Learning Objectives

1. Identify the purposes of the Main Steam System.

Objectives

2. Recognize the purpose, function and operation of the following major components:
   a. Safety/Relief /Auto Depressurization Valves
   b. Reactor Head Vent Valves
   c. Main Steam Line Flow Restrictors
   d. Main Steam Line Isolation Valves
   e. Equalizing Header
   f. Turbine Bypass Valves
   g. Turbine Stop Valves
   h. Turbine Control Valves
   i. Main Turbine
   j. Combined Intermediate Valves
   k. Extraction Steam System
   l. Moisture Separator Reheaters
   m. Steam Seal System

Learning Objectives

3. Describe the following flowpaths for the Main Steam system:
    a. Safety/Relief /Auto Depressurization Valves
    b. Main Steam Line Flow Restrictors
    c. Main Steam Line Isolation Valves
    d. Turbine Bypass Valves
    e. Main Turbine
    f. Moisture Separator Reheaters
    g. Steam Seal System

4. List the Main Steam System setpoints for;
    a. MSIV Closure
    b. SRV lifting
    c. RPS Bypass of Main Turbine Scrams

Learning Objectives

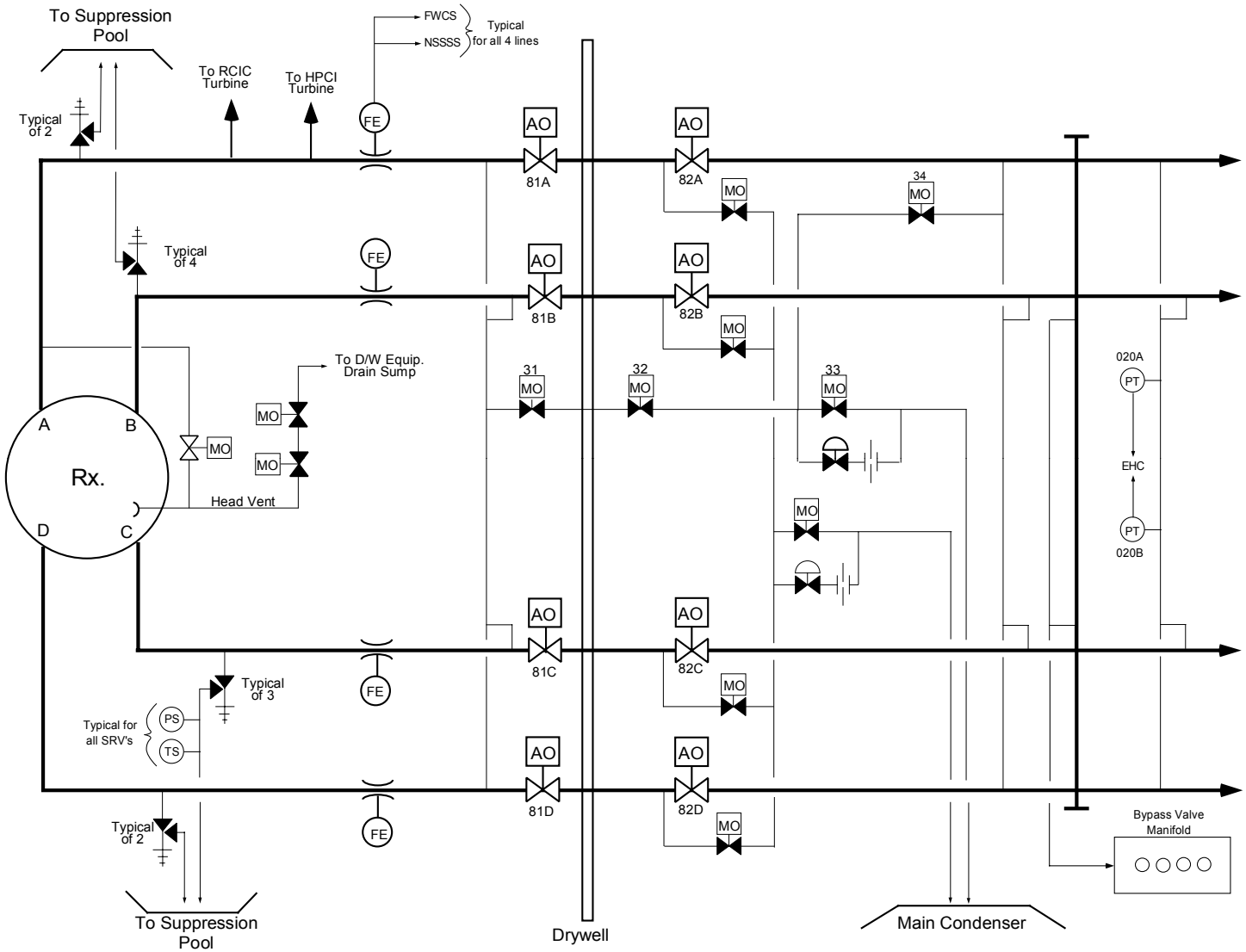
5. Recognize how the Main Steam system interfaces with the following systems or components :
   a. Reactor Vessel System (Section 2.1)
   b. Recirculation Flow Control system (Section 7.2)
   c. Reactor Protection System (Section 7.3)
   d. Condensate and Feedwater System (Section 2.6)
   e. Reactor Core Isolation Cooling System (Section 2.7)
   f. High Pressure Coolant Injection System (Section 10.1)
   g. Electro-Hydraulic Control System (Section 3.2)
   h. Offgas System (Section 8.1)
   i. Automatic Depressurization System (Section 10.2)
   j. Feedwater Control System (Section 3.3)
   k. Nuclear Steam Supply Shutoff System (Section 4.4)
   l. Residual Heat Removal System (10.4)

Objectives

6. Identify the different modes of safety/relief valve operation.

System Purposes

- To direct steam from the reactor vessel to the main turbine and other steam loads.
- To provide over pressure protection for the reactor vessel and reactor coolant system
- To direct steam to safety systems


To Suppression Pool
To RCIC Turbine
To HPCI Turbine
FWCS
NSSSS
Typical for all 4 lines
Typical of 2
FE
AO
81A
82A
MO
34
Typical of 4
81B
82B
To D/W Equip. Drain Sump
31
32
33
020A
PT
EHC
020B
A
B
Rx.
D
C
Head Vent
81C
82C
Typical of 3
Typical for all SRV's
PS
TS
81D
82D
Bypass Valve Manifold
To Suppression Pool
Drywell
Main Condenser

System Components

Safety/Relief Valves

- The safety/relief valves (SRV's) prevent over pressurization of the reactor vessel
- Provide a reactor coolant system barrier from any abnormal operational transient.

Main Steam Line Flow Restrictors

- To limit steam line flow in a severed line to approximately 200% of rated flow for that steam line and to provide steam line flow indications to the NSSSS and FW systems.

