CHAPTER 5: STEAM, TURBINE AND FEEDWATER SYSTEMS

MAIN FUNCTIONS OF THE STEAM, TURBINE & FEEDWATER SYSTEMS

- Provide the means for the transfer of heat energy from the primary heat transport system, and for the production of steam.
- Convey the steam produced in the steam generators to the high pressure turbine and other balance of plant loads.
- Provide for overpressure protection of the steam generator secondary side.
- Provide instrumentation for steam generator level and pressure control.
- Provide for a crash cool of the steam generators on a loss-of-coolant.
- Enable testing of one turbine stop valve at a time without interruption to the unit and without causing problems in control of steam generator water levels.
- Provide feedwater to each steam generator and maintains steam generator secondary side water levels.
- Provide for cooldown of the heat transport system following a design basis earthquake.
- Provide for a remote manual isolation of each pair of steam generators from the steam system (as may be required in the event of a tube leak).

MODULE A: STEAM SYSTEM

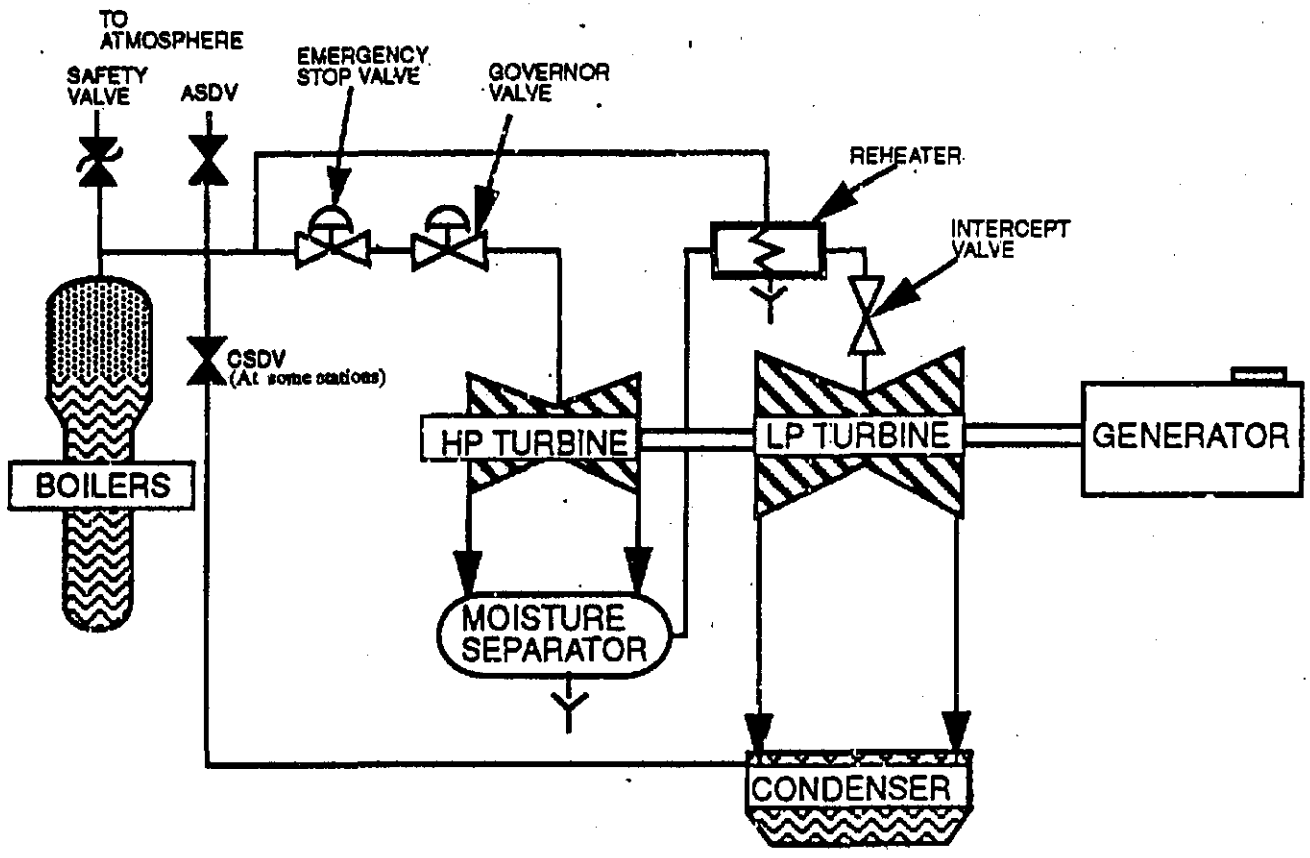
MODULE OBJECTIVES:

At the end of this module, you will be able to describe the following features of a CANDU reactor:

1. **How steam is produced, transferred to the turbine, condensed, and returned to the boilers;**
2. **The reasons for the main design and operating features of the Turbine;**
3. **The process of optimizing the thermodynamics of the steam and feedwater cycle;**
4. **The use of three element control to minimize fluctuations of steam generator level;**
5. **The use of standby equipment to ensure that the boilers can maintain their role as heat sinks;**
6. **The steam flows during 'Poison Prevent' Operation, regulation of steam generator pressure and protection against overpressure.**

STEAM SYSTEM

- Safety valves installed on top of the boiler protect the steam system from over pressure.
- The pressure from the boilers drives the steam to the high pressure (HP) turbine through the following valves:
  - ⇒ the emergency stop valves which are to quickly stop the steam flow to the turbine to prevent damage to the turbine
  - ⇒ the governor valves, which control the quantity of steam flowing to the turbine, and therefore the speed of the turbine when not connected to the grid, and the electrical output of the unit when the generator is synchronized to the grid.



- From the governor valve the steam passes through the HP turbine.
- Steam leaves the high pressure turbine at approximately 900 kPa and 170°C at 10% moisture
- It passes to the moisture separator which removes the moisture in the steam. Steam leaving the moisture separator has the same temperature and pressure as that at the turbine outlet but without moisture.
- The steam next passes through a reheater, which uses steam directly from the boiler to heat the steam from the moisture separator to a superheated condition at about 230°C and 900 kPa. Since the Reheater drains are at saturation temperature, they are returned directly to the boilers.

- Before entering the LP turbine, the steam passes through intercept valves. In a fashion similar to the emergency stop valves, these valves shut off steam to the LP turbine in an emergency.
- The steam finally passes through the low pressure turbine and is then exhausted to the condenser at approximately 5 kPa(a), 35°C and 10% moisture.

TURBINE BYPASS

- Condenser Steam Discharge Valves are installed to allow the steam to bypass the turbine and flow directly to the condenser on loss of turbine so that the reactor can continue to operate at the power required to prevent a 'poison-out'. They are also used to discharge steam on a loss of line, or on a turbine trip, so that the main steam safety valves do not lift.
- Atmospheric Steam Discharge Valves are low capacity valves used to control steam generator pressure via the steam pressure control program. They are opened in proportion to the pressure error, normally with an offset in the steam pressure setpoint. These valves may also be used to provide a heat sink during shutdown for decay heat removal when the main condenser is unavailable.

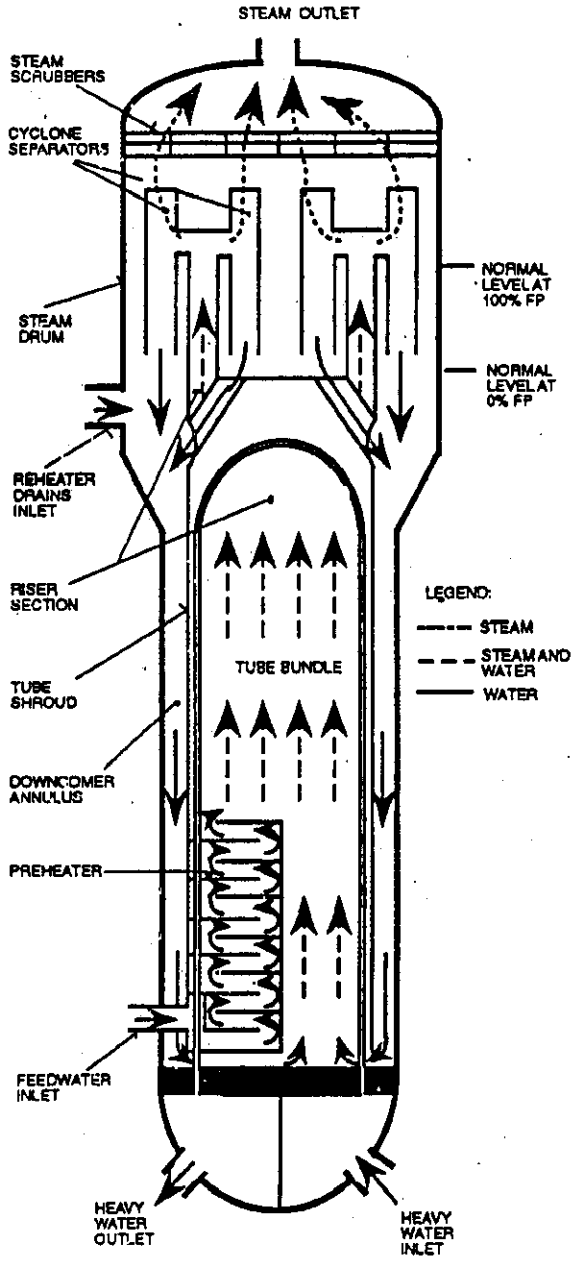
EXTRACTION STEAM

The efficiency of the thermodynamics of the steam and feedwater cycle can be optimized by taking some of the energy of the steam at various points between the main steam header and the low pressure turbine and using it to heat the feedwater. Extraction steam is supplied to the following:

