FEEDWATER SYSTEM
TRAINING SYSTEM DESCRIPTION (IRI-07-SD)
IRI POWER PLANT

(Date)

PREFACE

This Training System Description (SD) has been designed to assist you in meeting the requirements of Module IRI-07 of the Power Plant Training Program. It contains information about the IRI Power Plant Feedwater System. This includes system function, flow path, and details about the major system components and operation.

You should review each chapter objective. In doing so you will be better prepared to learn the required information. You should also walk down the system and identify the components and controls. Should you have additional questions about the system, ask your supervisor.

A separate document, Feedwater System Operating Procedure IRI-07-SOP, covers detailed operation of the Feedwater System.

FEEDWATER SYSTEM

TRAINING SYSTEM DESCIRPITON

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1.0 Introduction

Chapter Objectives:

1. Describe the functions of the Feedwater System
2. State, from memory, the functions of the Feedwater System
3. Draw a simplified Feedwater System diagram. Describe the flow path and how the Feedwater System performs its function.
4. List the normal Feedwater System operating parameters of pressure, temperature and flow.

1.1 Function

The function of the Feedwater System is to supply high-pressure water to the boiler during startup, normal, and emergency operations. The System automatically maintains the proper flow to and water level in the boiler drum. The Feedwater System also supplies water for Desuperheater Sprays that control the Superheat steam temperature.

1.2 Basic System Description

(Refer to **Drawings 1** when reading this section)

Feedwater is supplied by the Deaerator, which also provides the necessary Net Positive Suction Head (NPSH) to the Boiler Feed Pumps. The Boiler Feed Pumps (BFP) must supply a constant flow necessary to replace water in the boilers that has been changed to steam. The Boiler Feed Pumps (BFP) must also develop the required pressure to overcome head and drum pressure.

Five (5) Boiler Feed Pumps on Units 1 and 2, three (3) Boiler Feed Pumps on Unit 7 and three (3) Boiler Feed Pumps on Unit 8 supply the Feedwater System High Pressure Heaters and Header. The Feedwater header supplies heated, high-pressure water, through level control valves, to the boiler drums on Units 1, 2, 3, 6, 7, and 8.

The Feedwater Header supplies Desuperheater Sprays to control the steam temperature.

1.2.1 Feedwater System Parameters

Total Boiler steam flow capacity	1,149,000 pounds per hour
Total BFP capacity (minus turbine BFP)	1,471,068 pounds per hour (3,084 gpm)

1.3 System Flow Path

Units 1 and 2 the Feedwater System starts at the bottom of the Deaerator. The feedwater exits the bottom of the Deaerator to the suction of the five (5) Boiler Feed Pumps (BFP). The Deaerators are high enough to supply the Net Positive Suction Head (NPSH) to the Boiler Feed Pumps. Four (4) of the Boiler Feed Pumps, numbered 1, 2, 4, and 5 are motor driven and pump number 3 is a turbine driven pump. The pumps can provide feedwater to any of the High Pressure (HP) Feedwater Heaters, 1, 2, 6, 7 and 8. After the feedwater is heated in the HP heaters it is then sent through drum level control valves on the boilers 1, 2, 3, 6, and 7 from the drum level control valves to the Economizer inlet valves.

Unit 7 is basically the same a Units 1 and 2, with the exception of the Deaerator. The Deaerator on 7 is in two parts one the Deaerator, and two the Deaerator Storage Tank. The Feedwater System starts in the Deaerator Storage Tank; water exits the Deaerator Storage Tank and as with Units 1 and 2 is high enough to supply the NPSH for the suction of the three (3) Boiler Feed Pumps. The Boiler Feed Pumps are numbered 71, 72 and 73. As with Units 1 and 2 these pumps can also pump water to any of the HP heaters and boilers.

Unit 8 is the same as Unit 7 the Feedwater System starts at the Deaerator Storage Tank. As with Unit 7 the Deaerator Storage Tank provides the NPSH to the three (3) Boiler Feed Pumps suction. The Boiler Feed Pumps are numbered 81, 82, and 83. These pumps pump the feedwater through the drum level control valve to the Low Temperature Economizer on the Unit 8 boiler.

