Power Steam Valve Overview

Edited April 5, 2017

McILVAINE

Continuously updated Decision Guides and Request for Your Input

There are similarities and differences in the high performance steam cycle on /off and control valve requirements for nuclear, ultra-supercritical coal, supercritical coal, and gas turbine combined cycle plants. What sizes are required? What is the appropriate valve selection for each application. Also what features are best e.g. support (trunnion, floating or a unique design)? What materials are best for base load and rapid cycling applications? What are general valve investment costs? This analysis is in the early stages. We have identified some suppliers and their products and are asking them for comments.

The following resources are available

- Three just updated power point presentations
    - Overview (this slide deck)
    - Chinese questions and coatings (separate slide deck)
    - Supplier Details (separate slide deck
- Power Plant Valves (a continuously updated Mcilvaine Decision Guide)
- Ultra supercritical valve details by location (excel spreadsheet)
- High performance Valve articles in the Global Decision Orchard

We welcome the following input from all sources

- Case histories
- Product details
- Specific answers to the questions on this slide and more detailed questions on subsequent slides

How will this Data be used and why Participate?

- The Decision Guides will be continually updated and are freely accessed by anyone
- The site will be publicized.
- Derivative articles will be published in *Valve World* and *Valve World Americas*
- This initiative is part of the broader “Empowering IIoT with IIoW”.
- IIoT will generate continuous white papers on the performance of each valve. IIoW including analysis of valve options will be important to upgrading valves where IIoT identifies the opportunities
- Debate on alternatives will be encouraged

McILVAINE

On-off Ball Valve >750 F Vendor Contributions

Generator type				
	Vendor Experience	Valve Sizes	Valve Design	Special Materials
Coal -subcritical Coal-supercritical Coal-ultra supercritical Gas Turbine CC Nuclear Biomass Solar Thermal Geothermal	In which of these applications have you had actual experience? Which applications are particularly suited to your company? Are you working on ultra-supercritical designs?	What valve sizes are available for these applications? Which have been the most commonly purchased?	What major options are available and which are best and also which features are best e.g. for ball -trunnion, floating, other? Are any of your ball valves also used for control purposes? Distinguish between on-off and control applications	Have you supplied unique coatings, seals or materials? Are there any special actuation options?

McILVAINE

Details on each Valve in a USC System

- The accompanying excel spreadsheet has detailed analysis which Mcilvaine has conducted relative to control valves for ultra supercritical coal plants.
- The charts contain valve duty, flow, services, and materials for present USC and the materials and conditions for 350 bar and 700C
- Please review this chart and provide insights relative to your offerings for the valves which would be utilized in these systems

McILVAINE

Specific Issues and Evaluation Considerations discussed in Mcilvaine webinars

Application	Issues	Discussion
Boiler Feed	Single Valve or Dual Valve	Achieving the most economical and effective solution to boiler feed valving while avoiding cavitation and retaining startup and variable load performance
Turbine Bypass	Stellite Delamination	Mostly affecting steam valves in high pressure (hp) turbine bypass or hot reheat (hrh) lines; can result in valve damage/seat leakage or damage to turbine
Turbine Control	Cycling	More prevalent in CCGT plants than base-load coal-fired plants, and can require special valve capabilities for the increased thermal and mechanical stress
Two-Seated Valves	Center cavity over-pressurization (CCOP)	Center cavity over-pressurization can be an issue with two seated valves, including double block & bleed valves
Vent & Drain	Repair/Replace	The economics of repairing or replacing worn valves

McILVAINE

All of these issues are covered in Power Plant Valves to which you have access

Are Special Valve Designs needed for Fast Cycling HRSGS? - Conval says, yes

- When Heat Recovery Steam Generator (HRSG) combined cycle plants were first designed and built several decades ago, many of the originally-installed actuator/valve packages included lower-quality, foreign made globe, gate and ball valves.
- Conval says that these inferior valves only last 4-5 years or less. By comparison, where Conval's were specified and installed, typical valve life has been more like 16-20 years. Based on this real-life experience, more HRSG maintenance supervisors and planners are choosing to replace original lower-quality, foreign made valves with new Conval Camseal ball valves, Swivldisc gate valves and Clampseal globe valves.
- Conval valves are being used in such key HRSG processes as isolation, vents, drains, and feedwater. By their very nature, these plants frequently cycle up and down, on and off, which is very difficult on any mechanical equipment. Most OEM valves simply cannot perform in these highly demanding circumstances.
- **What is your experience on valve life vs design?**

McILVAINE

Specific Issues and Options for Steam Valves

Factors creating issues

- Higher temperatures
- Higher pressures
- Fast and frequent cycling
- Entrained water drops

Resulting issues

- Valve trim wear
- Cavitation
- ‘flashing
- Vibration
- Seal damage

Options

- Follow ISA guidelines for control valves
- Buy severe service valves (need definition)
- Consider special materials and coatings
  - Prevent stellite liberation
  - Fuse coating to base material
- Separate small start up valve for low loads
- Change inspection, operations, and maintenance procedures
- Specify valve after you know pump feed pressure
- Faster response and reliable actuators
- Repair rather than replace
- Buy all HP valves from one vendor
- Do not oversize feedwater valve
- Require tight shut off (better tolerances)
- Hydraulic actuators for fast response
- Electric actuator increases reliability

McILVAINE

Specific Issues and Evaluation Considerations

(Repair/Replace).. See presentation in Power Plant Valves

By Arvo Eilau, Pentair Valves & Controls

Current global power generation market conditions, driven by an abundance of natural gas fuel, recent advances in gas turbine technologies and more efficient combined-cycle component operation, have placed enormous demands on critical valves within thermal generation systems.

Pentair proceeded to review valve products designed for combined-cycle power facilities in these small to medium bore drain and vent applications. Applications were selected for their severe duty cycles (temperature and flow), directly related to cycling of the combustion turbine/heat recovery steam generator, and their strict boiler and piping code design requirements. Our project objective, beyond continuous product improvement, was to evaluate the products' overall contribution to the customer's corporate strategy objectives as previously outlined. This research would also compare a repairable product to a replacement product to determine which offered superior benefits.

Application
Boiler Feed
Turbine Bypass
Turbine Control
Hazardous Fluid Handling
Two-Seated Valves
Inlet Air
Repair/Replace

McILVAINE

Who should specify HP Valves?

- L&T supplied a complete solution for HP valves requirements for the UMPP Mundra Project. The innovative packaging concept facilitated in economics of scale, spares and service.
- **Mundra Ultra Mega Power Project** (**Mundra UMPP**) is a subbituminous coal-fired power plant in Tunda village at Mundra, Kutch district, in Gujarat, India. The coal for the power plant is imported primarily from Indonesia. The source of water for the power plant is sea water from Gulf of Kutch.
- There is the option for complete supply of high pressure valves for either coal plants or combined cycle gas turbine plants.
- L&T is a group within Larsen Toubro who furnishes complete plants and also supplies its own design HRSG.
- So the options are
  - Owner buys all high pressure valves from one supplier
  - Owner buys a high pressure valves from several suppliers and can pick the best from each
  - HRSG supplier provides valves associated with this process
  - Plant supplier specifies and buys valves rather than the owner

Water Quality Problems which can affect Valve Performance

Common Water Quality Problems

TRIMTECK OPTIMUX™

Major Problem	Deareator	Feedwater System	Boiler	HP Boiler	Turbine	Super-Heater	Steam-Using Equipment	Condensate System
Scale								
Hardness		X	X					
SiO_2		X		X				
Corrosion								
Oxygen	X	X	X	X	X	X		
Alkalinity/CO_2			X	X		X	X	X
Ammonia		X						
Chelate		X	X					
Deposits								
Metal Oxides		X	X	X				
Organics		X	X	X				
Carryover								
Entrained liquids			X	X	X	X		
Dissolved Solids						X	X	X

