Power Generation

Application Guide

Contents

Built for the job.

ValvTechnologies designs and manufactures valves specifically for the unique demands of power generation applications.

The standard operating conditions of power generation: **high temperatures**, **high pressures** and at times, **high cycling**, can severely impact the service life of a valve. Special consideration should be made in the selection of metallurgy, sealing design and operation. ValvTechnologies, a leading global manufacturer of metal-seated, severe service valves, has a proven performance record of providing field tested, **ZERO LEAKAGE** solutions.

Our approach at ValvTechnologies is to utilize our technology, product management, inventory control, asset management, and world-wide service and support, to help solve process problems in your plant. By equipping the most knowledgeable people with the latest technology, we have created solutions where quality and dependability are built into our products and services from start to finish. By focusing on this principle, we become an integral part of our customer's asset management strategy.

ValvTechnologies' valves meet the standards of:

- ASME codes B31.1 Power Piping Code
- ASME Section 1 Boiler and Pressure Vessel Code
- B16.34 Valve Standards
- ASME TDP-1 1998 Prevention of Water Damage to Steam Turbines, Part 1

ValvTechnologies metal-seated valves are designed to meet virtually any process condition. Our standard class valves are available from 3/8 - 36 inches, up to ASME/ANSI Class 4500 (Special Class valves available in all ratings) and are manufactured in a variety of forged and cast materials and end connections to meet plant specifications.

Zero Leakage = True Cost Savings

Long Term Reliability

Reduce Valve Maintenance

Improve Heat Rate

Saves Energy, Time and Money

Four Year, Zero Leakage. Guaranteed.

All ValvTechnologies' valves manufactured for the power industry are stringently tested to meet the zero leakage testing criteria and are backed by a **four year, absolute ZERO LEAKAGE guarantee**. With our industry leading guarantee, ValvTechnologies valves will decrease heat loss in power plants, reduce maintenance costs and downtime and increase plant availability.

Designed for Severe Service Applications

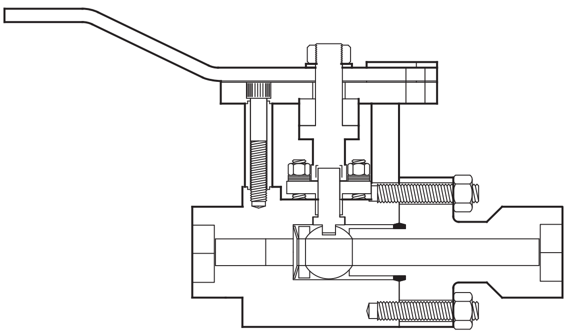
Operating Issues with Globe Type Valves

Globe type valves often develop dangerous leak paths due to their torque seated design. Their linear operation requires an operator to seat the plug by exterior force, often repetitively, as the flowstream can cause the valve to become unseated.

The rotary operating design of a ball valve is inherently better designed for high pressure steam applications than compared to the linear design of the typical globe type valve. The quarter-turn, rotary action of the ball valve protects the downstream seat while in the open position, eliminating the probability of developing severe seat erosion and downstream leak paths — which left unchecked can develop into serious reliability and maintenance concerns.

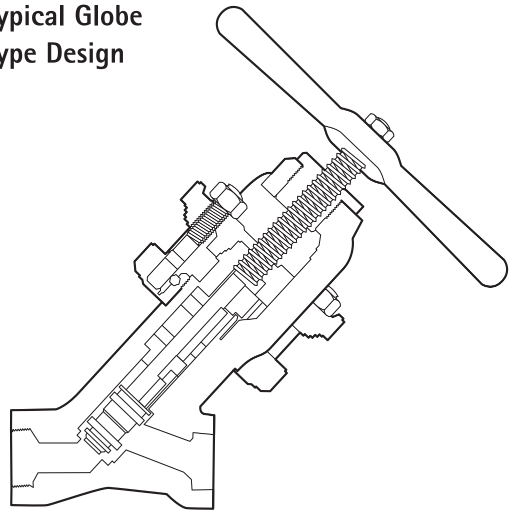
ValvTechnologies' valves employ an **integral, metal downstream seat** that results in tight shut-off every time. The valves perform well in high pressure, high temperature and high cycle service conditions. Through the integration of field experience and customer feedback, ValvTechnologies' V1 Series design features have become industry design standards that when required, provide proven long-term performance.

ValvTechnologies' V1 Series Design



- Straight through bore path
- **Integral seat** eliminates possibility of potential leak path
- High pressure provides tight shut-off, pushing the ball into the seat
- Tested to **Zero Leakage**

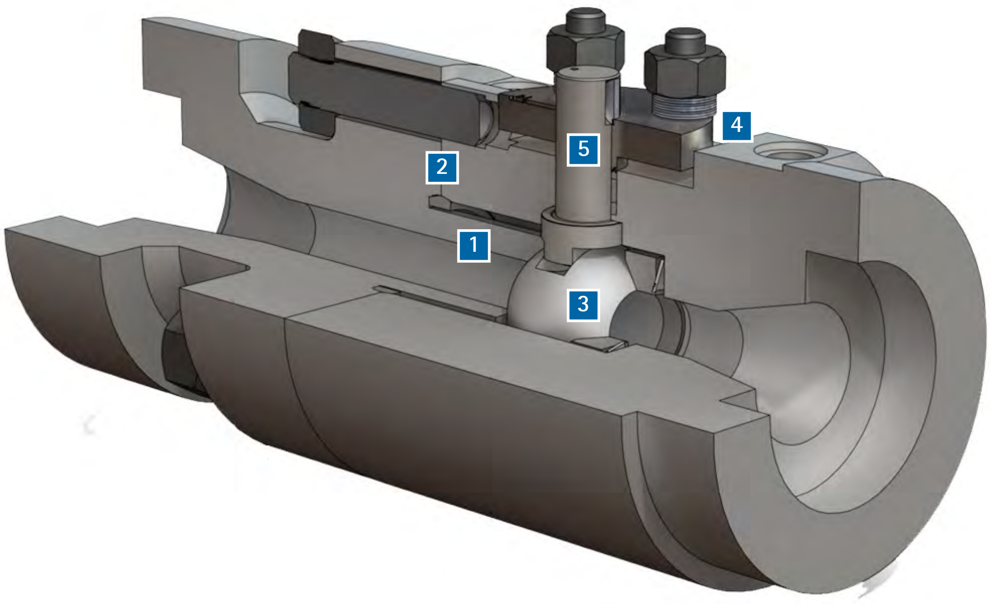
Typical Globe Type Design



- Restricted flow path, Reduced Cv
- Sealing surface is unprotected
- Seals against pressure, torque seated
- High pressure can cause the plug to become unseated, allowing dangerous leak through
- Tested to a leak rate

V1 Series

The Flagship of the ValvTechnologies Product Line



The ValvTechnologies' design features are the implementation of extensive industry experience.

1 Integral Metal Seat.
With our patented Cerament and Rocket Applied Metallic (RAM) coatings, the integral seat in ValvTechnologies' rotary operating valves are resistant to attack of abrasive magnetite or ferrous oxides in the steam flow.

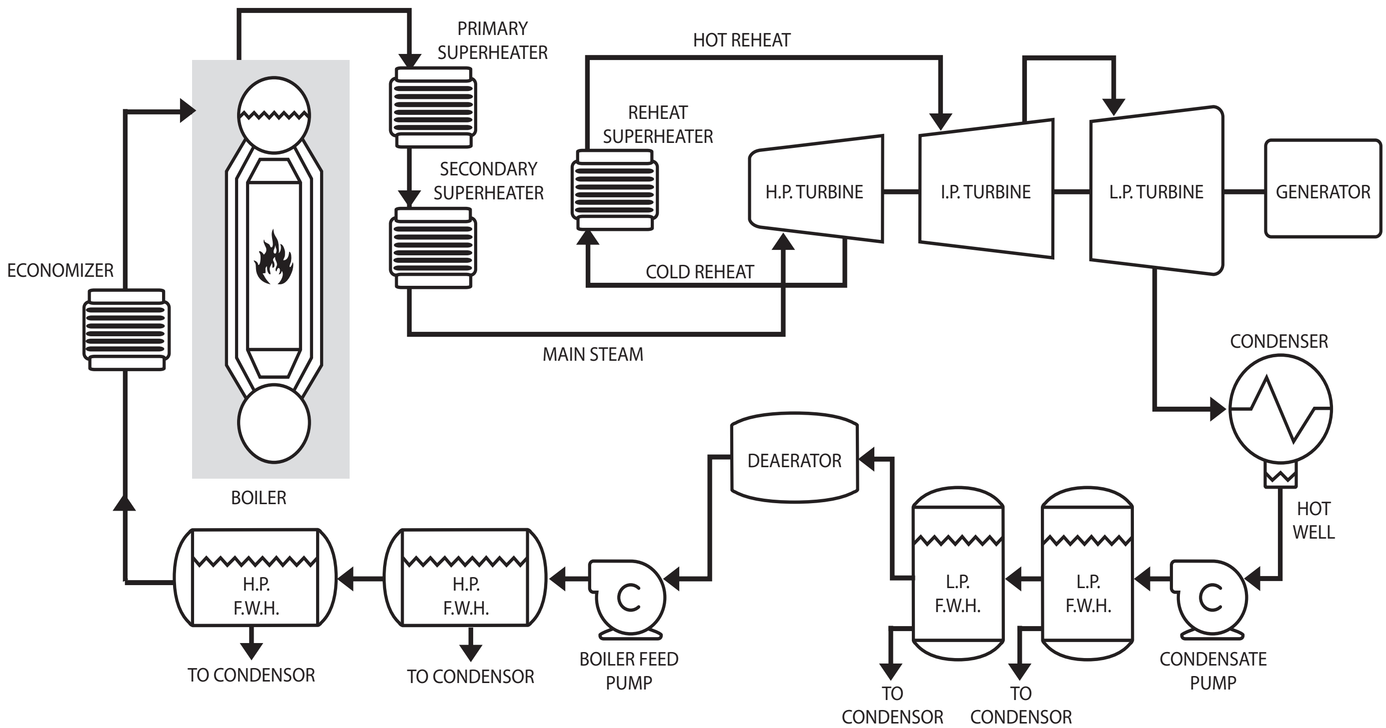
2 Body Seal Ring.
ValvTechnologies employs a field proven seal ring technology to ensure sealing under all operating conditions, up to 1400 °F (760 °C). The body seal ring is loaded at a pressure higher than 20,000 psi (1379 bar). In addition, all 3 inch and larger, Class 4500 valves contain a secondary Grafoil seal ring to further guarantee reliability.

3 Patented Coating Process.
The sealing surfaces are overlaid with Tungsten or Chromium Carbide using our exclusive RAM® process. These surfaces have a hardness of 68 - 72 Rc to allow long periods of operation in the most severe conditions.