There is a tie line between the Deaerator on Units 1, 2 and 7. With this tie line feedwater from Units 1 and 2 can supply the Boiler Feed Pumps on Unit 7 and vice versa.

The Feedwater System also supplies feedwater to the De-Superheater Spray nozzles to cool the steam between the 465 pound steam system and the 165 pound steam system. (Refer to: 400 pound Steam System UTA-PP13 and Extraction Steam System UTA-PP15). The De-Superheater Sprays are also used to control steam temperatures from the Boilers.

In the Feedwater System is a shell and tube Feedwater Cooler, which uses cooling water from the Cooling Tower to cool the feedwater. This cooler takes a portion of the feedwater from the High Temperature Feedwater Heater off Unit 8 boiler, this water passes through the cooler and discharges the cooler feedwater to the Unit 7 Deaerator Storage Tank. At the present time this cooler is not in service.

2.0 System Major Components

Chapter Objectives:

1. Describe how the Feedwater System Components perform their functions, and how they inter face with other System components.
2. Draw from memory a diagram of the Feedwater System showing major components.
3. State from memory, the names and purposes of major Feedwater System components.
4. Describe the construction of and flow paths through the major components.

The Feedwater System consist of the following major components:

1. Boiler Feed Pumps
2. Feedwater Heaters
3. Feedwater Regulation
4. De-Superheating Spray

2.1 Boiler Feed Pumps (BFP)

There are five (5) Boiler Feed Pumps on Units 1 and 2, four (4) of these pumps are motor driven and one (1) is turbine driven. All of the pumps are Byron Jackson centrifugal pumps.

The pumps are equipped with recirculation valves. When operating the BFP's for some time at reduced capacity, much of the pump horsepower is transferred into the liquid in the form of heat. A recirculation line prevents the liquid in the pump from becoming hot enough to vaporize and causing cavitation and possible BFP impeller damage. The recirculation lines are piped from the discharge line of each of the BFP's prior to the discharge check valve.

The recirculation flow is routed through a manual block valve, air-operated valve, orifice and another manual block valve to the suction line of the BFP’s. The recirculation valve automatically opens when the BFP discharge decreases to approximately 45,000 pounds per hour flow to assure a flow above the minimum flow required. At 40,000 pounds per hour an alarm is sounded in the Control Room.

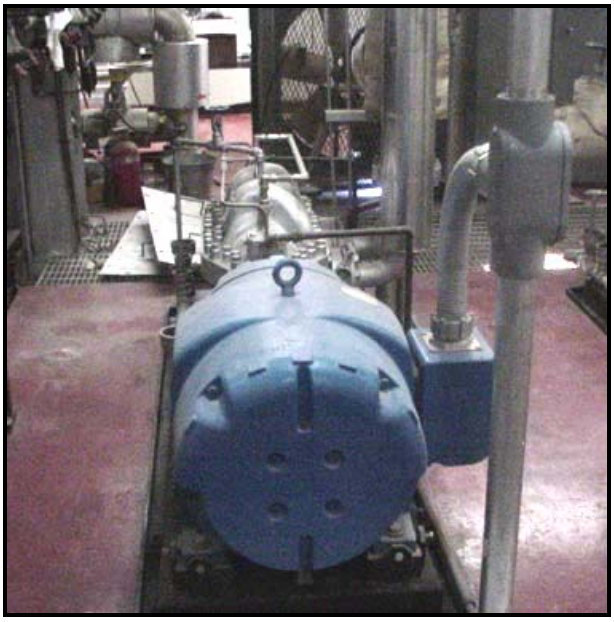


Figure 1 – Boiler Feed Pump 1

Unit 7 has three (3) Byron Jackson centrifugal Boiler Feed Pumps. These pumps work the same as Units 1 and 2. Each pump has a recirculation valve which recirculates water back to the suction line.

Figure 2 – Unit 7 Boiler Feed Pumps

Unit 8 has three (3) centrifugal Boiler Feed Pumps. Each pump has a recirculation valve which recirculates water back to the condensate inlet of the Deaerator. These BFP's only supply feedwater to Unit 8 Low Temperature Economizer inlet.

