

Best Practices

SIMULATOR Training

Surender Kumar



Objectives of Simulators

Simulation Training is an exercise where a direct On–Job Hands–on skill is developed and the Operators responses and reflexes are fine–tuned to react to the urgent of necessities.

- Operator Training
- Engineering Analysis
- Optimizing Control Loops

Operator Training

Purpose of Training Simulator

- Improvement of plant operational skills
- Familiarity of plant MMI functions
- Understanding of basic plant dynamics
- Study of control system functions
- Act as a *bridge* between a hard panel operated system and a new advanced plant DCS –Applicable for Renovated Plants

Benefits and functions of simulators

- Recent studies indicated that simulator training reduce operator-training time by a factor of five. Not only operators are trained faster, but they are more confident and skilled.
- Optimum procedures, minimizing the potential for costly accidents.
- When used to test and tune new control logic prior to plant commissioning,
- Start-up problems and start-up time are reduced.
- Control system logic changes can be tested on the simulator prior to implementation in the plant.
- Simulators increase the proficiency levels and raise the skills to handle the emergencies in actual practice.

Need for Simulator Training

- Automatic plants continue to operate without operator intervention for long periods.
- Little opportunity for new operators to practice operation.
- Simulator affords possibility to practice all operations without risk of plant damage due to incorrect operator action.

Typical Operation features

- Modern Power plants are complex
- Operation from Operator Workstations using Monitor / Keyboard
- Large amount of information available
- Operator expected to handle vast number of operating and performance monitoring screens
- Operator expected to locate faulty equipment which might be preventing an automatic sequence from completion
- Operator expected not only to keep generating power but also to do so with the highest fuel efficiency

Operator interfaces as in real plant

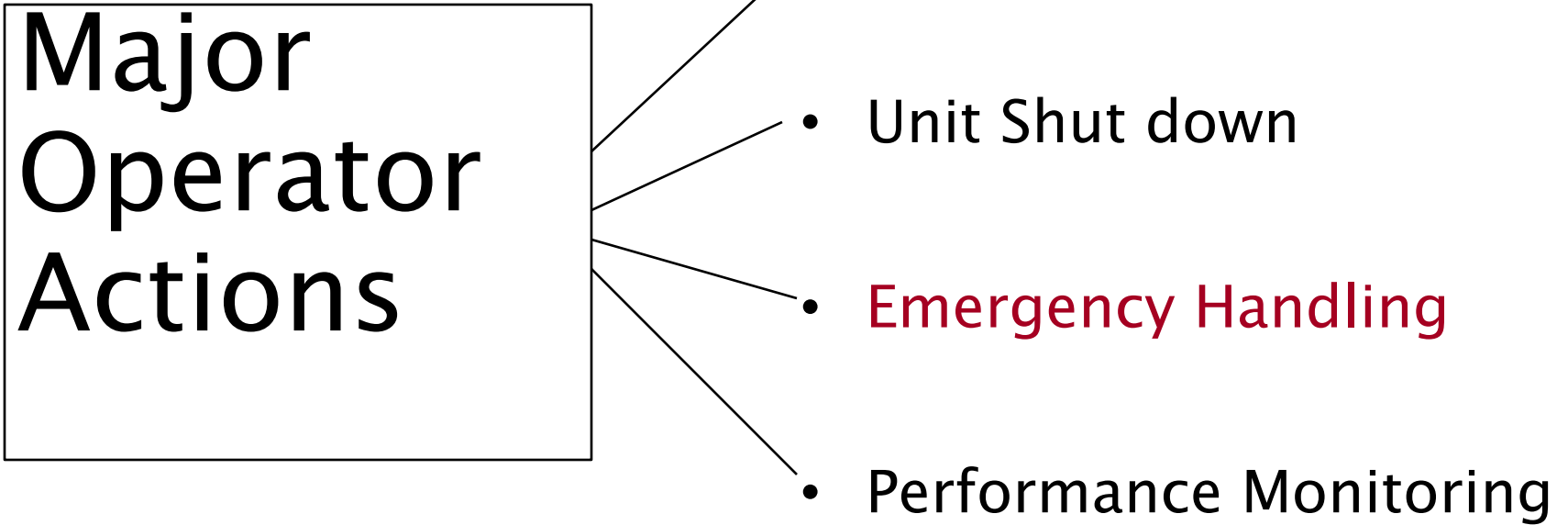
- Same type of operating conditions can be repeatedly created to improve operator reaction to a condition
- Any type of emergency condition can be created to train in emergency handling