4 Live Loaded Gland Area.
The V1 Series gland packing design features a four stud, live-loaded assembly designed for heavy industrial applications. The packing material is high purity Grafoil® surrounded by Carbon Fiber / Inconel anti-extrusion rings. The six Bellville springs (per stud) provide constant load pressure through extreme thermal shocks and prevent wear leaks in high cycle service.

5 Blow-out Proof Stem.
ValvTechnologies' design utilizes a one piece, hard-faced, blow-out proof stem that is inserted through the inside of the body cavity eliminating the possibility of blow-out through the gland area.

Fossil Fuel



Fossil Fuel Power Plant – Basic Operation

A fossil fuel power plant is a system of devices for the conversion of fossil fuel energy into electric energy. Types of fossil fuels include: coal, oil, natural gas, lignite and diesel. The most common type of fossil fuel plant in North America is the coal-fired boiler.

Coal-fired units produce electricity by burning coal in a boiler to heat water to produce steam. The steam, at tremendous pressure, flows into a turbine, which spins a generator to produce electricity. The steam is cooled, condensed back into water, and returned to the boiler to start the process over.

Generally coal-fired boilers heat water to about 1,000 °F (540 °C) to create steam. The steam is piped to the turbines at pressures of 1,500 - 3600 psi (103 - 248 bar). The turbines are connected to the generators and spin them at 3600 revolutions per minute to make alternating current electricity at 20,000 volts. The steam exits the low pressure turbine into the condenser where it is cooled to water; the condenser hot well supplies the suction to the condensate pump.

Standard ValvTechnologies Applications

HP Feedwater System

- BFP Recirc
- BFP Recirc Isolation
- BFP Discharge Isolation
- BFP Turbine Above & Below Seat Drains
- Feedwater Heater Isolation Inlet & Outlet
- Feedwater Heater Bypass
- Shell Side Water Level Control Isolation / Heater Drain
- Feedwater Drains
- Shell Side Drains & Vents

Boiler System

- Economizer Drains & Vents
- Water Wall Header Drains & Vents
- Mud Drum Blowdown
- Steam Drum Gauge / Sight Glass Isolation
- Start-up, Drum Level Control
- Steam Drum Continuous Blowdown & Block
- Steam Drum Instrument Isolation
- Secondary Superheater Header Drains & Vents
- Secondary Superheater Instrument Isolation
- Primary Superheater Header Drains & Vents
- Primary Superheater Instrument Isolation
- Reheat Superheat Header Drains & Vents
- Reheat Superheat Instrument Isolation
- Reheat Spray Isolation
- (ERV) Electronic Relief Valve & Isolation

Sootblower System

- Sootblower Header Isolation
- Sootblower Control Valve Isolation
- Sootblower Control Valve Downstream Block
- Sootblower Header Crossover Isolation
- Sootblower Bank Isolation
- Individual Sootblower Isolation
- Sootblower Thermal Drains

Turbine Steam & Extraction System

- Main Steam Drains
- Main Steam Stop Before & After Seat Drains
- Main Steam Turbine Isolation, Double Block and Bleed
- Main Steam Attemporator / Superheat / Reheat Spray Isolation
- HP Turbine Bypass
- Turbine Drains
- Extraction Steam Isolation
- Extraction Steam Drain Valves

LP Feedwater System

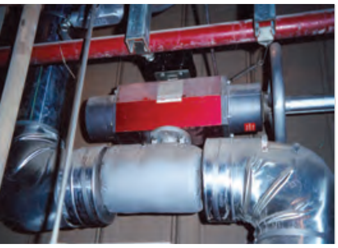
- Feedwater inlet isolation
- Feedwater outlet isolation
- By-pass isolation
- Shell side vents
- Shell side drains
- Level control isolation
- Manual dump to condenser
- Shell side instrument isolation

Inerting Steam System

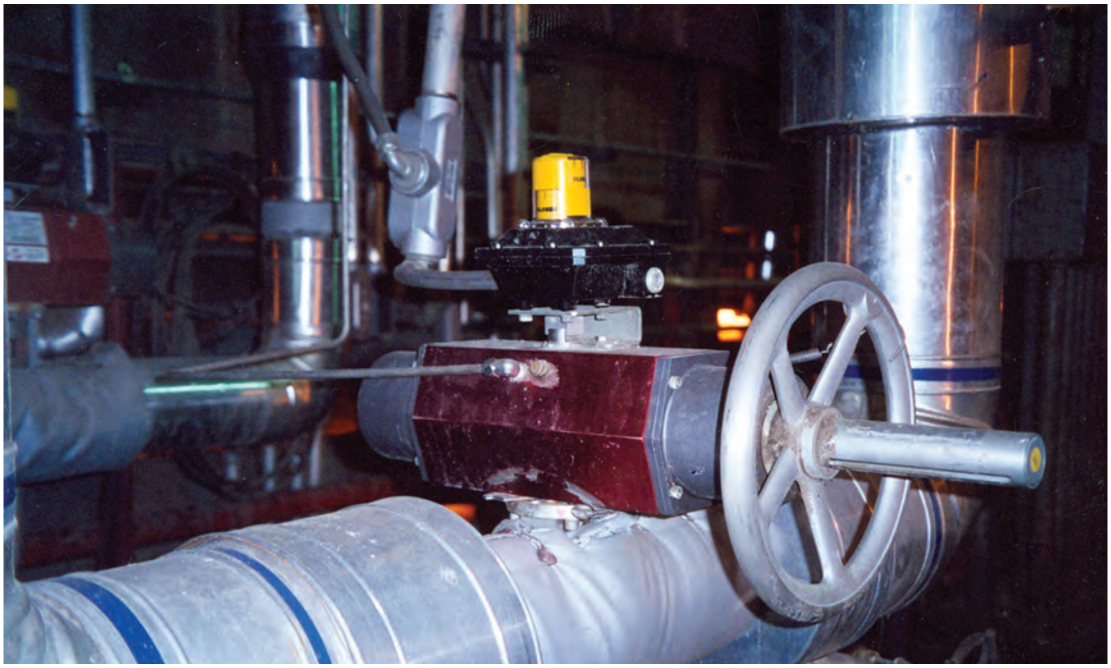
- Automated Isolation Steam to Pulverizer
- Manual Isolation Steam to Pulverizer
- Inerting Steam Supply
- Inerting Steam Supply Line Drains
- Thermal Drains

ValvTechnologies provides field proven solutions for severe service applications.

High Pressure Feedwater System



Pictured right and above are boiler feed pump recirculation valves . These ValvTechnologies XACTROL models have been in successful operation for over eight years without requiring trim or packing replacement.

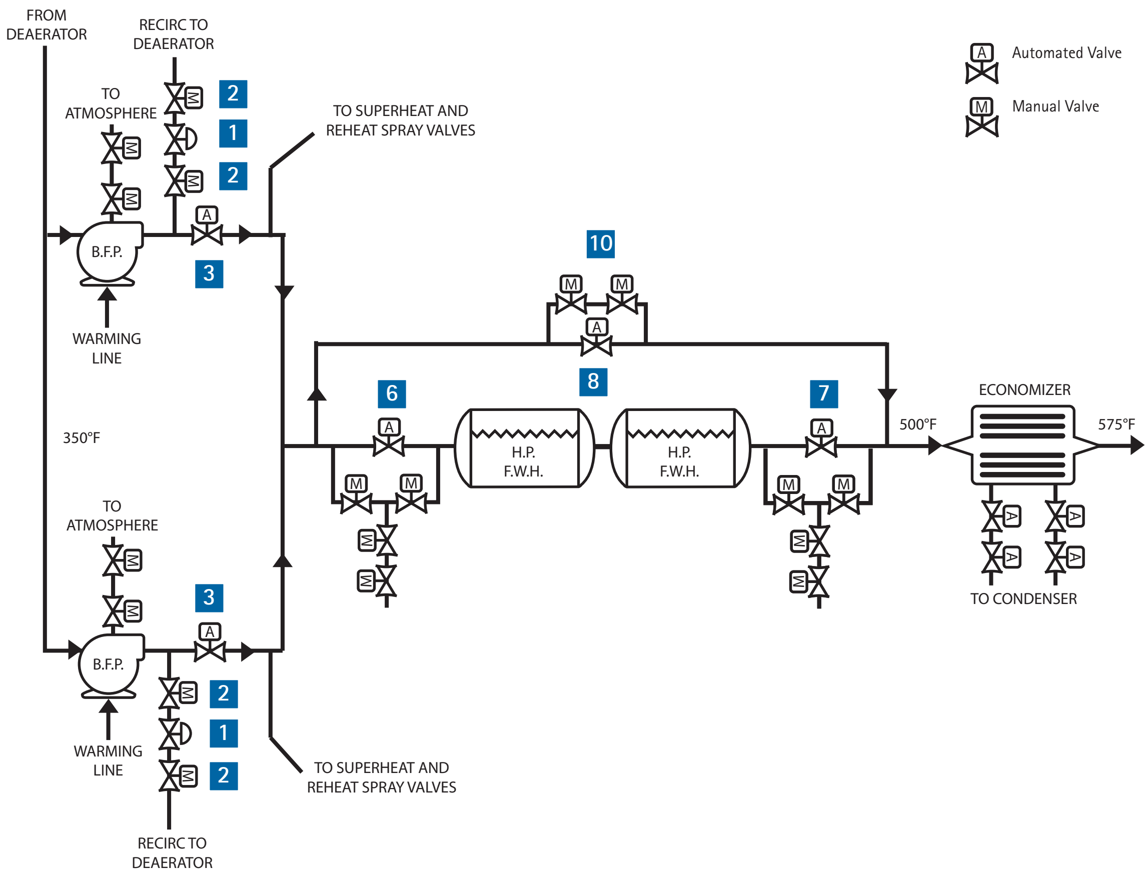


The purpose of the high pressure (HP) feedwater system is to increase the pressure and temperature of the water before it enters the economizer system. The feedwater system consists of the following major components:

- Boiler Feed Pumps
- Feedwater Heaters
- Feedwater Regulation

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 provide a continuous flow of water to the boiler. The BFPs must also develop the required pressure to overcome head and drum pressure.

The system also supplies HP feedwater to the main steam de-superheater and the hot reheat de-superheater. The de-superheaters control the temperature of the steam during normal operation and are used heavily during start-up and in low load running conditions.