System Components

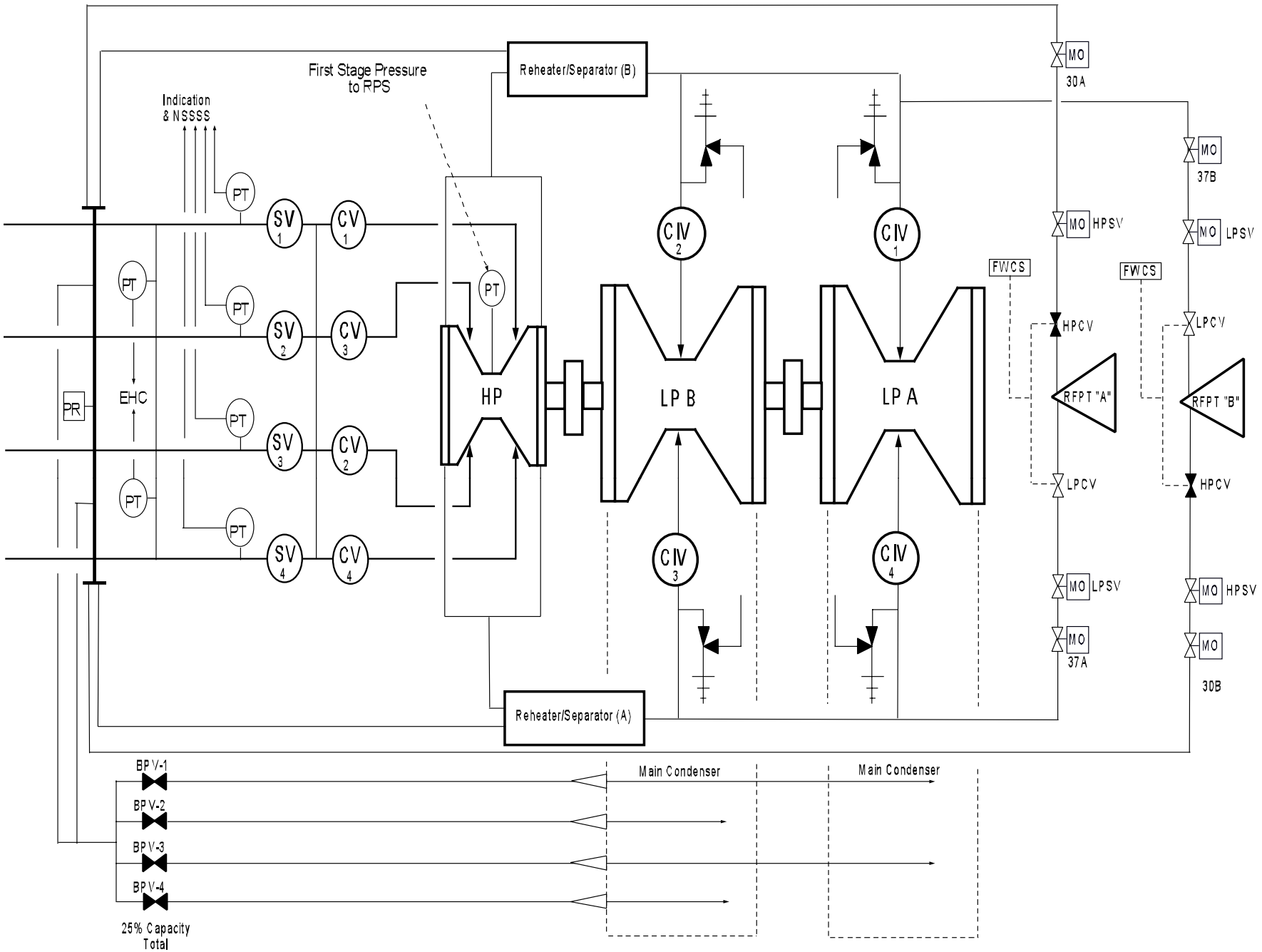
Main Steam Isolation valves

- The MSIVs in conjunction with the steam line flow restrictors, limit the

  release of radioactive materials to the environment and vessel inventory loss.

Reactor Head Vents

- Prevent the build up of non-condensable gasses in the upper head region


First Stage Pressure
to RPS
Indication
& NSSSS
Reheater/Separator (B)
Reheater/Separator (A)
PT
SV 1
SV 2
SV 3
SV 4
CV 1
CV 3
CV 2
CV 4
PR
EHC
HP
LP B
LP A
CIV 2
CIV 1
CIV 3
CIV 4
MO 30A
MO 37B
MO HPSV
MO LPSV
FWCS
HPCV
LPCV
RFPT "A"
RFPT "B"
MO LPSV
MO 37A
MO HPSV
MO 30B
BPV-1
BPV-2
BPV-3
BPV-4
25% Capacity
Total
Main Condenser
Main Condenser

System Components

Equalizing Header

- The pressure equalizing header provides a common steam line point to route steam to various plant components.

Turbine Bypass valves

- The turbine bypass valves work with the turbine control valves to ensure a constant reactor pressure for a given reactor power level.

System Components

Turbine Stop valves

- The turbine stop valves a rapid closure capability, 0.1 seconds, upon detection of potentially unsafe turbine conditions.

Turbine Control valves

- The turbine control valves regulate the steam flow to the turbine
  - This will control reactor pressure during normal operation.
- The control valves also provide the throttle mechanism for rolling, synchronizing, and loading the turbine generator.

System Components

Main Turbine

- The main turbine converts the heat energy of the steam to rotational mechanical energy of the main generator.

Moisture Separator Reheaters

- The MSR's perform the following functions:
  - remove moisture from the HP turbine exhaust
  - add heat to steam exhausted from the HP turbine

