Flexbilization Training on Flexible Operation Simulator

FLEXPERT

A Joint Initiative under Indo-Germany Energy Forum

Background

- Government of India has set an ambitious target of 500 GW renewable energy installation by year 2029-30.

- RE capacity will be added at a rapid pace and due to its injection in large amount, Frequent cyclic & low load operation at higher ramp rates is going to be a real challenge for conventional coal based plants.

- For security, reliability and stability of grid with economic power, Flexible Operations of Thermal Power Plants is only viable & economical option till we get high capacity cost effective storage solutions.

CEA Notifications

- **CEA has already come out with a time bound mandate to achieve Flexibilization by coal-based power plants.**
- Coal fired generating units shall achieve minimum power level of 40% according to phasing plan
- The preliminary phasing has been worked out in the CEA report “Flexibilisation of coal fired power plant - **A road map for achieving 40% technical minimum load” published in Feb 2023**
- Subsequently a draft phasing plan has been prepared for coal based generating units.

Becoming a Flexpert

How to become a FLEXPERT

Study
e-learning, awareness workshops and professional seminars

Target: acknowledge the need for flexibility, understand principles of flexible power plant operation

Try
a) Simulator training to try out flexible operation at an Indian reference plant

b) Test runs at own plant (according to IGEF procedure) guided by own senior or external experts

Apply
Implement new procedures in the operational scheme (e.g. mill sequences, switch over of pumps and fans)

- Increase level of automation for routine sequences and optimize subordinate controls
- Optimize main control loops and implement advanced control solutions

Continuous improvement process

Training Objective

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Importance for any Power Plant

Safe, reliable and efficient operation & maintenance are of importance for any power plant.

Require competent operations & maintenance staff.

Concerns

A single mistake on the part of an operator can result in huge production loss

Even the most trained & experienced operator is at the risk of making a mistake if he has not faced a similar situation for a long period of time

Practical experience can only be achieved through hands-on working experience and long years of service

Training in whole gamut of plant operation

Companies can increase profitability through increase in efficiency, stability and minimum faults

Power plant simulator is an advanced hands-on-training tool, used mainly for the plant operation staff training in areas such as unit start-up, shut-down, load, operation, emergency handling etc.

Simulator gives the feeling of operating a real power plant without incurring any generation loss or damaging any plant equipment's.

It raises the level of proficiency and builds up confidence required to handle emergencies in an actual plant operation.

Simulator is the best tool for an operator to build, practice, keep up to date and develop confidence on their skill

Why Simulator Training?

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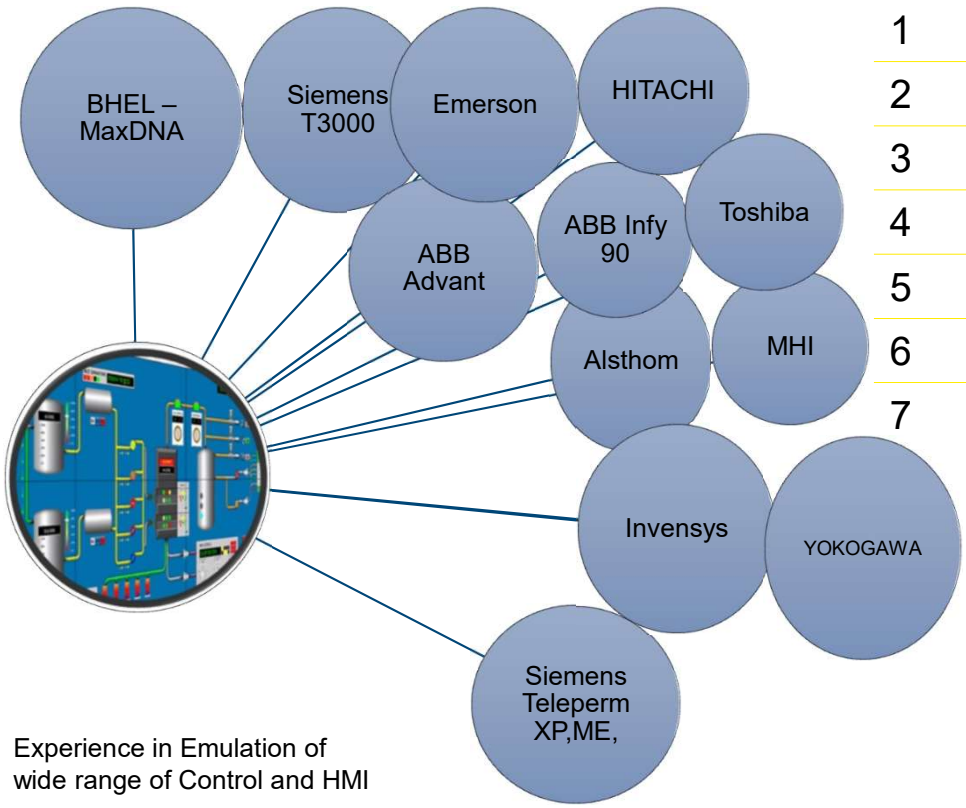
- Special skills and confidence are required for coal-fired power plant operators to adapt to fluctuating power generation scenario with variable renewables.
- Flexibilization operation is new for the operators. A training simulator which is able to simulate the required behavior of the flexibilization is required for the operator **to practice and build up confidence.**
- Operator will learn fast ramp up and ramp down as well as minimum stable load operation – with necessary monitoring of the parameters.
- Learning flexibilization operation effects on:

  - Main steam pressure and temperature
  - Super-heater spray
  - Air-fuel ratio
  - Condenser
  - Feed water flow
  - Ramp rate
  - Turbine operation

STEAG's Unique capabilities

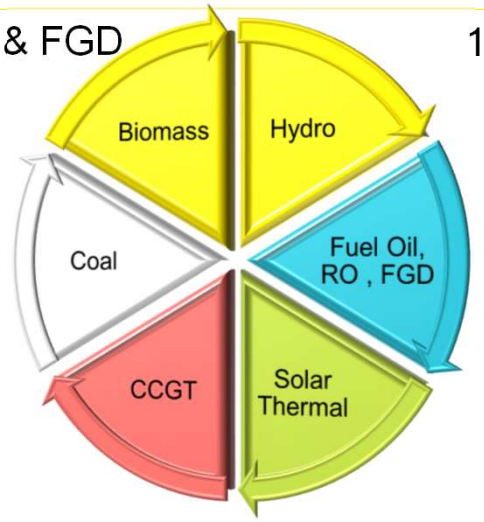
Why STEAG ?	STEAG being Owner and operators of various power plants adds value for testing the developed simulator and make It as close as real plant behaviour including flexibilization
	STEAG's exclusive collaboration with TRAX , USA who is world's renowned Simulator tool developer and supplier of more than 350 simulators globally
	STEAG has approved Training Centre with various simulators with requisite knowledge of knowhow to set up training centre with various simulators.
	STEAG's Training Centre is approved by Ministry of Power, Government of India
	STEAG has successfully executed as a turnkey project for setting up training centre with 11 high fidelity Simulators for the biggest utility (69 GW installed capacity) in India NTPC (National Thermal Power Corporation)
	Apart from NTPC, STEAG helped to set up training centre for RAWEC-KSA,HIWPT-KSA, NAPTIN- Nigeria, ZPC – Zimbabwe, BPC- Botswana, various Indian state utilities
	STEAG's experience in Simulators covers most of the fuel technologies (coal, gas, hydro, oil, solar, Biomass) and key global OEMs of equipment's and DCS. STEAG is from Non OEM background and hence having experience of emulation of almost all OEMS main equipment and DCS
	STEAG is having many happy customers with Annual maintenance contract to keep simulator up to date