NOTE: Some units have two trains of high pressure feedwater heaters

HP Feedwater System					
Item	**Applications**	**Temp Range (°F)**	Pressure (psi)	**Size (inches)**	VTI Model
1	BFP Recirc	300 – 360	2000 - 4800	2 – 6	XACTROL
2	BFP Recirc Isolation	300 – 360	2000 - 4800	2 - 6	V1-1
3	BFP Discharge Isolation	300 – 360	2000 - 4800	20 – 24	PSGV
4	BFP Turbine Above Seat Drains	750 – 1050	600 - 2800	1.5	V1-1
5	BFP Turbine Below Seat Drains	750 – 1050	600 - 2800	1.5	V1-1
6	Feedwater Heater Isolation Inlet	300 - 360	2000 - 4800	20 – 24	PSGV
7	Feedwater Heater Isolation Outlet	300 - 360	2000 - 4800	20 – 24	PSGV
8	Feedwater Heater Bypass	300 - 360	2000 - 4800	20 – 24	PSGV
9	Shell Side Water Level Control Isolation / Heater Drain	500 – 600	600	4 – 6	V1-2
10	Feedwater Isolation Bypass Block	300 - 360	1500 – 4800	1 – 1.5	V1-1
11	Shell Side Drains	500 – 600	600	2	V1-3
12	Shell Side Vents	500 – 600	600	1	V1-3

High Pressure Feedwater System

Pictured above is an ASME / ANSI Class 2500 Parallel Slide Gate Valve (PSGV) installed in a high pressure feedwater isolation application. If the heater has a tube leak, it must be isolated for repair. On units with elevated pressures, the PSGV allows for repeated leak free isolation.

1. Boiler Feed Pump Recirc

The pump starts with the discharge valve in the closed position. The recirc control valve provides minimum flow protection for the boiler feed pump. It discharges into the deaerator, and in some designs the recirc valve discharges into the condenser. The recirc control valve endures a lot of velocity and therefore needs periodic maintenance. The ValvTechnologies' solution is an XACTROL – Mark I or Mark III (trim design).

2. Boiler Feed Pump Recirc Isolation

The recirc control valve is one of the most troublesome valve applications in the plant because the valve is often damaged in the closed position; and as it continues to leak, severe system damage can occur. Most installations were not designed with an isolation valve, but the addition of a recirc isolation valve can protect the system from a leaking recirc control valve and allow for online maintenance. Some plants have installed gate and globe valves in this application. Seat erosion is a problem in the gate and globe valves, because the sealing surfaces are directly exposed to the flow when the valve is in the open position. In addition, these valves are seat tested to a leak rate versus ValvTechnologies' Zero Leakage standard.

NOTE: When isolation valves are added to the system, and operating conditions cause the recirc valve to open, the control system on the isolation valve needs to be configured so that it opens and closes with the recirc valve.

3. Boiler Feed Pump Discharge Isolation

When you have twin pumps discharging into a common header, it is critical that the block valves achieve positive isolation so that maintenance can be performed on the BFP while the other pump remains online. A leaking valve could result in an extended period of running at reduced load, while pump A is not operating; because the valve must be able to isolate to perform pump maintenance.

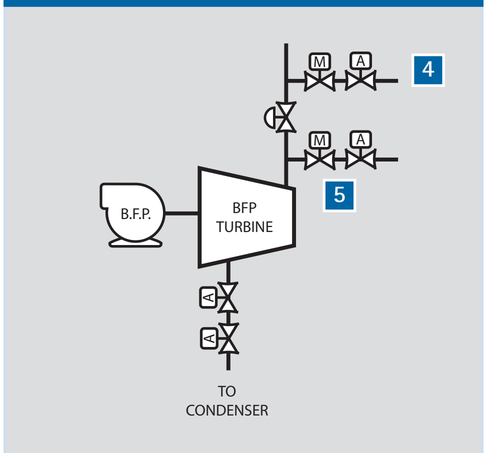
(4 – 5). BFP Turbine Above Seat Drains / Below Seat Drains

These valves are open during the warm-up cycle, to allow the turbine and steam lines to slowly come up to temperature during start-up.

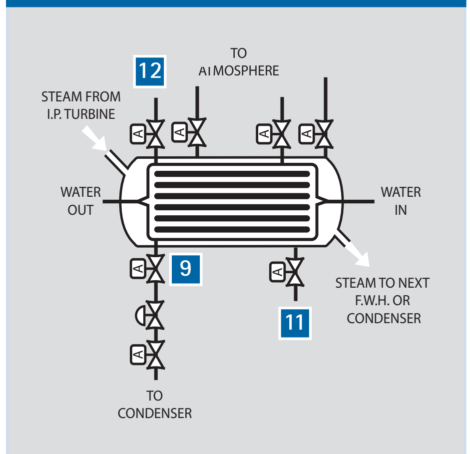
(6 – 7). Feedwater Heater Isolation Inlet / Outlet

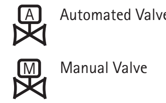
High water level in the feedwater heater lowers efficiency, and is an indicator that the heater has tube leaks requiring offline maintenance. The feedwater isolation (inlet/outlet) valves are closed to remove the heater from service to make the repairs. If the isolation valves leak or positive isolation cannot be achieved, the heater tube leaks cannot be repaired until a boiler outage occurs. If the heaters remain out of service the heat rate will increase and drastically effect plant efficiency; increasing plant fuel cost by thousands of dollars daily. As costly as this is to the plant, the heater needs to be repaired quickly and without incident. Some companies

Detail of BFP Turbine



Detail of HP Feedwater Heater





have safety procedures in place that prohibit maintenance personnel from working behind a single source of isolation (i.e. heater tube repairs). In this instance, a double block and bleed would be preferred.

8. Feedwater Heater Bypass

The feedwater heater bypass allows the unit to stay online during feedwater repair. The valve sees equal pressure on each side; and leaking is not an issue.

9. Shell Side Water Level Control Isolation / Heater Drain

This application maintains proper water level on the shell side of the heater. Since the level control valve controls the flow of condensate at the saturation point into a vessel at lower pressure, flashing will always be present. A ball valve inherently protects the seat when in open position versus a gate or glove type design, which leaves the sealing surface unprotected and susceptible to high velocity erosion. Additionally, the ball design provides greater Cv than a globe type; an added benefit to the application.

10. Feedwater Isolation Bypass Block

These valves make up a bypass line around the inlet and outlet feedwater heater isolation valves. They are used while the heater is being brought up to service temperature.

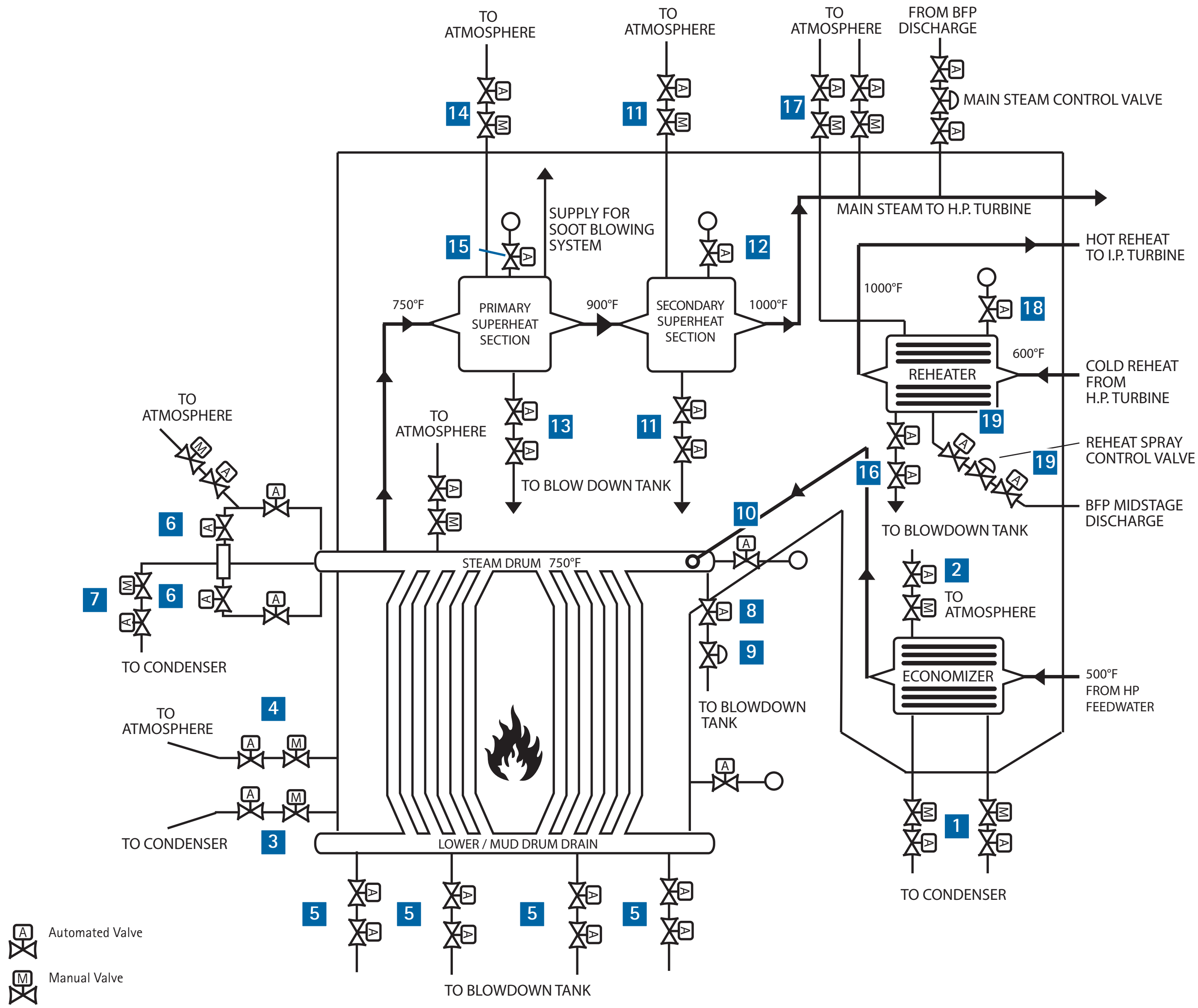
(11 – 12). Shell Side Drains / Vents

These valves are used when the feetwater heater is either removed from service or during system warm-up.

Boiler System

The boiler contains the most ValvTechnologies' applications than any other section of the plant.

Pulverized coal is air-blown into the furnace from fuel nozzles at the four corners and it rapidly burns, forming a large fireball at the center. The thermal radiation of the fireball heats the water that circulates through the boiler tubes near the boiler perimeter. The water circulation rate in the boiler is three to four times the throughput and is typically driven by pumps. As the water in the boiler circulates, it absorbs heat and changes into steam at 750 °F (370 °C) and up to 3,000 psi (22 MPa). Steam is separated from the water inside a drum and then is directed into superheat pendant tubes that hang in the hottest part of the boiler. The steam exits the superheater at 1000 - 1050°F (540 - 566 °C) through the superheater outlet header, then travels to the main steam line into the turbine.