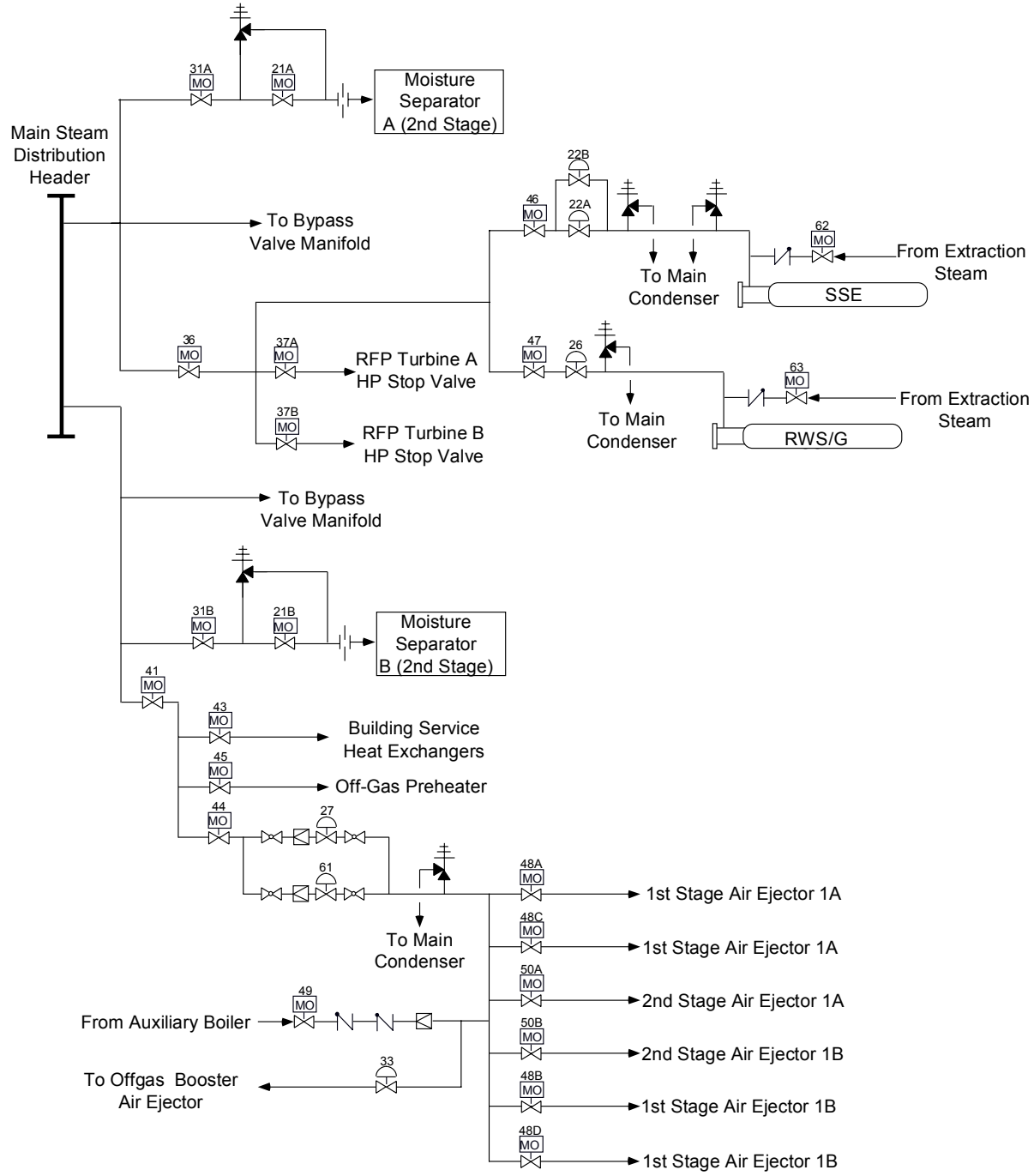
System Components

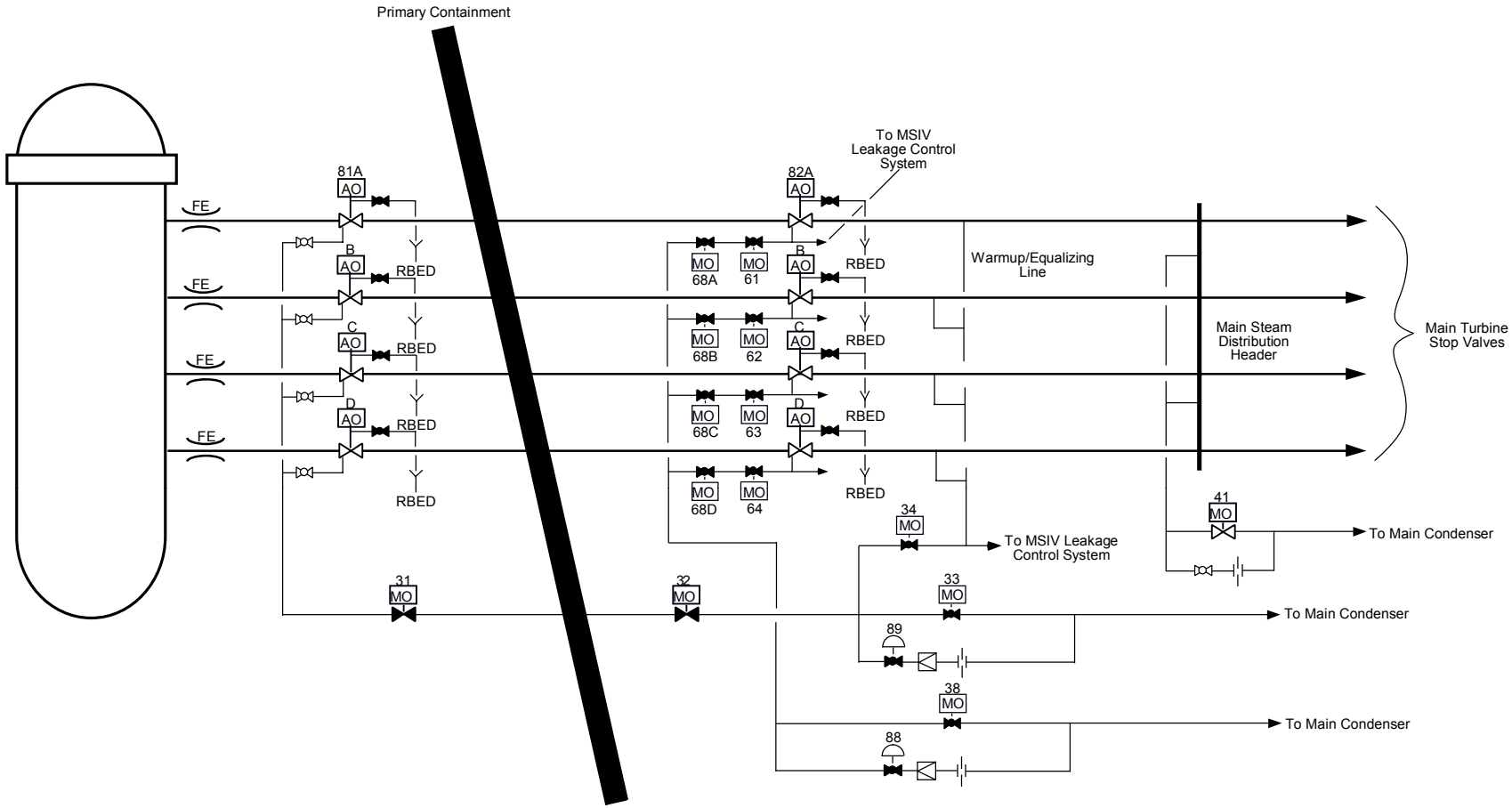
Combined Intermediate valves

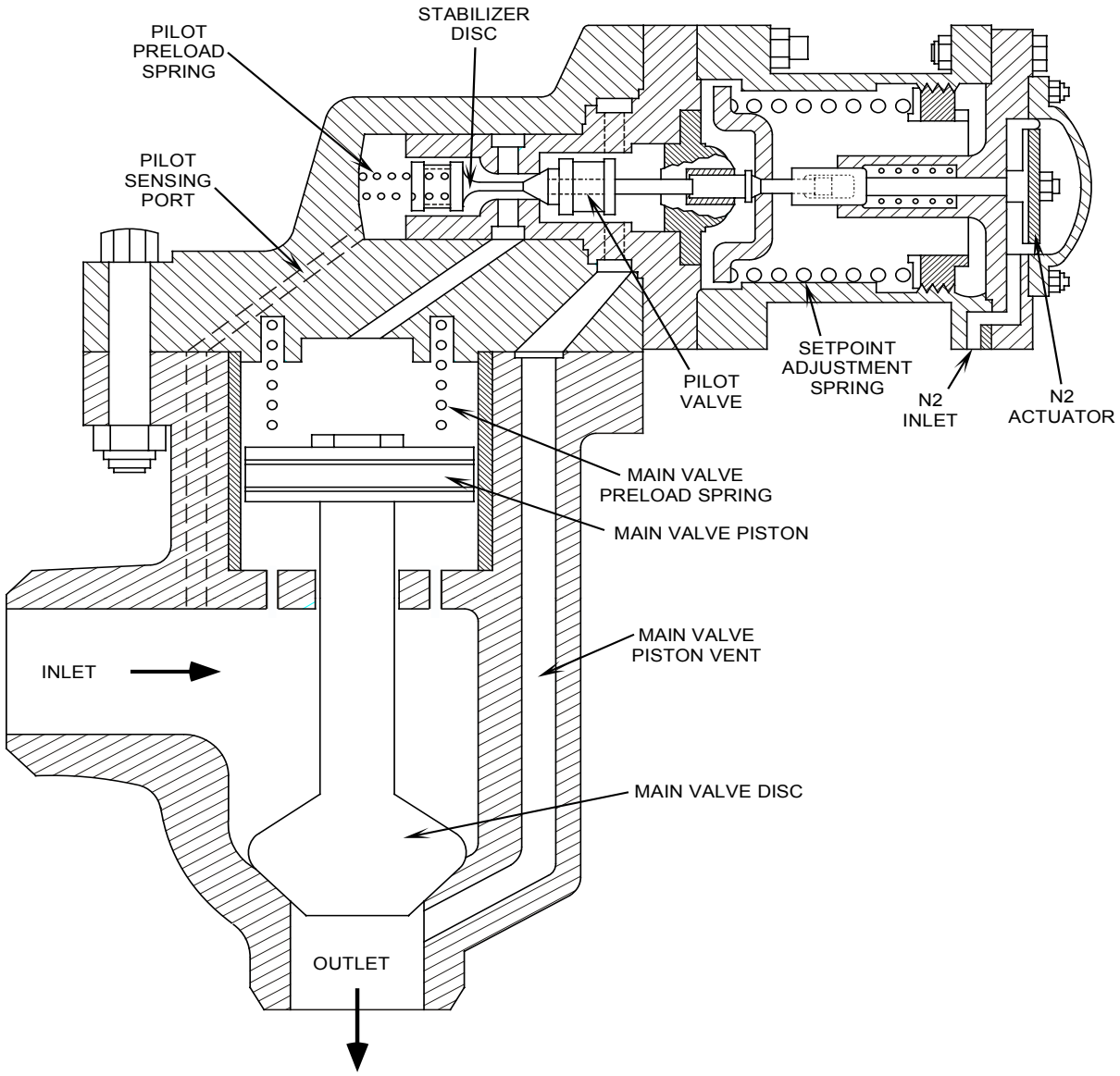
- The CIV's close on a turbine trip to prevent a turbine overspeed from the large steam and water inventory in the piping between the HP/ LP turbines and the MSRs.
- The intercept portion of the CIV's also throttle steam flow to the LP turbines during overspeed conditions.

