

## 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.

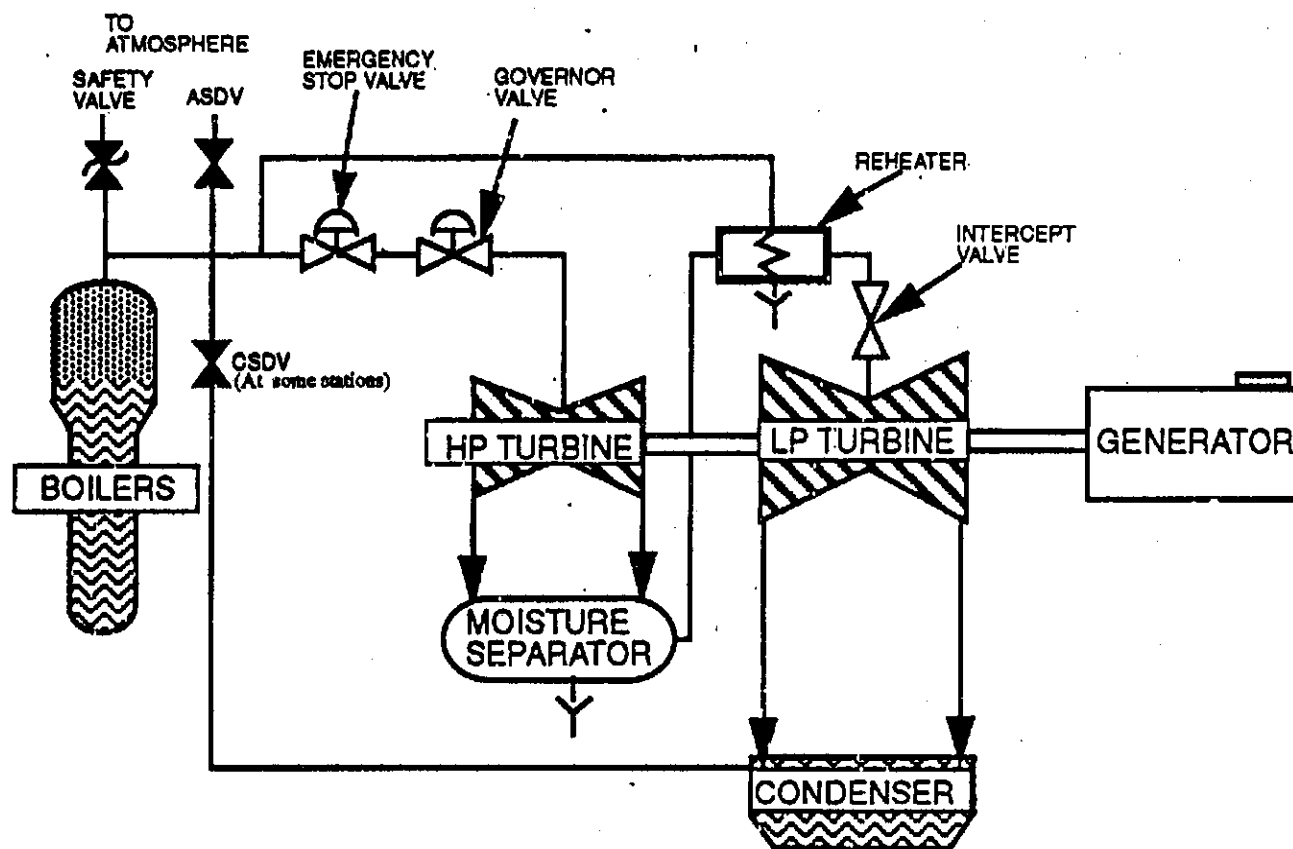
- The pressure from the boilers drives the steam to the high pressure (HP) turbine through the following valves:

⇒ 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.