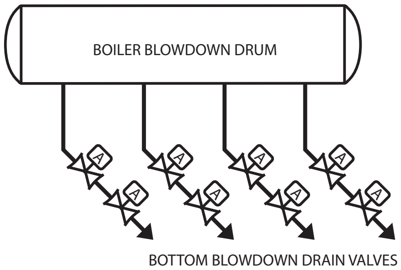
Boiler System					
Item	**Applications**	**Temp Range** (°F)	Pressure (psi)	Avg. **Size** (inches)	VTI Model
1	Economizer Header Drains	500 – 550	1500 - 3600	1.5 - 2	V1-1
2	Economizer Header Vents	500 – 550	1500 - 3600	1	V1-1
3	Water Wall Header Drains	650 – 750	1500 - 3600	1.5 - 2	V1-1
4	Water Wall Header Vents	650 – 750	1500 - 3600	1	V1-1
5	Mud Drum Blowdown Drains	600 – 700	1500 – 2800	2	V1-1
6	Steam Drum Gauge / Sight Glass Isolation	750 – 800	1500 – 2800	1	V1-4
7	Start-up, Drum Level Control	750 – 800	1500 – 2800	2 – 6	V1-1, V1-4
8	Steam Drum Continuous Blowdown Block	750 – 800	1500 – 2800	1.5 - 2	V1-1
9	Steam Drum Continuous Blowdown	750 – 800	1500 – 2800	1 - 2	XACTROL Mark II
10	Steam Drum Instrument Isolation	750 – 800	1500 – 2800	1	V1-1
11	Secondary Superheater Header Drains & Vents	1000 – 1050	1500 - 3600	1	V1-1
12	Secondary Superheater Instrument Isolation	1000 – 1050	1500 - 3600	1	V1-1
13	Primary Superheater Header Drains	850 – 900	1500 - 3600	1.5 - 2	V1-1
14	Primary Superheater Header Vents	850 – 900	1500 - 3600	1	V1-1
15	Primary Superheater Instrument Isolation	850 – 900	1500 - 3600	1	V1-1
16	Reheat Superheater Header Drains	500 - 1050	500 - 700	1	V1-1
17	Reheat Superheater Header Vents	500 - 1050	500 - 700	1	V1-1
18	Reheat Superheater Instrument Isolation	500 - 1050	500 - 700	1	V1-1
19	Reheat Spray Isolation	350 - 400	1000 - 1500	2	V1-1

(1 – 4). Economizer Drains & Vents / Water Wall Drains & Vents

The function of the boiler drain and vent valves is to drain the boiler for maintenance outages. The valves are always closed while the boiler is in operation.

5. Mud Drum Blowdown Drains

These valves are normally open for a short period of time during start-up and then closed. At a pre-determined interval these valves are cycled to remove impurities, sludge or solids from the boiler mud drum / bottom drum. The valves are exposed to solids, therefore it is important that the sealing surfaces are resistant to particle build-up and galling.



Boiler System

Pictured above: The function of the boiler drain and vent valves is to drain the boiler for maintenance outages. The valves are always closed when the boiler is in operation and must remain absolutely leak free while the plant is online — to ensure plant efficiency.

6. Steam Drum Gauge / Sight Glass Isolation
The gauge glass is a visual sign of the water level in the drum. The ValvTechnologies' valve is used to isolate the gauge glass from the boiler drum. High pressure and temperature, which could be as much as 2800 psi (193 bar), requires the gauge to be positively isolated to ensure safety during periodic maintenance.

7. Start-up, Drum Level Control
During start-up this valve maintains a predetermined water level in the steam drum to avoid water impeding into the superheater. Although this valve controls the water level in the steam drum, a ball or globe on/off valve is typically used for this application.

8. Steam Drum Continuous Blowdown Block
This valve isolates the continuous blowdown valve, as described below.

9. Steam Drum Continuous Blowdown
Continuous blowdown valves are used to control the quality of the water in the boiler by draining floating and suspended impurities from the boiler drum. The valves are designed to continually flow at a certain flow rate, yet adjust to a variation in flow rates. Typically valves designed for this service have been the angle globe style with a mitered seat. As the flow is reduced to minimum it creates very high velocities and causes wire damage; destroying the valve. When supplied with an XACTROL Mark – II, the valve comes complete with a fine control position indicator. ValvTechnologies valve internals are hardfaced making the moving elements less likely to wear. Plus, the flow rates remain consistent — reducing steam costs and increasing the life of the valve.

(10 – 12) Primary Superheater Drains / Vents / Instrument Isolation
The primary superheater is fed from the steam drum into a inlet superheater header. Steam enters the primary superheater at 750 °F (399 °C) and exits through the outlet header at 850 – 900 °F (455 - 482 °C). The valves in these applications are exposed to high temperatures and pressures, and require zero leakage isolation.

(13 – 15) Secondary Superheater Drains / Vents / Instrument Isolation
Steam enters the secondary superheater through an inlet header and exits through an outlet header into the main steam line. At the inlet the temperature is 850 – 900 °F (455 - 482 °C), and at the outlet the temperature is 1000 – 1050 °F (540 - 566 °C). The vents and drains are typically high maintenance due to the high temperature and high pressure environment; which can result in ongoing packing and stem leaks. ValvTechnologies lived-loaded packing and integral seat design eliminates these issues.

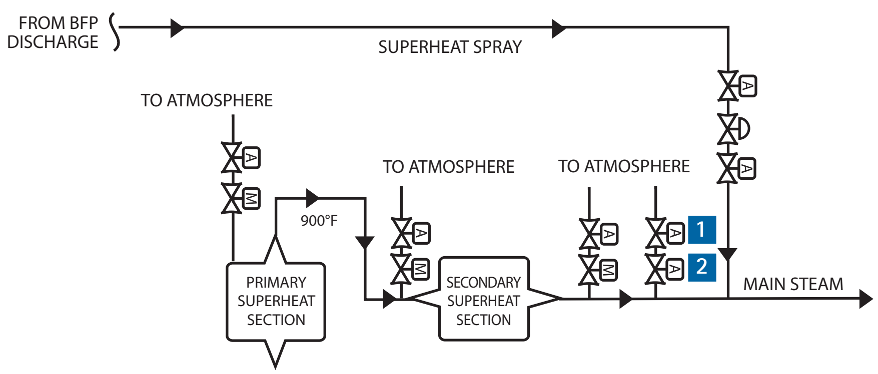
(16 – 18) Reheat Superheaters Drains / Vents / Instrument Isolation
Steam from the last stage of the high pressure turbine exhaust enters into the inlet reheat header at 500 – 700 °F (260 - 370 °C). The steam is reheated to 1000 – 1050 °F (538 - 566 °C),

exits through the outlet header and goes to the intermediate pressure (IP) turbine. The steam enters and exits at the same pressure. Due to the high temperature, valves in this system can have numerous maintenance issues which can be resolved by utilizing ValvTechnologies' RAM© coatings, which are far more wear resistant and handle higher temperatures better than cobalt-based alloys.

19. Reheat Spray Control Valve Isolation

The reheat spray control valves experience extreme conditions. The reheat spray isolation valves allow online maintenance of the control valves. In the event these valves cannot be positively isolated, water will leak into the hot reheat steam line, which will adversely affect the steam temperature going to the IP turbine. It's important to configure the inlet or upstream block valve to close when the control valves closes, and to open when the control valve opens.

Electronic Relief Valve (ERV)

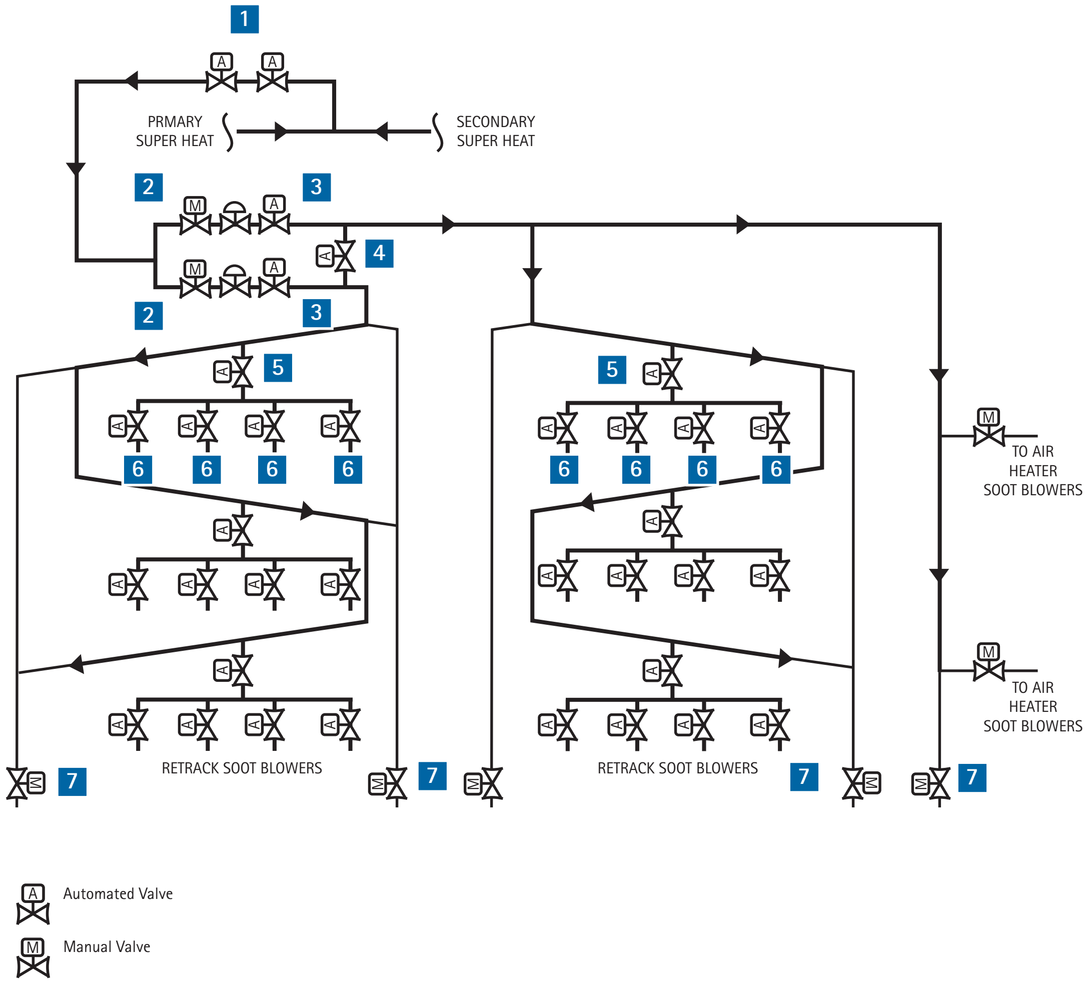


Pictured above: This Electronic Relief Valve (ERV) was installed to provide protection to the safety relief valves, which if operated could cost the plant thousands of dollars in replacement.