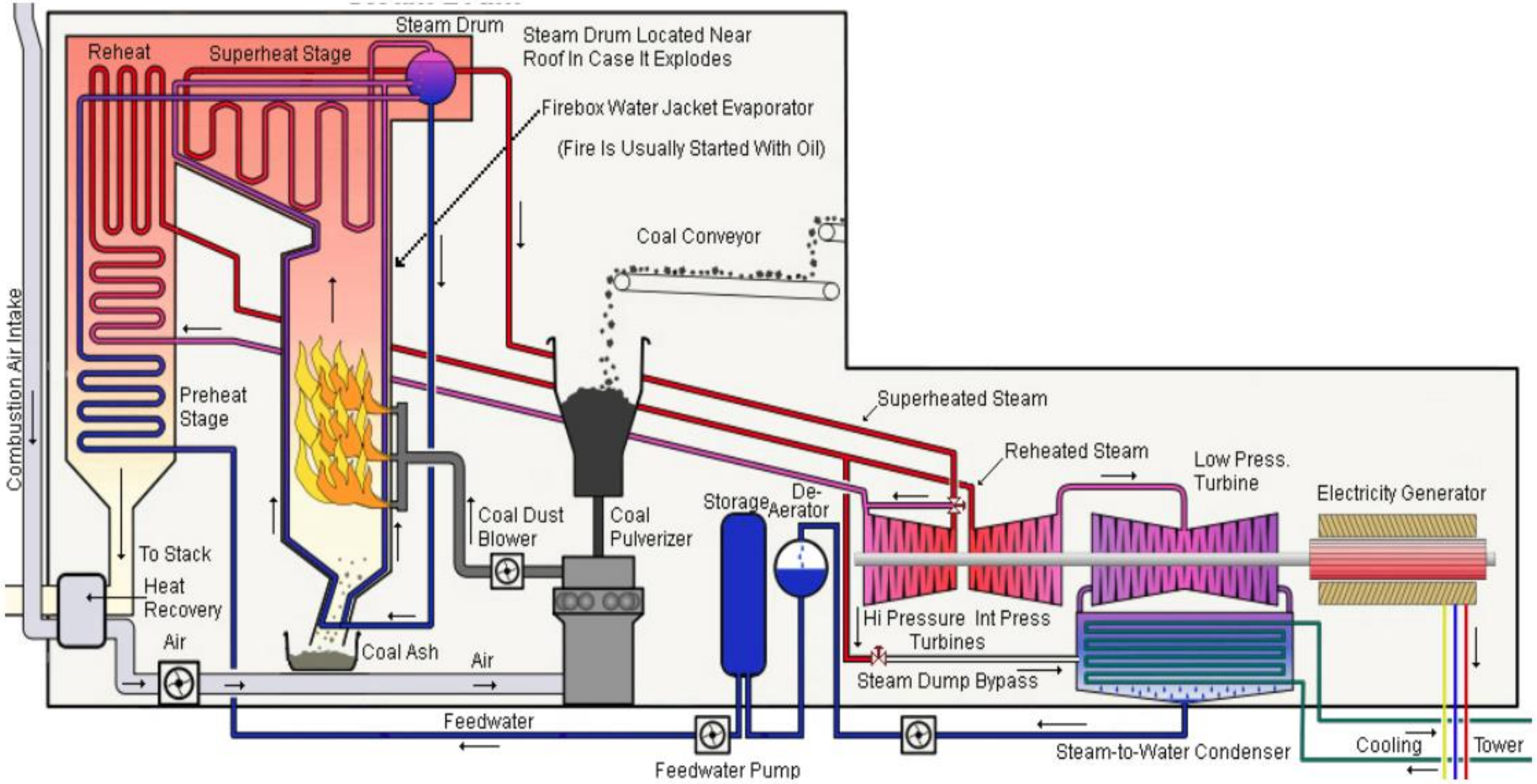
McILVAINE

Control Valves for High Temperature Service

Emerson Control Valve Handbook

- Control valves for service at temperatures above 450°F (232°C) must be designed and specified with the temperature conditions in mind. At elevated temperatures, such as may be encountered in boiler feedwater systems and superheater bypass systems, the standard materials of control valve construction might be inadequate. For instance, plastics, elastomers, and standard gaskets generally prove unsuitable and must be replaced by more durable materials. Metal-to-metal seating materials are always used. Semi-metallic or laminated flexible graphite packing materials are commonly used, and spiral-wound stainless steel and flexible graphite gaskets are necessary. Cr-Mo steels are often used for the valve body castings for temperatures above 1000°F (538°C). ASTM A217 Grade WC9 is used up to 1100°F (593°C). For temperatures on up to 1500°F (816°C) the material usually selected is ASTM A351 Grade CF8M, Type 316 stainless steel.
- For temperatures between 1000°F (538°C) and 1500°F (816°C), the carbon content must be controlled to the upper end of the range, 0.04 to 0.08%. The 9%Cr−1%Mo−V materials, such as ASTM A217 grade C12a castings and ASTM A182 grade F91 forgings are le- used at temperatures up to 1200°F (650°C). Extension bonnets help protect packing box parts from extremely high temperatures. Typical trim materials include cobalt based Alloy 6, 316 with alloy 6 hardfacing and nitrided 422 SST.

A more detailed diagram of a thermal power plant indicating the various systems and processes contained within – the remainder of this presentation will examine each system and the control valve applications associated



Condensate System (Trimteck)

How do the condensate system needs differ for

- Sub critical coal fired boilers
- Supercritical coal fired boilers
- Gas turbine combined cycle - base load
- Gas turbine combined cycle with rapid cycling
- Gas turbine combined cycle with air cooling and condensate contamination
- Nuclear power generators
- Biomass at the industrial scale

Condensate System

TRIMTECK® OPTIMUX™

In the *Condensate System*, condensate is taken from the condenser hotwell, circulated through low pressure heaters, and to the deaereator.

The condenser acts as a heat exchanger that serves the purpose of creating a vacuum which increases the efficiency of the turbine and recovering quality feedwater (condensate).

Main Components

- Condenser
- Condensate Pump
- LP Water Heater

Common Control Issues

Minimum Flow Requirement – pump requires constant minimum flow to prevent overheating and protect it from cavitation

Water Quality – dissolved and suspended impurities need to be ‘blown down’

