TRIMTECK®

OPTIMUX™

Control Valves for the Power Generation Industry

A Product and Applications Overview

July 2015

About Trimteck

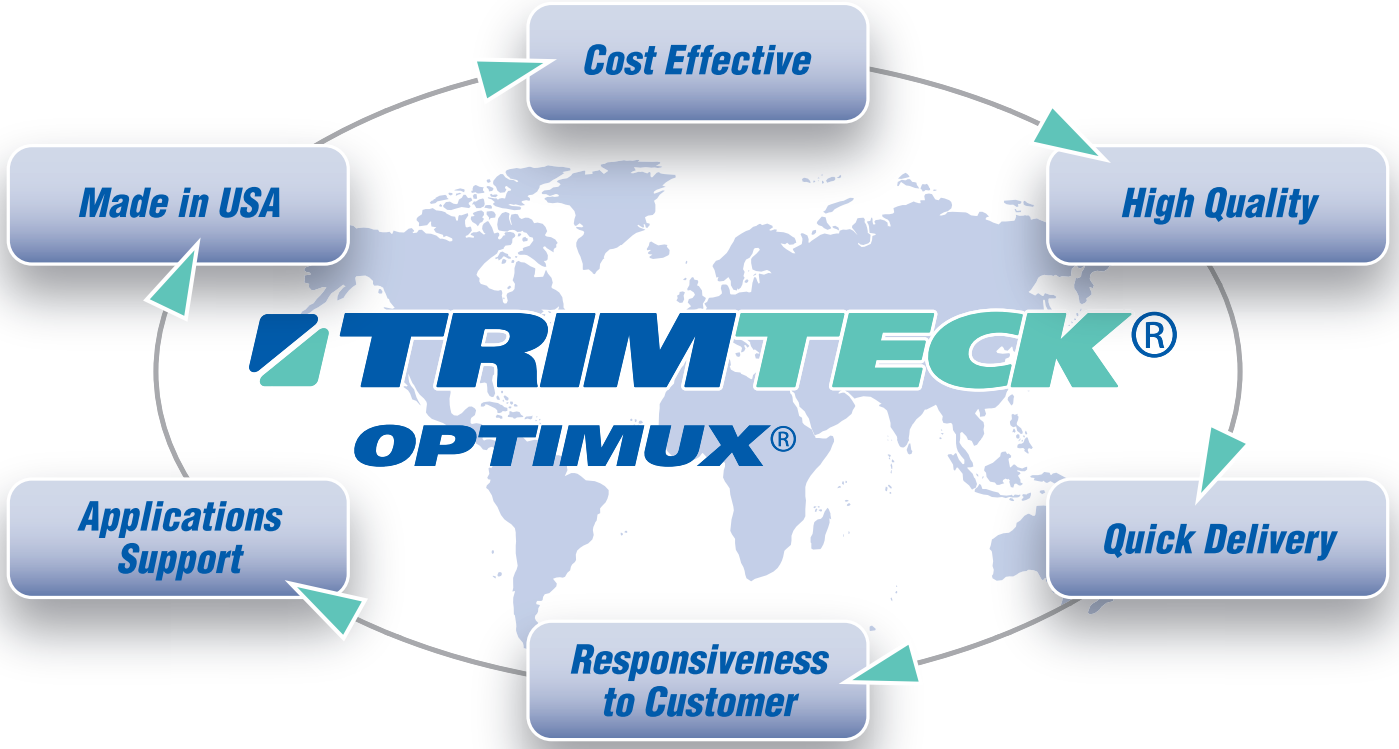
Trimteck is a family-owned American company with over thirty years of experience in engineering, manufacturing, and marketing flow control solutions and equipment for a variety of industries. Our application engineers and certified representatives are **committed to personalized customer service** and have an extensive line of products and technologies to draw upon when designing and specifying a solution.

With a comprehensive line of **Optimux control valves** – and an array of actuators, positioners, severe service trims, and other accessories – our engineers and representatives **can solve the most complex flow, pressure, and temperature control problems quickly and economically**. Moreover, our organizational focus on implementing highly efficient sourcing, engineering, manufacturing, assembly, and distribution processes enables us to **guarantee world-class quality, competitive pricing, and rapid delivery** to anywhere in the world.

Welcome to **Trimteck**.

Value Proposition

We are an innovative, agile organization that competitively offers a full line of control valves of exceptional quality and proven design