STEAG Simulator Credentials



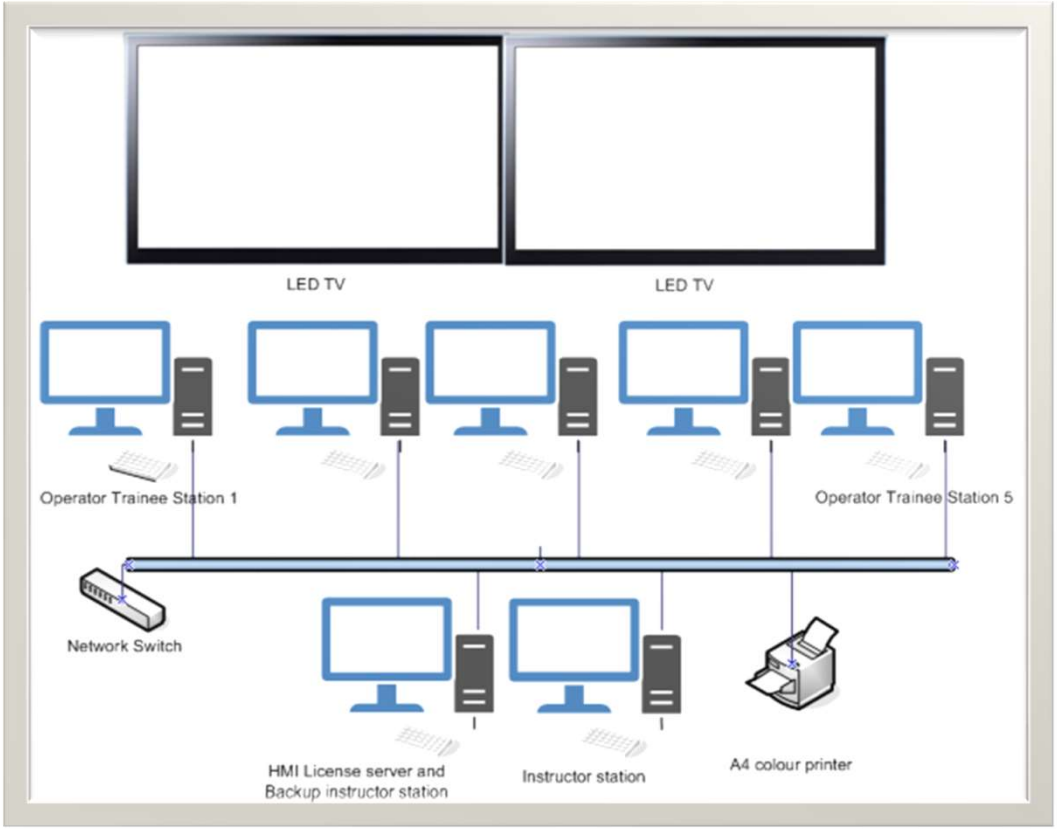
Experience in Emulation of wide range of Control and HMI

Sr. no.	Type OF simulator	Credential Nos.
1	Coal Fired	25
2	CCGT	6
3	Solar Thermal	1
4	Oil fired	1
5	Hydro	1
6	Biomass	1
7	RO & FGD	1



Simulation of Different Fuel Technology

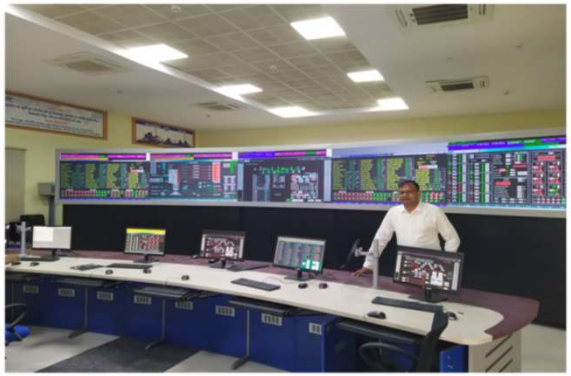
General Network Architecture of a Simulator



General Network Architecture of a Simulator

General Items :
(1) Operator Desk Tables
(2) Instructor Desk
(3) Printer Desk
(4) Chair
(5) UPS
(6) Workstation & Monitors
(7) Printer
(8) Firewall
(9) Network Switch
(10) LVS
(11)Software Licenses for Running simulator

However Architecture can vary as per the customer requirement



ProTRAX- Simulation Tool

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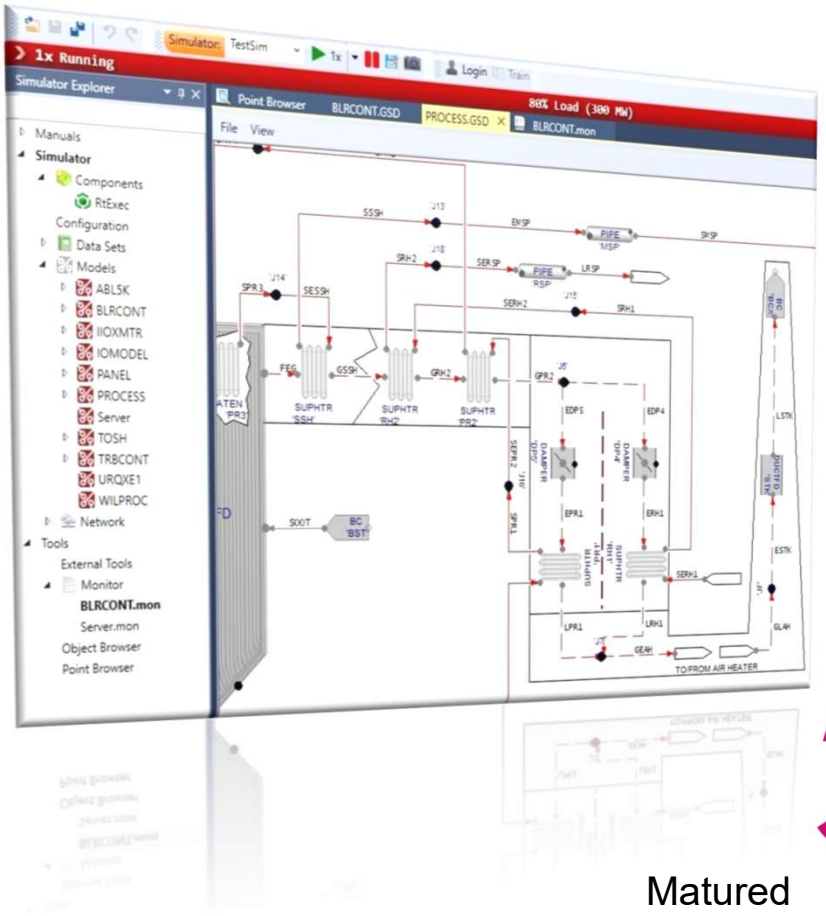