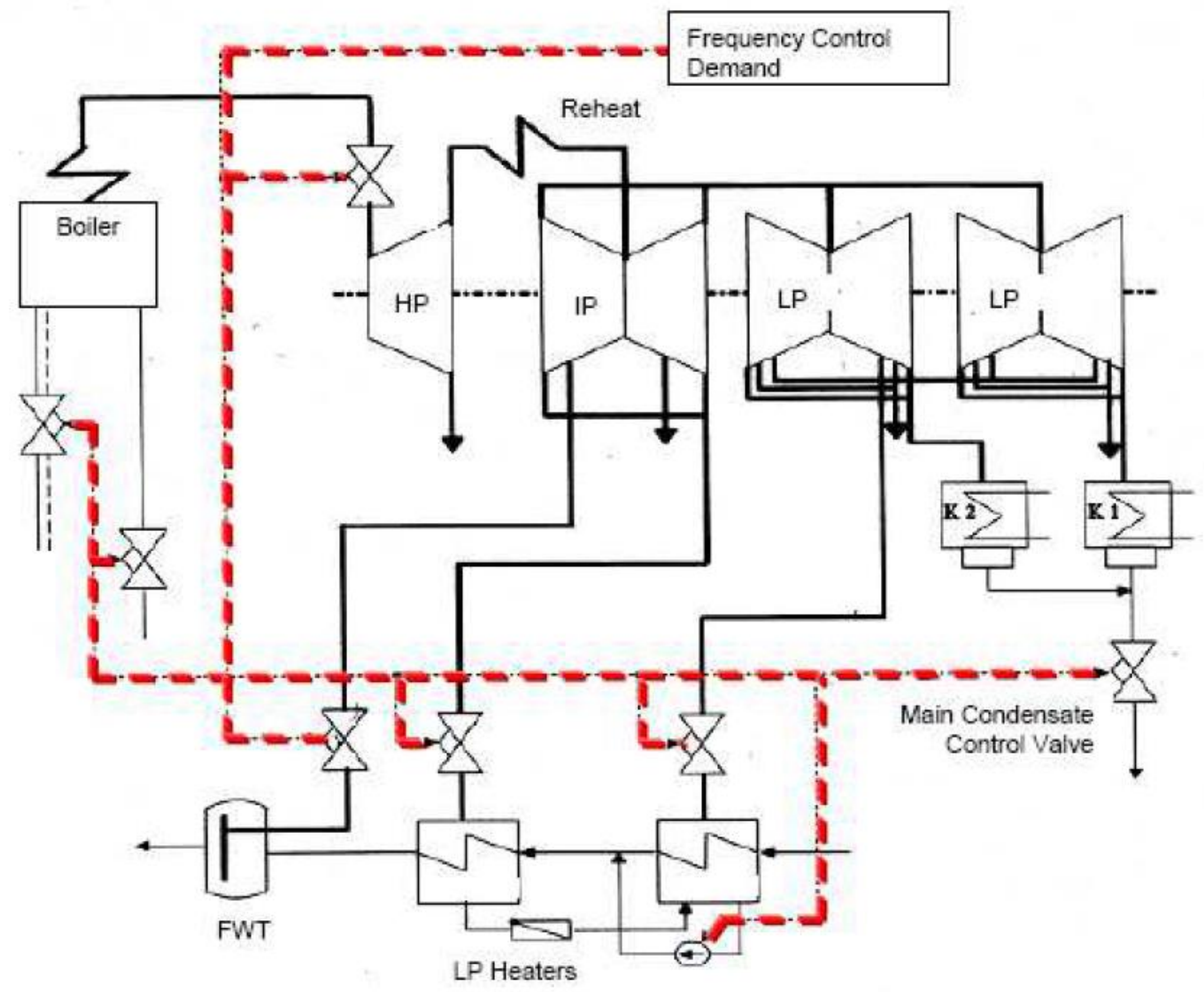
McILVAINE

Condensate Throttling at Lunen USC

Siemens has a number of recent installations of ultrasupercritical coal fired plants in Germany.

We would like more input from the suppliers of the valves for these plants.

There were large plants installed around 2012 and should reflect the latest in high pressure and temperature valve technology.



McILVAINE

Condensate System Control Applications -Trimteck

What valve designs and valve sizes are needed for control and on off for

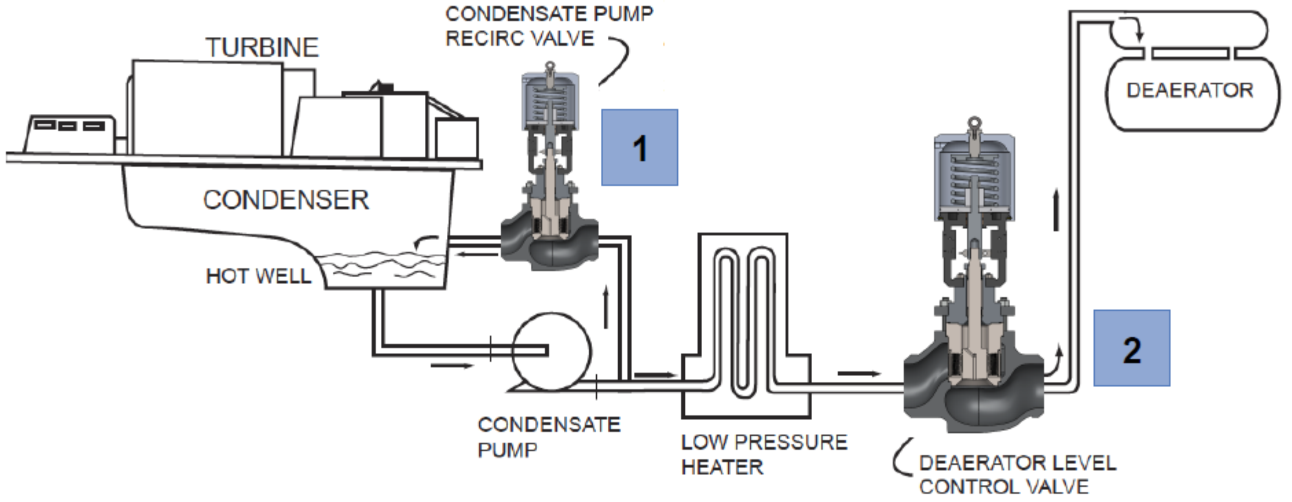
- Deaerator
- Deaerator level control
- Low pressure heater
- Condensate pump
- Condensate recirculation pump
- condenser

Condensate System Control Valve Applications

TRIMTECK® OPTIMUX™

1. ***Condensate Pump Recirculation Valve***: Used to allow additional flow required through the pump; outlet pressure from the pump ranges from 300 to 600 psi at temperatures from 100° to 150° F; experiences cavitation and must have positive shutoff i.e. a soft seat

2. ***Deareator Level Control Valve***: Maintains a level in the deareator, an open style of feedwater heater. Requirements: High Rangeability; Cavitation Protection at Low Flows; Low Resistance at Increasing Flows.



McILVAINE

Feedwater System TrimTeck

How do the feedwater system needs differ for

- Sub critical coal fired boilers
- Supercritical coal fired boilers
- Gas turbine combined cycle - base load
- Gas turbine combined cycle with rapid cycling
- Nuclear power generators
- Biomass at the industrial scale

Feedwater System

TRIMTECK® OPTIMUX™

The *Feedwater System* provides the boiler with water in the proper volume and at the design pressure and temperature – this usually means that feedwater is delivered to the boiler at approximately 2400-3200 psig and 300-500° F.

Main Components

- **Low and High Pressure Feedwater Heaters**
- **Deaerator**
- **Boiler Feedpump**

Common Control Issues

Low Flow – insufficient flow to the boiler can result in overheating of tubes

High Flow – excessive flow can result in wet steam entering the turbine and damaging the turbine blades