Agenda

I. Introduction to Power Generation

II. Condensate System

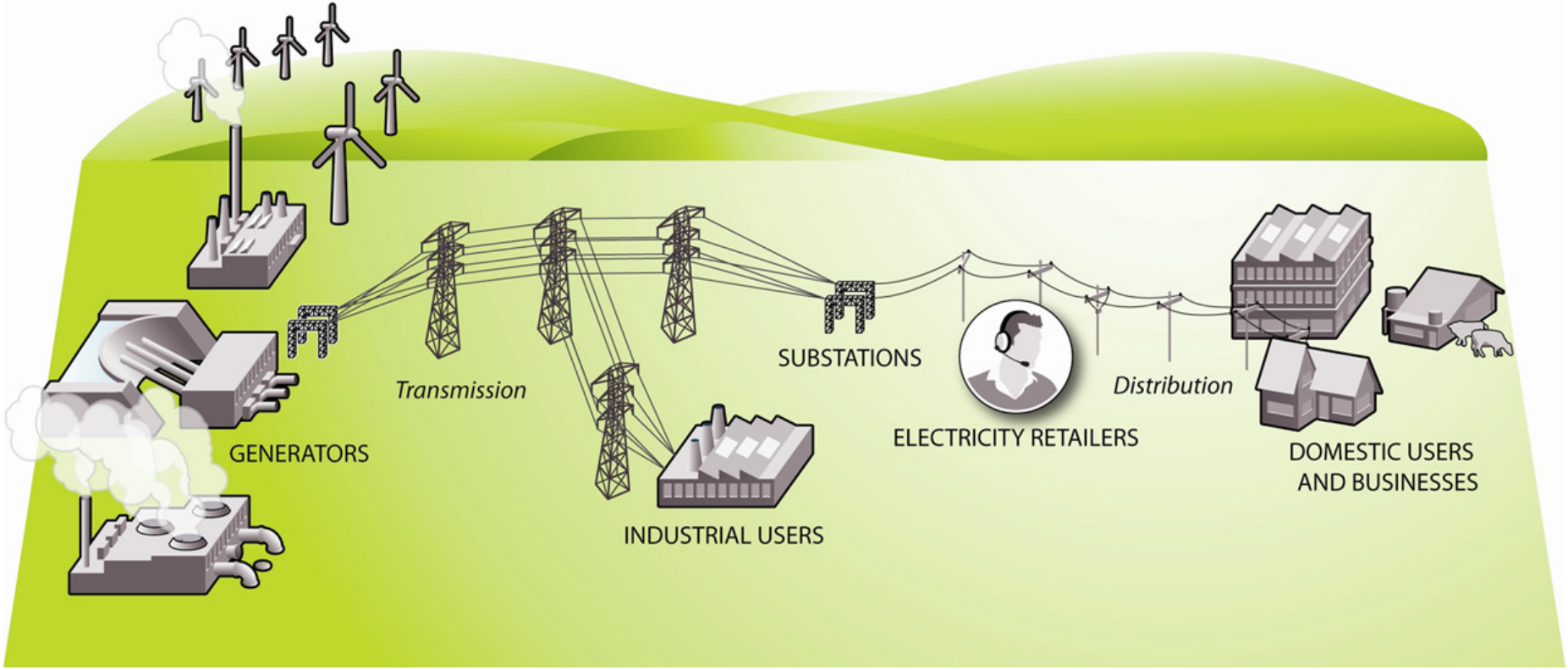
III. Feedwater System

IV. Main Steam System

V. Power References & Case Studies

VI. Products

Power Generation is the production of electricity from sources of primary energy; for utilities, it is the first process in delivering electricity to customers.



Classifying Power Plants

Power Plants are commonly categorized by what *primary energy source* they use, as well as how much *output* they produce, which is typically measured in MW.

This presentation will focus on conventional *thermal* power plants, in which fuel is burned and the resulting physical energy spins a turbine, which turns a generator that produces electricity – most renewable sources of electric generation, such as hydro, wind, and photovoltaic solar, are not thermal and are referred to as unconventional

Thermal Power Plants are generally classified by fuel source, as follows:

Nuclear

A controlled fusion reaction using uranium heats water to create steam power.

Fossil

One of the following fossil fuels are burned:

- Coal
- Natural Gas
- Crude Oil

Biomass

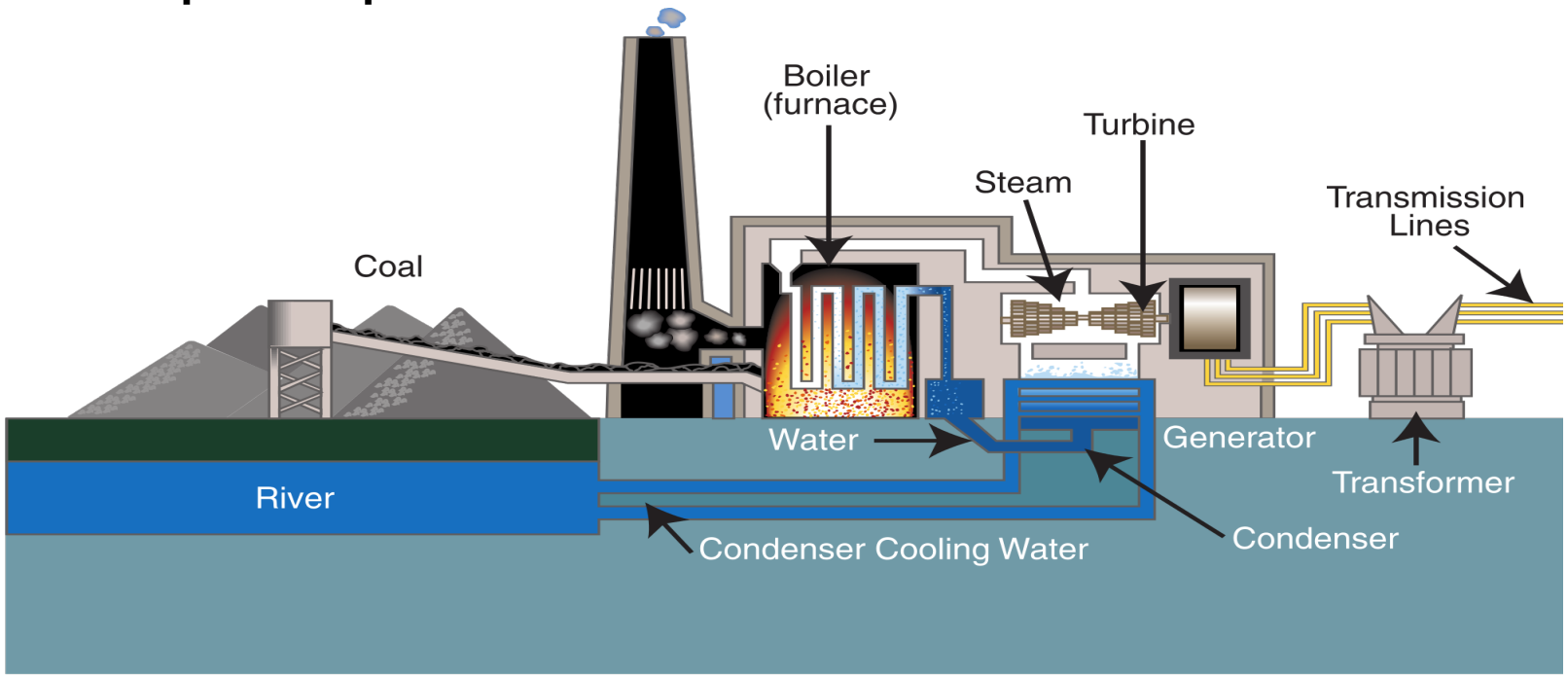
Biological matter derived from living or recently-living materials are burned.

- Switchgrass
- Solid Organic Waste
- Wood

The conventional *thermal power generation process is a continuous cycle*, each part of the cycle builds upon the previous process in a continuous loop