Type & Level of Training

No.	Item	Function	Training Level	
			Fresh	Experienced
1	Plant dynamics (Abnormal /Failure)	Plant dynamics of Plant trip/major Control system failure	●	
2	Plant dynamics (Start-up/Shut down)	Function of Control system during start-up/shut down	●	
3	Start-up/Shut down operation	Operation procedure of start-up/shut down	●	
4	Emergency Operation	Emergency Operation procedure in case of failure	●	●
5	Complex Operation	Capability for complex and skilled operation		●

Unit Operator

Major Operator Actions



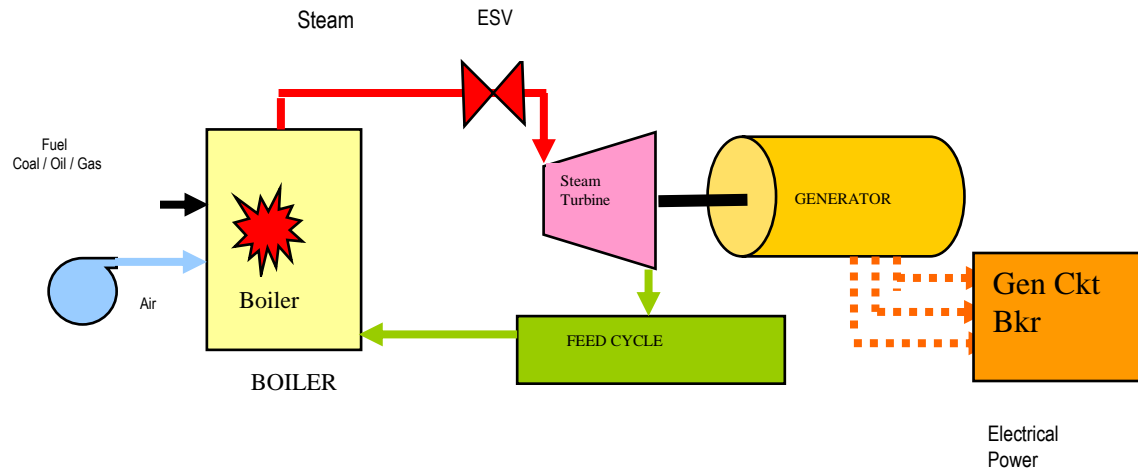
```
graph LR; A[Major Operator Actions] --- B[• Unit Start-up]; A --- C[• Unit Shut down]; A --- D[• Emergency Handling]; A --- E[• Performance Monitoring];
```

- Unit Start-up
- Unit Shut down
- Emergency Handling
- Performance Monitoring

Operator Training

Emergency Handling

A simplified Schematic of a Power Plant



Operator Training

Key Features of Simulator

- Fairly accurate model of real plant. Model will respond to operator actions exactly as the real plant would
- Facility to **Freeze /Start** simulator at will. This permits instructor to explain intermediate condition of plant
- Facility to take **Snap Shots** of any plant condition for replay to provide opportunity to learn the best response to a plant condition.