- low pressure heaters
- deaerator
- high pressure heaters

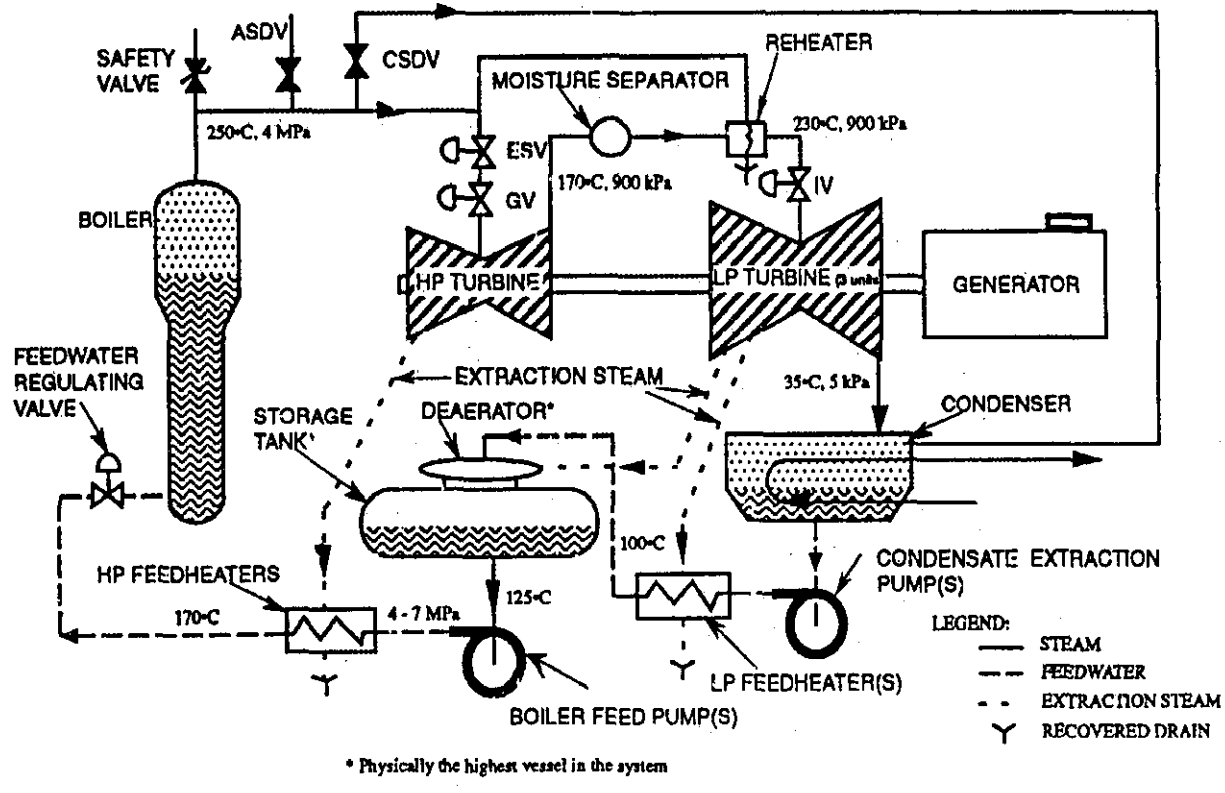
BOILER

- Hot pressurized heat transport heavy water enters the boiler and passes through the tube bundle. Heat transfers from the heavy water to the feedwater, causing the feedwater to boil.
- The steam leaving the top of the tube bundle is about 90% water. To prevent damage to the turbine, only dry steam must leave the boiler.
- Cyclone separators, located above the tube bundle, dry the steam by giving the steam/water mixture a swirling centrifugal motion. The water, being denser than steam, moves to the outside area of the separator and is drained off.
- The steam scrubbers, located above the cyclone separators, remove the last traces of moisture.
- Water separated from the steam in the cyclone separator and steam scrubber drains to the outside of the boiler's tube shroud. The amount of water cycling through the tube bundle, through the downcomer, is typically ten times as much as feedwater entering the boiler.
- The water in the boiler moves through natural circulation without the use of pumps. The water and steam in the tube bundle move upward because of the decrease in density due to the addition of heat. The water that comes out from the cyclone separators is relatively dense, and falls down the downcomer to begin the cycle again.
- The feedwater flow in the boiler starts from the preheater. The preheater heats the feedwater to near saturation temperature. Inside the boiler the feedwater circulates up around the tube bundle and down the downcomer many times while acquiring the latent heat of vaporization, and finally leaves the boiler as nearly saturated steam.



FEEDWATER SYSTEM

- The water leaving the condenser is at relatively low temperature and pressure.
- A series of heat exchangers raises the condensate temperature to about 170°C.
- The preheater increase the temperature to almost saturation temperature in the boiler.
- A set of pumps, known as boiler feed pumps (BFP), force the feedwater into the boilers.



* Physically the highest vessel in the system

LOW PRESSURE FEEDHEAT SYSTEM

- The first stage in the boiler feedwater heating is through the LP feedheating system.
- The condensate extraction pump (CEP) delivers the condensate from the condenser hotwell to the LP feedheaters.
- The low pressure feedheating system gets its name from the low pressure condition of the feedwater, at about 1400 kPa.
- The LP feedheaters use extraction from the LP turbines as their heating medium. The extraction steam condenses in the shell of the heater. A separate pump recovers this condensate by pumping it to the condenser hotwell. The feedwater leaves the last LP feedheater at approximately 80°C to 100°C.

DEAERATOR AND STORAGE TANK

- The deaerator is the next stage in the feedwater heating process. This is the highest vessel in the feedheating system. The deaerator adds heat to and removes non-condensable gases from the feedwater.
- The incoming feedwater enters the deaerator near the top and sprays downward over cascade trays. Extraction steam from the LP turbine enters the deaerator near the bottom and passes upward. As a result the feedwater heats up to about 125°C. The deaerated feedwater and condensed steam drain from the deaerator into a storage tank. The storage tank supplies water for boiler operation.

HIGH PRESSURE FEEDHEATING SYSTEM

- From the deaerator storage tank, the feedwater undergoes one more stage of having its temperature and pressure raised.
- The boiler feed pumps (BFP) take suction from the deaerator storage tank and raise the feedwater pressure to between 4 and 7 MPa. The pump discharges the high pressure feedwater to the high pressure (HP) feedheaters.
- The HP feedheaters heat the feedwater to about 170°C. HP feedheater operation and construction are similar to that of the LP feedheaters. Extraction steam from the HP turbine normally supplies the heating medium.

CANDU BOILER FEED PUMPS AND LEVEL CONTROL

- Two main boiler feed pumps are required to supply the necessary flow, and one additional pump is on standby.
- One auxiliary pumps is also provided, it is sized so that it can supply the flow to remove decay heat in case of a loss of class IV supply to the main pumps.
- Connections to the Condensate system allow for recirculating flow when the pumps are operating but the level control valves are closed.
- The level in each steam generator is controlled individually.
- Since the measured level in a boiler is higher for a given mass of inventory as the power level increases due to the expansion of the water with increased boiling, the level setpoint as well as alarm and trip settings are increased automatically as a function of reactor power.
- Because of safety, range of control and maintenance considerations, each steam generator has a set of three control valves for feedwater control connected in parallel: one small valve to control feedwater during shutdown, startup, and low power operation, and two larger valves to control feedwater for on-power conditions. Each of the two large valves can handle the full power flow requirements. Isolating valves are provided for each control valve.
- The steam generator level control system balances feedwater to steam flow for all operating conditions: fast reactor runup, reactor setback, turbine trip and 'poison-prevent' mode.