McILVAINE

Feedwater Control Valve Applications -Trimteck

What valve designs and valve sizes are needed for control and on off for

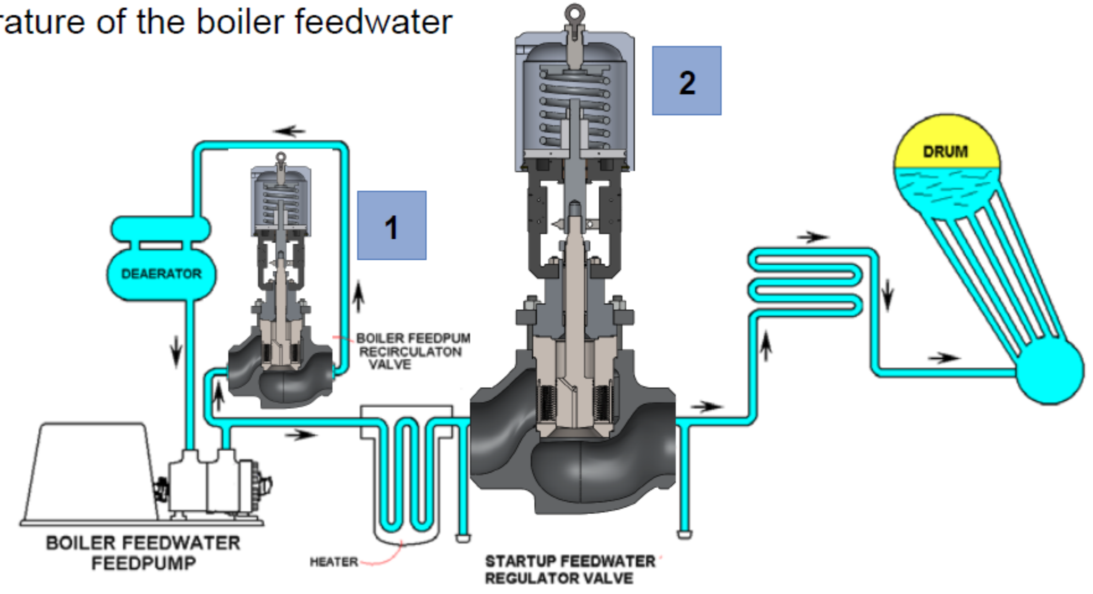
- Boiler feedwater pump
- Boiler feedwater recirculation
- Heater
- Feedwater regulator
- Other feedwater system applications

Feedwater System Control Valve Applications

TRIMTECK® OPTIMUX™

1. ***Boiler Feedpump Recirculating Valve***: This application is one of the most difficult ones in a power plant as it requires the valve to operate in both on-off and modulating service. Cavitation is present; requires an OpGL with multi-stage ST-2 or ST-4 + CVD-5B trim

2. ***Startup Feedwater Regulator Valve***: This valve is typically located after the HP Heater to control steam extracted from various stages of the turbine to raise the temperature of the boiler feedwater



- 16 -

McILVAINE

Main Steam System - Trimteck

How do the main steam system needs differ for

- Sub critical coal fired boilers
- Supercritical coal fired boilers
- Gas turbne combined cycle - base load
- Gas turbine combined cycle with rapid cycling
- Nuclear power generators
- Biomass at the industrial scale

Main Steam System

TRIMTECK® OPTIMUX™

The *Main Steam System* covers the portion of the plant that takes the steam from the boiler, sends it through superheaters, and into the high-pressure turbine. The steam exiting the high-pressure turbine is then sent through a reheater and fed into the low-pressure turbine.

Finally after all potential energy is extracted from the steam, it is dumped into the condenser to start the whole process over again.

Main Components

- Boiler
- Drum
- HP & LP Turbines
- Superheaters
- Reheater
- HP & LP Heaters

Common Control Issues

- With emphasis on planned cycling, new demands on boiler control during startup and low load operation

McILVAINE

Main Steam System Valves - Trimteck

What valve designs and valve sizes are needed for control and on off for

- Primary super heater
- Secondary super heater
- Main steam attemperator
- Reheater attemperator
- Turbine bypass
- Superheater bypass
- Other main steam applications

Main Steam System Valves

TRIMTECK® OPTIMUX™

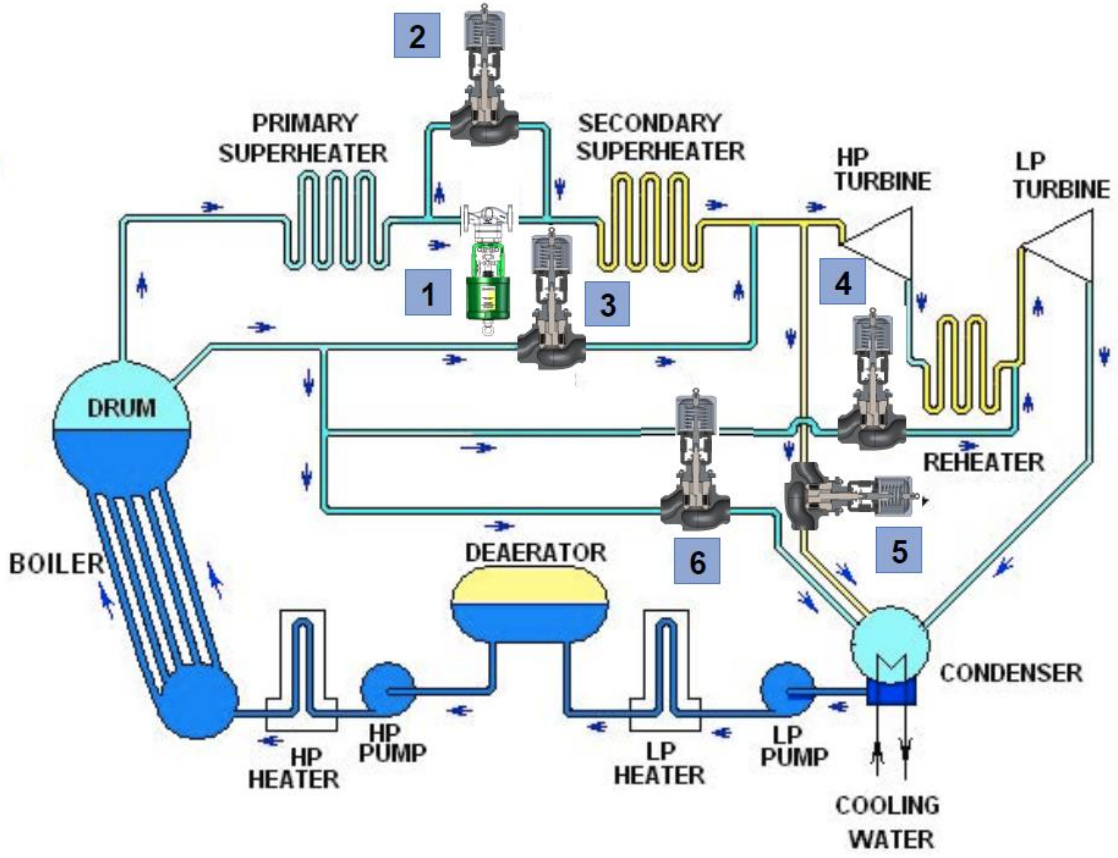
1. & 2. ***Superheater valves***: Maintain boiler pressure below 70%; and modulate pressure to the turbine

3. ***Main Steam Attemperator Valve***: Controls HP Turbine Temperature at 15% Load

4. ***Reheater Attemperator Valve***: Controls LP Turbine Temperature at 15% Load

5. ***Turbine Bypass Valve***

6. ***Superheater Bypass Valve***



- 19 -

BW Sliding Pressure Control Valves for Cycling once through Boiler

- The BW 401 Valves are also called the Sliding Pressure Control Valves in a Cycling, B&W, Once Through Boiler. These valves are critical components in the boiler start-up system. A typical Once Through plant will have several of these valves, whose primary function is to control main steam pressure to the turbine during ramping and de-ramping scenarios.

- In a Sliding Pressure scenario, the plant leaves the Main Turbine throttle valves pegged in the open position. The 401 valve, upstream of the secondary superheater, is then responsible for controlling steam load to the turbine. If done correctly, the plant is able to improve heat rate and efficiency because the process is isenthalpic so eliminating a pressure drop at the turbine governor valves, allows for a higher inlet temperature to the turbine, and in turn, an improved heat rate. Stable and precise control is required of these valves to reduce the potential for a unit trip on waterwall pressure/temperature excursions and to provide continual load control to the turbine.

- REXA Electraulic™ Actuators are well suited for this application, performing reliably in a hot and harsh environment, while providing tight control and first time start-ups, in automatic control, every time.