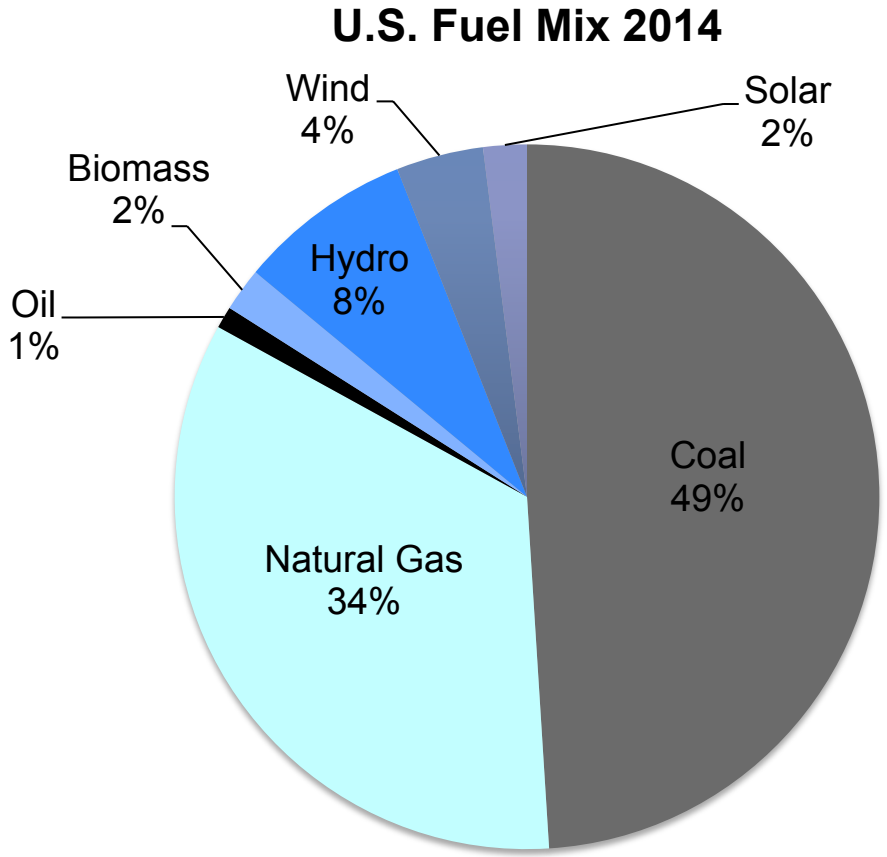
Power plants are therefore inherently *complex facilities* involving many systems and demanding the use of *critical instrumentation and control valves*

Regardless of the fuel used, the majority of thermal power plant processes are similar from plant to plant



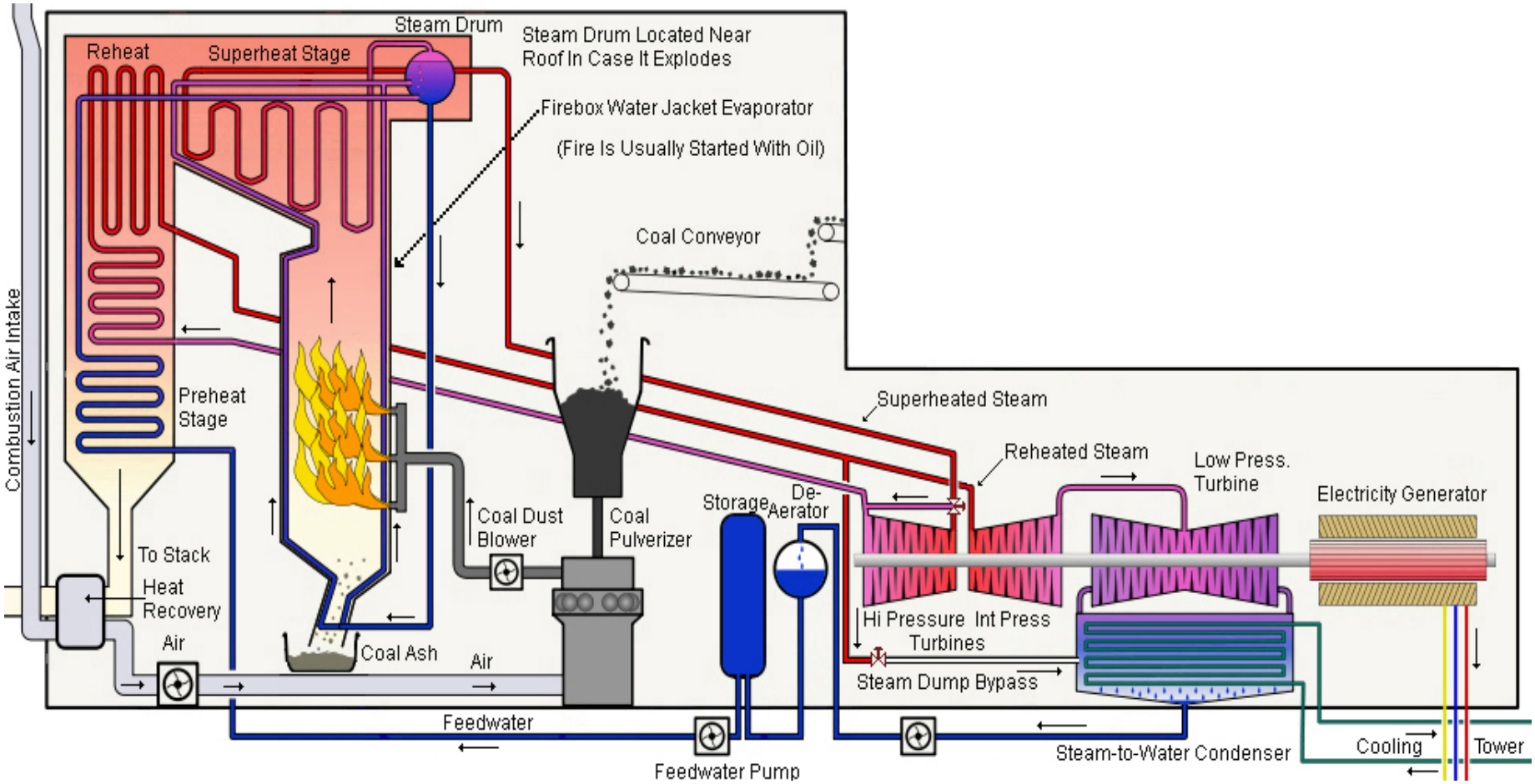
U.S. Power Generation Fuel Mix

Coal-fired power plants still represent almost half of the power plants in the U.S., however natural gas is rapidly becoming the leading power plant fuel due to its prevalence and low cost



Overview: Systems in a Conventional Thermal Power Plant

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



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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’