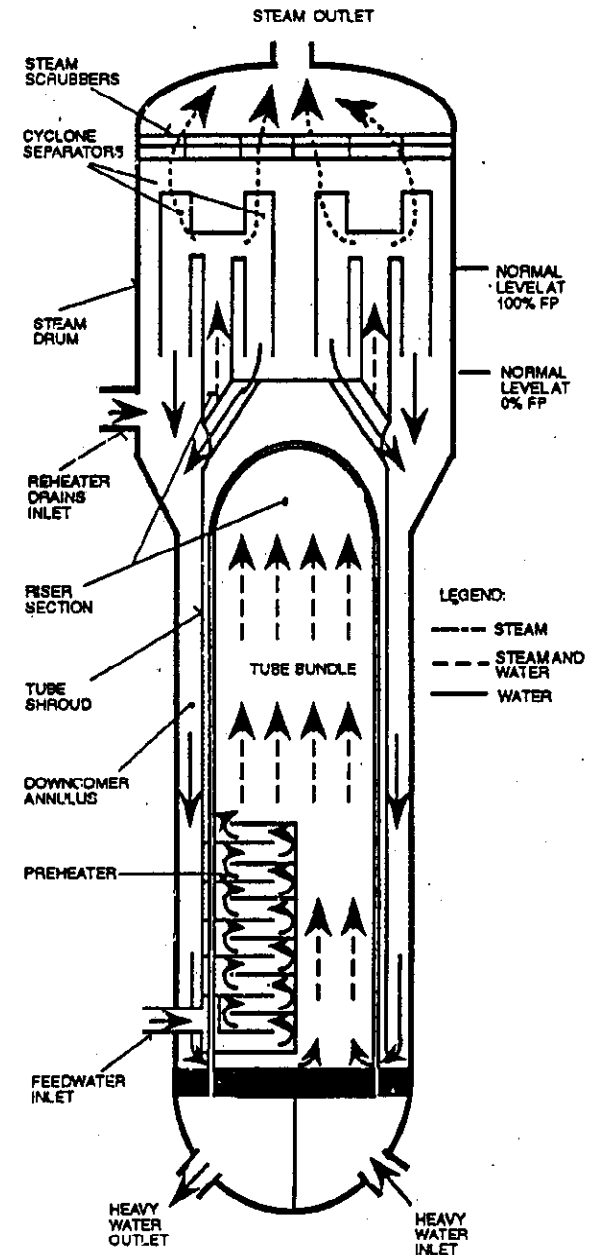
### **EXTRACTION STEAM**

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.