McILVAINE

Steam Conditioning Valves

A steam conditioning valve is used for the simultaneous reduction of steam pressure and temperature to the level required for a given application. Frequently, these applications deal with high inlet pressures and temperatures and require significant reductions of both properties. They are, therefore, best manufactured in a forged and fabricated body that can better withstand steam loads at elevated pressures and temperatures.

Forged materials permit higher design stresses, improved grain structure, and an inherent material integrity over cast valve bodies. The forged construction also allows the manufacturer to provide up to Class 4500, as well as intermediate and special class ratings, with greater ease versus cast valve bodies.

Due to frequent extreme changes in steam properties as a result of the temperature and pressure reduction, the forged and fabricated valve body design allows for the addition of an expanded outlet to control outlet steam velocity at the lower pressure. Similarly, with reduced outlet pressure, the forged and fabricated design allows the manufacturer to provide different pressure class ratings for the inlet and outlet connections to more closely match the adjacent piping.

McILVAINE

Steam Conditioning Valves

Emerson Control Valve Handbook

- Steam conditioning valves represent state-of-the-art control of steam pressure and temperature by integrally combining both functions within one control element unit.
- These valves address the need for better control of steam conditions brought on by increased energy costs and more rigorous plant operation. Steam conditioning valves also provide better temperature control, improved noise abatement, and require fewer piping and installation restrictions than the equivalent desuperheater and pressure reduction station.
- Steam conditioning valve designs can vary considerably, as do the applications they are required to handle. Each has particular characteristics.

Steam Conditioning Valve

The simplified trim configuration (used in the steam conditioning valve) accommodates rapid changes in temperature, as experienced during a turbine trip. The cage is case hardened for maximum life and is allowed to expand during thermally induced excursions. The valve plug is continuously guided and utilizes cobalt-based overlays both as guide bands and to provide tight, metal-to-metal shutoff against the seat.

The steam conditioning valve incorporates a spray water manifold downstream of its pressure reduction stage.

The manifold features variable geometry, backpressure activated spray nozzles that maximize mixing and quick vaporization of the spray water.

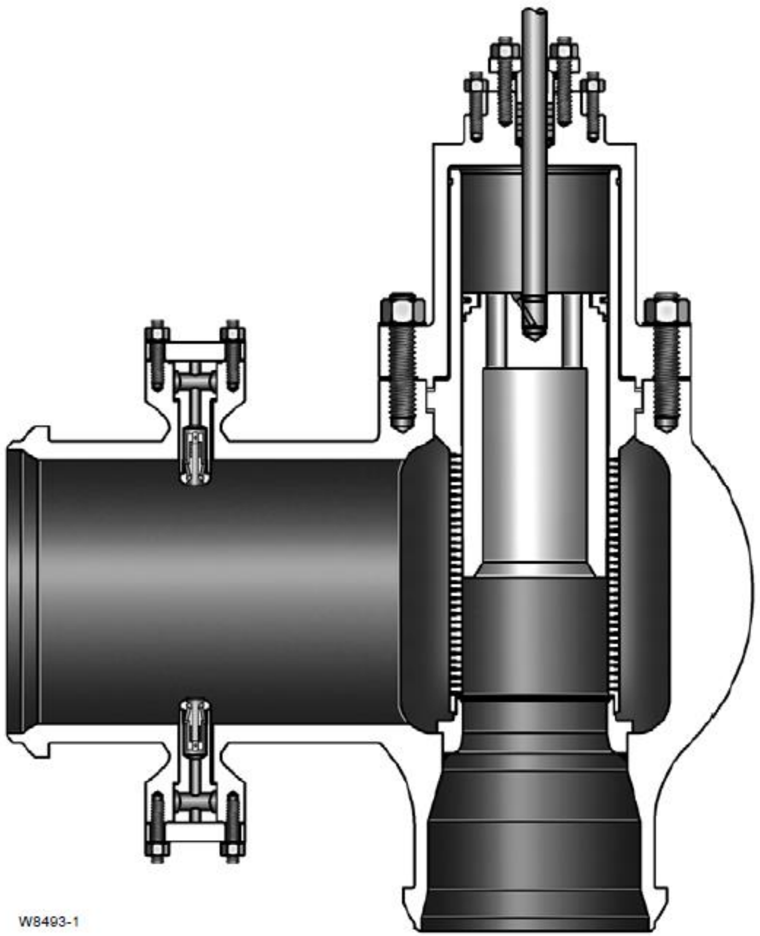


Figure 7-9. Cross-Section View of Steam ConditioningValve

McILVAINE

Steam Coolers

The steam cooler normally is used when an application requires a separation of the pressure reduction and desuperheating functions.

The steam cooler is equipped with a water supply manifold. The manifold (multiple manifolds are possible) provides cooling water flow to a number of individual spray nozzles installed in the pipe wall of the outlet section.

The result is a fine spray injected radially into the high turbulence of the axial steam flow.

The combination of large surface area contact of the water and high turbulence in the steam make for very efficient mixing and rapid vaporization.

McILVAINE

Turbine Bypass System

The turbine bypass system allows operation of the boiler independent of the turbine. In the start-up mode, or rapid reduction of generation requirement, the turbine bypass not only supplies an alternate flow path for steam, but conditions the steam to the same pressure and temperature normally produced by the turbine expansion process.

By providing an alternate flow path for the steam, the turbine bypass system protects the turbine, boiler, and condenser from damage that may occur from thermal and pressure excursions.

For this reason, many turbine bypass systems require extremely rapid open/close response times for maximum equipment protection.

This is accomplished with an electrohydraulic actuation system that provides both the forces and controls for such operation.

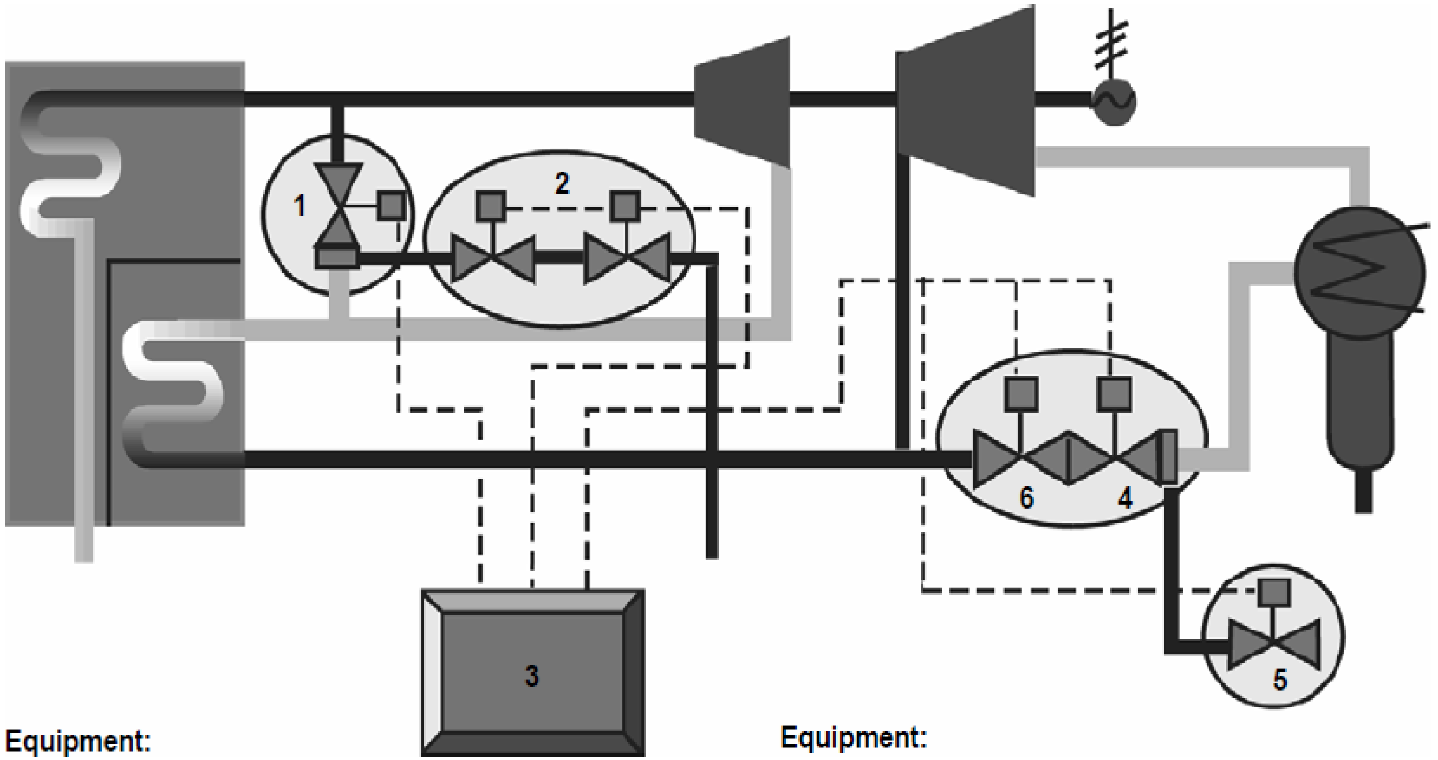
Additionally, when commissioning a new plant, the turbine bypass system allows start-up and check out of the boiler separately from the turbine.