Electronic Relief Valve					
Item	**Applications**	**Temp Range (°F)**	Pressure (psi)	**Size (inches)**	VTI Model
1	Electronic Relief Valve	1000 - 1050	2000 - 4000	2 - 4	ERV
2	Electronic Relief Valve Isolation	1000 - 1050	2000 - 4000	2 - 4	ERV

On a subcritical unit, the ERV is simply a protection device for the spring-loaded safety valves. It is set lower than the first safety valve, and the intent of the ERV is to blow down the unit prior to the safety valves having to lift. On a supercritical unit the ERV serves as a protection device for the safety valves, but additionally may be considered for up to 10% of the total relieving capacity. Typically pilot operated relief valves leak after a few cycles. This is a result of the many moving parts and the steam cutting the disc as the valve flows. The ValvTechnologies ERV solves this problem by only having two moving components, seating surfaces protected in the open and closed position, and all valves tested to **zero leakage.**

Sootblower System



Sootblower System					
Item	**Applications**	**Temp Range (°F)**	Pressure (psi)	**Size (inches)**	VTI Model
1	Sootblower Header Isolation	700 - 1000	1500 - 3600	3 - 4	V1-1
2	Sootblower Control Valve Isolation	750	1500 - 3600	2 - 3	V1-1
3	Sootblower Control Valve Downstream Block	750	400 - 600	2 - 3	V1-1
4	Sootblower Header Crossover Isolation	750	400 - 600	2 - 3	V1-1
5	Sootblower Bank Isolation	750	400 - 600	2 - 3	V1-1
6	Individual Sootblower Isolation	750	400 - 600	2	V1-2
7	Sootblower Thermal Drains	750	400 - 600	1	V1-1, V1-3

When fuel is burned there are unburned small particles (slag) that can be deposited on the furnace side of the boiler tubes and on the air heater surfaces. The particles are in a molten state and can accumulate on the tubes, becoming very large. The large slag deposits are often called "clinkers". The slag that is deposited on the boiler tubes and in the air heater can cause poor heat transfer and affect the boiler efficiency. Sootblowers are used to remove the deposits, and use superheated steam at 600 psi (41 bar). Some blowers are designed to rotate as the lance moves into the boiler and then retract after use. If the blower fails to retract, the furnace temperature will destroy the blower lance. In the air heater, within the cooler sections of the boiler, the blowers will be stationary mounted. There are more unburned solids when coal is used as fuel. Fuel oil can also cause tube deposits and natural gas burns clean enough that blowers are seldom needed.

1. Sootblower Header Isolation
This valve isolates the system from the steam supply which can come from main steam, cold reheat or even extraction steam. In the event main steam is used, an attemporator will be used to reduce the temperature of the steam prior to entering the bank of sootblowers.

(2 – 3). Sootblower Control Valve Isolation & Downstream Block
These valves are used to positively isolate the control valve(s) so that repairs can be made while the boiler is online. The control valve endures severe service operating conditions and will require periodic maintenance.

4. Sootblower Header Crossover Isolation
The header crossover line connects the "A" and "B" side of the steam supply.

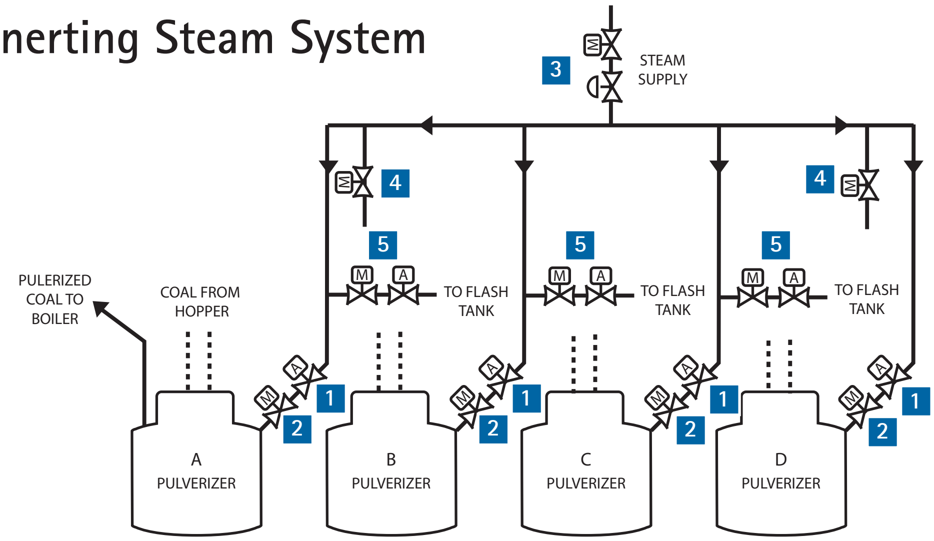
5. Sootblower Bank Isolation
There are several banks of sootblowers. These valves isolate the banks from the steam supply lines to allow online maintenance of the sootblower bank.

6. Individual Sootblowers Isolation
Due to the severe service conditions, the individual blowers are high maintenance items. Some sootblower installations are installed without individual blower isolation valves. Without an isolation valve it is necessary to remove an entire bank of blowers from service while repairs are made.

7. Sootblower Thermal Drains
Thermal drain valves operate on temperature. The valve opens when the temperature drops below a pre-set point to relieve the condensed water out of the header, and closes when the temperature rises to a set point. The existing valve is typically an automated ball valve or steam trap. Problems include seat and packing leakage as the result of high cycling. ValvTechnologies valves solve the problem with repeatable tight shut off, and the surface finish of the RAM® hard-coating will actually improve each time the valve is cycled. As with all ValvTechnologies' ball valves, the gland packing is live loaded as a standard, suitable for high cycling operation.

Pictured above are two thermal drains. These drain valves operate on temperature and can see a lot of cycles. ValvTechnologies has been successful in providing a solution for this application that provides repeatable, tight shut-off.

Inerting Steam System



Inerting Steam System					
Item	**Applications**	**Temp Range (°F)**	Pressure (psi)	**Size (inches)**	VTI Model
1	Automated Isolation Steam to Pulverizer	600	300 - 600	3 - 4	V1-1
2	Manual Isolation Steam to Pulverizer	600	300 - 600	3 - 4	V1-1
3	Inerting Steam Supply	600	300 - 600	4	V1-1
4	Inerting Steam Supply Line Drains	600	300 - 600	1	V1-1
5	Thermal Drains	600	300 - 600	1	V1-1, V1-3

The inerting steam system supplies smothering steam to the pulverizer in the event of a fire. This is a critical safety system, that if not working properly, could cause serious damage. It is important to note that a typical unit may have up to four pulverizers.

(1 – 2). Automated & Manual Isolation Steam to Pulverizer

These valves isolate the smoothing steam to the pulverizer. It is important that these valves have tight shut-off when not in use to avoid leaking saturated, smothering steam into the pulverizer, because moisture can adversely affect the flow and operation of the pulverizer.

(3 – 4). Inerting Steam Supply & Drains

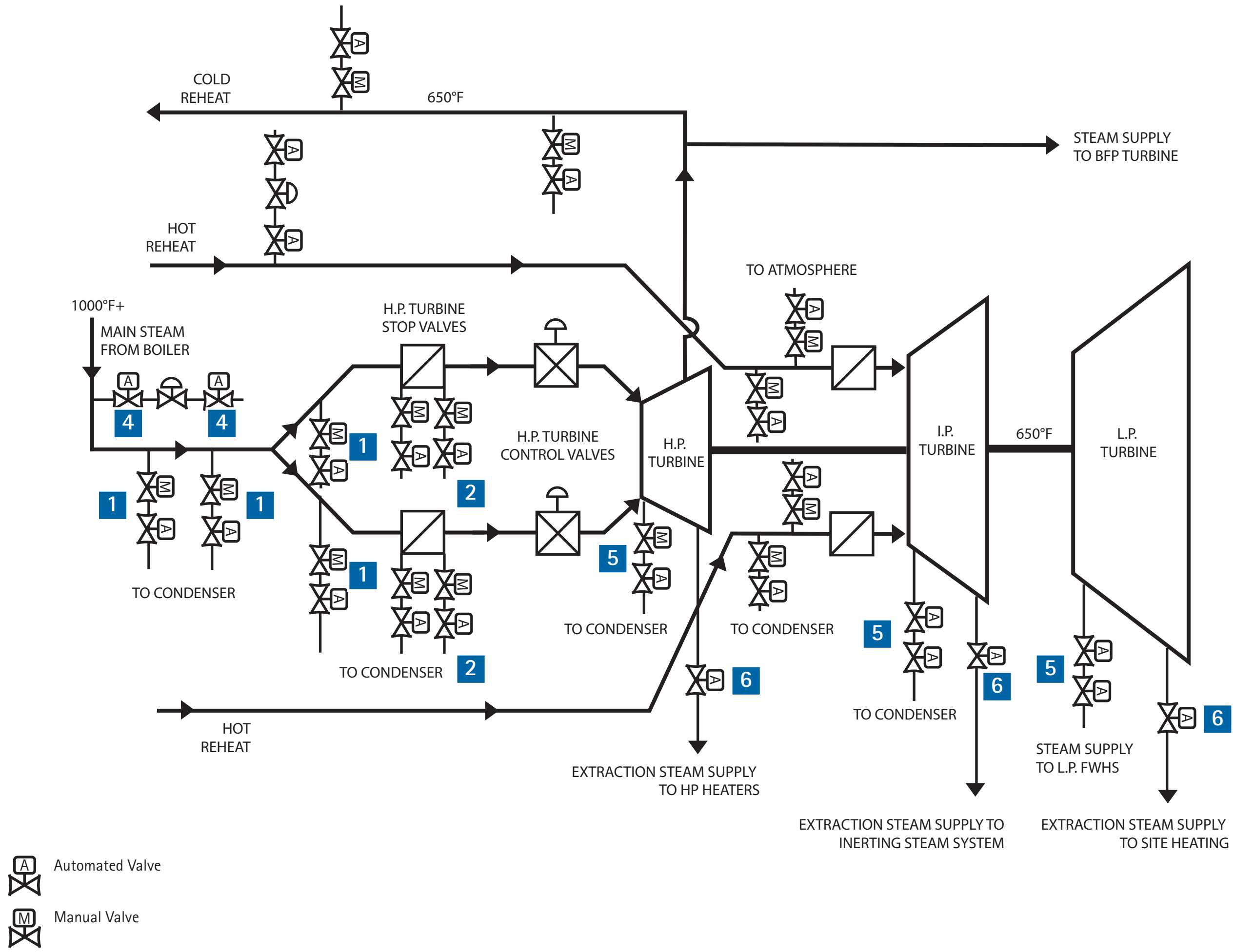
This valve isolates the steam source to the inerting system. This valve is typically open and closed only when the control valve is leaking or when online system maintenance is performed. Its important that this valve does not encounter leak by because if steam were to leak downstream of this valve, it could saturate the coal that is in the pulverizers. The inerting steam supply line drains are used to drain the steam and pressure when the inerting steam system is offline.