ProTRAX is the Simulation tool for

(1) Plant process and Control model development and

(2) Execution of the entire Simulator along with all instructor features

30+ years

Matured

Precise

STANDARD

All International standards for Accuracy

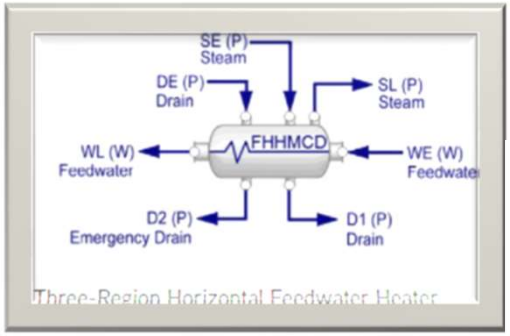
SIMULATION TOOL:ProTRAX

ProTRAX

STEAG is using ProTRAX simulation tool for modeling .STEAG is exclusive partner of TRAX in India .

ProTRAX:

- For over 30 years, TRAX has been the world's leading supplier of high-fidelity fossil plant operator training simulators.
- Incredible experience: over 300 simulators delivered
- ProTRAX, is a modular, dynamic simulation system designed for use on standard computers. There are around 200 standard process modules in the ProTRAX library that have been tested in hundreds of training simulators and engineering-grade simulators.
- Software is mature, precise, and conforms to all international standards for accuracy. GUI Based Modeling tool



MALFUNCTIONS

ProTRAX provides the ability to fail any piece of equipment — including pumps, fans, heat exchangers, valves, etc. — or control element. Instructors can choose from standard failure modes for any component, or create an unlimited number of additional malfunctions.

ProTRAX Features

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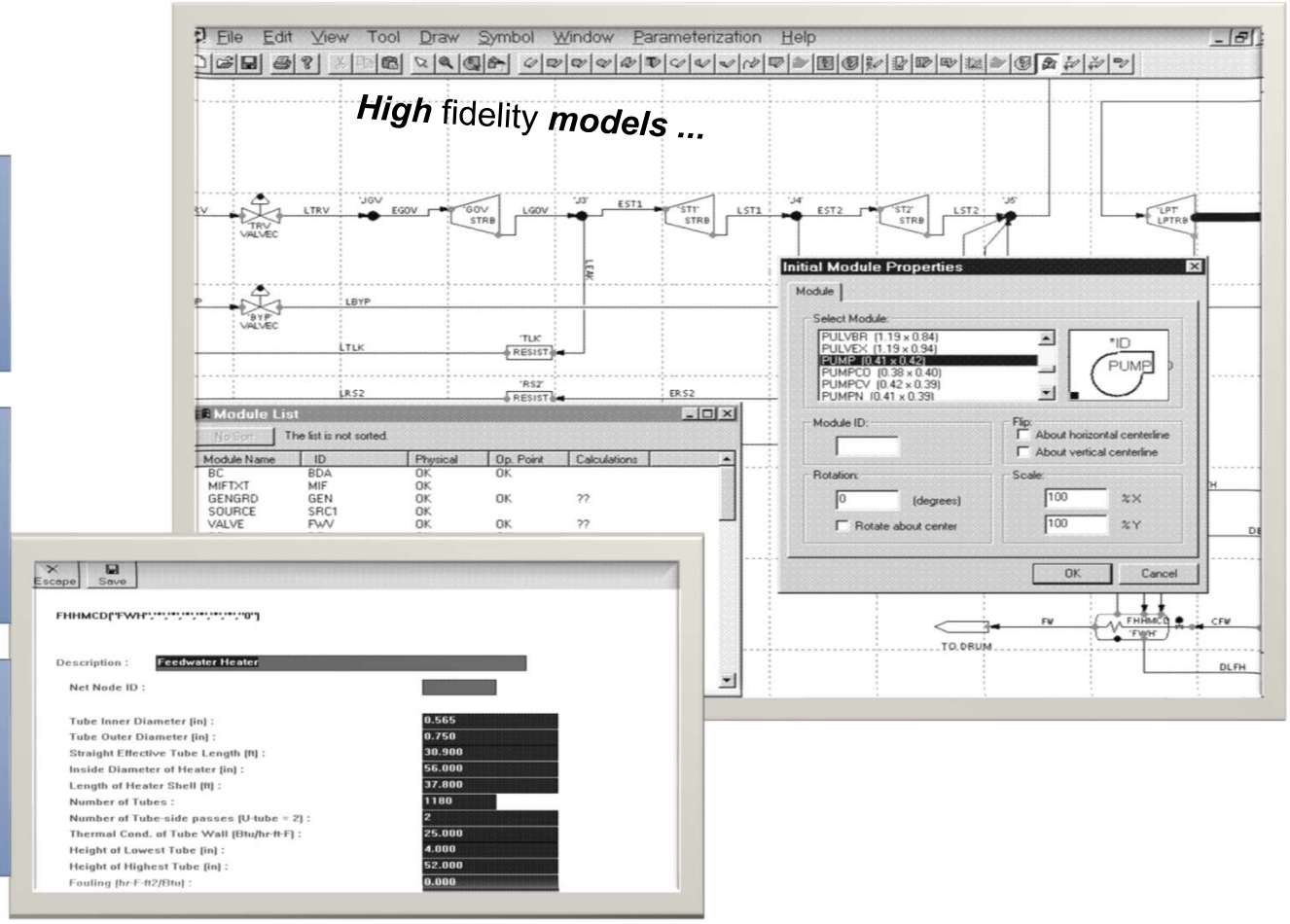
Ease of Model Development –
Drag and drop of components...