CHAPTER 5: STEAM, TURBINE AND FEEDWATER SYSTEM

MODULE B: SIMULATOR EXERCISES

MODULE OBJECTIVES:

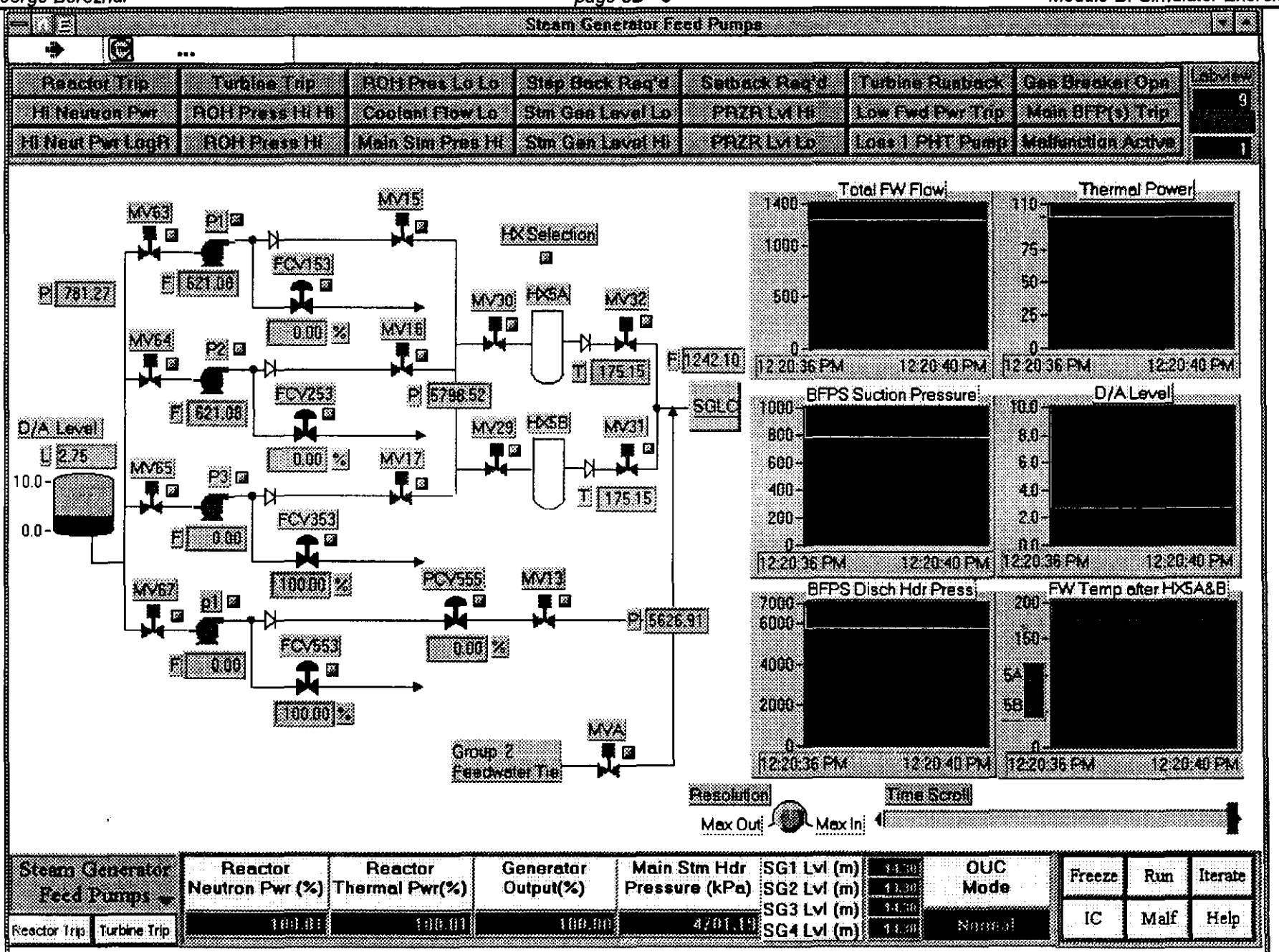
At the end of this module, you will be able to:

1. **Identify the parameters associated with the Steam, Turbine and Feedwater systems;**
2. **Respond correctly to the following events:**
   - **Fail Closed all Feedwater LCVs & MVs**
   - **Turbine Spurious Trip**
   - **Feedwater LCV101 Fails Open**
   - **Feedwater LCV101 Fails Closed**
   - **All Main BFPs Trip**
   - **Throttle PT Fails Low**

STEAM GENERATOR FEED PUMPS PAGE

Screen shows the portion of the feedwater system that includes the Deaerator, the boiler feed pumps, the high pressure heaters and associated valves, with the output of the HP heaters going to the Steam Generator Level Control Valves. The following parameters are displayed:

- **Deaerator Level (m)**
- **Boiler Feedpump Suction Header Pressure (kPa)**
- **Boiler Feed Pump inlet valves (MV63 to MV68), outlet valves (MV13 to MV18) and associated popup menus allowing them to be opened or closed**
- **Main Boiler Feed Pumps (P1 to P4) and Auxiliary Boiler Feed Pumps p1 and p2 with associated popup menus for control selections**
- **Recirculating flow control valves FCV153, 253, 353, 453, 553, 653; pressure control valves PCV555, 565; and associated popup menus for AUTO/MANUAL selection and controller parameter tuning**
- **High Pressure Heaters HX5A and HX5B and popup menus to select either or both heaters to be in-service**
- **HP Heater isolation valves MV29 to MV32 and popup menus for open and close control**
- **Pressure at inlet and outlet of HP heaters (kPa)**
- **Flow at inlet header to Steam Generator Level Control Valves (kg/sec)**