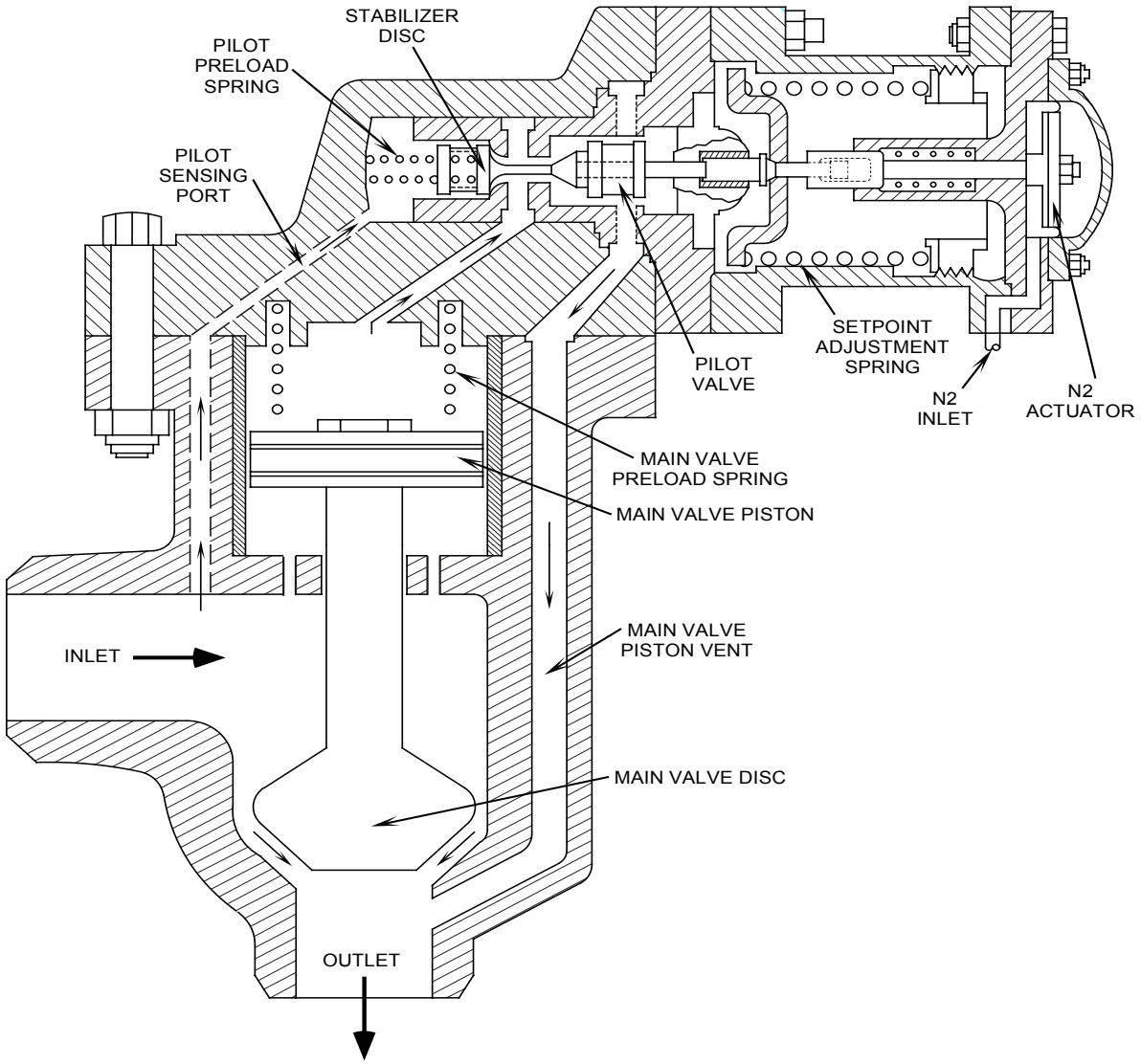
Extraction Steam System

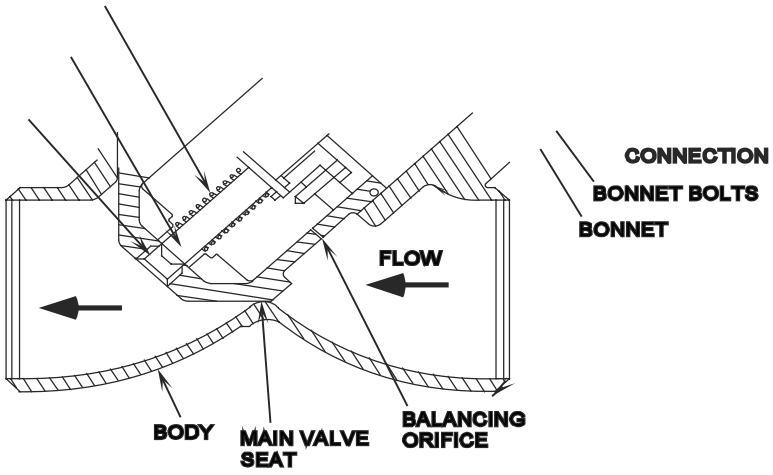
- Extraction steam is removed from various turbine stages to:
  - remove excess moisture
  - improve the overall cycle efficiency via feedwater heating.


Main Steam Distribution Header
31A MO
21A MO
Moisture Separator A (2nd Stage)
To Bypass Valve Manifold
22B
46 MO
22A
62 MO
From Extraction Steam
To Main Condenser
SSE
36 MO
37A MO
RFP Turbine A HP Stop Valve
47 MO
26
63 MO
From Extraction Steam
37B MO
RFP Turbine B HP Stop Valve
To Main Condenser
RWS/G
To Bypass Valve Manifold
31B MO
21B MO
Moisture Separator B (2nd Stage)
41 MO
43 MO
Building Service Heat Exchangers
45 MO
Off-Gas Preheater
44 MO
27
61
48A MO
1st Stage Air Ejector 1A
To Main Condenser
48C MO
1st Stage Air Ejector 1A
50A MO
2nd Stage Air Ejector 1A
49 MO
From Auxiliary Boiler
50B MO
2nd Stage Air Ejector 1B
33
To Offgas Booster Air Ejector
48B MO
1st Stage Air Ejector 1B
48D MO
1st Stage Air Ejector 1B


Primary Containment
To MSIV
Leakage Control
System
81A
AO
82A
AO
FE
FE
FE
FE
B
AO
C
AO
D
AO
RBED
RBED
RBED
RBED
MO
68A
MO
61
MO
68B
MO
62
MO
68C
MO
63
MO
68D
MO
64
Warmup/Equalizing
Line
Main Steam
Distribution
Header
Main Turbine
Stop Valves
34
MO
To MSIV Leakage
Control System
41
MO
To Main Condenser
31
MO
32
MO
33
MO
To Main Condenser
89
38
MO
To Main Condenser
88


PILOT
PRELOAD
SPRING
STABILIZER
DISC
PILOT
SENSING
PORT
PILOT
VALVE
SETPOINT
ADJUSTMENT
SPRING
N2
INLET
N2
ACTUATOR
MAIN VALVE
PRELOAD SPRING
MAIN VALVE PISTON
MAIN VALVE
PISTON VENT
INLET
MAIN VALVE DISC
OUTLET


STABILIZER DISC
PILOT PRELOAD SPRING
PILOT SENSING PORT
PILOT VALVE
SETPOINT ADJUSTMENT SPRING
N2 INLET
N2 ACTUATOR
MAIN VALVE PRELOAD SPRING
MAIN VALVE PISTON
INLET
MAIN VALVE PISTON VENT
MAIN VALVE DISC
OUTLET