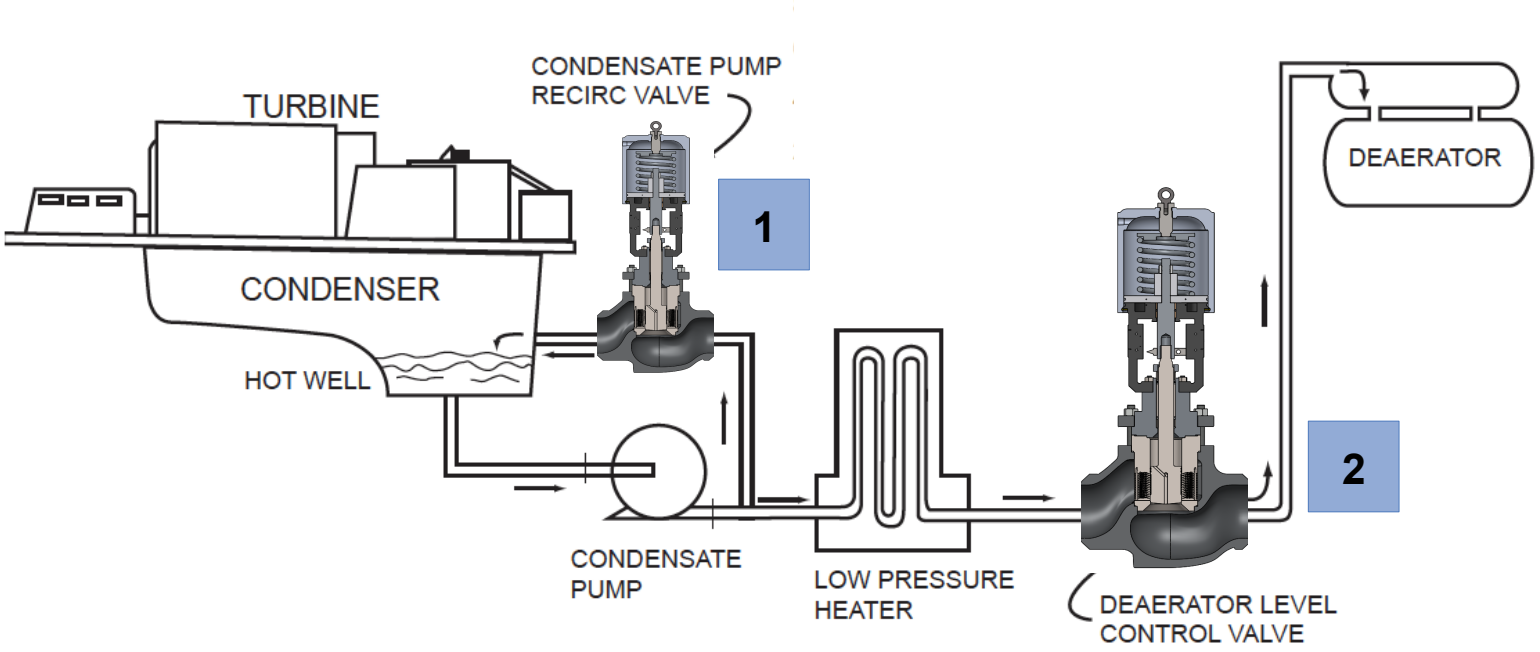
Common Water Quality Problems

Major Problem	Deaerator	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

Condensate System Control Valve Applications

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 100º to 150º 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.



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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^{0} F.

Main Components

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

Common Control Issues

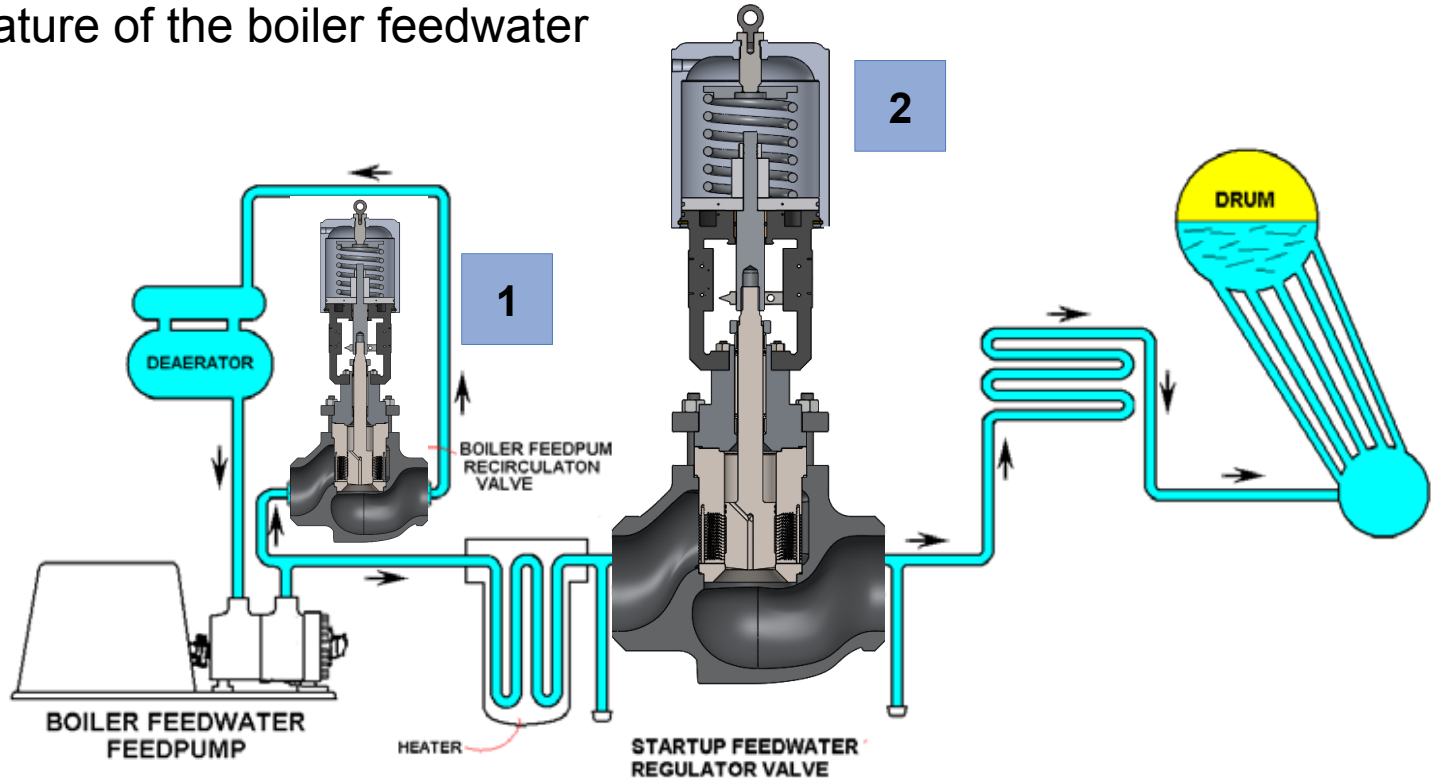
Low Flow – insufficient flow to the boiler can result in overheating of tubes