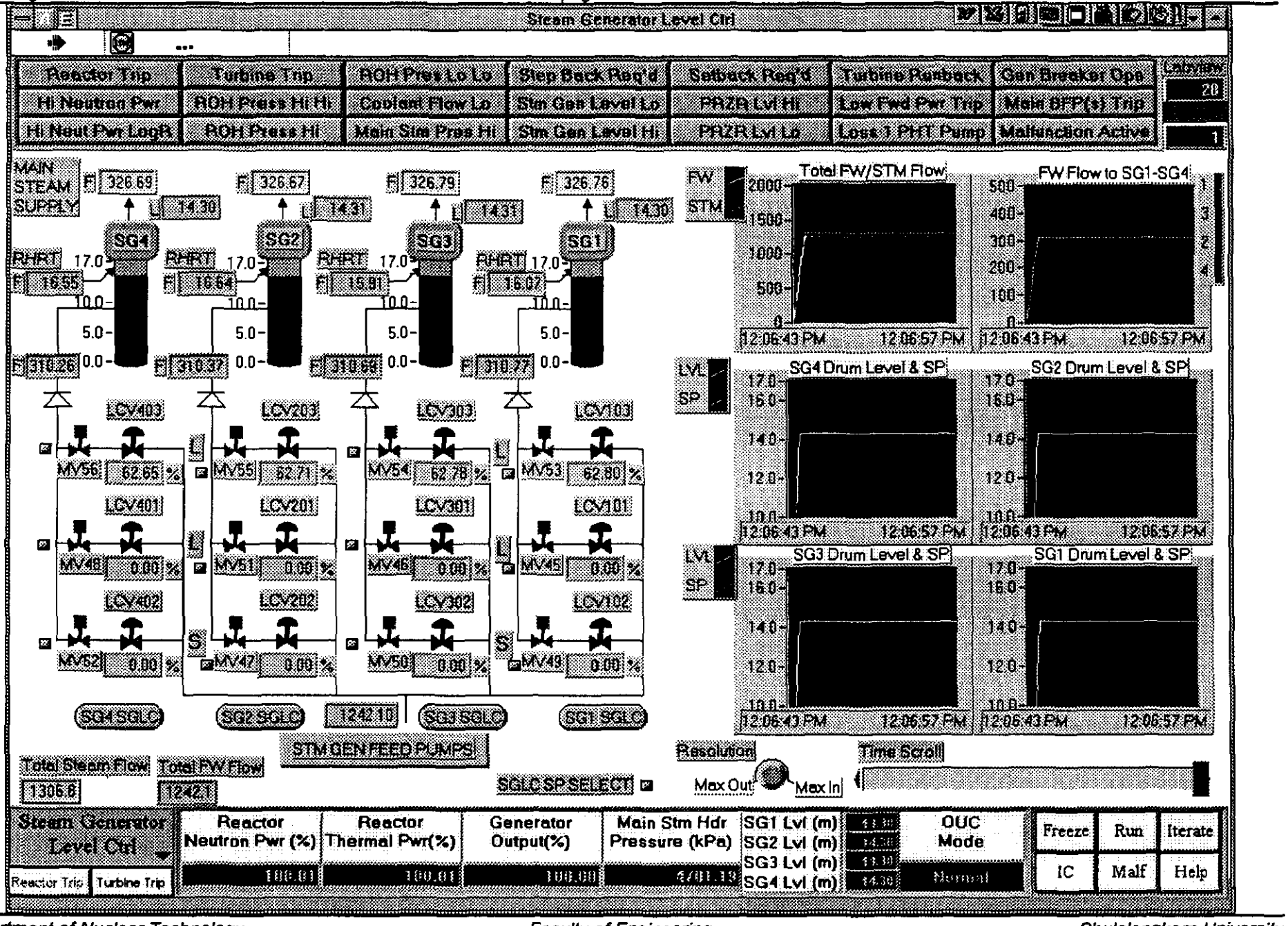

Steam Generator Feed Pumps
Reactor Trip
Turbine Trip
ROH Pres Lo Lo
Step Back Req'd
Setback Req'd
Turbine Runback
Gen Breaker Opn
Hi Neutron Pwr
ROH Press Hi Hi
Coolant Flow Lo
Stm Gen Level Lo
PRZR Lvl Hi
Low Fwd Pwr Trip
Main BFPS(s) Trip
Hi Neut Pwr Log1
ROH Press Hi
Main Stm Pres Hi
Stm Gen Level Hi
PRZR Lvl Lo
Loss I Pmt Pump
Malfunction Active
MV63
P1
MV15
HX Selection
FCV153
F 621.08
P 781.27
0.00 %
MV30
HX5A
MV32
MV16
MV64
P2
F 621.08
FCV253
P 5796.52
F 1242.10
T 175.15
SGLC
0.00 %
MV29
HX5B
MV31
MV17
D/A Level
L 2.75
10.0
0.0
MV65
P3
T 175.15
F 0.00
FCV353
100.00 %
FCV555
MV13
MV67
p1
P 5626.91
F 0.00
0.00 %
FCV653
100.00 %
MVA
Group 2 Feedwater Tie
Total FW Flow
1400
1000
500
0
12:20:36 PM
12:20:40 PM
Thermal Power
110
75
50
25
0
BFPS Suction Pressure
1000
800
600
400
200
0
D/A Level
10.0
8.0
6.0
4.0
2.0
0.0
BFPS Disch Hdr Press
7000
6000
4000
2000
0
FW Temp after HX5A&B
200
150
5A
5B
0
Resolution
Max Out
Max In
Time Scroll
Steam Generator Feed Pumps
Reactor Trip
Turbine Trip
Reactor Neutron Pwr (%)
Reactor Thermal Pwr(%)
Generator Output(%)
Main Stm Hdr Pressure (kPa)
SG1 Lvl (m)
SG2 Lvl (m)
SG3 Lvl (m)
SG4 Lvl (m)
OUC Mode
Normal
Freeze
Run
Iterate
IC
Malf
Help

STEAM GENERATOR LEVEL CONTROL PAGE

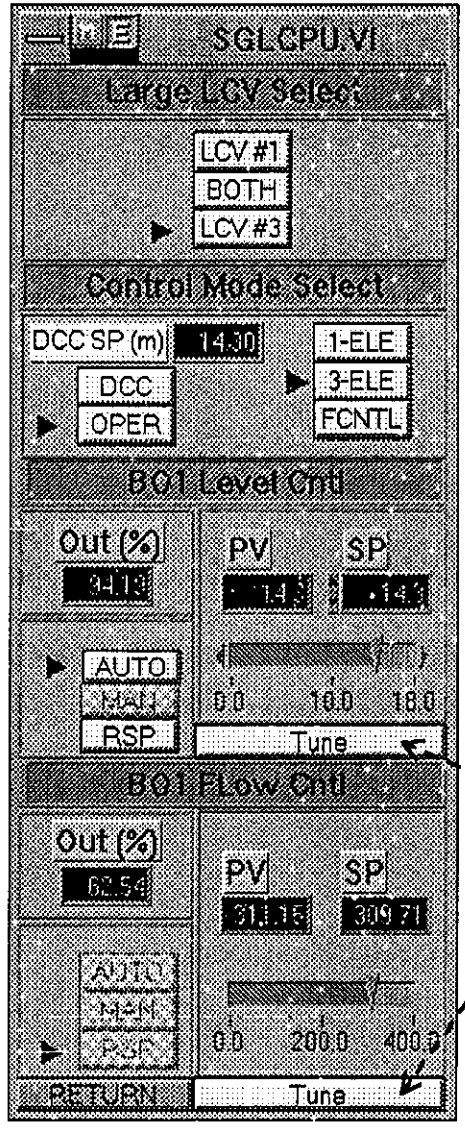
Screen shows each of the four boilers and associated level control valves. The following parameters are described (starting near the top of the screen) for Steam Generator 1, the same applies to SG 2, 3 and 4.

- **Steam Generator Flow (kg/sec)**
- **Steam Generator Level (m)**
- **Reheater Flow (kg/sec)**
- **Feedwater Flow (kg/sec)**
- **Large Level Control Valve (LCV103) Status and Opening (%)**
- **Large Level Control Isolation Motorized Valve (MV53) Status and AUTO/MANUAL Controller Popup Menu**
- **Large Level Control Valve (LCV101) Status and Opening (%)**
- **Large Level Control Isolation Motorized Valve (MV45) Status and AUTO/MANUAL Controller Popup Menu**
- **Small Level Control Valve (LCV102) Status and Opening (%)**
- **Small Level Control Isolation Motorized Valve (MV49) Status and AUTO/MANUAL Controller Popup Menu**
- **Steam Generator 1 Level Control (SG1 SGLC) Popup Menu**
- **Steam Generator Level Control Setpoint (SGLC SP) Select Popup Menu**

Total Steam Flow (kg/sec) and Total feedwater Flow (kg/sec) to all four Boilers is shown at the bottom left hand corner


Steam Generator Level Ctrl
Reactor Trip
Turbine Trip
ROH Pres Lo Lo
Step Back Req'd
Setback Req'd
Turbine Runback
Gen Breaker Opn
Hi Neutron Pwr
ROH Press Hi Hi
Coolant Flow Lo
Stm Gen Level Lo
PRZR Lvl Hi
Low Fwd Pwr Trip
Main BFP(s) Trip
Hi Neut Pwr LogR
ROH Press Hi
Main Stm Pres Hi
Stm Gen Level Hi
PRZR Lvl Lo
Loss 1 PHT Pump
Malfunction Active
Labview
20
1
MAIN STEAM SUPPLY
SG4
SG2
SG3
SG1
RHRT
LCV403
LCV203
LCV303
LCV103
LCV401
LCV201
LCV301
LCV101
LCV402
LCV202
LCV302
LCV102
SG4 SGLC
SG2 SGLC
SG3 SGLC
SG1 SGLC
1242.10
STM GEN FEED PUMPS
Total Steam Flow
1306.8
Total FW Flow
1242.1
SGLC SP SELECT
Total FW/STM Flow
FW Flow to SG1-SG4
SG4 Drum Level & SP
SG2 Drum Level & SP
SG3 Drum Level & SP
SG1 Drum Level & SP
Resolution
Max Out
Max In
Time Scroll
Steam Generator Level Ctrl
Reactor Trip
Turbine Trip
Reactor Neutron Pwr (%)
Reactor Thermal Pwr(%)
Generator Output(%)
Main Stm Hdr Pressure (kPa)
SG1 Lvl (m)
SG2 Lvl (m)
SG3 Lvl (m)
SG4 Lvl (m)
OUC Mode
Normal
Freeze
Run
Iterate
IC
Malf
Help

Steam Generator Level Controller Popup Menu with OPERator Control Mode Selected



Under 3 Element Control the Output of the level controller is an input to the flow controller's setpoint

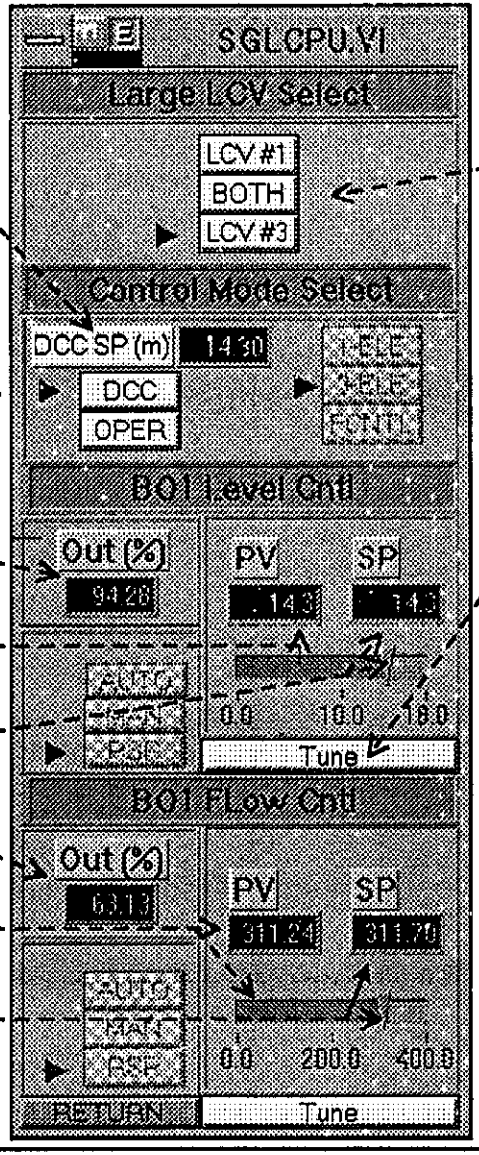
The Output signal of the flow controller determines the opening of the flow control valve