Figure 3 – Unit 8 Boiler Feed Pumps

2.1.1 Boiler Feed Pump Data

Units 1 and 2

Manufacturer	Byron Jackson
Quantity	Five (5)
Capacity	370 gpm (pumps 1&2)
	264 gpm (pumps 3,4, & 5)

Motors

Manufacturers	Baldor (pumps 1&2)
	Westinghouse (pumps 4&5)
Horsepower	200 (pumps 1,2 & 5)
	150 (pump 4)
Speed	3550 rpm
Voltage	480 volts AC

Turbine

Manufacturer	General Electric
Quantity	One (1)
Horsepower	150
Speed	3550 rpm

Unit 7

Manufacturer	Byron Jackson
Quantity	Three (3)
Capacity	370 gpm

Motors

Manufacturer	Baldor (pump 71)
	General Electric (pumps 72&73)
Horsepower	200
Speed	3550 rpm
Voltage	480 volts AC

Unit 8	
Manufacturer	LATER
Quantity	Three (3)
Capacity	400 gpm (pump 82)
	306 gpm (pumps 81&83)
Motors	
Manufacturer	Bingham-Willamette
Horsepower	200
Speed	3560 rpm
Voltage	480 volts AC
Power Supplies	
BFP 1	_____
BFP 2	_____
BFP 4	_____

2.1.2 Boiler Feed Pump Controls

All the Boiler Feed Pumps are controlled and monitored from the DCS displays in the Control Rooms.

2.2 Feedwater Heaters

There are a total of six (6) Feedwater Heaters with the Feedwater System. Three (3) heaters are of the shell and tube, extraction steam type and three (3) are flue gas type heaters. Units 1, 2 and 7 have the shell and tube extraction heaters. Steam from the turbine extraction or from the 165 pound steam header can supply these heaters. The feedwater heaters are shell and tube, U-tube type heaters. Feedwater enters the bottom of the heater and passes through the tubes, picking up heat from the steam on the shell side of the heater; the feedwater exits the top of the heater. Steam from the 165 pound steam header or from the turbine extraction, (refer to: Extraction Steam System IRI-15), enters the top of the shell and through baffles is directed across the tubes, as the steam crosses the tube it gives up heat to the water passing through the tubes and condenses. As it condenses it falls into the bottom of the heater in the drain section of the heater.

From the drain section of the heater the condensate (drips) is returned to the Deaerator.

There are two (2) Feedwater Heaters on Unit 6 Heat Recovery Steam Generator (HRSG) and One on Unit 8 HRSG. These heaters use flue gas to heat the feedwater. (Refer to: Heat Recovery Steam Generators IRI-18).

2.2.1 Feedwater Heaters Data

Feedwater Heaters 1 and 2	
Design	Shell and tube, U-tube, 2 pass
Tube Service	352 square feet
Water Inlet Temperature	220 degrees Fahrenheit
Water Outlet Temperature	422 degrees Fahrenheit
Pressure	800 psi
Feedwater Heater 7	
Design	Shell and tube, U-tube, 2 pass
Water Inlet Temperature	220 degrees Fahrenheit
Water Outlet Temperature	406 degrees Fahrenheit
Pressure	800 psi

2.2.2 Feedwater Heater Controls

The inlet and outlet feedwater valves to the Extraction Steam Feedwater Heaters on Units 1, 2 and 7 are manually operated valves. The inlet and outlet valves on the HRSG Feedwater Heaters are also manual valves.

2.3 Feedwater Regulation

The Feedwater Regulation is controlled from the DCS in the Control Rooms. The Feedwater Regulation maintains a constant boiler drum level by regulating feedwater flow to the boiler drums. The system provides for drum level control from startup through the normal full operating load range.

Feedwater Flow is controlled by two (2) separate modes of control:

Single element – The single-element system responds to the drum level to control the level control valve. The level controller compares the drum level set point, set on the DCS to the actual drum level. The controller in "AUTO" generates a signal, which regulates the level control valve to maintain the drum level. In "MANUAL" the level is controlled by the operator.

Three-element – The three-element system utilizes measurements of steam flow, feedwater flow and drum level to control feedwater flow.