Object oriented GUI based model building and runtime software since 1989	**Windows operating system**
Large library of component models (Plant Equipment)	**Structured data entry**
First principles modeling	**Training features**



ProTRAX – Instructor Functions

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- Training Scenarios
- Trends
- Plot
- Logs
- Initial Condition
- Run/Freeze
- Fast/Slow Time
- Dynamic Schematic
- Malfunctions
- Parameter Changes
- Snapshots

ProTRAX - Malfunctions

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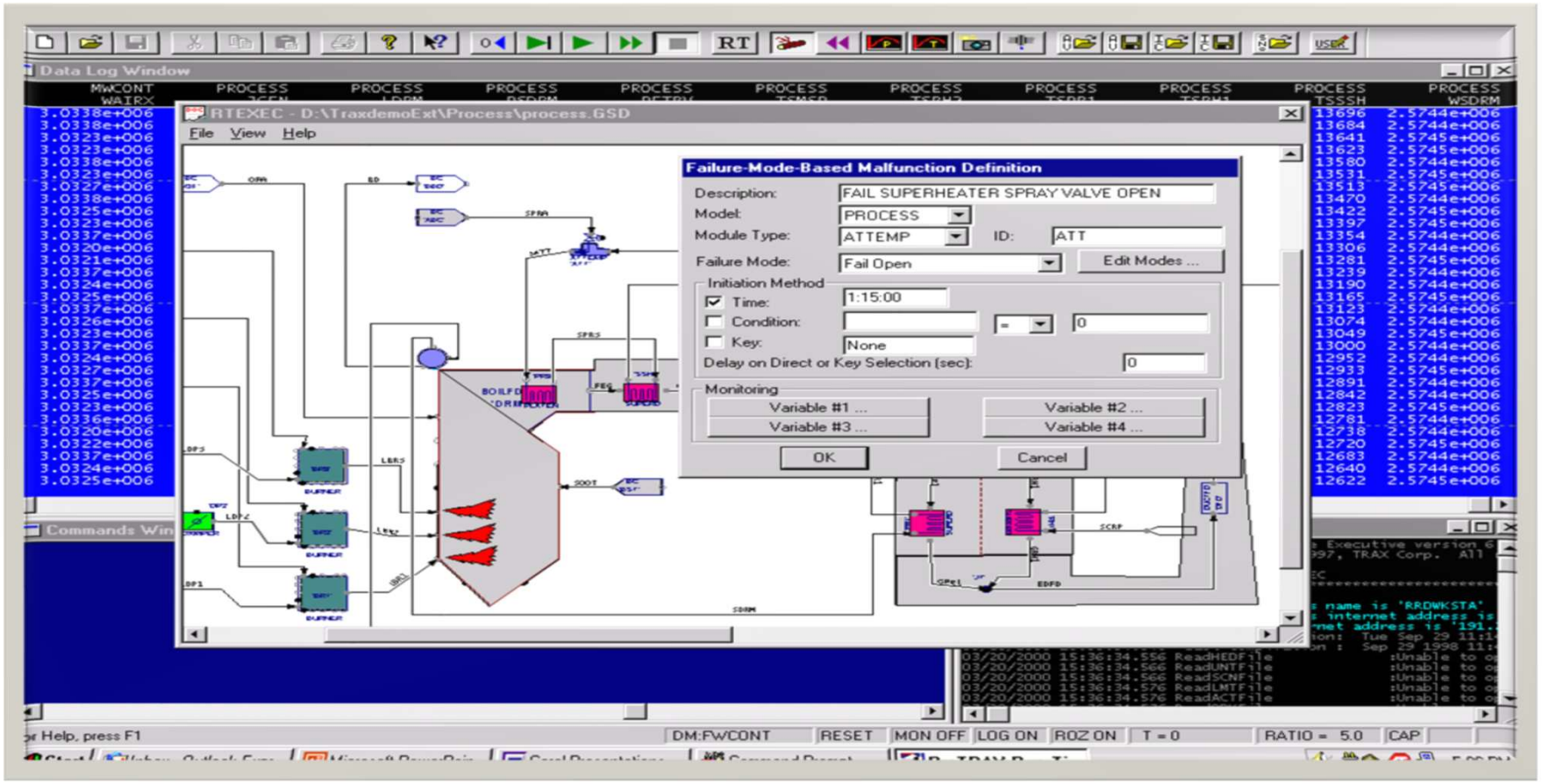

Basic Model Development steps on GUI based ProTRAX Modeling Tool

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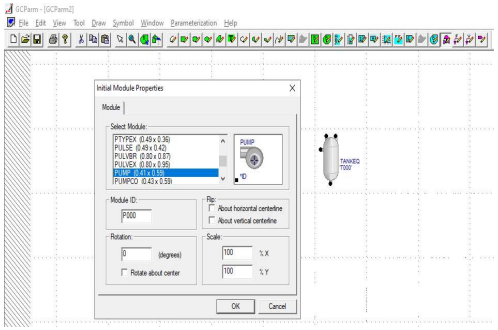
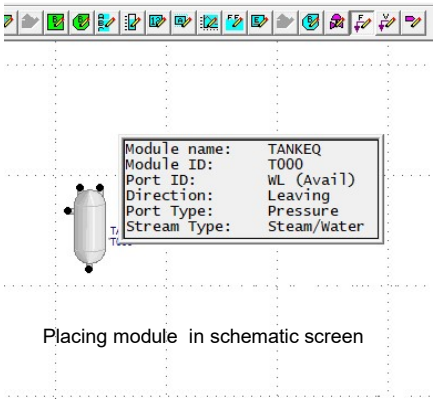
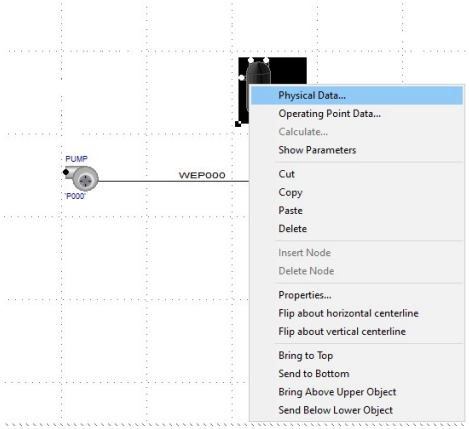


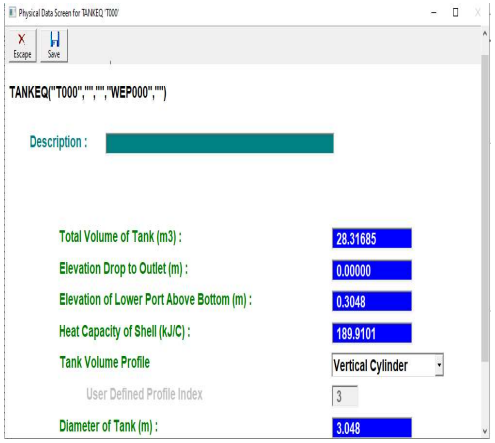
Selection of suitable component



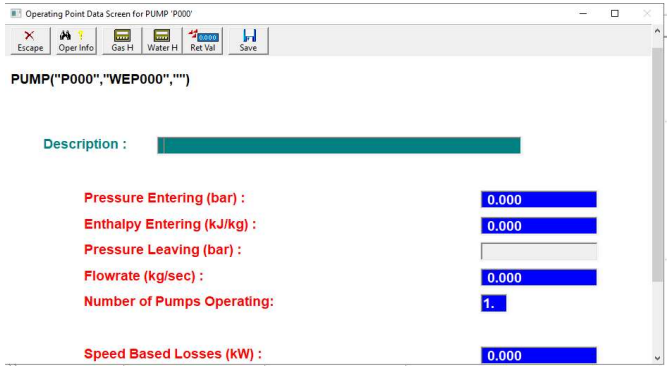
Placing module in schematic screen



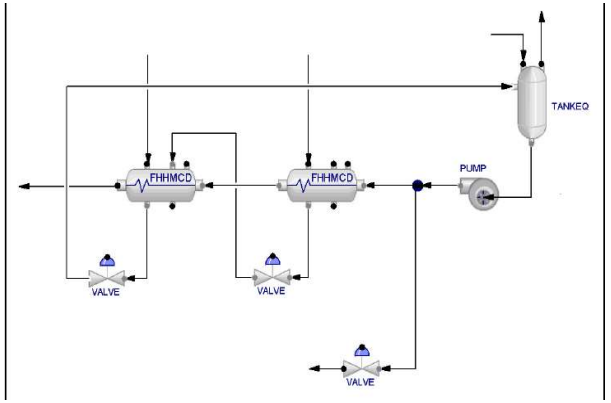
Component property window for parameterization