Operator can select 1 Element, 3 Element or Flow Control; DCC setpoint is displayed for reference only

Operator can manually select the value of the level control setpoint

Tuning the parameters of the level and/or flow controller will alter the response of the boiler level control system

Steam Generator Level Control 'SG1 SGLC' Popup Menu



Computer Generated Setpoint

Selection of Control: Computer (DCC) or Manual (OPER)

Output signal of level controller

Present value of boiler level

Boiler level setpoint

Output signal of flow controller

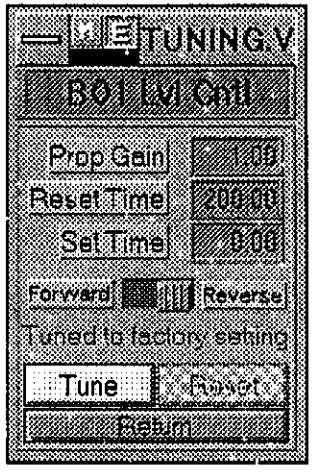
Present value of feedwater flow

Feedwater flow setpoint

Selection of either or both control valves to be in service

Select 'Tune' if analogue controller parameters are to be changed

Popup menu to tune analogue controller parameters

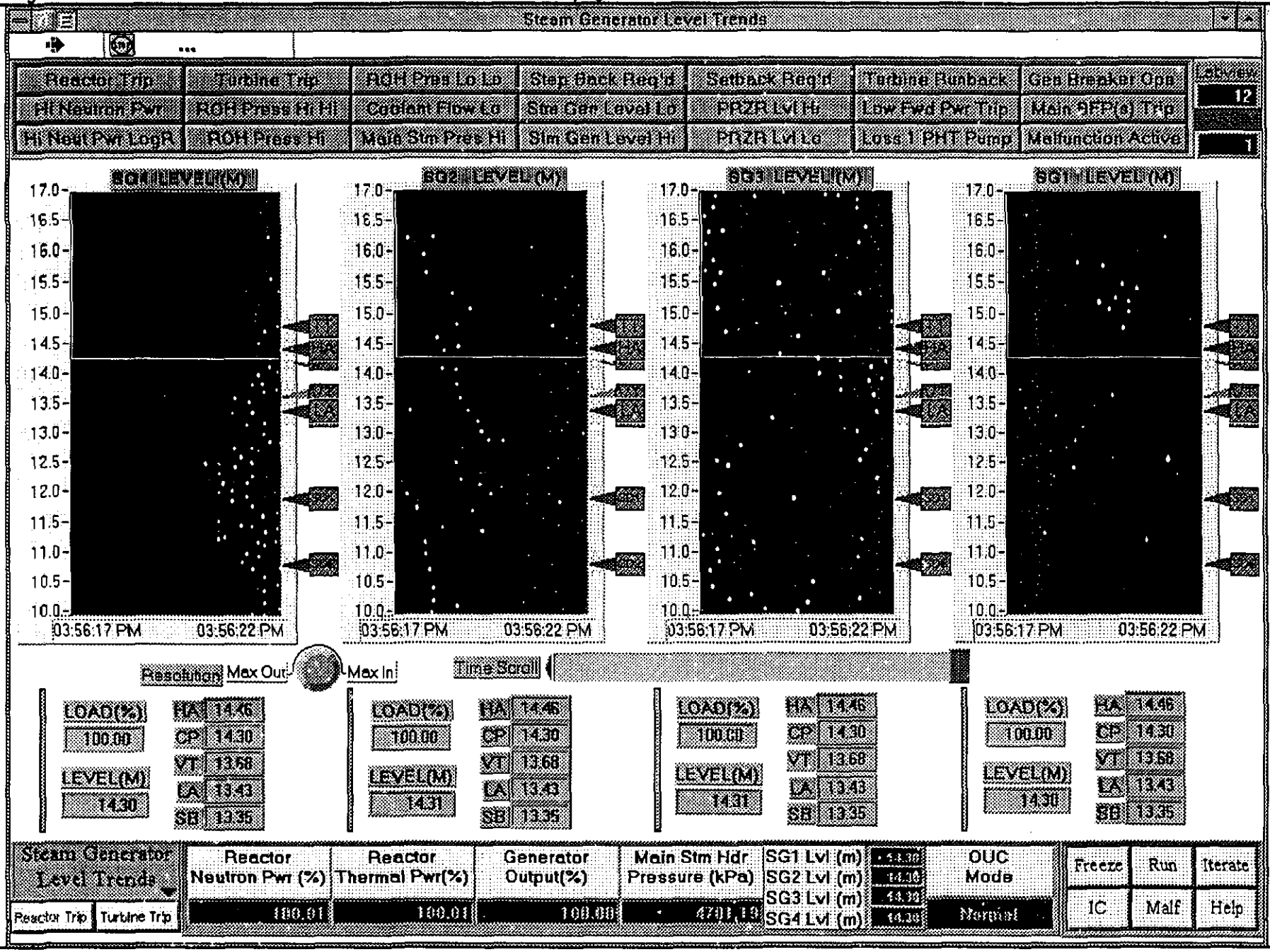


When DCC is in control, actions on the analogue controller will have no effect on the level control valves. It is possible, however to tune the controller parameters in anticipation of transfering control to the analogue controller.

STEAM GENERATOR LEVEL TRENDS PAGE

Screen shows the steam generator level displays, including the actual level, the alarm, control and trip points. These points are identified as follows:

- **TT - Turbine Trip**
- **HA - High steam generator level Alarm**
- **CP - Control (or set) Point**
- **VT - Valve Transfer Point**
- **LA - Low Steam generator level Alarm**
- **SB - SetBack reactor**
- **SDS1 - ShutDown System 1 trip**
- **SDS2 - ShutDown System 2 trip**


Steam Generator Level Trends
Reactor Trip
Turbine Trip
HOH Press Lo Lo
Step Back Req'd
Setback Req'd
Turbine Runback
Gen Breaker Opn
Hi Neutron Pwr
ROH Press Hi Hi
Coolant Flow Lo
Stm Gen Level Lo
PRZR Lvl Hi
Low Fwd Pwr Trip
Main SFP(s) Trip
Hi Neut Pwr LogR
ROH Press Hi
Main Stm Press Hi
Stm Gen Level Hi
PRZR Lvl Lo
Loss 1 PHT Pump
Malfunction Active
Overview
12
1
SG4 LEVEL(M)
SG2 LEVEL(M)
SG3 LEVEL(M)
SG1 LEVEL(M)
17.0
16.5
16.0
15.5
15.0
14.5
14.0
13.5
13.0
12.5
12.0
11.5
11.0
10.5
10.0
03:56:17 PM
03:56:22 PM
Resolution
Max Out
Max In
Time Scroll
LOAD(%)
100.00
LEVEL(M)
14.30
14.31
HA 14.46
CP 14.30
VT 13.68
LA 13.43
SB 13.35
Steam Generator Level Trends
Reactor Trip
Turbine Trip
Reactor Neutron Pwr (%)
Reactor Thermal Pwr(%)
Generator Output(%)
Main Stm Hdr Pressure (kPa)
SG1 Lvl (m)
SG2 Lvl (m)
SG3 Lvl (m)
SG4 Lvl (m)
OUC Mode
Normal
Freeze
Run
Iterate
IC
Malf
Help