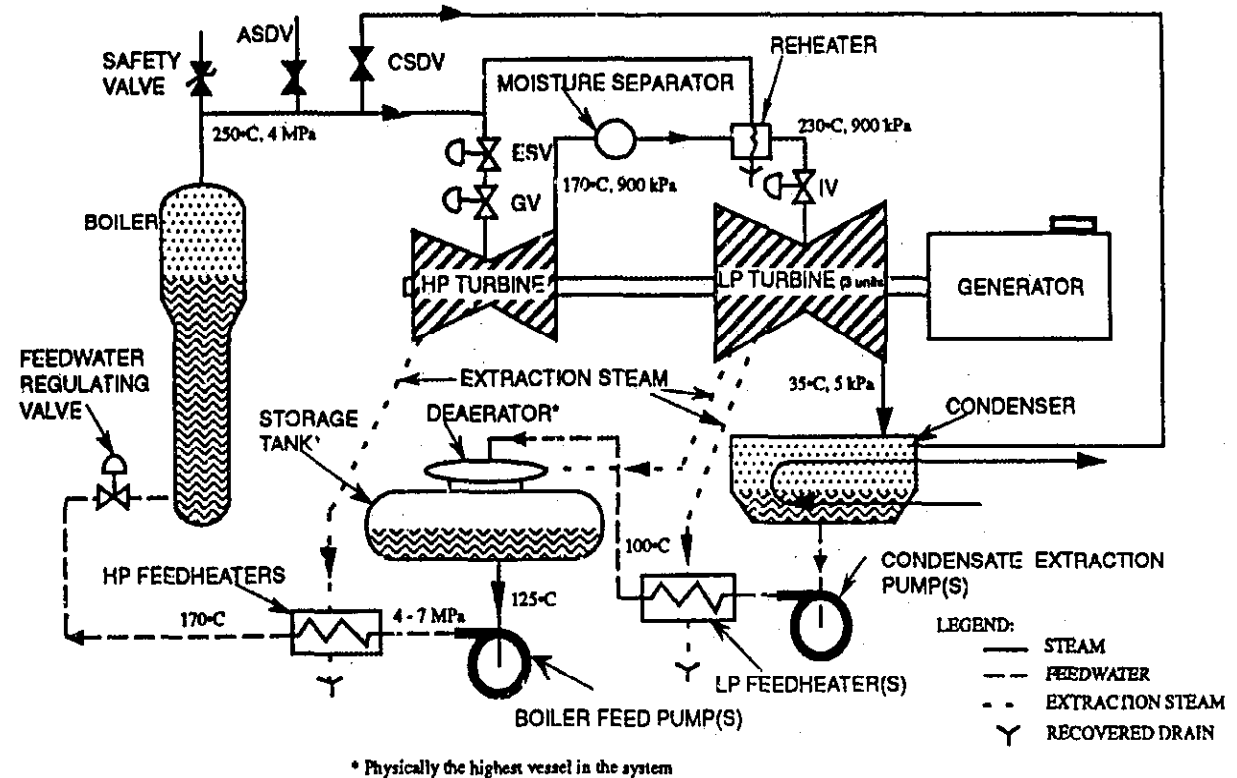


## FEEDWATER SYSTEM

- 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.

## 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:

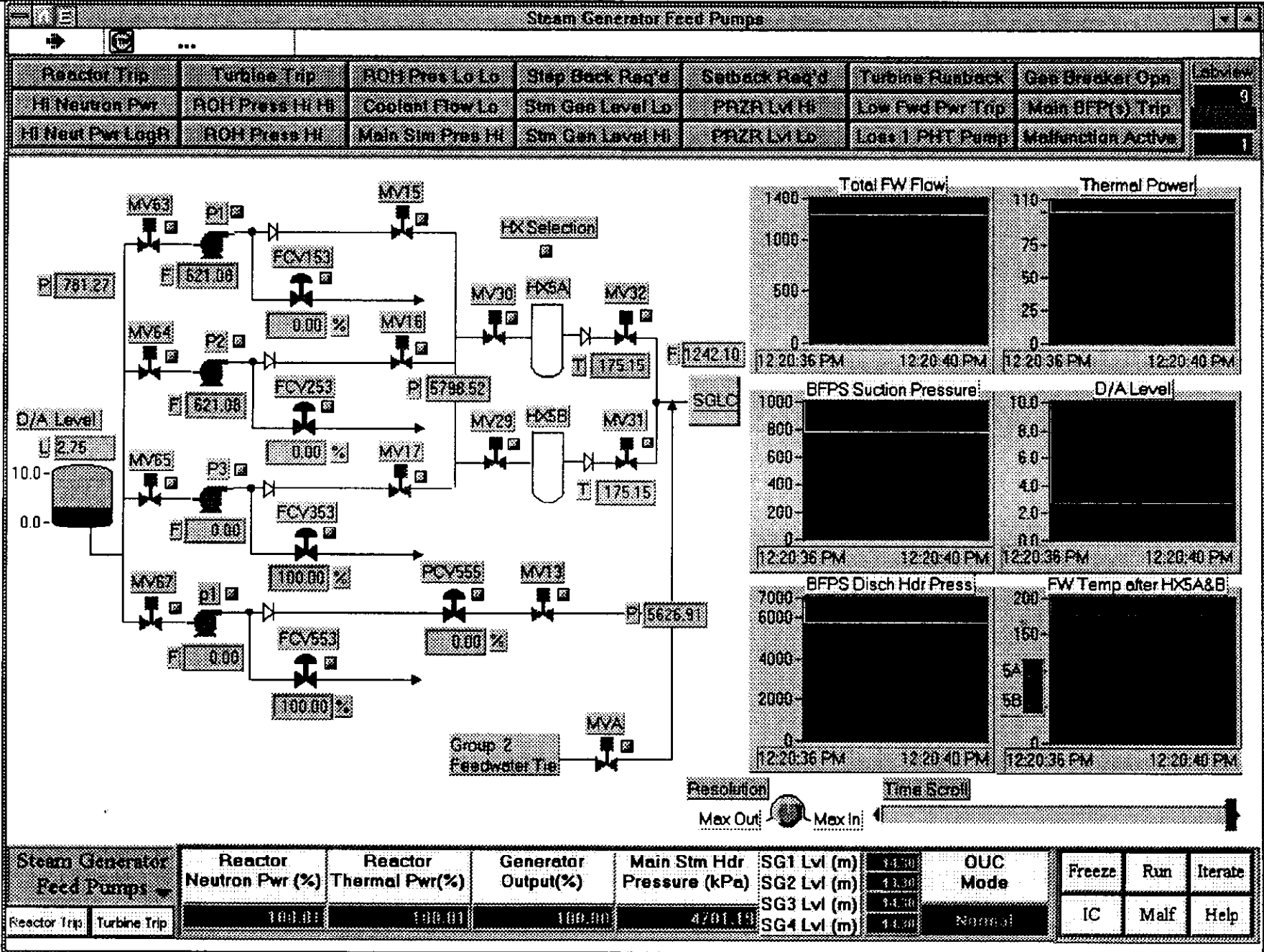
At the end of this module, you will be able to:

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 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 Prog'd	Setback Prog'd	Turbine Runback	Gas Breaker Ops
HI Neutron Pwr	ROH Press HI HI	Carbon Flow Lo	Stm Gen Level Lo	PRZR Lvl HI	Low Fed Pwr Trip	Meht 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

MAIN STEAM SUPPLY

F 326.69

L 14.30

F 310.26

SG4

RHRT 17.0

F 16.55

F 310.32

SG2

RHRT 17.0

F 16.54

F 310.37

SG3

RHRT 17.0

F 16.07

F 310.77

SG1

RHRT 17.0

F 14.31

F 326.76

SG4 SGLD

12.42.11

SG2 SGLD

12.42.11

SG3 SGLD

12.42.11

SG1 SGLD

12.42.11

Total Steam Flow

1305.6

Total FW Flow

1242.1

SG4 Drum Level & SP

LVL 17.0

SP 15.0

SG2 Drum Level & SP

LVL 17.0

SP 15.0

SG3 Drum Level & SP

LVL 17.0

SP 15.0

SG1 Drum Level & SP

LVL 17.0

SP 15.0

Total FW/STM Flow

500

FW Flow to SG1-SG4

500

Resolution

Max Out

Max In

Time Scroll

SG1 SG SP SELECT

Steam Generator Level Ctrl	Reactor Neutron Pwr (%)	100.01	Reactor Thermal Pwr (%)	100.01	Generator Output (%)	100.00	Main Stm Hdr Pressure (kPa)	4701.13	SG1 Lvl (m)	17.00	SG2 Lvl (m)	17.00	SG3 Lvl (m)	17.00	SG4 Lvl (m)	17.00	OUC Mode	Normal	Freeze	IC	Run	Malf	Iterate	Help
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## 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

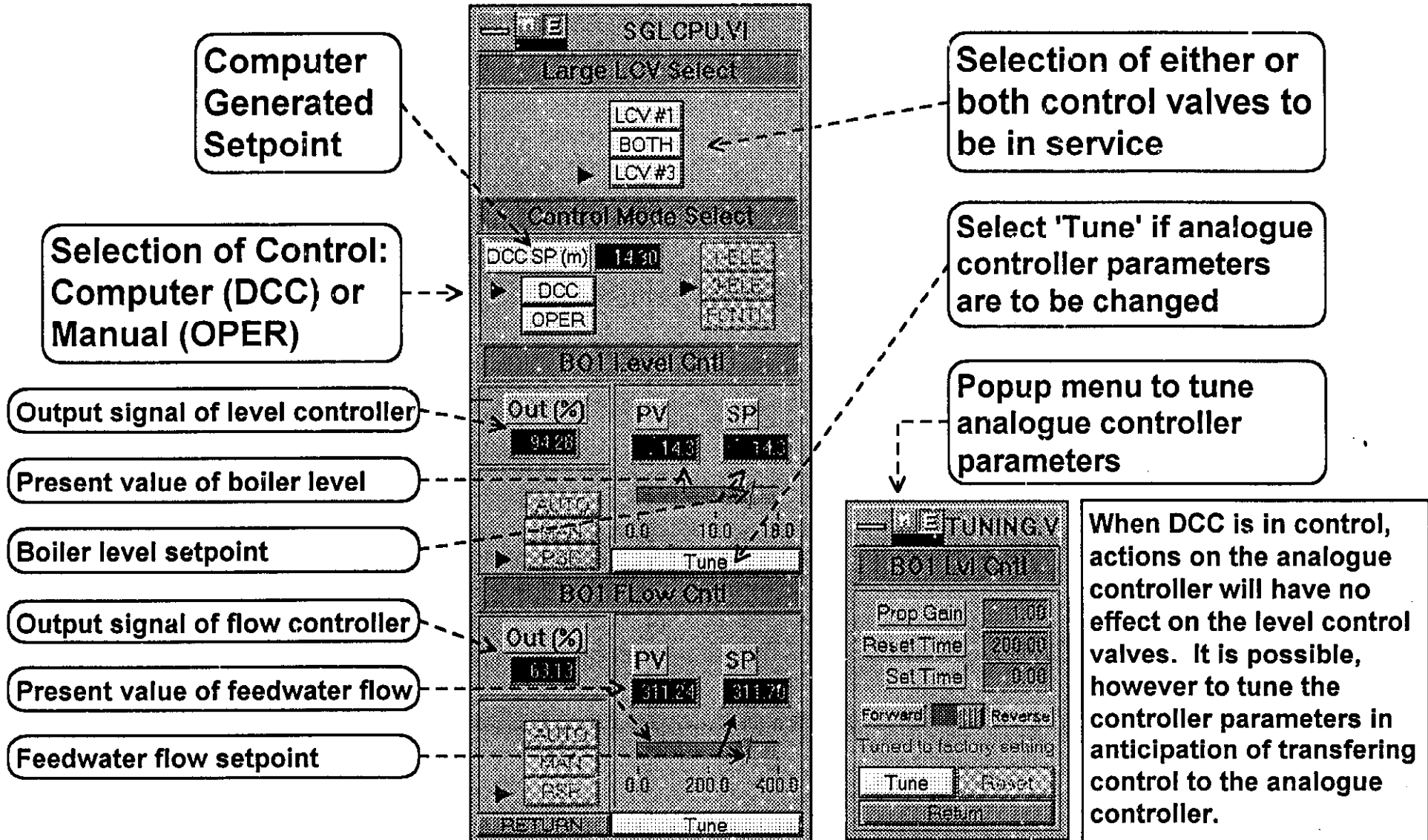
The Output signal of the flow controller determines the opening of the flow control valve