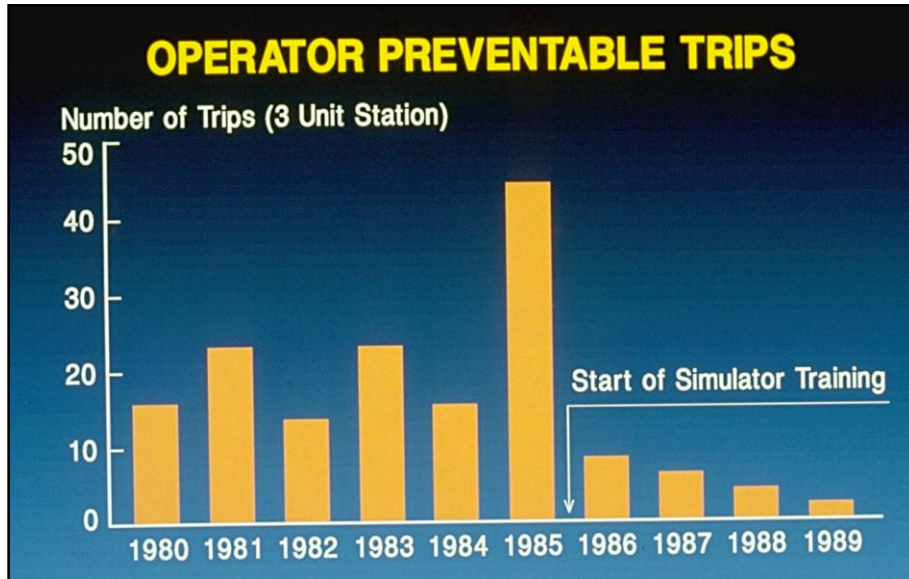
Key Features of Simulator

- Facility to run the model in real time / high speed. Permits speeding up of slow plant processes such as boiler pressure build up. This can be very useful in avoiding tiresome waiting to observe process response to operator actions
- **Replay of frames**
- Remote functions
- **Back track**

Computer aided Exercises

- **Malfunctions of plant equipment can be created to simulate actual plant equipment.**
- Historical record of operator actions can be kept for analysis and evaluation of **operator performance**

Simulator Training is Effective



Demonstrated Benefits
of
\$1000/Mw/Yr

EPRI Study....

Basic Contents

- **Process model**
 - Can be accurate to within 1-2% of real plant for critical parameters
 - Can simulate process behaviour even in transient condition to within 10-20 % of real plant
- **Control model**
 - All real plant closed and open loop controls can be accurately emulated / copied
- **Operator interface**
 - DCS based screens or hard-panels can be simulated

Man Machine Interface

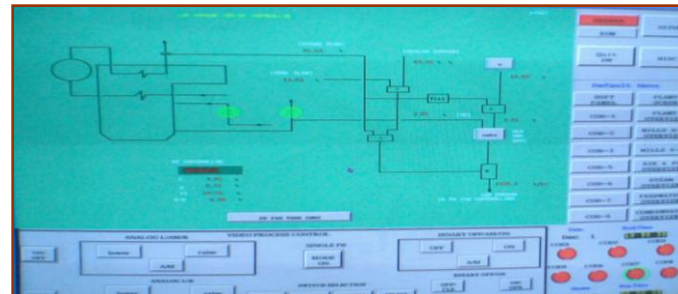
- Conventional Panel
Mode of operation



- Soft Panel
operation



- Video Process
Console



System Models

- Air and Flue Gas system
- Boiler System
- Fuel System
- Condensate and Feed Water System
- Electrical Generation System
- Main Steam System
- Turbine system

Control Panels

- Fuel firing & FSSS
- Air & Flue Gas System
- Steam System
- Feed Water System
- Regenerative Feed Heating System
- Turbine
- Generator



Initial Conditions

- Electrical supply failure
- Cold start up
- Purge ready
- Ready to roll turbine
- Ready to synchronise generator grid
- System at 50/100/150MW....

Logic Controls

- Furnace safeguard supervisory system
- Run up Run back
- Boiler follow mode
- Turbine follow mode
- Coordinated mode of control (CMC)
- Sliding and fix pressure mode of operation

Logic Control

- Automatic turbine run up system
- Automatic turbine tester (ATT)
- Turbine stress evaluator (TSE)
- All auto/manual control of operating parameters
- Starting permissive/interlocks and protections
- Functional group/sub group control/sub loop control mode of control for safe starting and stopping of equipments



Data Acquisition System

Data Acquisition System

Bar Charts

Plant Mimics

Trends Curves (X-t, X-Y)