STEAM GENERATOR LEVEL MANUAL CONTROL

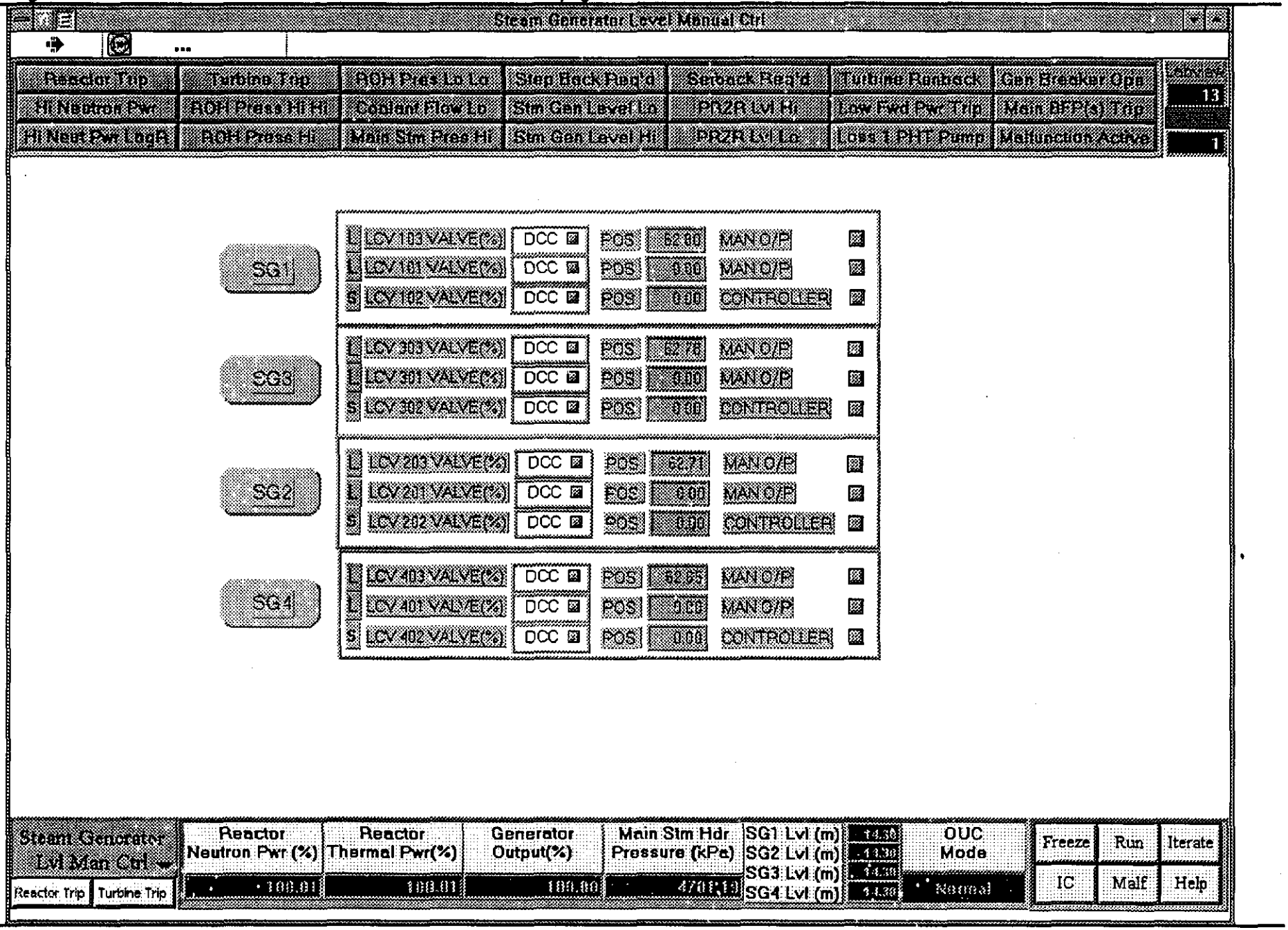
This screen allows the manual control of the level in each of the four steam generators. Since the actions are the same for any one steam generator, SG1 is the only one described here.

Under normal operating conditions all level control valves are under DCC Control. At full power normally one large valve (LCV103 for SG1 at the 100%FP Initial Condition) is in control, the other large valve and the small valve are closed.

While under DCC control the MAN O/P (Manual Output) station tracks the DCC signal.

Transferring control from DCC to MANUAL allows direct control of the valve's position by the operator.

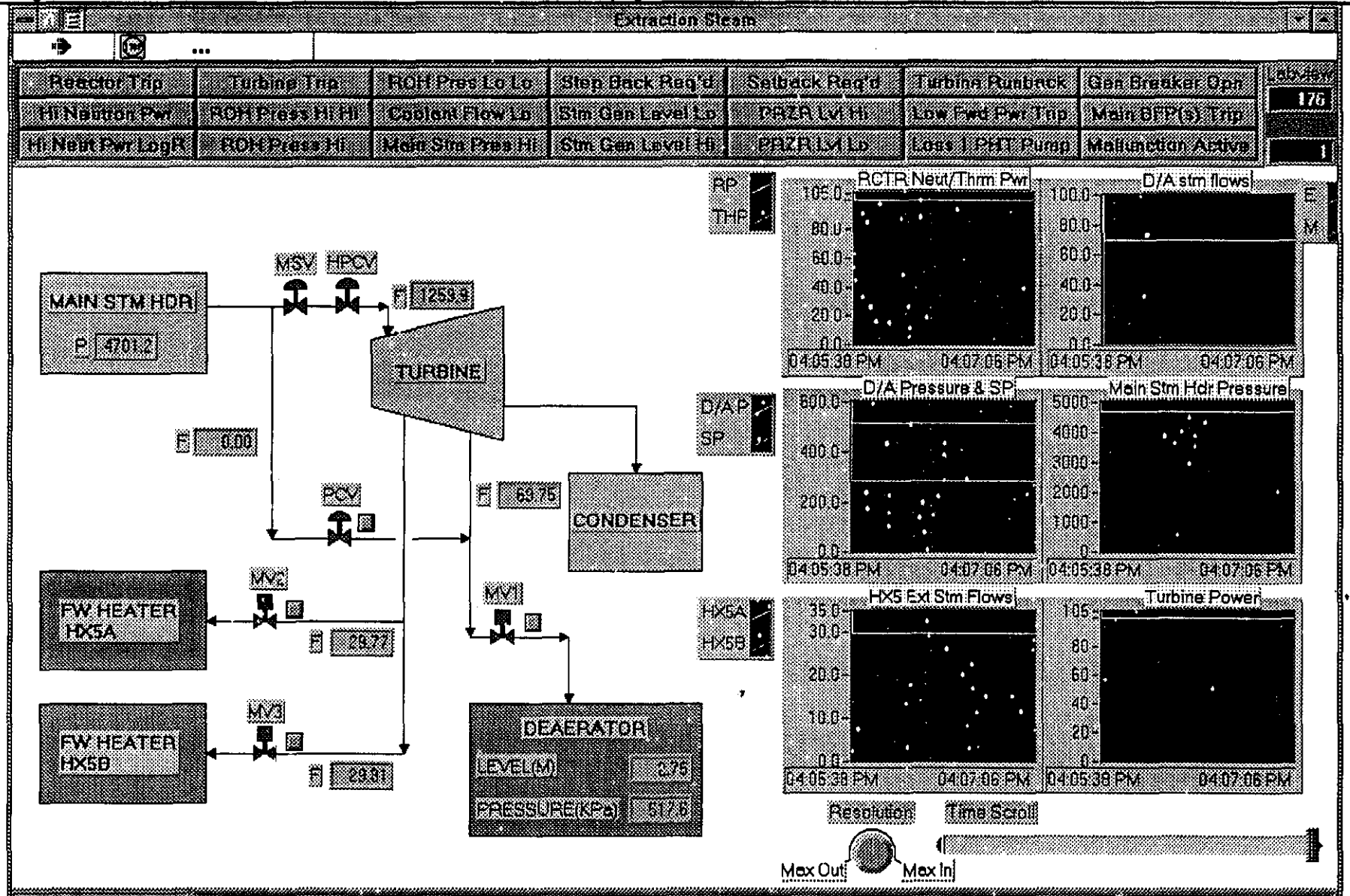
For the small valves, transfer from DCC to AUTO allows for tuning of the controller and valve control to be transferred from the DCC to either AUTO or MANUAL control.


Steam Generator Level Manual Ctrl
Reactor Trip
Turbine Trip
ROH Pres Lo Lo
Step Back Req'd
Setback Req'd
Turbine Runback
Gen Breaker Opn
Hi Neutron Pwr
ROH Press Hi Hi
Coolant Flow Lo
Stm Gen Level Lo
PRZR Lvl Hi
Low Fwd Pwr Trip
Main BFP(s) Trip
Hi Neut Pwr Log(t)
ROH Press Hi
Main Stm Pres Hi
Stm Gen Level Hi
PRZR Lvl Lo
Loss 1 PHT Pump
Malfunction Active
Alarms
13
1
SG1
L LCV 103 VALVE(%) DCC POS 52.80 MAN O/P
L LCV 101 VALVE(%) DCC POS 0.00 MAN O/P
S LCV 102 VALVE(%) DCC POS 0.00 CONTROLLER
SG3
L LCV 303 VALVE(%) DCC POS 52.78 MAN O/P
L LCV 301 VALVE(%) DCC POS 0.00 MAN O/P
S LCV 302 VALVE(%) DCC POS 0.00 CONTROLLER
SG2
L LCV 203 VALVE(%) DCC POS 52.71 MAN O/P
L LCV 201 VALVE(%) DCC POS 0.00 MAN O/P
S LCV 202 VALVE(%) DCC POS 0.00 CONTROLLER
SG4
L LCV 403 VALVE(%) DCC POS 52.85 MAN O/P
L LCV 401 VALVE(%) DCC POS 0.00 MAN O/P
S LCV 402 VALVE(%) DCC POS 0.00 CONTROLLER
Steam Generator Lvl Man Ctrl
Reactor Trip
Turbine Trip
Reactor Neutron Pwr (%)
100.01
Reactor Thermal Pwr(%)
100.01
Generator Output(%)
100.00
Main Stm Hdr Pressure (kPa)
4701.19
SG1 Lvl (m)
SG2 Lvl (m)
SG3 Lvl (m)
SG4 Lvl (m)
14.30
OUC Mode
Normal
Freeze
Run
Iterate
IC
Malf
Help