Physical data of the module



Operating data of the module



Sample model

Customization of Generic module(Equipment) to plant Specific Module- Using Equipment Physical Data & Operating Data

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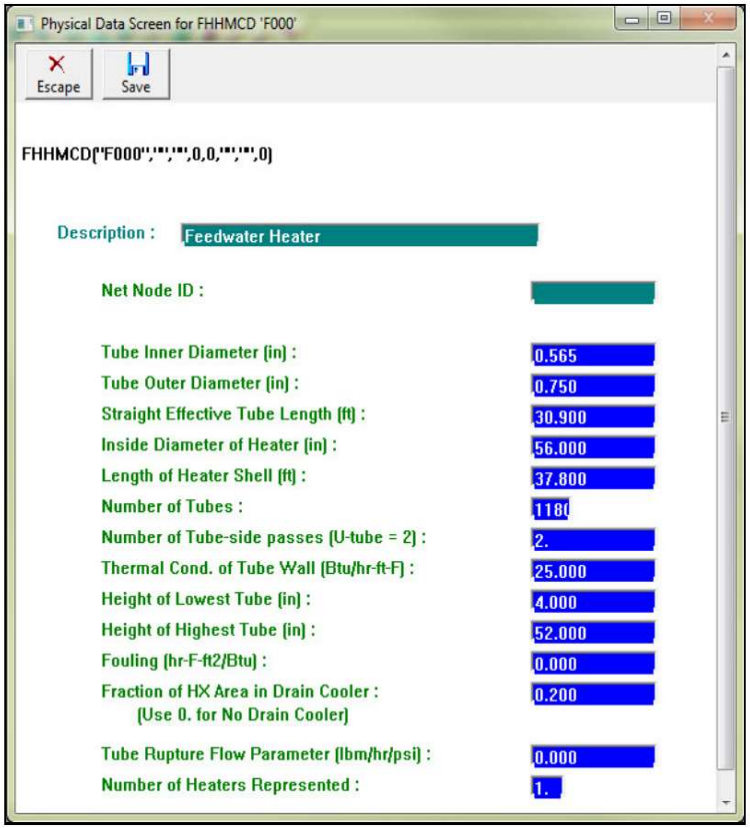
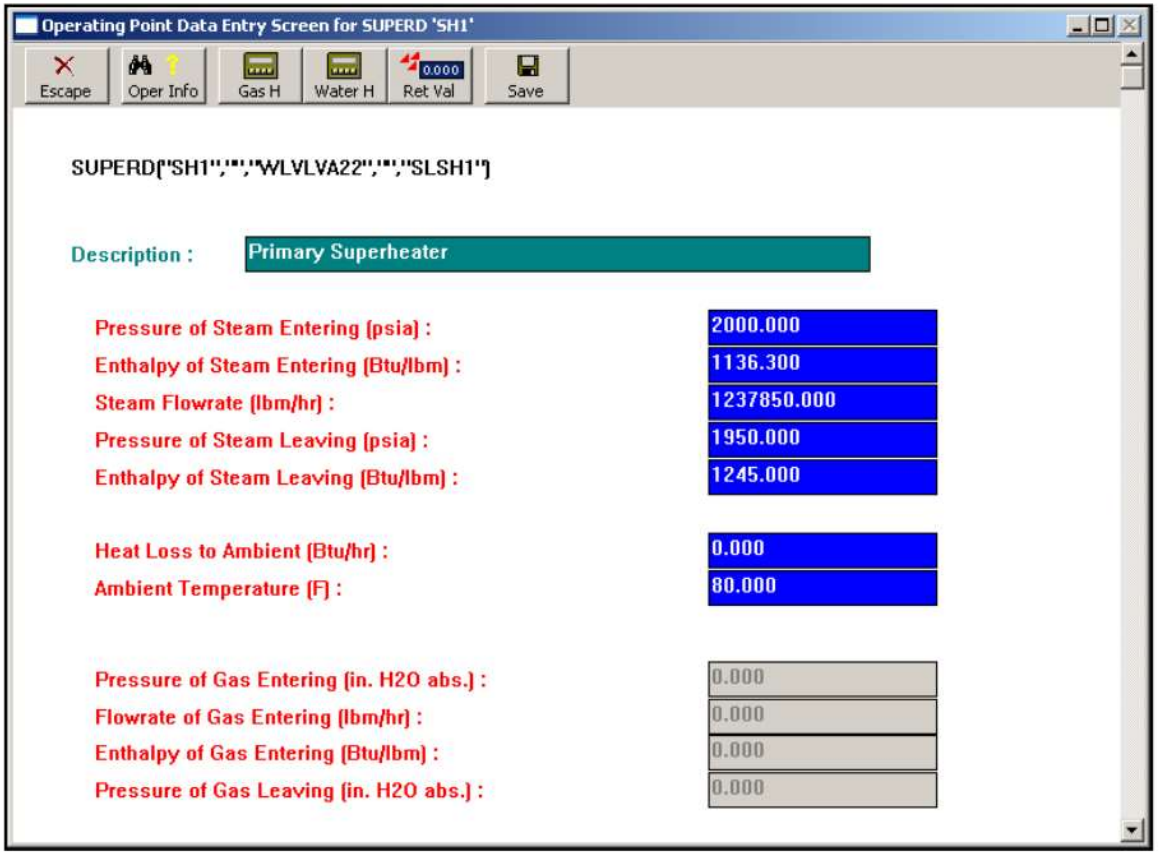
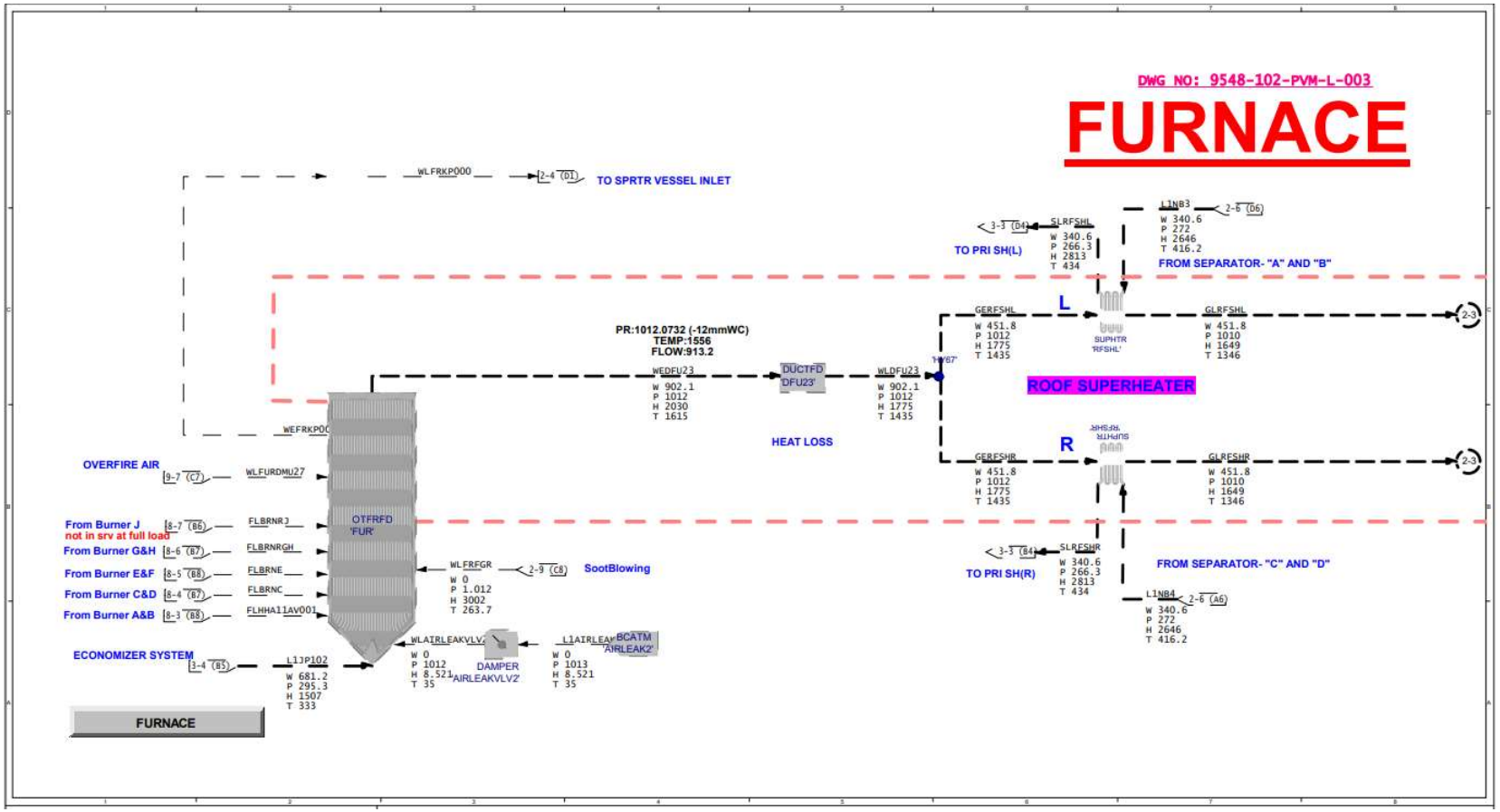
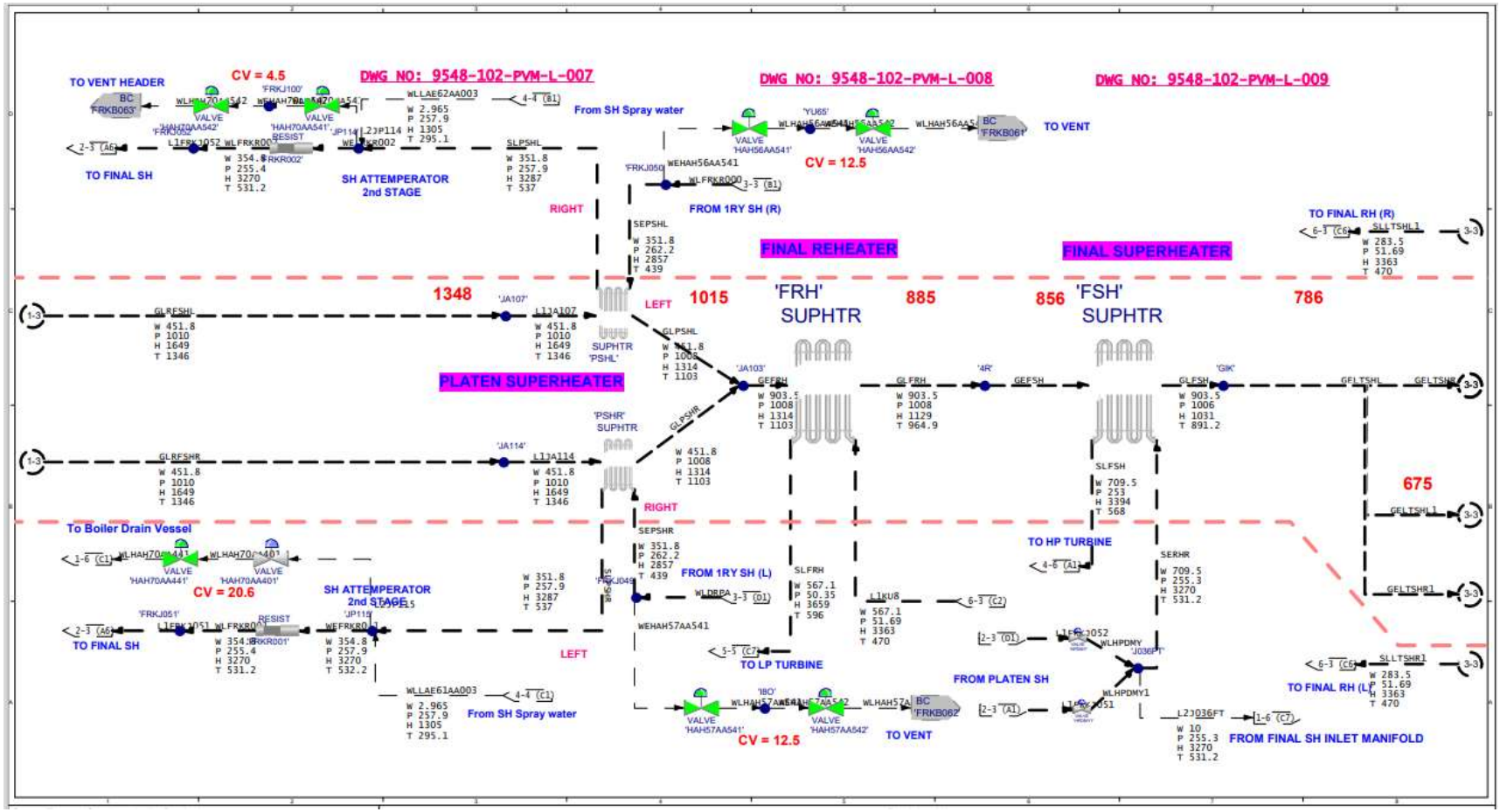