This means quicker plant start-ups, which results in attractive economic gains.

McILVAINE

Turbine Bypass System

The major elements of a turbine bypass system are turbine bypass valves, turbine bypass water control valves, the electro-hydraulic system.



Equipment:

1. HP Turbine Bypass Steam Valves
2. HP Turbine Bypass Control and Water Isolation Valves
3. EHS Electrohydraulic System–
   Electrical Control Logic
   Hydraulic Control Logic
   Accumulators and Accumulator Power System

Hydraulic Power Unit
Control Cabinet
Piston Actuators and Proportional Valves

Equipment:

4. LP Turbine Bypass Steam Valves
5. LP Turbine Bypass Water Valves
6. LP Turbine Bypass Steam Stop Valves (optional)
3. EHS Electrohydraulic system

B2569 / IL

Figure 7-14. Turbine Bypass System

Turbine Bypass System Valves

Turbine Bypass Valves

Whether for low-pressure or high-pressure applications, turbine bypass valves are usually the manifold design steam conditioning valves previously described with tight shutoff(Class V). Because of particular installation requirements these manifold design valves will occasionally be separated into two parts: the pressure-reducing portion of the valve and then the outlet/manifold cooler section located closer to the condenser.

Regardless of the configuration, however, a cost effective solution is a fixed-orifice device (usually a sparger) located downstream for final pressure reduction to minimize the size of the outlet pipe to the condenser.

Turbine Bypass Water Control Valves

These valves are required to control the flow of the water to the turbine bypass valves. Due to equipment protection requirements, it is imperative that these valves provide tight shutoff (Class V).

Electro-Hydraulic System

This system is for actuating the valves. Its primary elements include the actual hydraulic actuators, the hydraulic accumulator and power unit, and the control unit and operating logic.

CE-Boiler Throttle Bypass

- The CE – BTB Valves (Boiler Throttle Bypass Valves) are used in conjunction with the BT valves to control Main Steam Pressure in a CE, Once Through Boiler. These valves are also responsible for controlling waterwall pressures through transfer from flash tank/separator system to once through operation.
- In a CE Once through Boiler design, the original valves for these applications were large unbalanced style Sulzer valves. These valves are critical components in the boiler start-up system, and require a high amount of force to operate. A typical Once Through plant will have several of these valves. Stable control is required of these valves to reduce the potential for a unit trip on waterwall pressure/temperature excursions.
- REXA Electraulic™ Actuators are well suited for this application. They perform reliably in hot, nasty environments, while providing tight control and first time start-ups, in automatic control, every time.

McILVAINE

CE-Main Steam Pressure Reducing Valves

- The CE – BT Valves are also called the Main Steam Pressure Reducing Valves in a Base Loaded, CE, Once Through Boiler. In a CE Once Through Boiler design, the original valves for this application were large, unbalanced-style, Sulzer valves. These valves are critical components in the boiler start-up system, and require an excessive amount of force to operate. A typical Once Through plant will have several of these valves.
- Their primary function is to control main steam pressure to the turbine during ramping and de-ramping scenarios. Stable control is required of these valves to reduce the potential for a unit trip on waterwall pressure/temperature excursions. Rexa Electraulic™ Actuators are well suited for this application. They perform reliably in hot, nasty environments, while providing tight control and first time start-ups, in automatic control, every time.

McILVAINE

FW "W" Main Steam Pressure Reducing Valves

- The FW “W” Valves are the main steam pressure reducing valves in a Base Loaded, FW, Once Through Boiler. These valves are critical components in the boiler start-up system. A typical Once Through plant will have more than one of these valves, whose primary function is to control main steam pressure to the turbine during ramping and de-ramping scenarios.

- The “W” Valve is located upstream of the separator system and typically is active in controlling through 25% load. Stable control is required of these valves to reduce the potential for a unit trip on waterwall pressure/temperature excursions. REXA Electraulic™ Actuators are well suited for this application, performing reliably in a hot and harsh environment, while providing tight control and first time start-ups, in automatic control, every time.

McILVAINE

Soot Blower Header Valves

Soot blowers utilize steam to dislodge flyash and other deposits on boiler tubes. They are not needed with some clean fuels such as gas.

Some poor coals have more than 30% ash and will need more robust soot blowing than coals with only a few percent ash.

What valve designs and sizes are recommended?

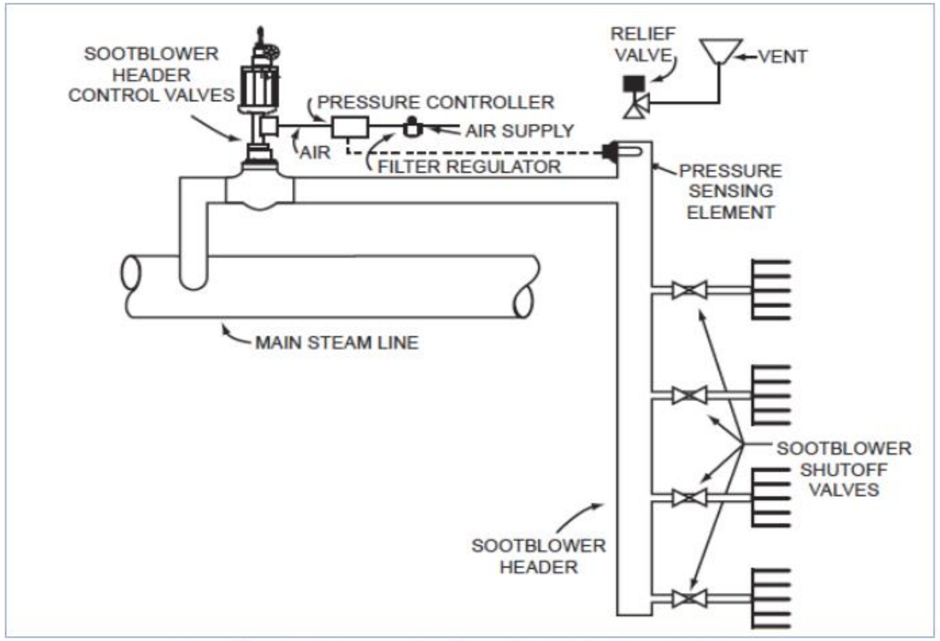
Sootblower Header Control Valve

TRIMTECK® OPTIMUX™

A *Regulating (Modulating) Valve* is required to control the pressure in the sootblower header. As the sootblowers open and close, the header control valve must respond quickly to avoid pressure surges that would set off safeties.