EXTRACTION STEAM PAGE

Screen shows the extraction steam flows from the Main Steam system to the Deaerator and the High Pressure Heaters in addition to the steam flow to the Turbine. The following parameters are displayed:

- **Main Steam Header Pressure (MPa)**
- **Steam Flow to the Turbine (kg/sec)**
- **Steam flow to the Deaerator from the Main Steam Header (kg/sec)**
- **Extraction Steam flow to the Deaerator (kg/sec)**
- **Extraction Steam flow to the High Pressure Heaters (kg/sec)**
- **Deaerator Level (m)**
- **Deaerator Pressure (kPa)**
- **Valve Status for MSV (Motorized or Emergency Stop Valve) and HPCV (High Pressure Turbine Control or Governor Valve)**
- **Valve status and popup menus to provide for manual control of motorized valves MV1, 2 and 3**
- **Valve status and popup menu for AUTO/MANUAL selection and controller parameter tuning**


Extraction Steam
Reactor Trip
Turbine Trip
ROH Pres Lo Lo
Step Back Req'd
Setback Req'd
Turbine Runback
Gen Breaker Opn
Hi Neutron Pwr
ROH Press Hi Hi
Coolant Flow Lo
Stm Gen Level Lo
PRZR Lvl Hi
Low Feed Pwr Trip
Main BFP(s) Trip
Hi Neut Pwr LogR
ROH Press Hi
Main Stm Press Hi
Stm Gen Level Hi
PRZR Lvl Lo
Loss 1 PHT Pump
Malfunction Active
MAIN STM HDR
P 4701.2
MSV
HPCV
F 1259.9
TURBINE
F 0.00
PCV
F 69.75
CONDENSER
MV2
FW HEATER HX5A
F 29.77
MV1
MV3
FW HEATER HX5B
F 29.31
DEAERATOR
LEVEL(M) 2.75
PRESSURE(KPa) 517.6
RP
THP
D/A P
SP
HX5A
HX5B
RCTR Neut/Thrm Pwr
D/A stm flows
D/A Pressure & SP
Main Stm Hdr Pressure
HX5 Ext Stm Flows
Turbine Power
04:05:36 PM
04:07:06 PM
Resolution
Time Scroll
Max Out
Max In
Extraction Steam
Reactor Trip
Turbine Trip
Reactor Neutron Pwr (%)
100.01
Reactor Thermal Pwr(%)
100.01
Generator Output(%)
100.00
Main Stm Hdr Pressure (kPa)
4701.19
SG1 Lvl (m)
SG2 Lvl (m)
SG3 Lvl (m)
SG4 Lvl (m)
OUC Mode
Normal
Freeze
Run
Iterate
IC
Malf
Help

ELECTRICAL CLASS IV

This screen shows the electric power output and the Class IV distribution systems.

The Generator Output (MW) and Synchronizing breaker status are shown at the top left hand corner of the display. The generator output is at 24kV, it is stepped up to the voltage of the grid (345kV in this simulation) by the Main Output Transformer, and stepped down to 13.8 kV by the Unit Service Transformer to supply (typically) half the unit's Class IV electrical load.

The connection from the generator to the grid is via a set of six switchyard breakers. These are arranged to maximize the reliability of the supply of power to and from the grid.

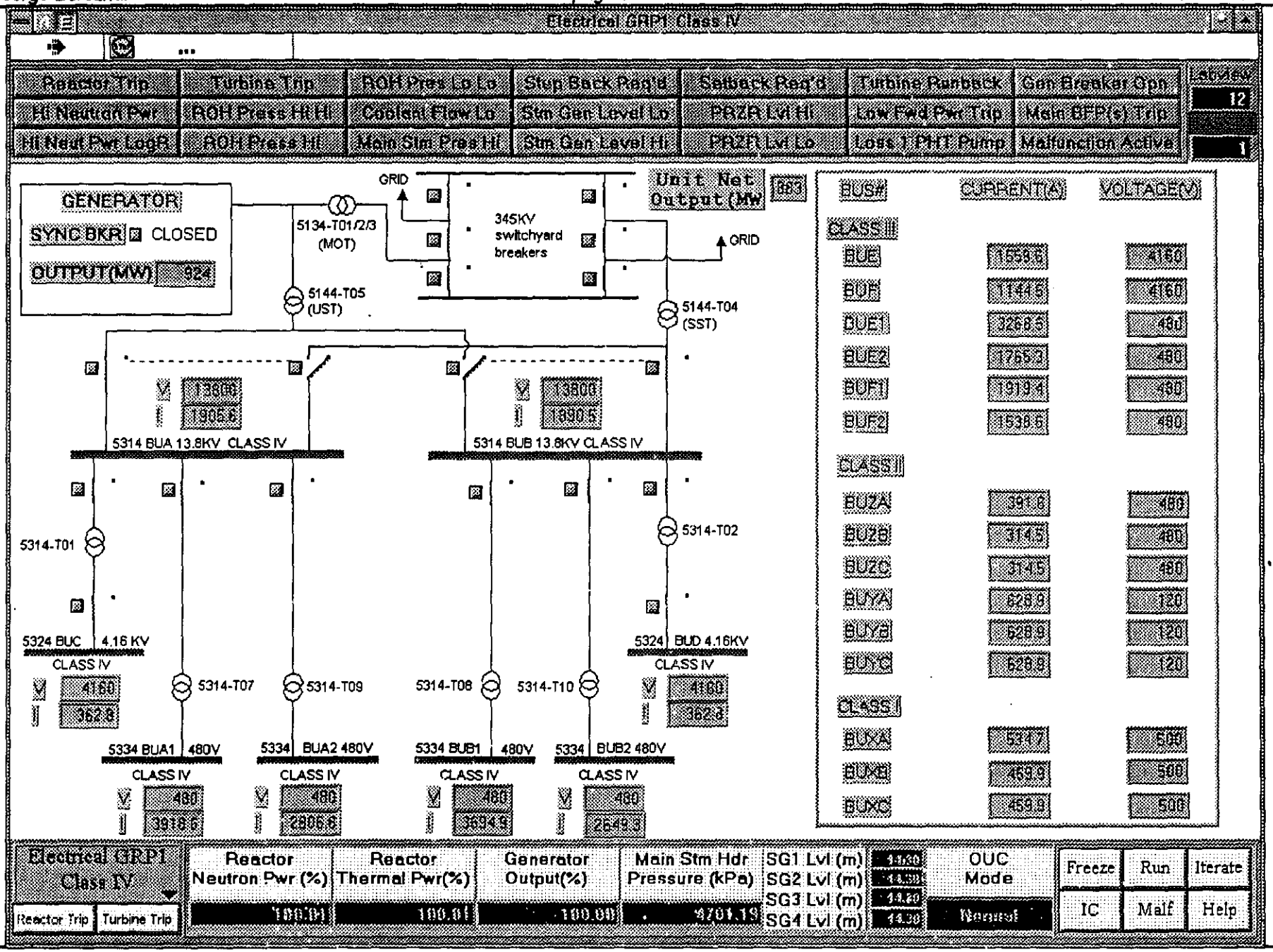
Normally half the station's Class IV load is supplied by the System Service Transformer, which steps the grid voltage from 345kV down to 13.8 kV.

To increase the reliability of Class IV power, the unit's loads can be supplied from either the Unit or the System Service Transformer.

Automatic transfer of the supply is done by opening/closing the appropriate breakers.

Step-down transformers supply the 4.16kV and 480V buses.

Each breaker is provided with a popup menu to allow the selection of CLOSE, TRIP or RESET positions.