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

Feedwater System Control Valve Applications

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



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Main Steam System

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

Main Steam System Valves

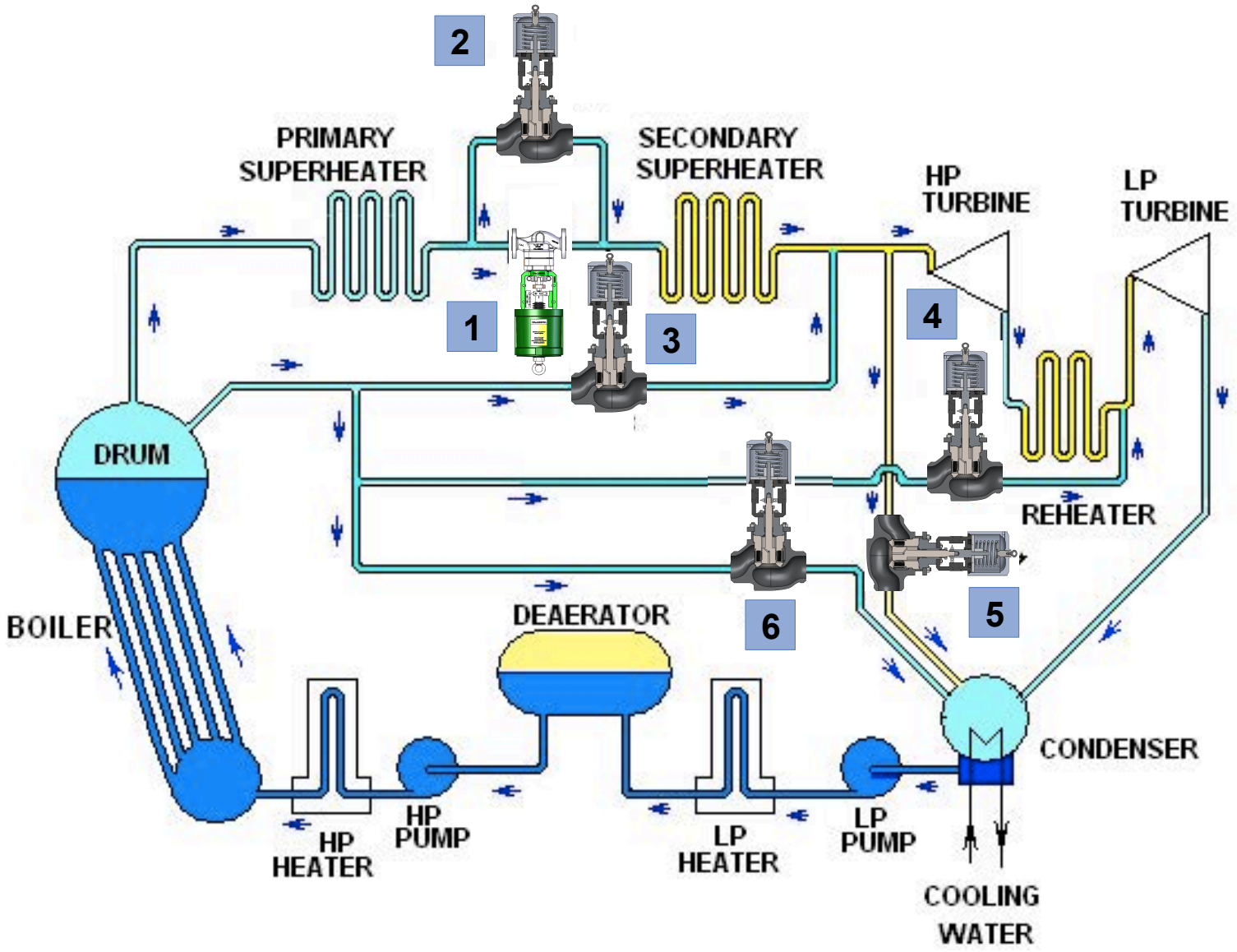
***1. & 2. Superheater valves*:** Maintain boiler pressure below 70%; and modulate pressure to the turbine