CONNECTION
BONNET BOLTS
BONNET
FLOW
BODY
MAIN VALVE SEAT
BALANCING ORIFICE

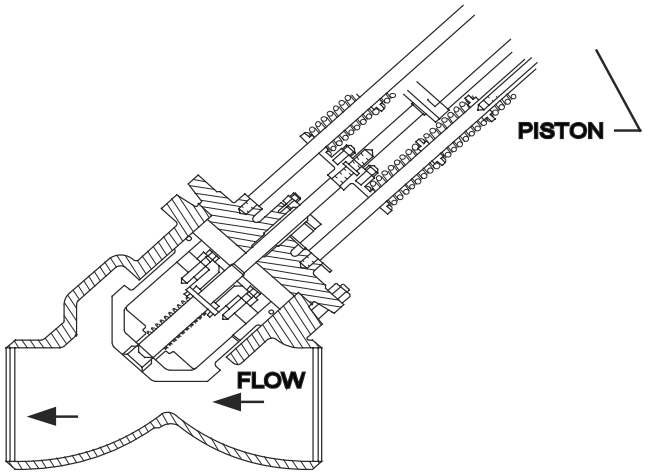
* PNEUMATIC SUPPLY

(1) OUTBOARD MSIV SUPPLY
CONTROL AIR SYSTEM

(2) INBOARD MSIV SUPPLY
NITROGEN

NOTE:

SOLENOID VALVES SHOWN
ENERGIZED, VALVE OPEN



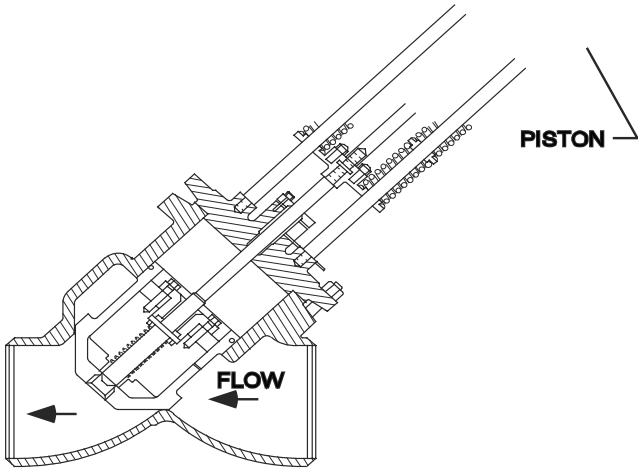
* PNEUMATIC SUPPLY

(1) OUTBOARD MSIV SUPPLY CONTROL AIR SYSTEM

(2) INBOARD MSIV SUPPLY NITROGEN

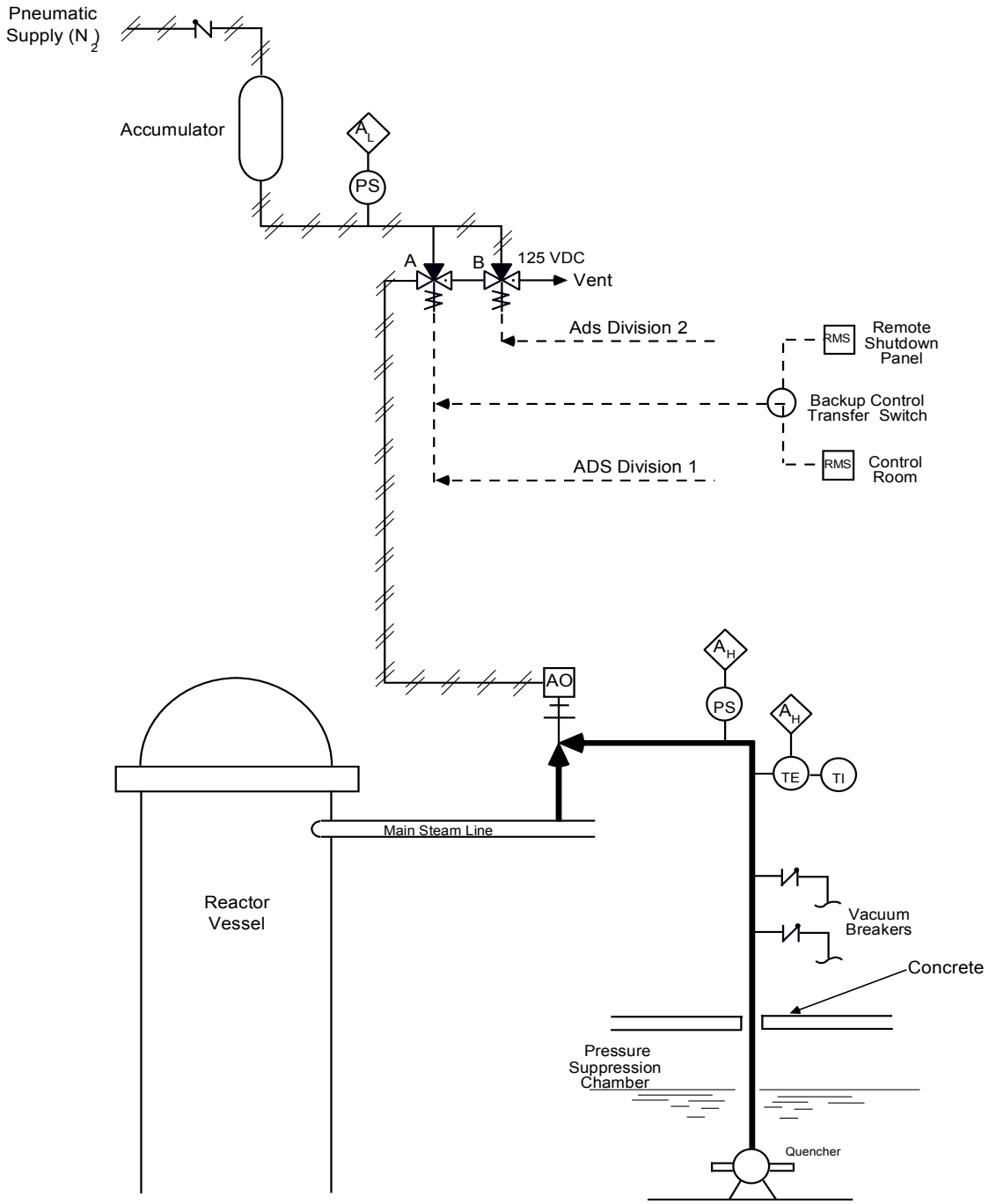
NOTE:

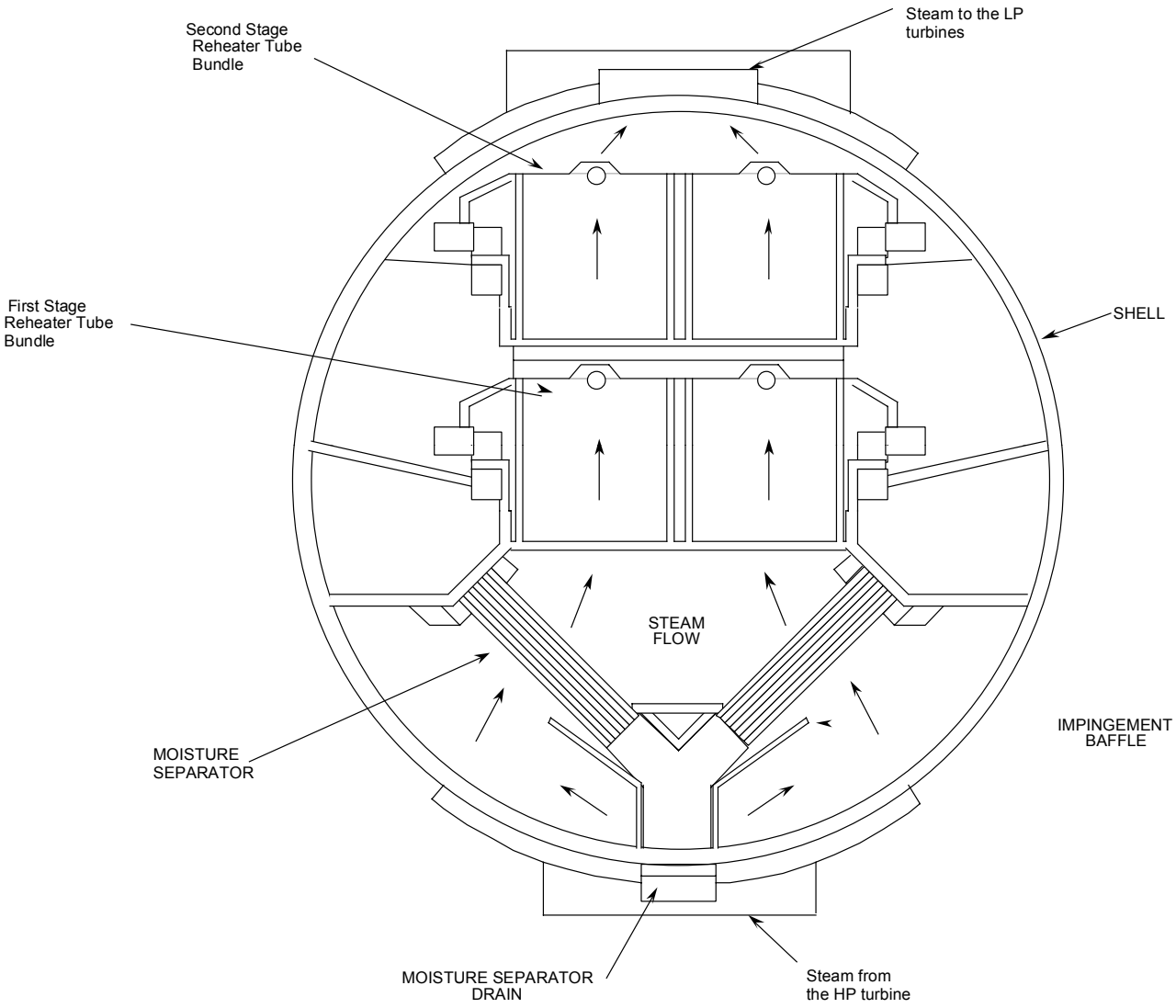
SOLENOID VALVES SHOWN DENERGIZED, VALVE CLOSED.