Electrical GRP1 Class IV
Reactor Trip
Turbine Trip
ROH Pres Lo Lo
Stop Back Req'd
Setback Req'd
Turbine Runback
Gen Breaker Opn
Hi Neutron Pwr
ROH Press Hi Hi
Coolant Flow Lo
Stm Gen Level Lo
PRZR Lvl Hi
Low Fwd Pwr Trip
Main BFP(s) Trip
Hi Neut Pwr LogR
ROH Press Hi
Main Stm Pres Hi
Stm Gen Level Hi
PRZR Lvl Lo
Loss 1 PHT Pump
Malfunction Active
Latview
12
1
GENERATOR
SYNC BKR CLOSED
OUTPUT(MW) 924
GRID
5134-T01/2/3 (MOT)
345KV switchyard breakers
GRID
Unit Net Output (MW)
883
5144-T05 (UST)
5144-T04 (SST)
13800
1905.6
13800
1890.5
5314 BUA 13.8KV CLASS IV
5314 BUB 13.8KV CLASS IV
5314-T01
5314-T02
5324 BUC 4.16 KV CLASS IV
4160
362.8
5324 BUD 4.16KV CLASS IV
4160
362.8
5314-T07
5314-T09
5314-T08
5314-T10
5334 BUA1 480V CLASS IV
480
3918.6
5334 BUA2 480V CLASS IV
480
2806.6
5334 BUB1 480V CLASS IV
480
3694.9
5334 BUB2 480V CLASS IV
480
2649.3
BUS# CURRENT(A) VOLTAGE(V)
CLASS III
BUE 1559.6 4160
BUF 1144.5 4160
BUE1 3268.5 480
BUE2 1765.3 480
BUF1 1919.4 480
BUF2 1538.6 480
CLASS II
BUZA 391.6 480
BUZB 314.5 480
BUZC 314.5 480
BUYA 628.9 120
BUYB 628.9 120
BUYC 628.9 120
CLASS I
BUXA 511.7 500
BUXB 459.9 500
BUXC 459.9 500
Electrical GRP1 Class IV
Reactor Trip
Turbine Trip
Reactor Neutron Pwr (%)
100.01
Reactor Thermal Pwr(%)
100.01
Generator Output(%)
100.00
Main Stm Hdr Pressure (kPa)
4701.19
SG1 Lvl (m)
SG2 Lvl (m)
SG3 Lvl (m)
SG4 Lvl (m)
14.30
OUC Mode
Normal
Freeze
Run
Iterate
IC
Malf
Help

ELECTRICAL CLASS III

This screen shows the electric power output, the standby generators and the Class III distribution systems.

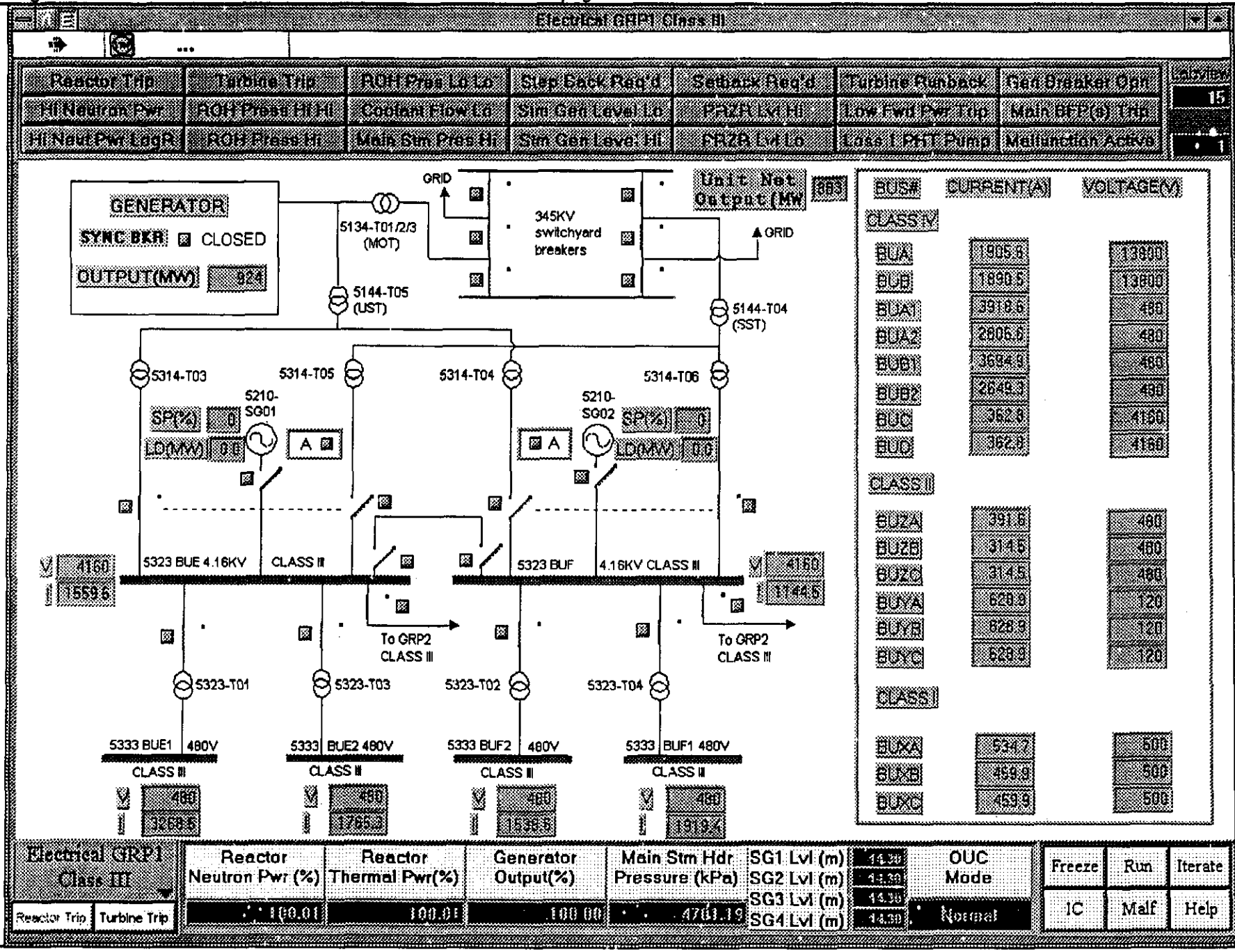
The Generator Output (MW), Synchronizing breaker status, Main Output Transformer, the six switchyard breakers and the connections to and from the Grid are as for the Class IV power.

Using the appropriate taps on the Unit and System Service Transformers, the voltages are stepped down to 4.16kV and 480V, and normally each transformer supplies half the unit's Class III electrical load.

To ensure that the loss of Class III power, is not last for more than approximately three minutes, standby generators are provided, which are automatically brought up to speed and synchronized when a loss of Class III power is detected.

There is a complex logic design to provide a combination of automatic and manual transfers of the supply to minimize the duration of a loss of Class III power.

Each breaker is provided with a popup menu to allow the selection of CLOSE, TRIP or RESET positions, subject to appropriate interlocks and permissives.


Electrical GRP1 Class III
Reactor Trip
Turbine Trip
ROH Pres Lo Lo
Step Back Req'd
Setback Req'd
Turbine Runback
Gen Breaker Opn
Hi Neutron Pwr
ROH Press Hi Hi
Coolant Flow Lo
Stm Gen Level Lo
PRZR Lvl Hi
Low Fwd Pwr Trip
Main BFP(s) Trip
Hi Neut Pwr LogR
ROH Press Hi
Main Stm Pres Hi
Stm Gen Level Hi
PRZR Lvl Lo
Loss LPHT Pump
Malfunction Active
GENERATOR
SYNC BKR CLOSED
OUTPUT(MW) 924
GRID
5134-T01/2/3 (MOT)
345KV switchyard breakers
Unit Net Output(MW 883
GRID
5144-T05 (UST)
5144-T04 (SST)
5314-T03
5314-T05
5314-T04
5314-T06
5210-SG01
5210-SG02
SP(%) 0
LD(MW) 0.0
A
5323 BUE 4.16KV CLASS III
5323 BUF 4.16KV CLASS III
To GRP2 CLASS III
5323-T01
5323-T03
5323-T02
5323-T04
5333 BUE1 480V CLASS III
5333 BUE2 480V CLASS III
5333 BUF2 480V CLASS III
5333 BUF1 480V CLASS III
BUS# CURRENT(A) VOLTAGE(V)
CLASS IV
BUA 1905.6 13800
BUB 1890.5 13800
BUA1 3918.6 480
BUA2 2805.6 480
BUB1 3564.9 480
BUB2 2649.3 480
BUC 362.9 4160
BUD 362.9 4160
CLASS II
BUZA 391.6 480
BUZB 314.5 480
BUZC 314.5 480
BUYA 628.9 120
BUYB 628.9 120
BUYC 628.9 120
CLASS I
BUXA 534.2 500
BUXB 459.9 500
BUXC 459.9 500
Electrical GRP1 Class III
Reactor Trip
Turbine Trip
Reactor Neutron Pwr (%)
Reactor Thermal Pwr(%)
Generator Output(%)
Main Stm Hdr Pressure (kPa)
SG1 Lvl (m)
SG2 Lvl (m)
SG3 Lvl (m)
SG4 Lvl (m)
OUC Mode
Normal
Freeze
Run
Iterate
IC
Malf
Help