***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

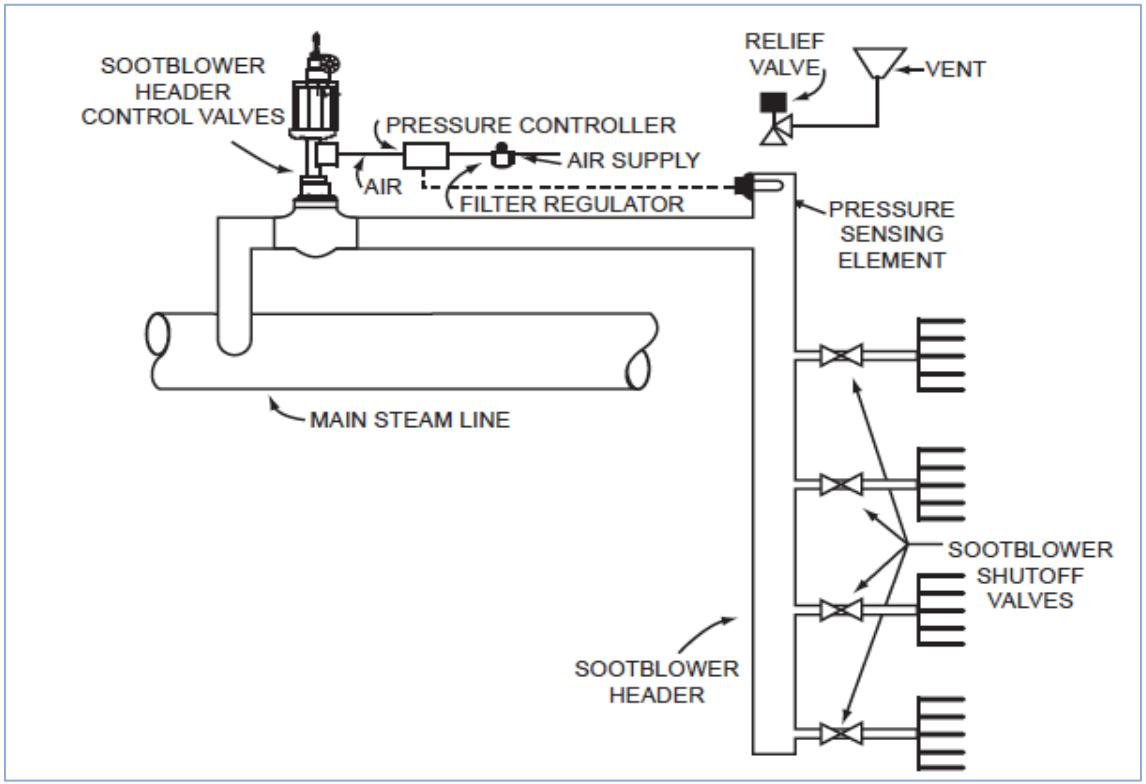


Sootblower Header Control Valve

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

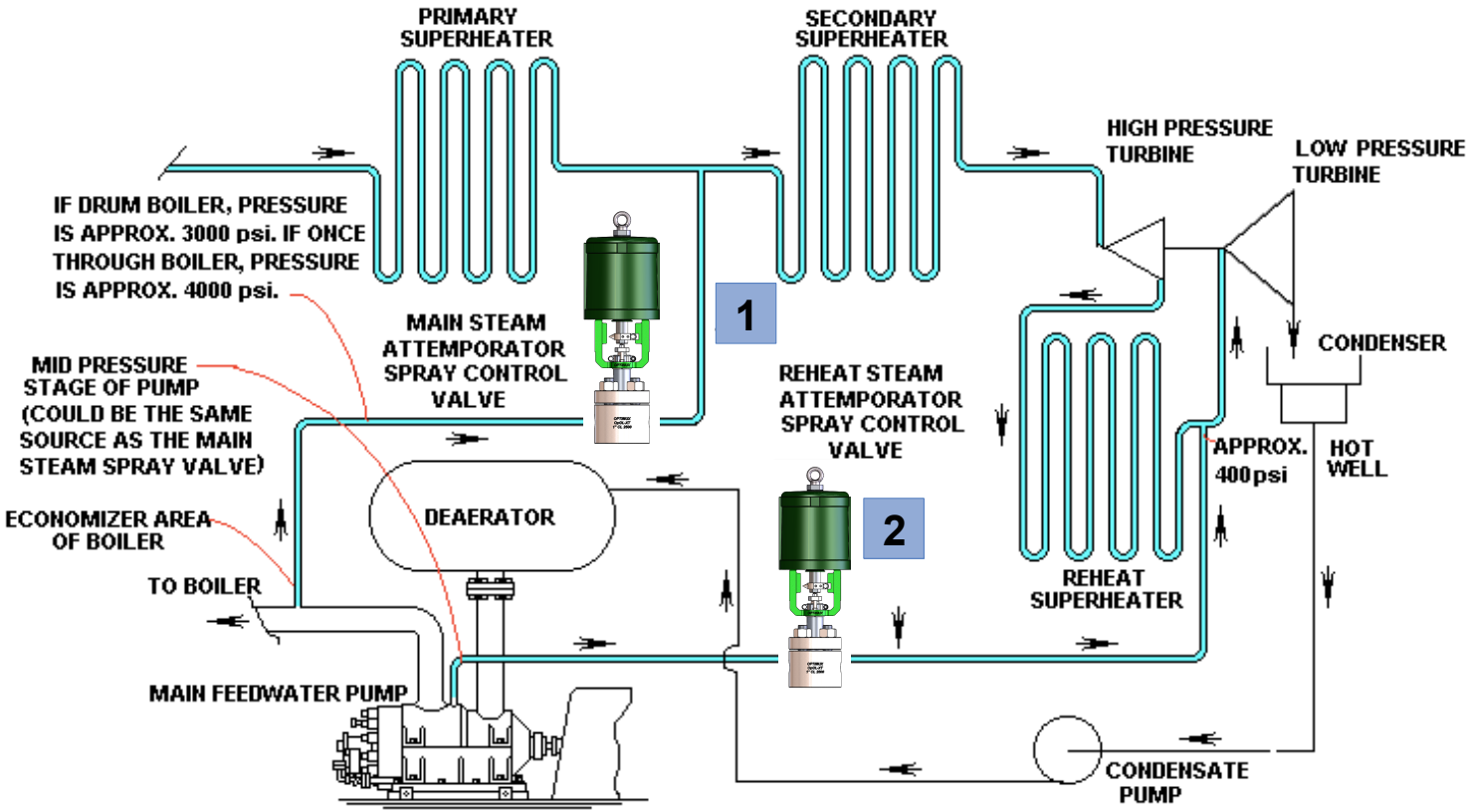


Sootblower System tied into the Main Steam Line

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

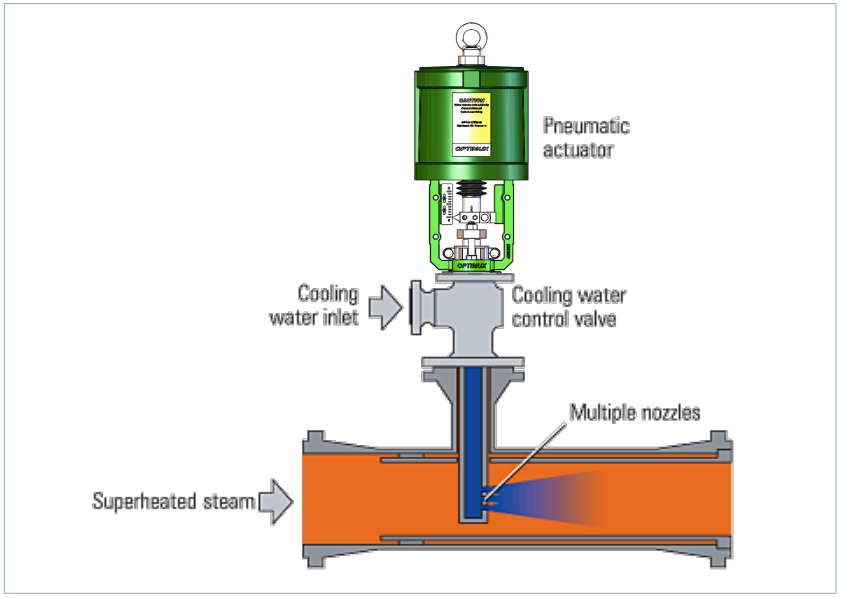


Desuperheaters

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



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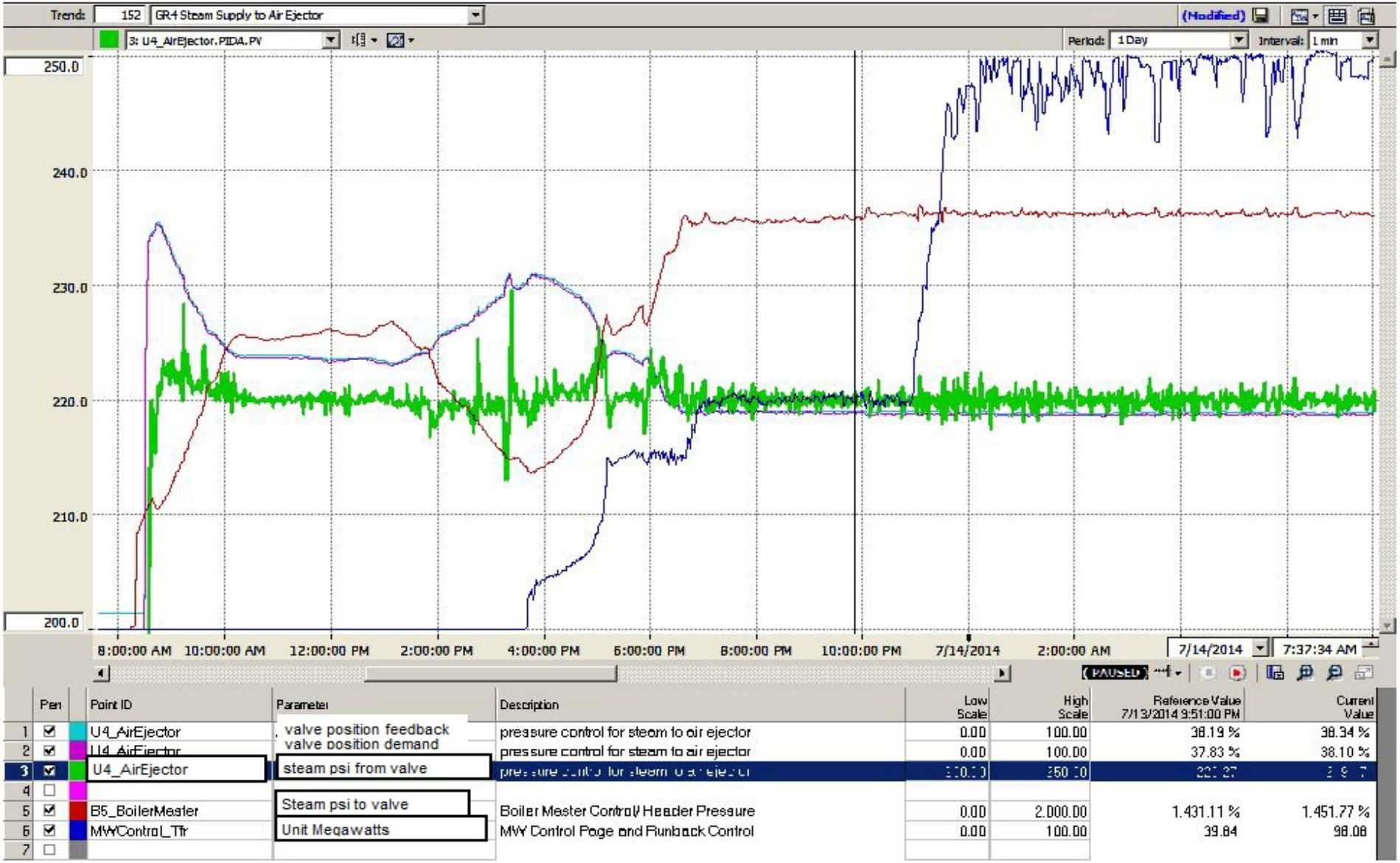
Case Study 1 – Kentucky Utilities

Steam Supply to Air Ejector on Condenser

End User	Louisville Gas & Electric Company (Kentucky Utilities)