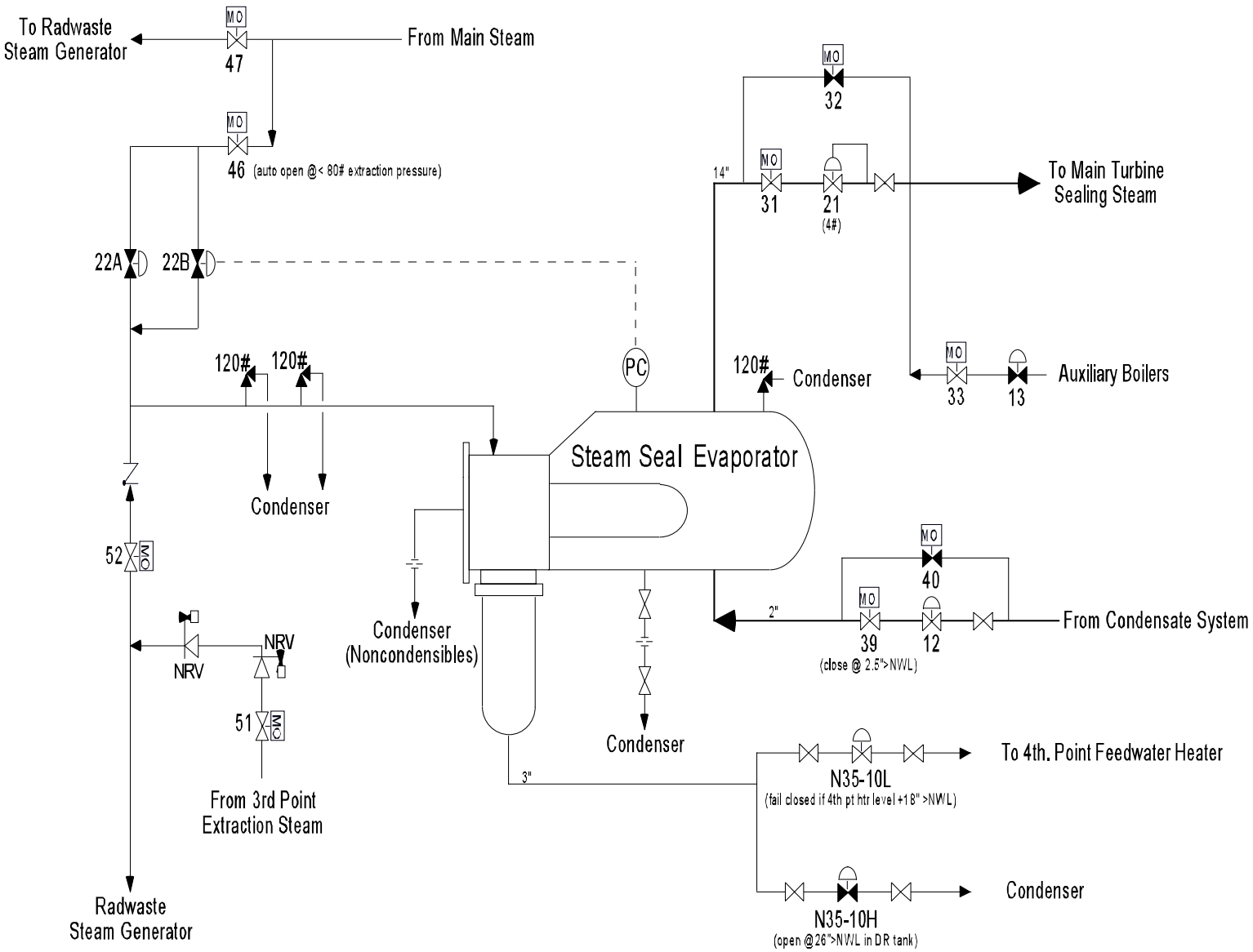


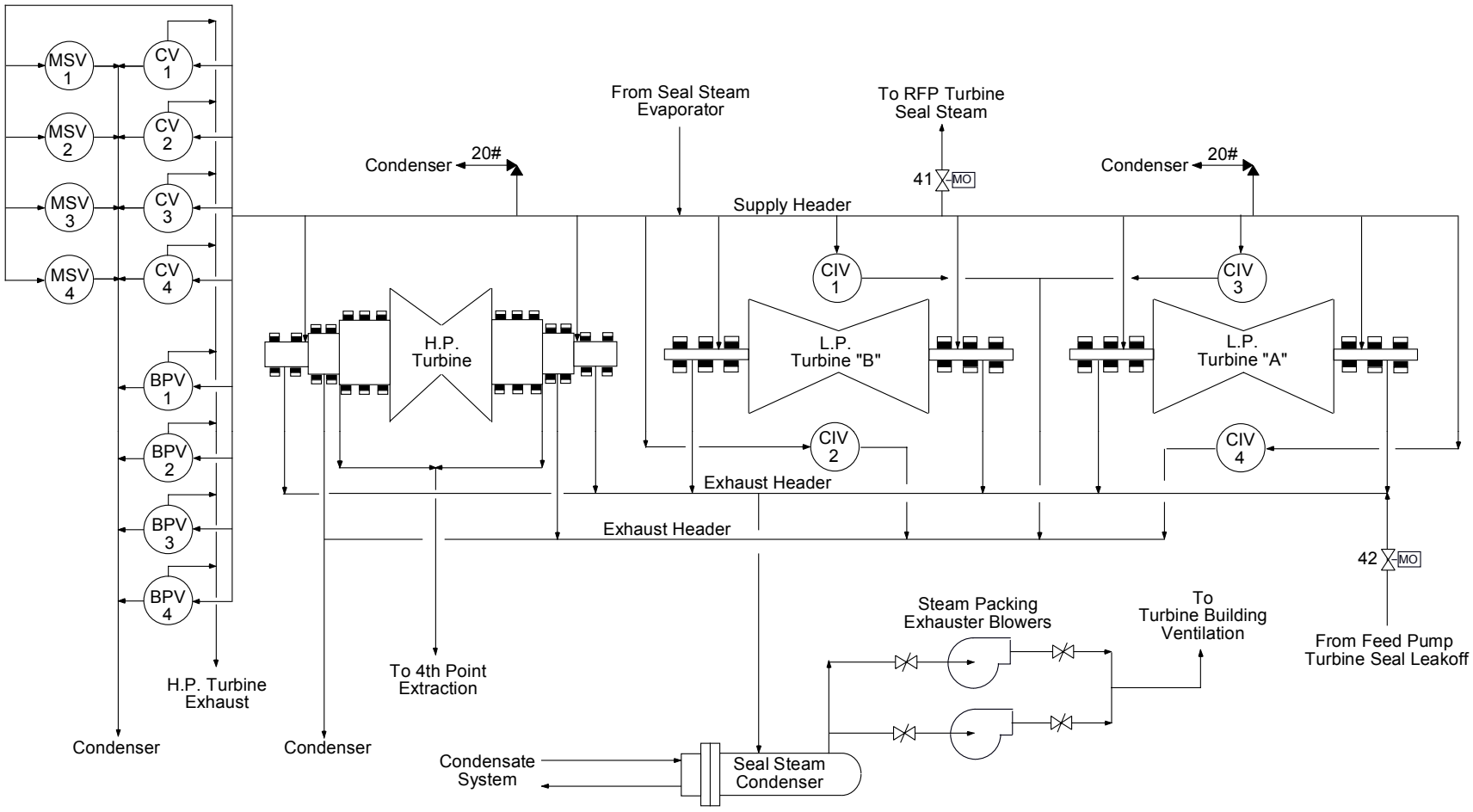
Main Steam Isolation signals

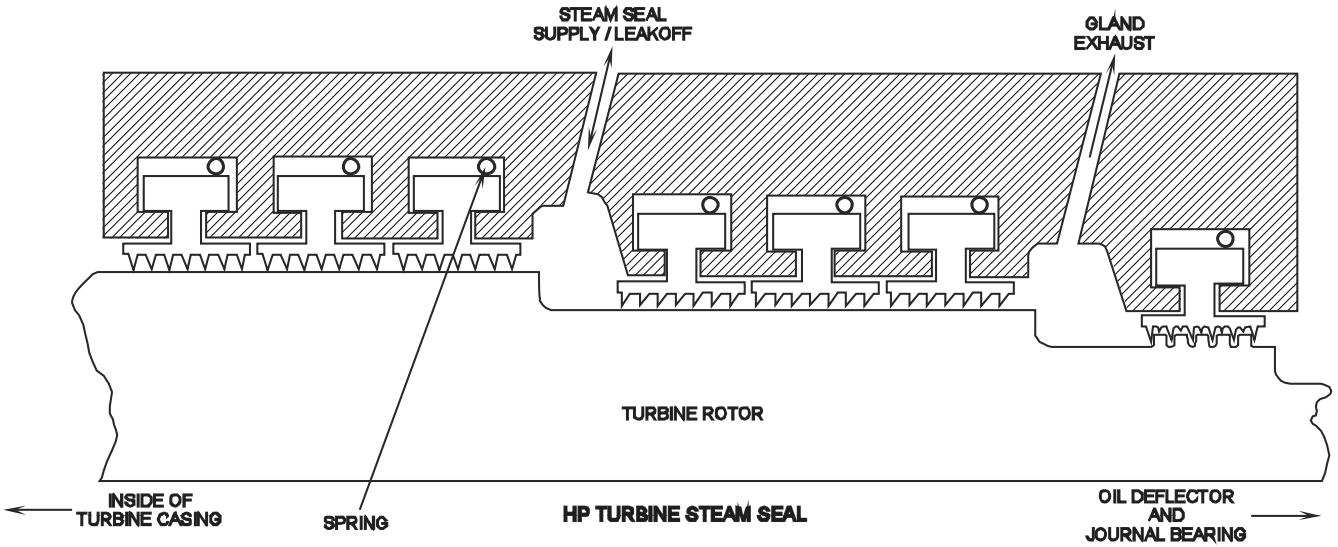
- Reactor vessel low water level (Level 1).
- Main steam line high radiation.
- Main steam line high steam flow.
- Main steam line low pressure (in RUN mode).
- Main steam line area high temperature (Steam Tunnel).
- Main steam line area high temperature (Turbine Building).
- Main condenser low vacuum.
- Main steam tunnel high delta T.

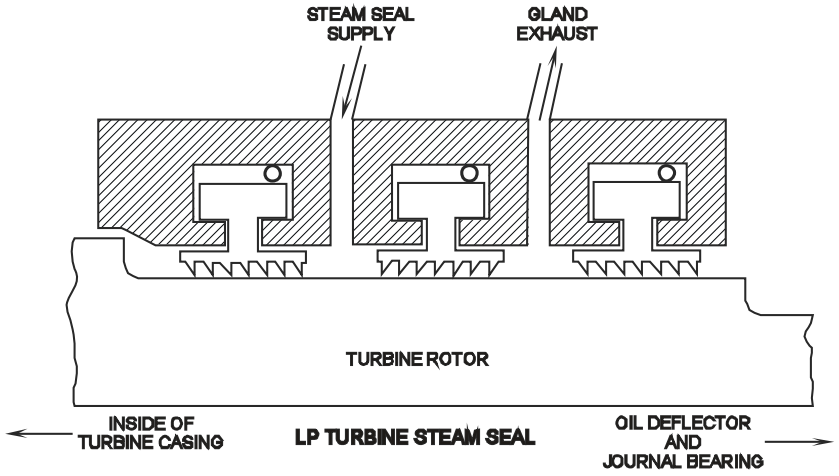

Pneumatic Supply (N_2)
Accumulator
A_L
PS
A
B
125 VDC
Vent
Ads Division 2
RMS
Remote Shutdown Panel
Backup Control Transfer Switch
ADS Division 1
RMS
Control Room
AO
A_H
PS
A_H
TE
TI
Main Steam Line
Reactor Vessel
Vacuum Breakers
Concrete
Pressure Suppression Chamber
Quencher