In AUTOMATIC, the steam flow is the primary signal to the drum level controller. The drum level controller then compares drum level to drum level setpoint set on the DCS. The output signal from the drum level controller is equal to steam flow if actual boiler drum level is equal to boiler drum level setpoint. An actual low boiler drum level is corrected by the drum level controller generating an output signal greater than steam flow. An actual high boiler drum level is corrected by the drum level controller generating an output signal less than steam flow. Thus, the output of the drum level controller is the desired feedwater flow, which is equal to steam flow if the actual boiler drum level is at setpoint.

The feedwater controller then compares actual feedwater flow to the desired feedwater flow signal sent from the drum level controller. This arrangement provides immediate response in feedwater flow to changes in steam flow.

Figure 4 – Unit 6 Feedwater Control Valve

3.0 System Operation

Chapter Objectives:

Describe the Feedwater System operation during:

- System Startup
- Normal Operation
- System Shutdown

NOTE**:** This System operation section is included for instructional purposes only, and should not be used as and operating procedure.

3.1 System Startup

All system components that have been tagged out for maintenance have had tags cleared and removed. All control and indication instrumentation on which maintenance or calibration has been preformed has been returned to service. The Instrument Air System is in service.

The system should be walked down to verify that all pump and motor lubrication are at their proper levels. That the system's valves have been placed in their proper startup positions with all drains closed except where otherwise noted. That all AC and DC electrical power supplies has been racked in and ready for service.

3.2 Normal Operation

All systems should be monitored for pressures, temperatures, flows, and levels. Pump and motor lubrication are monitored and filled as required. Any abnormal conditions should be reported and corrective action taken.

3.3 System Shutdown

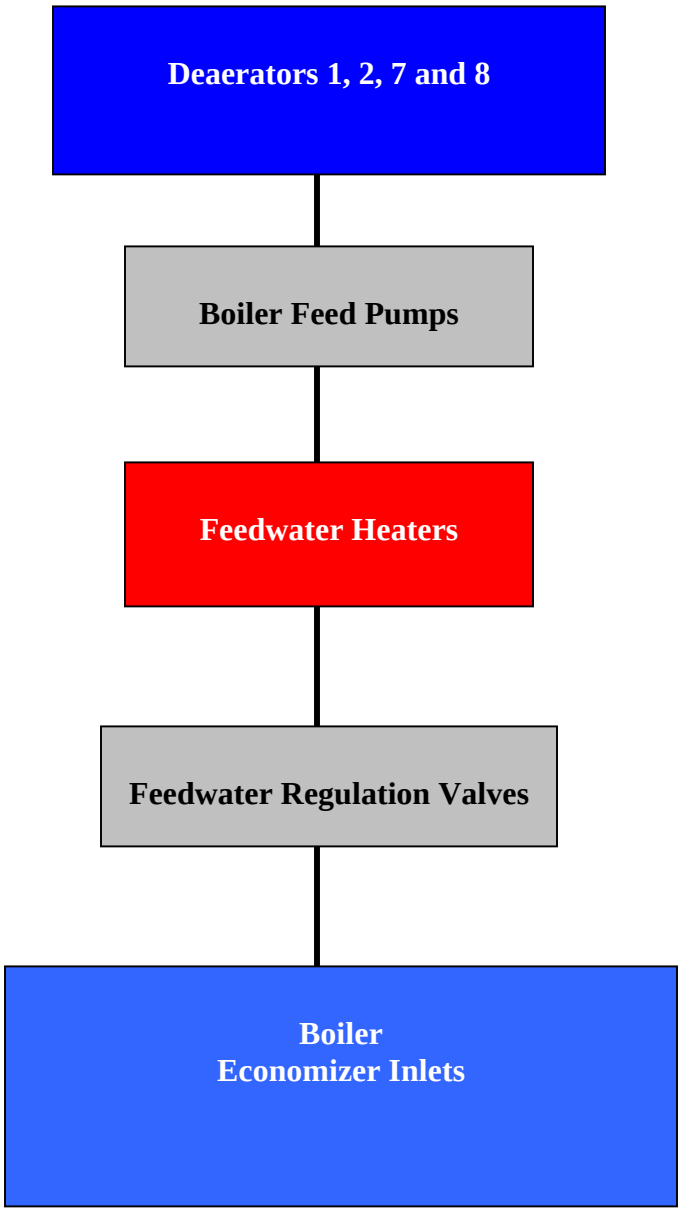
The Feedwater System is normally in operation.