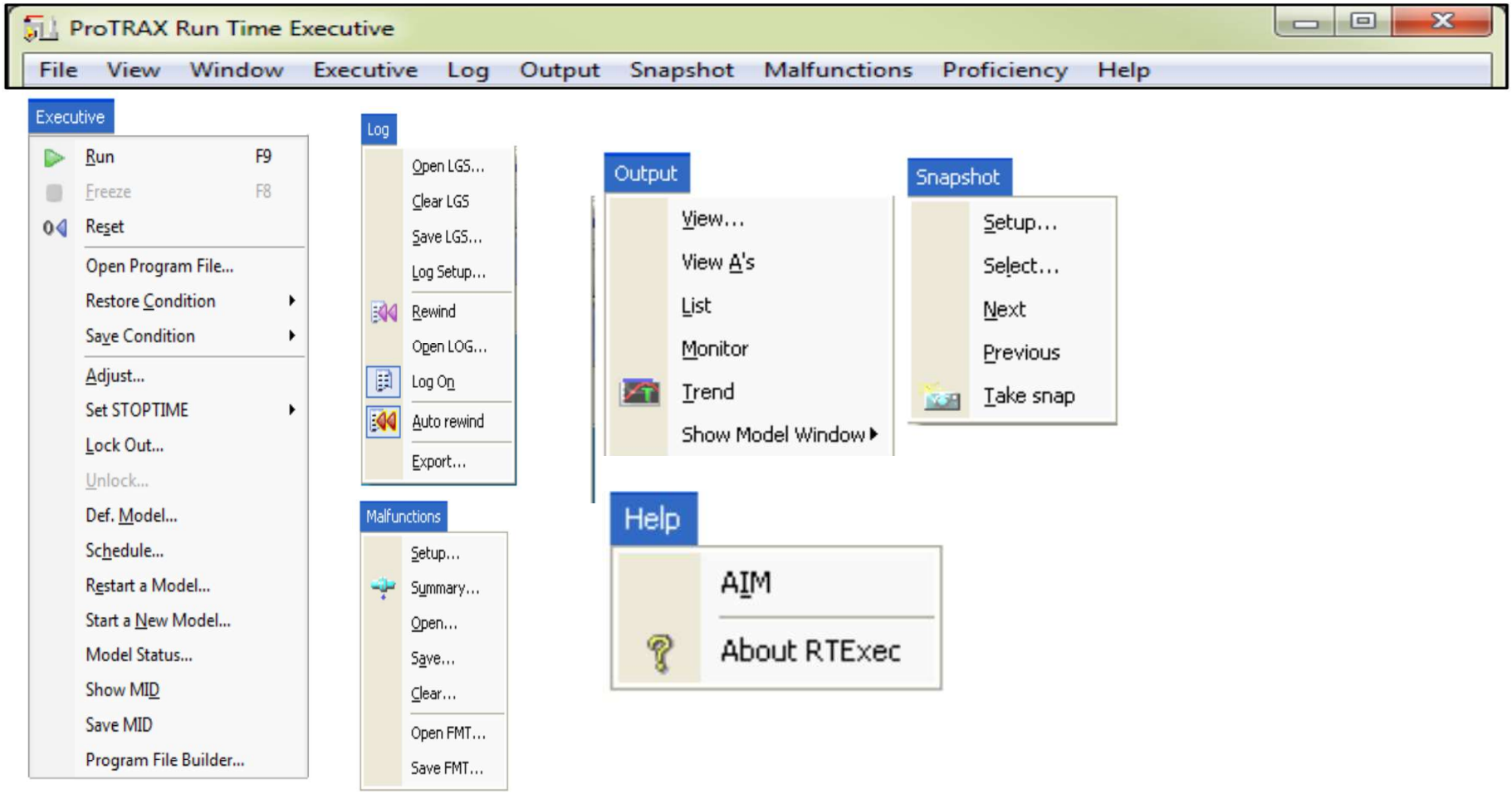
Plant model schematic (GUI Based)- Furnace screenshot



Plant model schematic (GUI Based)- Superheater screenshot



ProTRAX- RTEXEC Pull Down Menus



Simulator Room Picture-OTS Supplied by STEAG

Simulator Room Picture: RAWEC, Saudi Arabia

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RAWEC SAUDI ARABIA Captive Power plant
Simulation for 815 MW, Oil Fired
(1) 9+4 boiler,
(2) 5+2 Turbine
(3) 3+2 LIMESTONE FGDs
(4) 16+8 Sea water reverse osmosis Desalination plant

Simulator Room picture: NTPC Solapur RLI Training Centre

NTPC SOLAPUR

Eleven simulator in two set of hardware.

(1) 800 MW simulators

- KUDGI 800
- DARLIPALLI 800
- LARA 800 MW
- GADARWARA 800 MW
- TELENGANA 800 MW

(2) 660 MW simulators

- SOLAPUR 660 MW
- MEJA 660 MW
- BARH-II 660 MW
- TAMDA STAGE-II 660MW
- KHARGONE 660 MW
- BARH-I 660 MW

Simulator Room picture: NPTI Nangal Hydro Simulator

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Hydro Simulator , NPTI Nangal, 250 MW

Control System-ABB Advant

Turbine -Francis

Simulator Room picture: NTPC KUDGI

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LEFT PICTURE:

NAPTIN NIGERIA 440 CCGT SIMULATOR

HRSG-Siemens
ST-BHEL
GT-Siemens AG
V94.2 Combined Cycle
Fuel: HSD, Naptha, Natural Gas

RIGHT PICTURE:

NTPC KUDGI 800 MW
SG-Siemens
STG-Toshiba,
BOP-Yokogawa

Simulator Room picture: NAPTIN Nigeria

NAPTIN NIGERIA
440 CCGT
SIMULATOR

HRSG-Siemens
ST-BHEL
GT-Siemens AG
V94.2 Combined Cycle
Fuel: HSD, Naptha, Natural Gas

NAPTIN Nigeria: 1st Trainee Batch

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Simulator Room picture: RRVUNL, KOTA

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RRVUNAL KOTA THERMAL POWER PLANT 195/210 MW COAL FIRED

SG- MAXDNA
STG-MAXDNA
BOP-ABB

Case Study- MAHAGENCO 500 MW Flexible Simulator and first batch of Training

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Objective: To upskill Operation engineers as **"Flexperts"** for smooth operation of coal based generating units under flexible regime.