(5) Thermal Drains

Application described in previous section.

Turbine Steam & Extraction System

The turbine generator consists of a series of steam turbines interconnected to each other and a generator on a common shaft. There is a high pressure turbine at one end, followed by an intermediate pressure turbine, two low pressure turbines, and the generator. Superheated steam from the boiler is delivered through 20-24 inch (508–610 mm) diameter piping to the high pressure (1500 - 3600 psi / 103 - 248 bar) turbine where it exits the HP turbine last stage of blades at a pressure of 600 psi (4 MPa) and to 600 °F (320 °C). The steam exits the turbine cold reheat lines and passes back into the boiler where the steam is directed into the reheat superheater and heated back to 1000 - 1050 °F (540 - 566 °C). The hot reheat steam is conducted to the IP turbine where it falls in both temperature and pressure and exits directly to the long-bladed LP turbine and finally exits to the condenser.



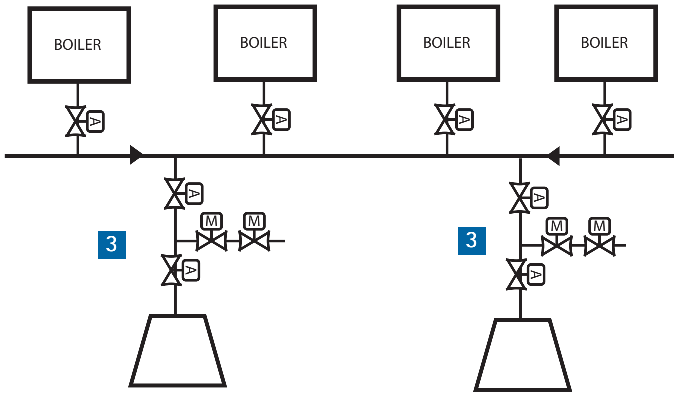
Turbine Steam & Extraction System

Turbine Steam & Extraction System					
Item	**Applications**	**Temp Range (°F)**	Pressure (psi)	**Size (inches)**	VTI Model
1	Main Steam Drains	1000 - 1050	1500 - 3600	1.5 - 2	V1-1
2	Main Steam Stop Before & After Seat Drains	1000 - 1050	1500 - 3600	2	V1-1
3	Main Steam Turbine Isolation, Double Block and Bleed	1000 - 1050	1500 - 2500	20 - 24	PSGV
4	Main Steam Attemporator / Superheat Spray Isolation	300 - 350	1500 - 3600	2	V1-1
5	Turbine Drains	500 - 900	1500 - 3000	1.5 - 3	V1-1
6	Extraction Steam Isolation	500 - 900	150 - 900	8 - 30	PSGV, V1-4

1. Main Steam Drains
The valves are opened during start-up and when the unit is removed from service for maintenance to remove pressure from the system. Due to the high temperature and pressure of this system, it is extremely important that these valves do not leak while the unit is online.

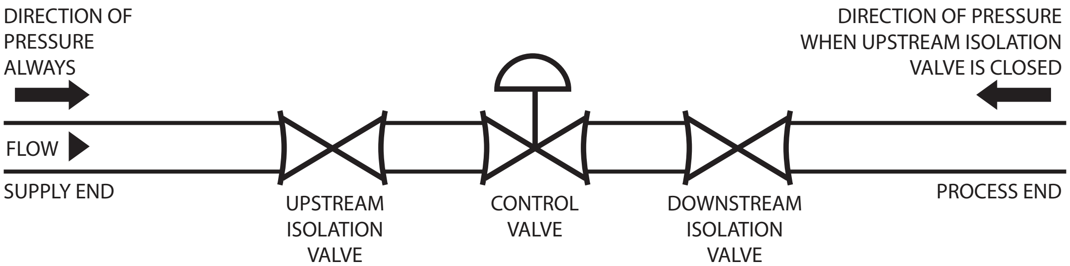
2. Main Steam Stop Before and After Seat Drains
When steam is introduced to the turbine during warm-up the valves are fully open. They stay in the open position until the turbine reaches 10% load and the valves are closed.

3. Main Steam Turbine Isolation, Double Block and Bleed
This application isolates the steam to the turbine from the boiler or from the main steam header. Some plants will have a header while in other plants the steam goes directly from the boiler to the turbine. In plants that have a header system it is important that this valve does not leak. Major turbine work cannot be performed if the steam cannot be isolated. Some customers incorporate double block and bleed capability into this application.



4. Main Steam Attemporator / Superheater Spray Isolation

The main steam control valve experiences boiler feed pump pressure. Due to the extreme temperature and pressure in the line, it is critical to isolate this valve for maintenance. The isolation valve also eliminates leakage of feedwater into the main steam line when the spray control valve is in the closed position. The upstream isolation valve should be configured in the control system to open and close as the control valve operates.



Pictured above: Main steam hot and cold reheat drain and vent valves. Steam is returned to the turbine in the hot reheat line at 1000°F (538°C) , 600 psi (41 bar). The drain valves are used to heat the steam lines during start-up and discharge into condenser.

5. Turbine Drains

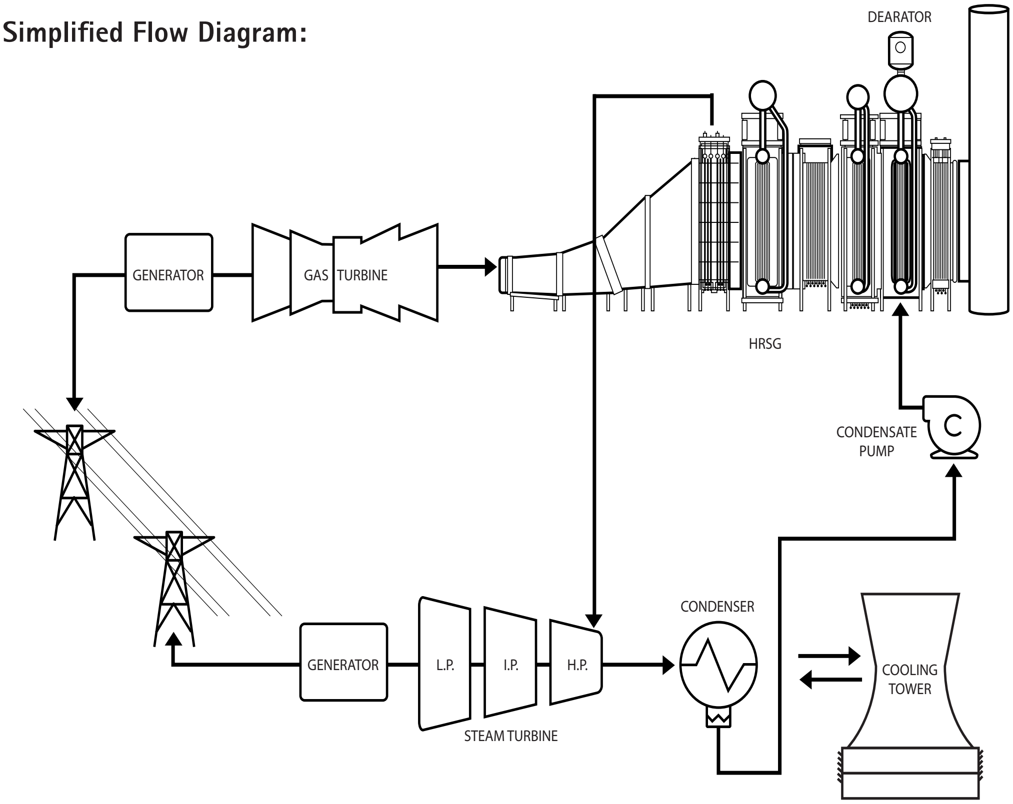
When steam is introduced to the turbine during start up, the valves are fully open. They stay open and drain to the condenser until the turbine reaches 10% load, and the valves are closed. The purpose of the valve is to warm the turbine during start-up and to eliminate the possibility of water getting into the turbine during the startup process or during unit trip or shutdown. Existing valves are typically automated globe valves that experience problems such as seat and packing leaks due to the linear rising stem, which also exposes the sealing surfaces in the open position. The ValvTechnologies' ball valve eliminates these problems because the seats are fully protected in the open and closed position. Packing leaks are virtually non-existent because the valve utilizes live-loaded packing and a quarter turn operation.

6. Extraction Steam Isolation

The steam coming off of the intermediate turbine or cold reheat line goes to the boiler feedwater heaters. It is important that the extraction steam isolation valves isolate during turbine trip to protect the turbine water induction.

Combined Cycle / Co-Generation

Simplified Flow Diagram:



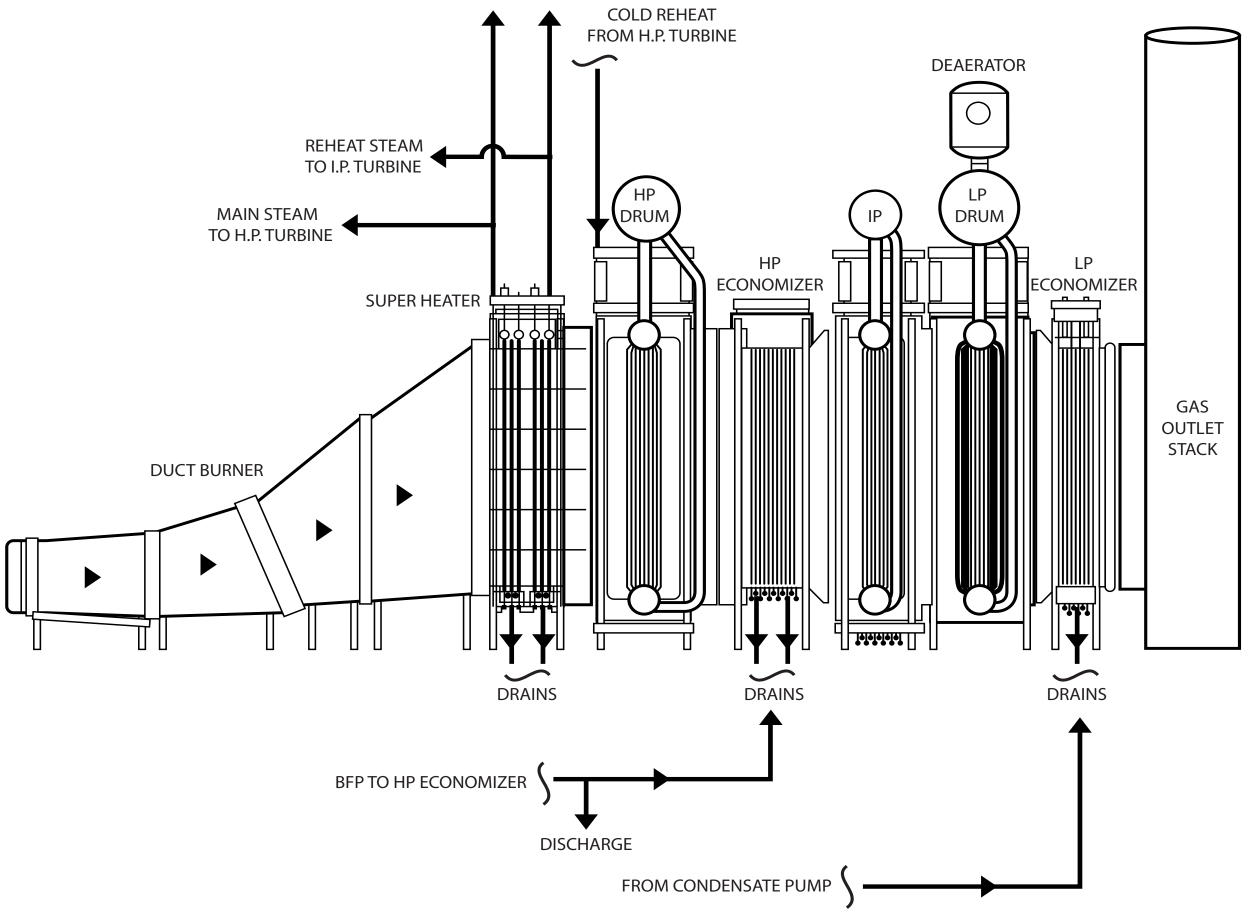
How Does A Combined Cycle Power Plant Work?

