS vendor tuning parameters (e.g. water carry-over in the oil stream of a three phase separator) shall be accessible in the engineering interface for easy verification during model acceptance and for modification.

7.2 Accuracy

The level of fidelity of simulated process areas is defined in the OTS project specification.

These levels are high, medium or low.

7.2.1 High fidelity

High fidelity modelling shall be based upon chemical engineering first order principles with rigorous calculations of flow, pressure, temperature, using multi components streams

Accuracy shall respect to the following criteria:

- Contractor shall verify that unit model output deviate by no more than 5 % from the equipment vendor data sheet
- The dynamic process model outputs shall be compared to at least, one reference steady state heat and material balance. The difference shall not exceed 5 % on the main streams for pressure, temperature, flow and fluid properties. OTS vendor shall explain the deviations and shall suggest a solution for filling the gap (model tuning...).

- The dynamic model shall reproduce dynamic responses with accuracy such that an experienced operator will not notice any significant difference between dynamic model and the expected (or observed) site behaviour.

Following requirements shall also be met on unit models:

- The change in compressor performance due to the change in the molecular weight is accounted for in the compressor model
- Hydrostatic head is taken into consideration in well, flowline and risers
- Piping elevation responsible for hydrostatic pressure drop between unit models is taken into account in high fidelity process areas
- Should the piping length be significant from an operation point of view, it shall be modelled as a unit model where wall friction and gravity effects are considered in the pressure drop calculation

7.2.2 Low and medium fidelity

Medium fidelity modelling is also based on first order principles, but some of the operations reactions or equipments can be simplified.

Low fidelity models shall be based upon a black box approach. Modelling assumptions and represented phenomena for low fidelity systems shall be discussed during the project execution.

For low and medium fidelity systems

- they shall be configured such that they deviate by no more than 10 % on the main streams of the reference heat and material balance
- they shall not be subject to quantitative accuracy checking in transient conditions
- qualitatively, they shall not exhibit inverse responses compared to the expected behaviour

7.3 Instrumentation and controls

The dynamic process model shall include all instrumentation devices located within the simulated systems, except the local instrumentation (like local pressure gauges).

The dynamic process model shall include all the main control loops of the simulated systems.

8. Control and safety systems simulation

Process control, process safety and emergency shutdown functions shall be simulated.

All control loops and logic points, including alarms, of the simulated systems shall be included.

The control and safety system replication shall be based on software solution: virtual stimulation using ICSS software and applications, or emulation. A mixed solution is allowed.

Advanced control systems shall be modelled with the same level of accuracy as the associated process system.

Start up shut down sequences for process unit packages of the simulated systems shall be included.



8.1 VIRTUAL STIMULATION case

The process control system shall be simulated using the ICSS vendor simulation software.

OTS vendor shall build the control and safety simulator. It shall be capable to load PCS, PSS and ESD configuration data without modification.

OTS vendor shall prepare for PCS, PSS and ESD systems, the typical exchange database that will be used for the interface with Dynamic Process Model.

8.2 EMULATION case

The control and safety simulator shall replicate in a high fidelity mode the control logic of the ICSS.

9. OTS MMI

9.1 Operator interface

Through the operator interface, the operator shall be able to operate the simulated plant as in real life.

Parts that are not simulated by the OTS shall be identified.

9.1.1 VIRTUAL STIMULATION case

The trainee functionalities shall be identical to the functionalities available on the ICSS

Graphic displays and display organization shall be identical to ICSS Operator Work Station.

Actions by the trainee shall be through the same keyboard or other data entry device used on the ICSS.

9.1.2 EMULATION case

The trainee functionalities shall be similar to the functionalities available on the ICSS

Graphic displays and display organization shall be similar to the ICSS Operator Work Station

Actions by the trainee shall be through the similar keyboard used on the ICSS.

9.2 Instructor interface

One or several graphic-based instructor stations shall be provided.

The functions that shall be available for the instructor are:

- With an operator interface like view, monitor the process behaviour and the actions performed by the trainees.
- Freeze and resume execution of the simulator
- Save and restore simulator states for future retrieval
- Execute the model faster or slower than real time
- Easily introduce and reset malfunctions

- Initiate fire and gas detection such that the effect is simulated in ESD
- Change ambient temperature
- Change boundary conditions at the battery limits (pressure, temperature)
- Create and run scenarios
- Create trends and profiles on the fly
- Create and run trainee assessments (trainee performance evaluation program)

9.3 Field operator interface

OTS shall allow performing field operator actions through a graphical interface.

9.4 Engineering interface

OTS shall propose engineering functions in the engineering interface.

For all material streams, pressure, temperature, composition and most of the thermodynamic properties shall be accessible in the engineering interface. It shall be possible to change the battery limit composition.

The streams shall be shown with a fluid dependant colour code, as per project definition.

The physical units shall be user modifiable in the engineering interface.

The tag names shall respect the equipment tag shown on P&ID's

10. Acceptance tests

A link test between dynamic process model and control simulator shall be performed before starting the integration of these two components. It shall be done according a test procedure. A test report shall be supplied.

Dynamic process model shall be validated at MAT against ATP.

An exhaustive test of OTS functions, described in ATP, shall be carried out at FAT

SAT shall be performed in order to test the OTS functionalities after its installation.

11. Deliverables

11.1 Light simulator option

In addition to the final OTS, OTS vendor shall be prepared to deliver an emulated simulator based on the Dynamic Process Model accepted at MAT stage.

11.2 Training to instructor

OTS vendor shall provide training courses to enable instructors to implement the Operator Training Program.

11.3 Technical documentation

OTS vendor shall provide the following documentation:

- Functional Detailed Specifications, subject to Company approval



- Acceptance Tests Procedures, subject to Company approval
- Instructor and maintenance Manual
- Installation Manual

The FDS shall address in details the following topics:

- System architecture and hardware
- System software with a sub section dedicated to communication with external programs
- Process model with sub sections such as thermodynamics, initial conditions, performance and accuracy, custom modelling
- PCS, PSS, ESD and packages model
- Instructor functions
- Training content

12. Glossary

ATP	Acceptance Test Procedure
ESD	Emergency Shut Down
FAT	Factory Acceptance Test
ICSS	Integrated Control and safety System
MAT	Model Acceptance Test
MMI	Man Machine Interface
OTS	Operator Training Simulator
PCS	Process Control System
PFD	Process Flow Diagram
PSS	Process Safety System
P&ID	Process & Instrumentation Diagram
SAT	Site Acceptance Test
SIE	Enterprise System Information