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



## 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	ROH Press Lo Lp	Stop Back Req'd	Setback Req'd	Turbine Runback	Gas Breaker Opp
HI Neutron Pwr	ROH Press Hi HI	Coolant Flow Lo	Site Gen Level Lo	PRZR LV HI	Low Pwr Pwr Trip	Main OPP(g) Trip
HI Neut Pwr LogR	ROH Press Hi	Main Sim Press Hi	Sim Gen Level Hi	PRZR LV Lo	Loss 1 PWT Pump	Malfunction Active

**SG1 LEVEL (M)**

**SG2 LEVEL (M)**

**SG3 LEVEL (M)**

**SG4 LEVEL (M)**

Reactor Max Out: **100.01**    Reactor Thermal Pwr (%): **100.01**    Generator Output (%): **100.00**    Main Sim Hdr Pressure (kPa): **4701.10**

Reactor Neutron Pwr (%): **100.01**    Reactor Thermal Pwr (%): **100.01**    Generator Output (%): **100.00**    Main Sim Hdr Pressure (kPa): **4701.10**

SG1 Lvl (m): **14.30**    SG2 Lvl (m): **14.30**    SG3 Lvl (m): **14.30**    SG4 Lvl (m): **14.30**

LOAD (%): **100.00**    LEVEL (M): **14.30**    OUC Mode: **Normal**

HA: 14.46    CP: 14.30    VT: 13.68    LA: 13.43    SB: 13.35

Reactor Trip    Turbine Trip

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 Top	Turbine Trip	ROH Pres Lo Lo	Stop Back Pkg'd	Setback Read	Turbine Runback	Gen Breaker Opp	13
HI Neutron Pwr	ROH Press HI HI	Coilium Flow Lb	Sim Gen Level Lo	PRZR Lvl Hi	Low Fwd Pwr Trip	Main BFP(s) Trip	
HI Neutr Pwr LogR	ROH Press HI	Main Sim Pres Hi	Sim Gen Level Hi	PRZR Lvl Lo	Loss 1 PHT Pump	Malfunction Active	1

LCV 103 VALVE (%)	DCC	POS	52.00	MAN O/P	
LCV 101 VALVE (%)	DCC	POS	0.00	MAN O/P	
LCV 102 VALVE (%)	DCC	POS	0.00	CONTROLLER	
LCV 303 VALVE (%)	DCC	POS	52.75	MAN O/P	
LCV 301 VALVE (%)	DCC	POS	0.00	MAN O/P	
LCV 302 VALVE (%)	DCC	POS	0.00	CONTROLLER	
LCV 203 VALVE (%)	DCC	POS	52.71	MAN O/P	
LCV 201 VALVE (%)	DCC	POS	0.00	MAN O/P	
LCV 202 VALVE (%)	DCC	POS	0.00	CONTROLLER	
LCV 403 VALVE (%)	DCC	POS	52.05	MAN O/P	
LCV 401 VALVE (%)	DCC	POS	0.00	MAN O/P	
LCV 402 VALVE (%)	DCC	POS	0.00	CONTROLLER	