Class V shutoff is required because any leakage though the header control valve would increase header pressure.

OpGL Globe Control Valve



Sootblower System tied into the Main Steam Line

- 20 -

McILVAINE

Attemperator Spray Control Valves

What valve designs and valve sizes are needed for control and on off for

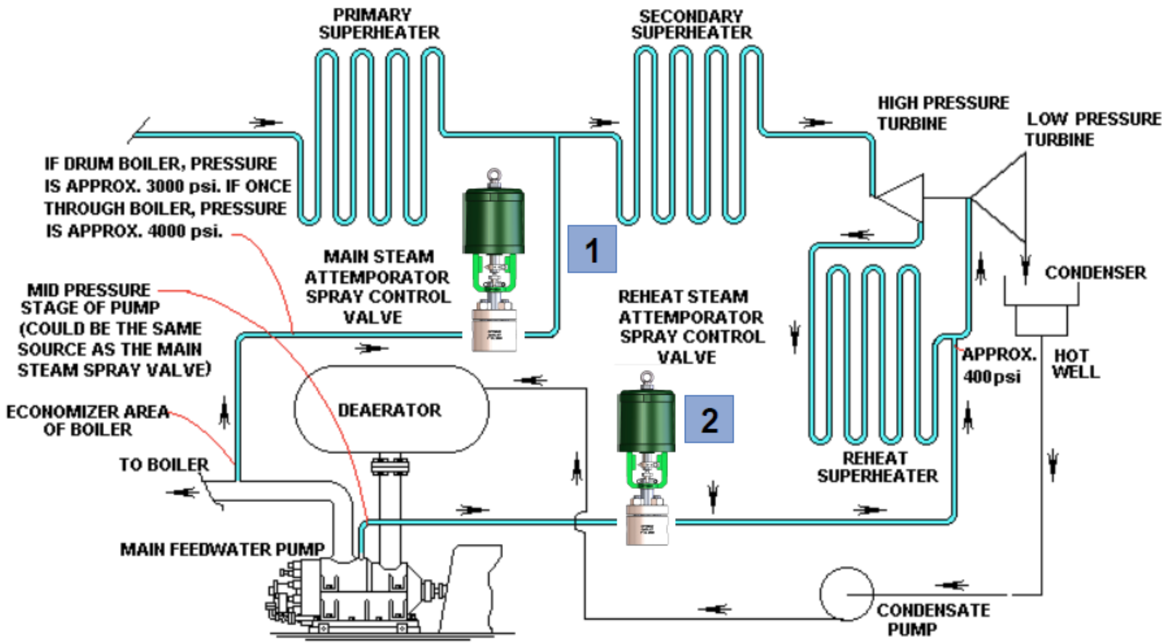
- Main attemperator
- Reheat attemperator
- Other attemperator applications

TRIMTECK® OPTIMUX™

Attemperator Spray Control Valves

Attemperator Spray Control Valves **control the amount of water required to control the steam temperature exiting the superheaters**

The *Main Steam Attemperator Control Valve (1)* **takes a relatively low pressure drop, but requires high rangeability; the** *Reheat Attemperator Control Valve (2)* **sees a significantly higher pressure drop – ST-2 Anti Cavitation trim is used**



McILVAINE

Overview of CCGT Major Systems

(Boiler Feed, HRSG, Turbine, Condenser, Flue gas, Other Systems)

Hot reheat bypass valve selection

HRH valve requirements are complex from a mechanical design standpoint. The ANSI 600-lb-rated valves range from 12 to 24 inches in diameter. They must tightly shut off and be able to be throttled (conflicting requirements for such difficult service), and their body and trim materials must deal with rapid thermal transients. Noise control and extended trim life also have become very important design requirements.

Unbalanced HRH valves are typically not used in this application because the actuation forces required for valves of this size would be too large for conventional pneumatic actuators. However, because tight shutoff is a design requirement, pilot-balanced trim is common. This design allows for the use of relatively low actuator thrust at full differential pressure (balanced when open), while enabling full unbalanced forces on the valve seat in the closed position (installed in the flow-to-close direction) to ensure tight shutoff.

Special materials, tolerances, body/trim/bonnet arrangements, and flow paths (warming lines, for example) are used to address the thermal cycling issues that HRH valves must deal with, such as weld fatigue and internal reliability. Many designs have forsaken pneumatic actuators fitted with standard positioners and volume boosters to meet stroking speed requirements in favor of smart positioners with boosters that improve diagnostic capabilities and reduce overshoot.

What is the latest information on smart positioners?

McILVAINE

Reheat Attemperator

- Reheat Attemperation is used as a final control of steam temperature into the IP section (sometimes LP section depending upon plant design) of the Steam Turbine. The steam extracted from the HP section of the turbine is passed back through the boiler, through the reheater, prior to entering the next stage of the turbine. A reheat attemperator is used here to spray water into either the reheat line to control the steam temperature. Like superheat attemperators, reheat attemperators are subject to the changes that are made in controlling main flue gas temperature in combustion. The reheat steam pressures exiting the HP section of the turbine; however, are much less than superheat steam pressures entering them, which means that the pressure drop across reheat temperature control valves is much greater. This dynamic can cause a cavitating process condition when these attemperators need to be operated close to the seat, which may be frequently in a cycling plant. These difficult service conditions typically make for rapid and excessive trim wear in these valves. Operationally, trim erosion in the reheat attemperators makes accurate reheat temperature difficult to impossible to control in cycling operation, costing the plant in efficiency.
- The use of REXA Linear and Rotary Actuators in reheat temperature control applications gives cycling power plants the ability to make substantial gains in efficiency, allowing for minimal valve throttling capabilities, tight shutoff, and maximum trim life, for virtually any manufacturers control valve.

Desuperheaters

What valve designs and valve sizes are needed for control and on off for

- Desuperheater control
- Desuperheater isolation

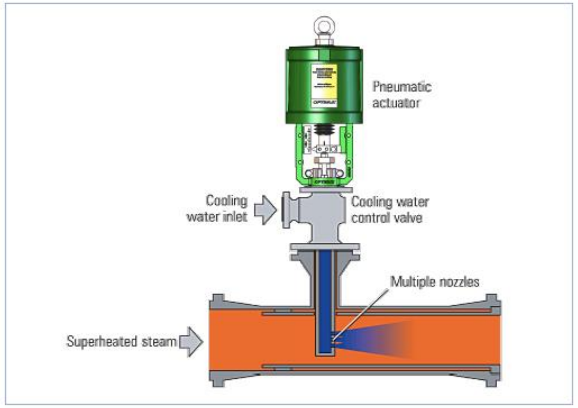
Desuperheaters

TRIMTECK® OPTIMUX™

A *desuperheater* works in conjunction with the attemperator valve – sometimes called the cooling water valve – to lower the temperature of superheated steam

An efficient and well-designed desuperheater is able to inject a predetermined amount of water into the steam flow and maintain a temperature of 10 degrees over the steam saturation temperature.