Heat Recovery Steam Generators (HRSG) utilize the exhaust gases from the combustion turbines (CT) to produce HP, IP and LP steam. The HP steam is used in the steam turbine. The IP steam is exported to a steam host as 150 - 600 psi (10 - 41 bar) process steam. If the HRSG is not designed for a steam host, the IP section will then be designed with a reheater. The LP steam is used internally by the HRSG to deaerate the incoming feedwater. The HRSG is a natural circulation water tube, three pressure level unit. Heat transfer is accomplished by convection through banks of finned tubes. Duct burners that use natural gas, provide supplemental firing that can increase the combustion gas temperature to 2500 ^{o}F (1371 ^{o}C); this added temperature increases steam production.

The condensate pump takes suction from the condenser hot well and directs flow into the LP economizer where the water is heated and then travels to the deaerator. From the deaerator the water is directed to the evaporator and to the LP drum. The boiler feed pump takes suction from the LP drum and supplies high pressure feedwater to the HP economizer. The feedwater then leaves the economizer and enters the HP drum. From the HP drum the water circulates though steam generating tubes and enters the superheater at 850 - 900 ^{o}F (454 - 482 ^{o}C). Steam exits the HP superheater and travels to the HP turbine at 1200 - 2500 psi (83 -172 bar) and 975 – 1050 ^{o}F (524 - 566 ^{o}C).

Main steam enters the HP turbine at design pressure and temperature, usually between 1200 – 2500 psi (83 - 172 bar) and 975 – 1050 °F (524 - 566 °C). The steam exits the last stage of the HP turbine at 600 °F (316 °C) and 600 psi (41 bar), then returns to the HRSG as cold reheat and enters the reheat superheater. Exiting the reheat superheater at 600 psi (41 bar) and 975-1050 °F (524 - 566 °C), the reheated steam is directed back to the turbine, through the reheat turbine, and exits the turbine at approximately 135 psi (9 bar) and 600 °F (316 °C). From the reheat turbine the steam travels through a large crossover pipe to the low pressure turbine, where the steam is condensed to water and the cycle starts all over again.

Detailed Diagram of a HRSG
Designed with a Reheat Section:



Combined Cycle Applications

Combined Cycle					
Item	**Applications**	**Temp Range (°F)**	Pressure (psi)	**Size (inches)**	VTI Model
1	BFP Recirc	300 - 360	2000 - 3000	2 - 4	XACTROL
2	BFP Recirc Isolation	300 - 360	2000 - 3000	2 - 4	V1-1
3	LP Header Economizer Drains	250 - 400	150 - 200	1.5 - 2	V1-1, V1-2
4	LP Header Economizer Vents	250 - 400	150 - 200	1	V1-1, V1-2
5	HP Header Ecomomizer Drains	350 - 500	1500 - 2500	1.5 - 2	V1-1
6	HP Header Ecomomizer Vents	350 - 500	1500 - 2500	1	V1-1
7	IP Steam Drum Drains	700	1500 - 2500	1.5 - 2	V1-1
8	IP Steam Drum Vents	700	1500 - 2500	1	V1-1
9	Steam Drum Gauge / Sight Glass Isolation	700	1500 - 2500	.75 - 1	V1-1
10	Superheater Header Drains	1000 - 1050	1500 - 2500	1.5 - 2	V1-1
11	Superheater Header Vents	1000 - 1050	1500 - 2500	1	V1-1
12	HRSG Hot Reheat & Main Steam Isolation	1000 - 1050	1500 - 2500	24	PSGV
13	Electronic Relief Valve	1000 - 1050	1500 - 2500	4	ERV
14	Main Steam Start-up Vent	1000 - 1050	1500 - 2500	4 - 8	V1-1, XACTROL
15	Main Steam Attemporator / Superheat Spray Isolation	300 - 360	1500 - 2500	2	V1-1
16	Turbine Bypass System	1000 - 1050	2000 - 3000	10 - 12	TBS
17	Fuel Gas Heat Exchanger	600	600	4 - 6	V1-2

1. Boiler Feed Pump Recirc
The pump starts with the discharge valve in the closed position. The recirc control valve (regulator) provides minimum flow protection for the boiler feed pump, and discharges into the deaerator. The recirc control valve endures a lot of velocity requiring needs periodic maintenance, including valve trim replacements. The ValvTechnologies' solution is an XACTROL – Mark I or Mark III (trim design) which is designed to endure harsh pressure differentials.

This ValvTechnologies' valve is installed in a cogeneration facility on the Gulf Coast. The application pictured is a vent valve located in the reheater section of the HRSG.

2. Boiler Feed Pump Recirc Isolation
The recirc control valve is one of the most troublesome valve applications in the plant because the valve is often damaged in the closed position; and as it continues to leak, severe system damage can occur. Most installations were not designed with an isolation valve, but the addition of a recirc isolation valve can protect the system from a leaking recirc control valve and allow for online maintenance. Some plants have installed gate and globe valves in this application. Seat erosion is a problem in the gate and globe valves, because the sealing surfaces are directly exposed to the flow when the valve is in the open position. In addition, these valves are seat tested to a leak rate versus ValvTechnologies' Zero Leakage standard.

NOTE: When isolation valves are added to the system, and operating conditions cause the recirc valve to open, the control system on the isolation valve needs to be configured so that it opens and closes with the recirc valve.

(3 - 4) LP Economizer Drains & Vents
These valves drain and vent the LP economizer when maintenance is needed.

(5 - 6) HP Economizer Drains & Vents
These valves drain and vent to the HP economizer when maintenance is needed.

(7 - 8) IP Steam Drum Drains & Vents
These valves drain and vent the IP drum when maintenance is needed.

9. Steam Drum Gauge / Sight Glass Isolation
This valve isolates the gauge / sight glass for periodic maintenance.

(10 - 11) Superheater Header Drains & Vents
Steam enters the superheater through an inlet header and exits through an outlet header into the main steam line. At the inlet the temperature is 750 – 800 ^{o}F (399 - 427 ^{o}C) and at the outlet the temperature is 1000 – 1050 ^{o}F (538 - 566 ^{o}C), design pressure. The vents and drains are typically high maintenance due to the high temperature and high pressure environment, and Valves in this system ordinarily have packing and stem leaks. ValvTechnologies lived loaded packing design and integral seat design eliminates packing leaks found in high temperature and pressure applications.

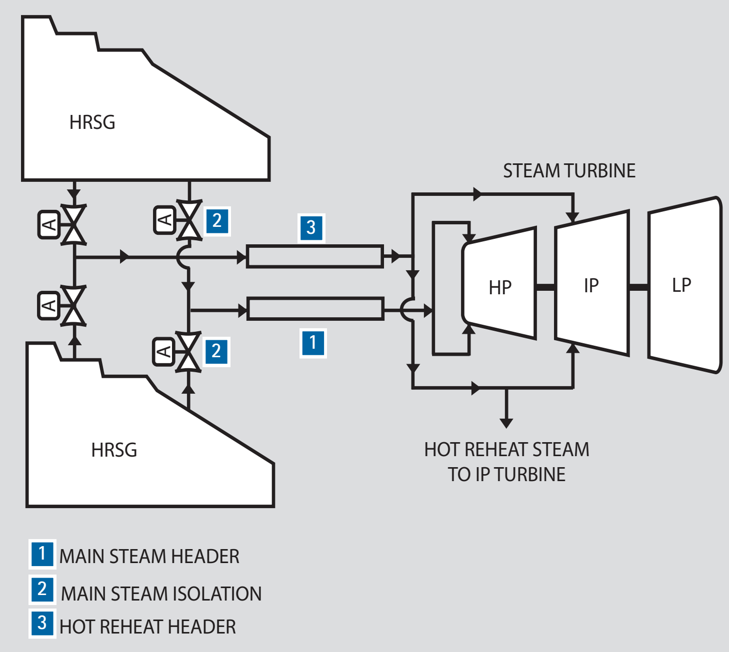
Combined Cycle Applications

12. HRSG Hot Reheat & Main Steam Isolation

Many combined cycle facilities are configured with two HRSG boilers that feed into one steam turbine. This is done to maximize capacity during peak electricity usage times. During the evening when electric usage decreases, one of the HRSG boilers is taken down and capacity reduced. During reduced plant capacity the valves are used to isolate the hot reheat and the main steam line that connects the two HRSG's to the steam turbine. The valves on the reheat lines will see operating conditions of 600 - 700 psi (48 bar) at 1000 – 1050 °F (538 - 593 °C), the main steam valves will see 1500 – 2200 psi (103 - 152 bar) at the same temperature.

These applications have been a reoccurring issue for many plants because of the high cycling — which can occur twice daily. The original equipment valves were designed with Stellite seat technology; that, if continually cycled, will create seat damage and critical leak paths that adversely affect plant efficiency.

Two HRSG Arrangement



13. Electronic Relief Valve

The ERV is simply a protection device for the spring-loaded safety valves. It is set lower than the first safety valve and the intent of the ERV is to blow down the unit prior to the safety valves having to lift. The ERV typically replaces pilot operated relief valves that leak after a few cycles.; a result of the many moving parts and the steam cutting the disc as the valve flows. The ValvTechnologies ERV solves the problem with only having two moving components, seating surfaces protected in the open and closed position and all valves tested to **zero leakage.** Some HRSG's are designed so that this valve has a dual function; as a start-up vent and also as an electronic relief valve.