- **Systematic Approach has been adopted for conducting the program -----**
  - ✓ Need for Flexibilization
  - ✓ Achieving Flexible Operation in Indian coal based plants - Key learning from test runs / case studies
  - ✓ Simulator training on ramp up / ramp down 100% - 40% unit load as per CEA prescribed ramp rates.
  - ✓ **Flexpert**

FLEXIBILIZATION - 1st Successful Completion of Pilot Training & Demo

40% Technical Min Load in Auto Mode on Simulator

SIMULATOR TRAINING SCHEDULE

Day	Session	Topics
Day 1	FN	• Welcome & Introduction • Expectations Mapping • Need for Flexibilization in India, CEA notifications • Achieving Flexible Operation in Indian coal based plants: ➢ Key learning from Case studies and ➢ Solutions implemented in the Flexible simulator
	AN	• Achieving Flexible Operation in Indian coal based plants: ➢ Financial implications for Flexibilization, Expected regulatory intervention with Flexibilization regime and ➢ Road map & way forward to achieve flexible operation • Experiences from Germany **Instructor led Interactive Simulator Training** • Manual Ramp down from 100% to 70% Unit load @ 3% ramp rate (existing simulator) • Noting down parameters in the log book and analysis • Manual Ramp down from 70% to 55% load @ 2% ramp rate (existing simulator) • Noting down parameters in the log book and analysis. • Recap, discussions and doubt clearing
Day 2	FN	• Manual Ramp down from 55% to 40% load @ 1% ramp rate and Unit Stabilization at 40% load without oil support (existing simulator). Noting down parameters in the log book and analysis • Unit ramp up from 40% to 55% , 70% and 100% load @ 1%, 2% and 3% ramp rates respectively in manual mode (existing simulator). • Noting down parameters in the log book and analysis
	AN	• Manual Unit ramp up to 100% continued and Noting down parameters in the log book and analysis • Manual Ramp down from 100% to 70%, 55% and 40% Unit load @ 3%, 2% and 1% ramp rates respectively in the **Flexible simulator** • Unit stabilization at 40% and Noting down parameters in the log book and analysis. • Recap, discussions and doubt clearing

SIMULATOR TRAINING SCHEDULE

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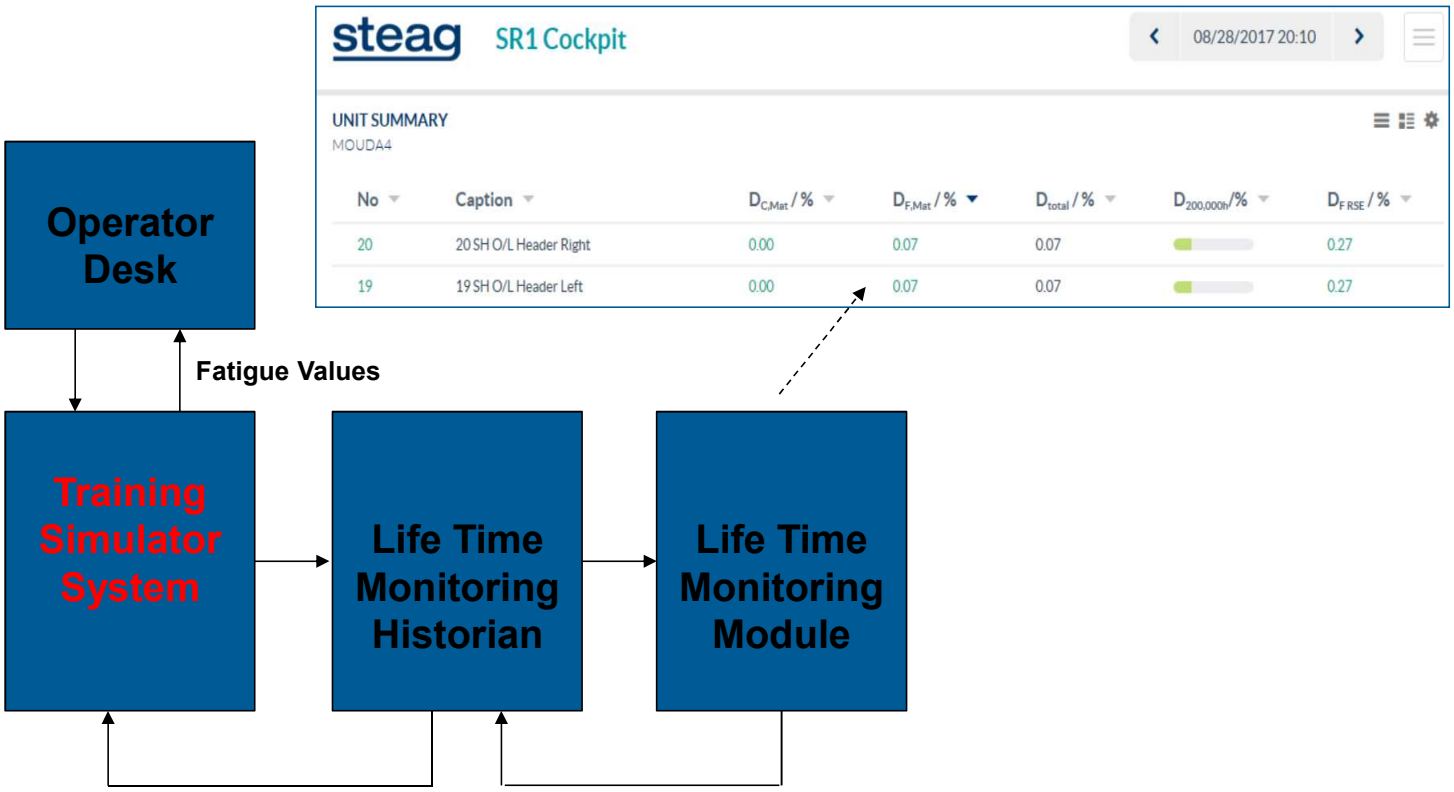
Day	Session	Topics
Day 3	FN	• Manual Unit ramp up from 40% to 55% , 70% and 100% load @ 1%, 2% and 3% ramp rates respectively in the **Flexible simulator** • Noting down parameters in the log book and analysis
	AN	• Auto mode Ramp down from 100% to 70%, 55% and 40% Unit load @ 3%, 2% and 1% ramp rates respectively in **Flexible simulator** • Unit stabilization at 40% and Noting down parameters in the log book and analysis • Recap, discussions and doubt clearing
Day 4	FN	• Auto Unit ramp up from 40% to 55% , 70% and 100% load @ 1%, 2% and 3% ramp rates respectively **in Flexible simulator** • Noting down parameters in the log book and analysis
	AN	**Hands on practice by participants** • Auto mode Ramp down from 100% to 70%, 55% and 40% Unit load @ 3%, 2% and 1% ramp rates respectively in **Flexible simulator** • Unit stabilization at 40% and Noting down parameters in the log book and analysis • Emergency handling scenarios on Flexible simulator • Recap, discussions and doubt clearing
Day 5	FN	• Auto Unit ramp up from 40% to 55% , 70% and 100% load @ 1%, 2% and 3% ramp rates respectively in Flexible simulator • Noting down parameters in the log book and analysis • Recap, discussions and doubt clearing
	AN	• Emergency handling scenarios on Flexible simulator • Online Assessment • Wrapping up and Feedback session

Integration of Flexible Simulator with Life Time Monitoring SR1



Simulator with SR1: Sequence of Actions

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1. Start the simulator for the start-up with specific ramping and / or disturbances and shut-down

2. Transfer the temperatures, pressures, main steam mass flow to SRx Server

3. Start SR1 calculations

4. Transfer fatigue results from SR1 to simulator historian

Advantages for the Trainees

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1. Increasing trainees' awareness of the impact of the boiler startup / shut down ramping on the wear of its thick-walled elements

2. Possibility of examining how different ramping values affect fatigue of thick-walled boiler elements and piping

Thanks

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