Modern desuperheater valve designs are capable of controlling water flow at high velocities, often overcoming the effects of caviation to finally deliver a controlled and atomized water spray



McILVAINE

Desuperheater Basics

Emerson Control Valve Handbook

- Superheated steam provides an excellent source of energy for mechanical power generation. However, in many instances, steam at greatly reduced temperatures, near saturation, proves a more desirable commodity. This is the case for most heat–transfer applications. Precise temperature control is needed to improve heating efficiency; eliminate unintentional superheat in throttling processes; or to protect downstream product and/or equipment from heat related damage.
- One method to reduce temperature is the installation of a desuperheater. A desuperheater injects a controlled, predetermined amount of water into a steam flow to lower the temperature of the steam. To achieve this efficiently, the desuperheater must be designed and selected correctly for the application. Although it can appear simplistic in design, the desuperheater must integrate with a wide variety of complex thermal and flow dynamic variables to be effective.
- The control of the water quantity, and thus the steam temperature, uses a temperature control loop. This loop includes a downstream temperature sensing device, a controller to interpret the measured temperature relative to the desired set point, and the transmission of a proportional signal to a water controlling valve/actuator assembly to meter the required quantity of water

McILVAINE

Fixed Geometry Nozzle Design

Emerson Control Valve Handbook

- The fixed geometry nozzle design is a simple mechanically atomized desuperheater with single or multiple fixed geometry spray nozzles. It is intended for applications with nearly constant load changes (rangeability up to 5:1) and is capable of proper atomization in steam flow velocities as low as 14 feet per second under optimum conditions.
- Standard installation of this type of unit is through a flanged branch connection tee on a 6-inch or larger steam pipe line. This design is usually not available for large Cv requirements. This unit requires an external water control valve to meter water flow based on a signal from a temperature sensor in the downstream steam line.

Variable Nozzle for 8” and Larger Pipes

Emerson Control Valve Handbook

- The variable geometry nozzle design is also a simple mechanically atomized desuperheater, but it employs one or more variable geometry, back pressure activated spray nozzles. Due to the variable geometry, this unit can handle applications requiring control over moderate load changes (rangeability up to 20:1) and is capable of proper atomization in steam flow velocities as low as 14 feet per second under optimum conditions.
- Standard installation of this type of unit is through a flanged branch connection tee on an 8-inch or larger steam pipe line. These units are available for large Cv requirements. This design requires an external water control valve to meter water flow based on a signal from a temperature sensor in the downstream steam line.

Self Contained Nozzle Design

Emerson Control Valve Handbook

- The self-contained design is also mechanically atomized with one or more variable geometry, back pressure activated spray nozzles. As a special feature, this unit incorporates a water flow control element that performs the function normally provided by an external water control valve. This control element has a plug that moves inside a control cage by means of an actuator, which receives a signal from a temperature sensor in the downstream steam line. The water flow then passes to the variable geometry nozzle(s) and is atomized as it enters the steam pipe line.
- Because of the close coordination of the intrinsic control element and the variable geometry nozzle(s), this unit can handle applications requiring control over moderate to high load changes (rangeability up to 25:1). It offers proper atomization in steam flow velocities as low as 14 feet per second under optimum conditions. Standard installation of this type of unit is through a flanged branch connection tee on an 8-inch or larger steam pipe line. These are available for moderate Cv requirements.

McILVAINE

Secondary Superheater Bypass Valves

- The BW 207 Valves are also called the Secondary Superheater Bypass Valves in a Base Loaded or Cycling, B&W, Once Through Boiler. These valves are critical components in the boiler start-up system. A typical Once Through plant will have a few of these valves, whose primary function is to control steam flow to flash tank and to maintain primary superheater outlet temperature during ramping and de-ramping scenarios.
- Stable control is required of these valves to reduce the potential for a unit trip on waterwall pressure/temperature excursions.
  REXA Electraulic™ Actuators are well suited for this application. They perform reliably in hot, nasty environments, while providing tight control and first time start-ups, in automatic control, every time!

McILVAINE

Metso Control Valves for 450 MW CHP ®® Plant

Metso has signed an agreement on a comprehensive valve delivery for Kilpilahti Power Plant in Porvoo, Finland.

- Metso's valves will be used in conjunction with the power plant's three different boiler units to control the power plant's process flows. Optimally selected, reliable valve solutions enable efficient and safe energy production at low costs and with minimal environmental impacts.
- The new, combined heat and power plant will generate 450 megawatts of steam and 30 megawatts of electricity. The plant, jointly owned by Neste, Borealis and Veolia, is planned to be commissioned in 2018.
- The delivery is included in Metso's third quarter 2016 orders received. The value of the order is not disclosed. Metso's valves will be delivered as a part of Valmet Corporation's boiler delivery for the project.
- Comprehensive valve solutions for power production
- Included will be 150 on/off and control valves. (0.33 valves/MW)
- "Our control and on-off valves have been on the markets for decades and have proven their reliability in similar power plant projects around the world. We also continuously invest in flow control solutions in power production, a good example being the globe valves we recently introduced for continuous, demanding use," says Metso Flow Control's Jyrki Koskela, Head of Sales and Service, Finland & Baltic Countries.

  "In power plant applications, durability and reliability are among the most important valve features because unscheduled interruptions in the continuous processes need to be minimal. The Kilpilahti owners are familiar with our valves, as there are plenty of Metso's flow control solutions in use also by Neste's Porvoo oil refinery," Koskela continues.

McILVAINE

Emerson Control Valve Order for 2800 MW Rabigh 2

- Emerson Process Management has received a purchase order valued at more than US$10 million for Fisher® control valves to be used in Saudi Electricity Company's (SEC) Rabigh Power Plant No.2 project. The contract was awarded by Doosan Heavy Industries of South Korea, the project's EPC contractor. The valves will help SEC maintain accurate, reliable control performance in demanding applications such as feedwater recirculation and steam control. The 2800MW (700MW X 4) power plant with an investment of US$3.4 billion is one of the major initiatives by SEC to meet the growing energy demand in Saudi Arabia. Emerson won the project largely on the basis of its global expertise, knowledge, and experience in the power industry.
- Under the contract, Emerson will supply 670 Fisher control valves for boiler, turbine gas, multi-stage flash desalination, and selective catalytic reduction applications as well as for the balance of plant. The work will also include valve engineering, project management, site start-up and commissioning support.
- The average is $15,000 per valve x 0.24 valves /MW
- Eight NPS24 EH valves will be used in high pressure feedwater control to the economizer, one of the key applications in a power plant. The project will also take advantage of Emerson's Fisher FIELDVUE™ DVC6200 digital valve controller with integral position transmitter, making it one of the first power plants to use the linkage-less feedback technology that helps improve reliability under harsh environments and high cycle applications .
- Fisher EH series valves are specially designed for high-pressure applications and incorporate proven techniques in flow-stream contouring for higher capacities and in valve trim design for reliability in severe applications.

McILVAINE

Nuclear Control Valve Requirements

Emerson Control Valve Handbook

- Since 1970, U.S. manufacturers and suppliers of components for nuclear power plants have been subject to the requirements of Appendix B, Title 10, Part 50 of the Code of Federal Regulations entitled Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants. The U.S. Nuclear Regulatory Commission enforces this regulation. Ultimate responsibility of proof of compliance to Appendix B rests with the owner of the plant, who must in turn rely on the manufacturers of various plant components to provide documented evidence that the components were manufactured, inspected, and tested by proven techniques performed by qualified personnel according to documented procedures. In keeping with the requirements of the Code of Federal Regulations, most nuclear power plant components are specified in accordance with Section III of the ASME Boiler and Pressure Vessel Code entitled Nuclear Power Plant Components. All aspects of the manufacturing process must be documented in a quality control manual and audited and certified by ASME before actual manufacture of the components. All subsequent manufacturing materials and operations are to be checked by an authorized inspector. All valves manufactured in accordance with Section III requirements receive an ASME code nameplate and an N stamp symbolizing acceptability for service in nuclear power plant applications.
- Section III does not apply to parts not associated with the pressure−retaining function, to actuators and accessories unless they are pressure retaining parts, to deterioration of valve components due to radiation, corrosion, erosion, seismic or environmental qualifications, or to cleaning, painting, or packaging requirements.

McILVAINE