Schedule of Alarms and

Logs

Operator Guidance mode

Performance Calculation

➤ Excess Air Control

➤ Boiler Efficiency

➤ Turbine Efficiency

➤ Unit/Turbine Heat rate

➤ TTD of different heaters

➤ Cycle Efficiency

➤ Specific Coal/oil consumption

SG-2

ST&STG

COND

FD WTR

ELECT

COMN

MIS

129 MW STG 150 MW PLF 93 % COST 2 Rs/KWH HR 1846 KCL/KWH

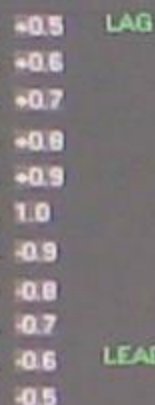
STG

PF

ACTUAL SPEED

KV
Hz
KV
Hz

POWER (ACT) : - 150 MW
 POWER (REACT) : - 84 MVAR
 FREQUENCY : - 49.96 HZ



GEN TFR-3

HV VOLTS : RY- 219 KV
 HV VOLTS : YB- 219 KV
 HV VOLTS : BR- 219 KV

EXCITER

PHASE : RY - 11.72 KV
 PHASE : YB - 11.72 KV
 PHASE : BR - 11.72 KV

EXC FIELD CURRENT : - 26 A
 EXC FIELD VOLT : - 135 V
 STG FIELD CURRENT : - 740 A

PHASE : R - 5916 A
 PHASE : Y - 5916 A
 PHASE : B - 5916 A

STG TEMP
 LIQ IN STG OK

DVR CONTROLS

DVR CHANNEL 1 / 2 SEL

CHANNEL 1 ON
 CHANNEL 2 OFF
 STG AUTO - 1/2 BAL VOLTS

STG EXCITATION ON / OFF

EXCITATION ON
 OVER EXC LIMTR OFF
 UNDER EXC LIMTR ON
 DVR ON
 PSS ON

STG VOLTAGE RAISE / LOWER

GCB AUTO SYN CMD ON

GCB READY TO CLOSE NO

SYNCHROSCOPE

TRIP PB

STG

EXCITER



>220 KV SY

CB/ISO

STG CONT

Combine Cycle Gas Turbine Simulator



Combine Cycle Gas Turbine Simulator

20/04/2003:20:38 Plant ASD A W T F O I L C M Process System

GT11 OVERVIEW

11MBY10EJ101

FIRE PROTECTION: TRIP

RESET

SGC LUBE OIL/ TRN SYS

SGC GAS TURBINE

RDY FOR START

CRIT MIS

RESTART

CTRL PNL KEYSW LOCAL

FUEL SELECTION RELS C/O

NG FO

MIXED OPERATION RELS

FUEL OIL PROPORTIONER ACTUAL VALUE %

%

SGC NG

SGC FO

SGC NAPHTHA OPERATION

FUEL OIL PROPORTIONER ACTUAL VALUE %

%

SGC NAPHTHA PURIFYING

TURB CTRL INDICATIONS

RUN UP FUNCTION ACT

SPEED CONTR. ACTIVE

LOAD CONTR. ACTIVE

OTC CONTROLLER ACT

LOAD LMT CTRL ACTIVE

LOAD LMT GEN ACTIVE

COP GRAD LMT CTRL

MASTER CONTROLLER CH1

MASTER CONTROLLER CH2

GT CONTROLLER FAULT

LOAD SETPOINT

NORM-GRAD

FAST-GRAD

BASE LOAD TEMP

PEAK LOAD TEMP

SPEED/LOAD CTRL

PRIM FREQ INFL

LOAD SETPOINT

BASE LOAD TEMP

SPEED/LOAD CTRL

PRIM FREQ INFL

CALC TURB OUT TEMP

33.53 °C

REACTIVE POWER

0.00 MVar

FREQ DEP LOAD SP

0.00 MW

ACTIVE POWER

0.00 MW

IND

CAP

TURBINE SPEED

157 S-1

POWER FACT VAL

POWER SET PT

DELATED 0.00 MW

0.00 MW

SPEED SETPOINT

157 S-1

157 S-1

GT NG START UP GT FO START UP

TEMP COMPR INL °C

ICV CONTROLLER %

COMPR OUTL °C

0.98 bar

NG FLOW Sm³/h NG ESU

FO FLOW L/s FO ESU

NOX WATER FLOW

HUM MON ACT

BOILER PRG REQ

SFC BLR PRG

WATER OPER MODE

DRY DENOX

AIR SYSTEM

NATURAL GAS SYSTEM

FUEL OIL SYSTEM

LUBE/LIFT OIL SYSTEM

HYDRAULIC SYSTEM

BEARING OIB / TEMP

PWR SUPPLY OVERVIEW

GT PROTNI

DENOX WTR

←

←

↑

→

↔

↔

✓

✗

✓

✗

A 3D architectural rendering of a nuclear power plant. The central feature is a large, white, hyperboloid cooling tower with a grid of vertical ribs. To its left is a complex of buildings, including a large rectangular structure with a grid-like roof and several cylindrical tanks. A prominent feature is a large, dome-shaped structure with a ribbed top. The entire facility is situated on a green landscape with a winding path and some trees. The text "THANK YOU" is overlaid in the center in a bold, pink font.

THANK YOU