Drum Level Control on a HRSG, provided by a ValvTechnologies' XACTROL.

14. Main Steam Start-up Vent

This valve is used during start-up. It vents steam to create flow in the boiler so that the tubes are not overheated. The controls on this valve can be configured to slowly close the valve, reducing flow as the steam temperature increases.

15. Main Steam Attemporator / Superheater Spray Isolation

The main steam attemporator / control valve experiences boiler feed pump pressure. Due to the extreme temperature and pressure in the line, it is critical to isolate this valve for maintenance. The isolation valve also eliminates leakage of feedwater into the main steam line when the spray control valve is in the closed position. The upstream isolation valve should be configured in the control system to open and close as the control valve operates.

16. Turbine Bypass System

The steam turbine bypass system will allow the operator to keep the gas turbine and the HRSG online in the event of a steam turbine trip or to facilitate faster start-ups of the CT and HRSG. The turbine bypass system also enables a combined cycle plant to operate at turndown conditions, below that which can be achieved solely with CTGs. The turbine bypass systems major function is to isolate the bypass loop during normal operation. The valves contained within the system must have tight isolation, as the system is isolated 95% of the time or more. Failure to properly isolate the system results in damaged seats and valves, loss of energy and control during start-up and turbine trips.

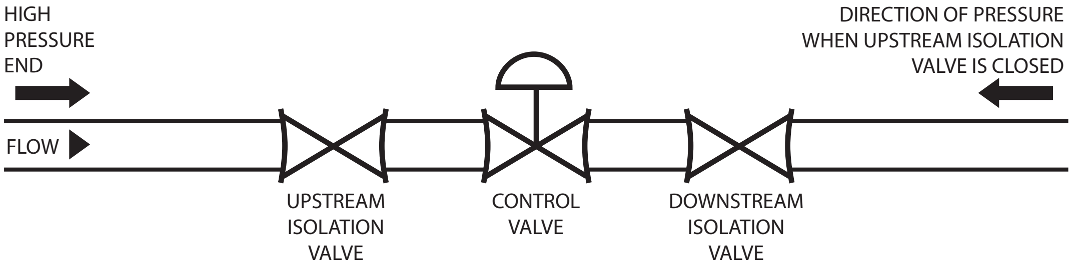
17. Fuel Gas Heat Exchanger

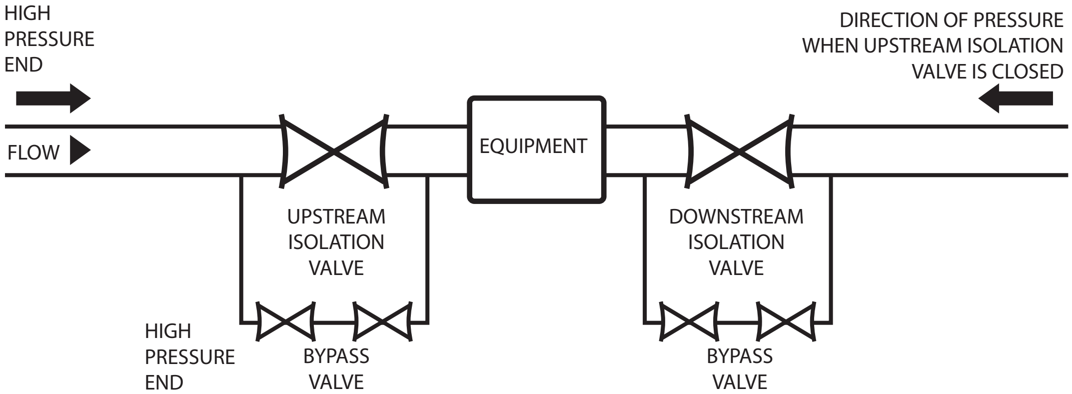
The fuel gas comes into with plant with suspended solids and at times a high moisture content. The pressure is 300 - 700 psi (21 - 48 bar). The solids are filtered out then the fuel gas goes through a pressure reducing station. This process causes the temperature to drop to -20 °F (-29 °C). The heat exchanger removes the moisture and increases the fuel gas temperature to a minimum of 170 °F (77 °C) to increase plant efficiency.

Proper Installation Direction
for Uni-directional Valves

Uni-direcitonal valves should not be installed in lines where a differential back pressure (from low to high) of >200 psi may exist.

Valves must be installed with the FLOW ARROW pointing from high to low pressure with the valve in the closed isolation position. Alternatively the high pressure end will be labeled. The high pressure end is defined as the end with the highest pressure, with the valve in the closed isolating position.





Conversion Tables

Temperature	
Degrees F	Degrees C
-20	-29
0	-18
32	0
50	10
100	38
150	66
200	93
212	100
250	121
300	149
350	177
400	204
450	232
500	260
550	288
600	316
650	343
700	371
750	399
800	427
850	454
900	482
950	510
1000	538
1050	566
1100	593
1150	621
1200	649
1250	677
1300	704
1350	732
1400	760
1450	788
1500	816
1550	843
1600	871
1650	899
1700	927
1750	954
1800	982
1850	1010
1900	1038
1950	1066
2000	1093

Pressure	
psi	Bar
1	0.069
2	0.138
3	0.207
4	0.276
5	0.345
10	0.689
20	1.379
30	2.068
40	2.758
50	2.758
100	3.447
150	6.895
200	10.342
300	13.789
400	20.684
500	27.679
600	34.474
700	41.369
800	48.263
900	55.158
1000	62.053
1500	68.948
2000	103.421
2500	137.895
3000	172.369
4500	206.843
6000	310.264
7500	517.107
9000	620.528
10500	723.949
12000	827.371
13500	930.792
15000	1034.214
17500	1206.583
20000	1378.951
22500	1551.320
25000	1723.689

Weight	
Pounds (lb)	Kilograms (kg)
1	0.45
2	0.91
3	1.36
4	1.81
5	2.27
10	4.54
20	9.07
30	13.61
40	18.14
50	22.68
100	45.36
150	68.04
200	90.72
250	113.40
300	136.76
350	158.76
400	181.44
450	204.12
500	226.80
600	272.16
700	317.52
800	362.87
900	408.23
1000	453.59
1100	498.95
1200	544.31
1300	589.67
1400	635.03
1500	680.39
1600	725.75
1700	771.11
1800	816.47
1900	861.83
2000	907.19
2100	952.54
2200	997.90
2300	1043.26
2400	1088.62
2500	1133.98

Conversion Factors

Temperature
$^{o}C = (5/9)(x-32)$

Pressure
1 psi = .068948 bar

Weight
1 pound = .4536 kilograms

Power Industry Acronyms

ANSI – American National Standards Institute
ASME - American Society of Mechanical Engineers
ASTM – American Society for Testing Materials
BTU – British Thermal Unit
CCW – Component Cooling Water
CD – Condensate System
Cv – Valve Flow Coefficient
DCS – Distributive Control System
ERV – Electronic Relief Valve
ESD – Emergency Shutdown
FP – Full Port
FW – Feedwater
GWe – Gigawatt Electric
GWh – Gigawatt Hour
HP – High Pressure
HRSG – Heat Recovery Steam Generator
HVOF – High Velocity Oxygen Fuel
LP – Low Pressure
MFIV – Main Feedwater Isolation Valve
MFRV – Main Feedwater Regulation Valve
MW – Megawatt
NPSH – Net Positive Suction Head
OTSG – Once-Through Steam Generator
PSG – Parallel Slide Gate
PSIG – Pound-Force per Square Inch Gauge
PTO – Power Take-Off
PWHT – Postweld Heat Treatment
RAM – Rocket Applied Metallic
RCP – Reactor Coolant Pump
RP – Reduced Port

ValvTechnologies Standard Products
for the Power Industry

High Temperature, High Pressure Steam Product Line					
Model	**Bore**	**End Size (inches)**	**ASME/ANSI Class**	**Body Materials**	**End Connections**
V1-1 (Metal Seated Ball Valve)	.38 .625 1.06 1.50 2.125	.25 – 4	900-4500	*Forge* A105 A182-F22 Cl.3 A182-F91 A182-F316	BW SW FNPT
V1-2 (Flanged - Metal Seated Ball Valve)	.625 12.06 1.06 13.25 2.13 15.25 3.06 17.25 4.06 19.25 6.06 24.25 8.06 29.25 10.06 35.25	.5 - 36	150-600	*Cast* A216 WCB A351 CF8M A217 Gr WC6 *Forge* A105 316H SS A182-F11	RF RJ GR
V1-3 (Metal Seated Ball Valve)	.625 1.06 1.5 2.13	.5 - 2	150-600	*Cast Body* A216-WCB A217-C12A A217-WC6 A217-WC9 *Forged End Cap* A105 A182-F11 A182-F22 F91	BW SW
ERV (Electronic Relief Valve)	Specially configured to customer specifications.	.5 - 36	150 - 4500	*Forge* A105 A182-F22 Cl.3 A182-F91 A182-F316 *Cast* A216 WCB	VTI standard options: BW x RF RF x RF
PSGV (Parallel Slide Gate)	Multiple bore options. See product specifications.	3 - 36	600-4500	*Cast* A216 WCB A217-C12A A217-WC6 A217-WC9	BW RF RJ
Nextech (Trunnion Mounted)	2.13 12.06 3.06 13.25 6.06 15.25 8.06 17.25 10.06 19.25	2 - 20	300-900	*Cast* A216 WCB A351 CF8M A217 Gr WC6 *Forge* A105 316H SS A182-F11	RF RJ Custom
XACTROL (Control Valve)	Specially configured to customer specifications.	.5 - 36	1500 - 4500	*Forge* A182-F22 Cl.3 A105 A182-F316 A182-F91	BW RF SW

Power Generation

Application Guide

Corporate Offices & Manufacturing

Headquarters
ValvTechnologies, Inc.
5904 Bingle Road
Houston, Texas 77092 U.S.A.
Telephone +1 713 860 0400
Fax +1 713 860 0499
sales@valv.com

To locate a distributor or satellite office near you, visit us online at: www.valv.com

Argentina / Chile / Peru
Lima
+51 1 628 1126
peru@valv.com

Brazil
Sao Paulo
+55 12 3322 6527
brazil@valv.com

China
Beijing
+86 10 65882188
china@valv.com

Chengdu
+86 28 86317266
china@valv.com

Shanghai
+86 21 53839881
china@valv.com

United Kingdom
Stockton on Tees
+44 1642 662814
europe@valv.com

Middle East
Dubai
+971 50 912 4052
middle.east@valv.com

ValvTechnologies products are certified to:

Rev 1
July 2009

pwr_app_guide_090731