All pumps should be taken out of service and breakers racked out. Close valving to isolate the system and open drain valves where system needs draining. Any part of the Feedwater System is to be worked on, proper clearance and tagging should be obtained.

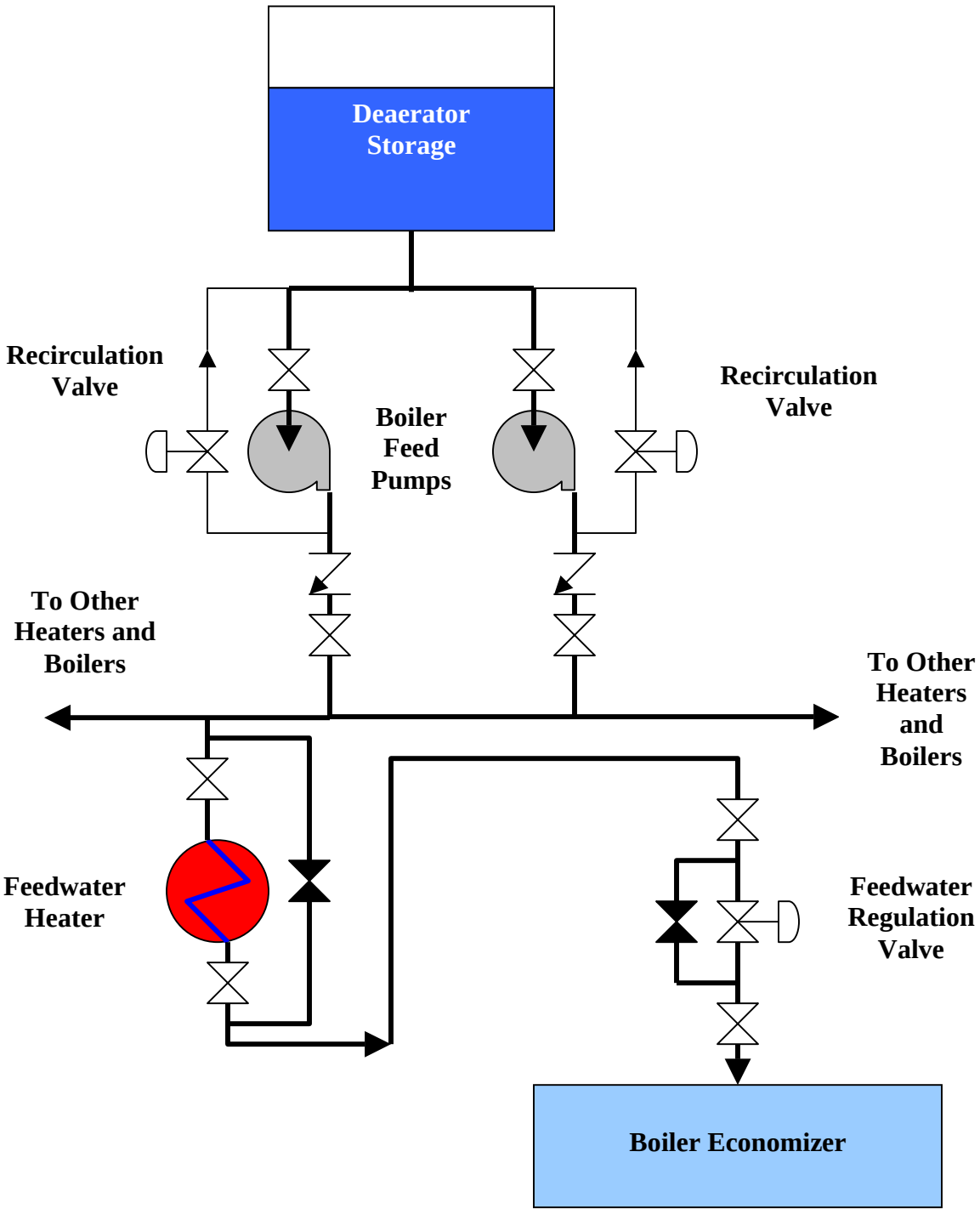
4.0 References

Byron Jackson

General Electric



Drawing 1 – Feedwater System Block Diagram



Drawing 2 – Typical Feedwater Flow Diagram