Location	Winchester, Kentucky, USA
Requirements	A severe duty socket-weld valve to reduce 1450psi/ 1000°F steam to 300psi steam to supply the air ejector for the turbine condenser. The valve needed to supply 750#/hour with one set of jets in service, and 1500#/hour with two sets of jets in service. Control within +/- 2 psi, 1% fluctuation, repeatability 0.5%
Trimteck Solution	1.5" CL2500 OpGL-XT Angle Control Valve Trim Material: 316+CVD-5B Body Material: WCB (Fabricated)

- **Note: Customer Testimonial Bulletin Available**

Case Study 1 – Kentucky Utilities DCS Data



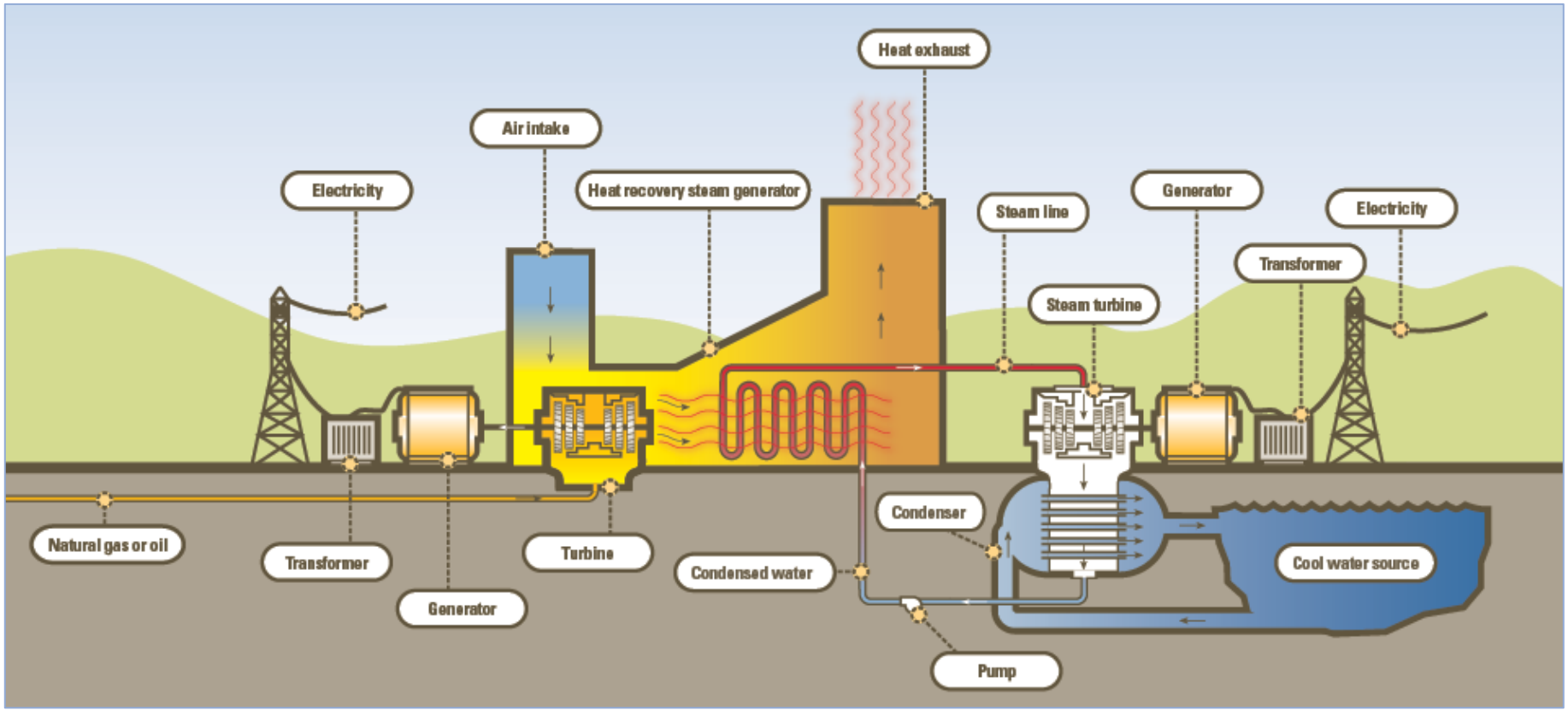
Case Study 2 – CFE Manzanillo Combined Cycle Plant