Reactor Neutron Pwr (%)	100.01	Reactor Thermal Pwr (%)	100.00	Generator Output (%)	100.00	Main Sim Hdr Pressure (kPa)	4701.13	SG1 Lvl (m)	14.50	OUC Mode	Normal	Freeze	Run	Iterate
Reactor Trip		Turbine Trip						SG2 Lvl (m)	14.30			IC	MalF	Help
								SG3 Lvl (m)	14.30					
								SG4 Lvl (m)	14.30					

## 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

Reactor Trip	Turbine Trip	ROH Pres Lo Lo	Step Back Req'd	Satback Req'd	Turbine Run/Brk	Gen Breaker Oper
Hi Neutron Pwr	ROH Press HI HI	Condens Flow Lb	Sim Gen Level Lo	PS2A LV HI	Low Pwr Per Trip	Main BFP(S) Trip
Hi Neutron Loggr	ROH Press HI	Main Ste Pres HI	Sim Gen Level Hi	PS2A LV Lo	Loss 1 PHT Pump	Maintenance/Active

RCIR Neut/Thrm Pwr	D/A sim flows
105.0	100.0
80.0	80.0
60.0	60.0
40.0	40.0
20.0	20.0
0.0	0.0
04:05:38 PM	04:05:38 PM

D/A Pressure & SP	Main Sim Hdr Pressure
800.0	5000
400.0	4000
200.0	3000
0.0	2000
0.0	1000
0.0	0
04:05:38 PM	04:05:38 PM

HX5A Ext Sim Flows	Turbine Power
35.0	185
30.0	80
20.0	60
10.0	40
0.0	20
0.0	0
04:05:38 PM	04:05:38 PM

Reactor Neutron Pwr	100.01
Generator Output (%)	100.01
Reactor Thermal Pwr (%)	100.01
Main Sim Hdr Pressure (kPa)	4701.00

SG1 LVl (m)	11.30
SG2 LVl (m)	11.50
SG3 LVl (m)	11.30
SG4 LVl (m)	11.30

Extraction Steam	Turbine Trip
100.01	100.01

OUC Mode	Iterate
Normal	Run
	Freeze
	IC
	Malf
	Help

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## **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 Press Lo Lo	Stop Back Pump	Satback Reg B	Turbine Runback	Gen Breaker Opn	12
Hi Neutron Pwr	ROH Press Ht Ht	Coolant Flow Lo	Stn Gen Level Lo	PRZR Lvl HI	Low Fwd Pwr Trip	Main BEP(S) Trip	
Hi Neut Pwr LogR	ROH Press Ht	Main Sim Pres Ht	Stn Gen Level Ht	PRZR Lvl Lo	Loss 1 Pwr Pump	Malfunction Activa	1

**GENERATOR**  
 SYNC BKR  CLOSED  
 OUTPUT(MW) 924

5134-T01/2/3 (MOT)  
 5144-T05 (UST)  
 345KV switchyard breakers  
 Unit Net Output (MW) 933  
 ORID

5314 BUA 4.16KV CLASS IV  
 5314 BUB 13.8KV CLASS IV  
 5314 BUJ 4.80V CLASS IV  
 5334 BUA1 480V CLASS IV  
 5334 BUA2 480V CLASS IV  
 5334 BUJ1 480V CLASS IV  
 5334 BUB2 480V CLASS IV  
 5324 BUC 4.16KV CLASS IV  
 5324 BUD 4.16KV CLASS IV

5144-T01  
 5144-T02  
 5144-T03  
 5144-T04 (SST)  
 5144-T05  
 5314-T07  
 5314-T08  
 5314-T09  
 5314-T10  
 5324 BUC 4.16KV CLASS IV  
 5324 BUD 4.16KV CLASS IV

BUS#	CURRENT(A)	VOLTAGE(V)
CLASS III		
BUE	1699.6	4160
BUF	1149.6	4160
BUE1	3269.3	480
BUE2	1765.3	480
BUF1	1919.4	480
BUF2	1538.6	480
CLASS III		
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	537.7	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) 3701.19  
 SG1 Lvl (m) 3460  
 SG2 Lvl (m) 3430  
 SG3 Lvl (m) 3420  
 SG4 Lvl (m) 3430  
 OUC Mode Manual  
 Freeze Run Malfunction Help  
 IC Malfunction 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.**