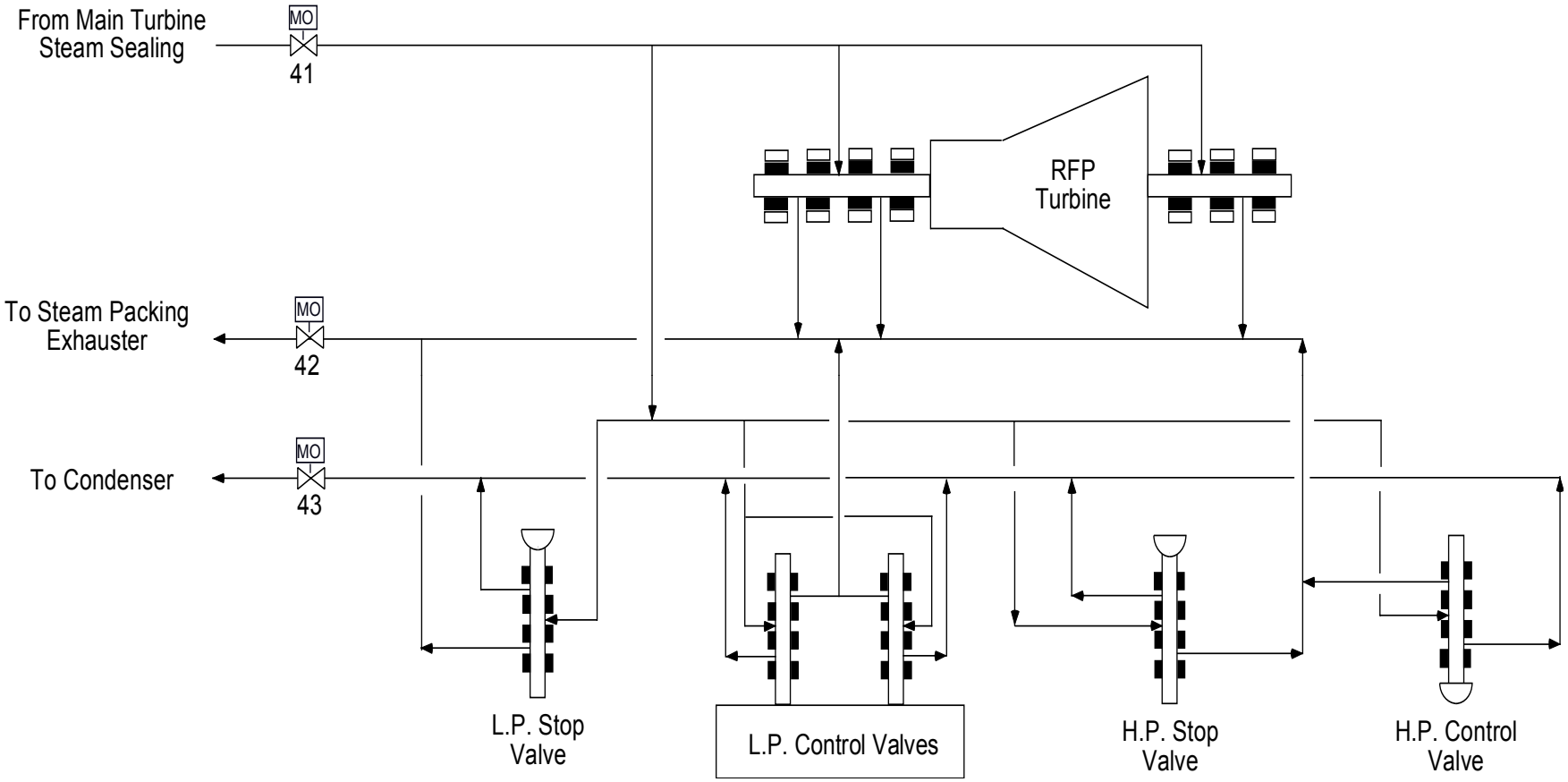

Second Stage
Reheater Tube
Bundle
Steam to the LP
turbines
First Stage
Reheater Tube
Bundle
SHELL
STEAM
FLOW
MOISTURE
SEPARATOR
IMPINGEMENT
BAFFLE
MOISTURE SEPARATOR
DRAIN
Steam from
the HP turbine


To Radwaste
Steam Generator
MO
47
From Main Steam
MO
46
(auto open @< 80# extraction pressure)
22A
22B
120#
120#
Condenser
52
MO
NRV
NRV
51
MO
From 3rd Point
Extraction Steam
Radwaste
Steam Generator
PC
Steam Seal Evaporator
Condenser
(Noncondensibles)
Condenser
3"
MO
32
14"
MO
31
21
(4#)
To Main Turbine
Sealing Steam
120#
Condenser
MO
33
13
Auxiliary Boilers
MO
40
2"
MO
39
12
(close @ 2.5"> NWL)
From Condensate System
N35-10L
(fail closed if 4th pt htr level +18" >NWL)
To 4th. Point Feedwater Heater
N35-10H
(open @26"> NWL in DR tank)
Condenser


MSV 1
MSV 2
MSV 3
MSV 4
CV 1
CV 2
CV 3
CV 4
BPV 1
BPV 2
BPV 3
BPV 4
From Seal Steam Evaporator
To RFP Turbine Seal Steam
Condenser
20#
41
MO
Supply Header
Condenser
20#
CIV 1
CIV 3
H.P. Turbine
L.P. Turbine "B"
L.P. Turbine "A"
CIV 2
CIV 4
Exhaust Header
Exhaust Header
42
MO
Steam Packing Exhauster Blowers
To Turbine Building Ventilation
From Feed Pump Turbine Seal Leakoff
H.P. Turbine Exhaust
To 4th Point Extraction
Condenser
Condenser
Condensate System
Seal Steam Condenser


STEAM SEAL
SUPPLY / LEAKOFF
GLAND
EXHAUST
TURBINE ROTOR
INSIDE OF
TURBINE CASING
SPRING
HP TURBINE STEAM SEAL
OIL DEFLECTOR
AND
JOURNAL BEARING


STEAM SEAL
SUPPLY
GLAND
EXHAUST
TURBINE ROTOR
INSIDE OF
TURBINE CASING
LP TURBINE STEAM SEAL
OIL DEFLECTOR
AND
JOURNAL BEARING


From Main Turbine
Steam Sealing
MO
41
RFP
Turbine
To Steam Packing
Exhauster
MO
42
To Condenser
MO
43
L.P. Stop
Valve
L.P. Control Valves
H.P. Stop
Valve
H.P. Control
Valve

System Interfaces

Reactor Vessel System (Section 2.1)

- The Main Steam System delivers steam from the reactor vessel to the various steam loads
- Vents non-condensable gases from the reactor vessel head area
- Provides over pressure protection for the reactor vessel.

Recirculation Flow Control System (Section 7.2)

- The Main Steam System provides a turbine first stage pressure signal to the arm the EOC - RPT.
  - Armed above 30% main turbine load (as sensed by first stage pressure).

System Interfaces

Reactor Protection System (Section 7.3)

- The Reactor Protection System uses the MSIV closure, TSV closure, and TCV fast closure signals to initiate reactor scrams.
- The Main Steam System provides a turbine first stage pressure signal to the arm the TSV closure and TCV fast closure scrams
- Armed above 30% main turbine load (as sensed by first stage pressure).

System Interfaces

Condensate and Feedwater System (Section 2.6)

- The RFPTs use steam from the outlet of the moisture separator/reheaters and/or steam line equalizing header as an energy source.
- Extraction steam from the various main turbine high pressure and low pressure stages is used to heat the feedwater before it returns to the reactor.

Reactor Core Isolation Cooling System (Section 2.7)

- The Reactor Core Isolation Cooling System uses steam from the 'A' steam line upstream of the MSIVs as the driving force for its turbine.

System Interfaces

High Pressure Coolant Injection System (Section 10.1)

- The High Pressure Coolant Injection System uses steam from the 'A' steam line upstream of the MSIVs as the driving force for its turbine.

Electro Hydraulic Control System (Section 3.2)

- The EHC System controls the operation of the BPVs, TCVs and CIVs to control turbine speed, reactor pressure and turbine generator load.

System Interfaces

Offgas System (Section 8.1)

- Uses main steam to drive the steam jet air ejectors and dilution steam to the off gas process flow
- Provides the components to establish and maintain main condenser vacuum

Automatic Depressurization System (Section 10.2)

- ADS uses seven of the eleven SRVs.

Feedwater Control System (Section 3.3)

- Uses steam flow signals from the steam line flow restrictors as part of the three element level control network and for indication.

System Interfaces

Nuclear Steam Supply Shutoff System (Section 4.4)

- NSSSS isolates the Main Steam System
- NSSSS also uses the steam line flow restrictors to develop the high steam flow signal for MSIV isolation.

OBJECTIVE REVIEW

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OBJECTIVE REVIEW

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   d. Main Steam Line Isolation Valves
   e. Equalizing Header
   f. Turbine Bypass Valves
   g. Turbine Stop Valves
   h. Turbine Control Valves
   i. Main Turbine
   j. Combined Intermediate Valves
   k. Extraction Steam System
   l. Moisture Separator Reheaters
   m. Steam Seal System

OBJECTIVE REVIEW

3. Describe the following flowpaths for the Main Steam system:
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    b. Main Steam Line Flow Restrictors
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    d. Turbine Bypass Valves
    e. Main Turbine
    f. Moisture Separator Reheaters
    g. Steam Seal System

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    b. SRV lifting
    c. RPS Bypass of Main Turbine Scrams

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   h. Offgas System (Section 8.1)
   i. Automatic Depressurization System (Section 10.2)
   j. Feedwater Control System (Section 3.3)
   k. Nuclear Steam Supply Shutoff System (Section 4.4)
   l. Residual Heat Removal System (10.4)