Condenser Level Control

End User	CFE Manzanillo 1250MW Combined Cycle Plant
Location	Manzanillo, Mexico
Requirements	High rangeability and cavitation control; previous Fisher valve in that service produced high volumes of hydrodynamic noise due to the pressure drop across the valve.
Trimteck Solution	8” CL300 OpGL ST-4 Globe Control Valve Trim Type: ST-4 Stacked Disc Anti Cavitation Material: 416SS+CVD-5B Body Material: WCB

Case Study 2 – Combined Cycle Plant Schematic

Combine Cycle power plants can achieve electrical efficiencies up to 60 percent, the term refers to the combining of multiple thermodynamic cycles to generate power; a heat recovery steam generator (HRSG) captures heat from high temperature exhaust gases to produce steam, which is then supplied to a steam turbine to generate additional electric power. The process is based on the Rankine cycle.



Case Study 3 – CFE Dos Bocas Combined Cycle Plant

Purge Cycle Valves for Boiler Burners

End User	CFE Dos Bocas 830MW Combined Cycle Plant
Location	Dos Bocas, Mexico
Requirements	Handle saturated steam at 662F, and provide Class V metal-to-metal shutoff to prevent leakage into the natural gas line.
Trimteck Solution	1” CL300 OpGL Globe Control Valve Function: On/Off Service with 3-Way Solenoid Control Trim Material: 316+CVD-5B Body Material: WCB

Case Study 4 – FPL Lauderdale Plant

Compressor Reject Control

End User	FPL Lauderdale 1724MW Gas/Oil Plant
Location	Dania, FL, USA
Requirements	Control water at 500 US Gallons/Min, and 125F, with a 300 psi pressure drop across the seat
Trimteck Solution	3" CL300 OpGL ST-2 Globe Control Valve Trim Type: ST-2 Multi Stage Anti Cavitation Cage Trim Material: 416SS+CVD-5B Body Material: WCB

- **Emergency inquiry for QTY2 of these control valves came during a plant outage in 2012**
- **The severe service valves needed to be on site within one week**
- **Trimteck sized, machined, built and tested both valves 24 hours from the moment the PO was placed**
- **Neither valve has required spare parts for three years**
- **This was a keynote installation for our approval with FPL**

Case Study 5 – Rocky River WWHR

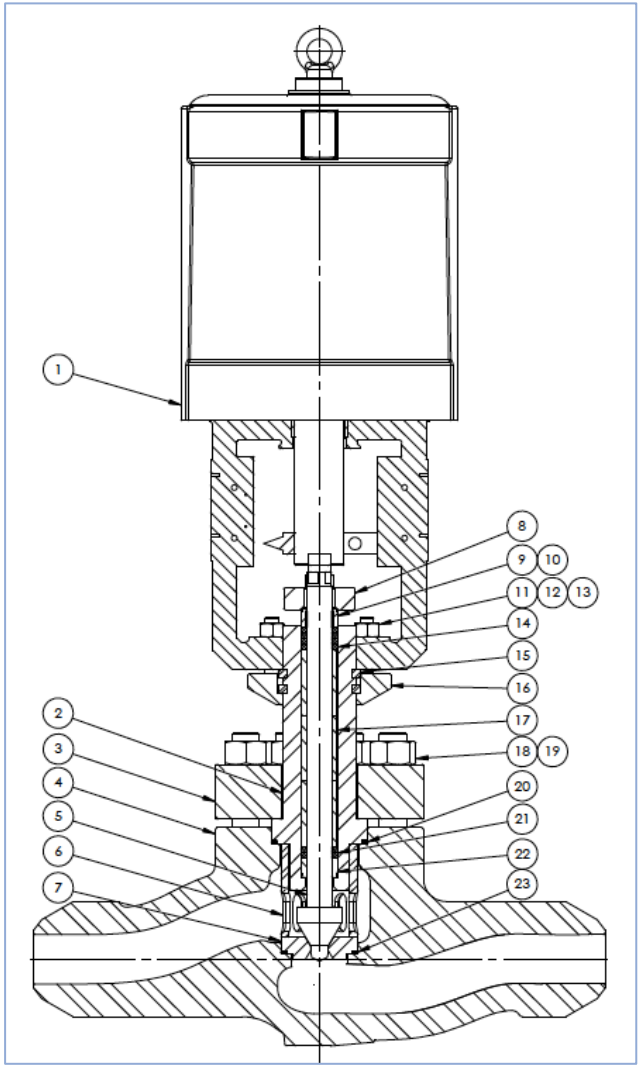
Turbine Bypass and Steam Attemperation

End User	Water & Sewer Authority of Cabarrus Country 2MW Biomass Plant
Location	Concord, NC, USA
Requirements	Main steam bypass valve along with spray water attemperator valve and desuperheater
Trimteck Solution	Turbine Bypass: 3” CL900 OpGL-XT ST-3 Globe Control Valve with Noise Abatement Trim Backpressure Aid: 6” CL900 ST-3D In-Line Diffuser Spray Water Attemperator Valve: 1” CL 150 OpGL Desuperheater Nozzle: OpDSH Varifix

Case Study 6 – Indiantown Cogeneration Plant

Superheater Attemperator Spray Valve

End User	Indiantown Cogeneration LP 330MW Coal-Fired Plant
Location	Indiantown, FL, USA
Requirements	Replacing a Copes Vulcan valve that was suffering from cavitation damage and losing ability to control over the required range – especially at low loads where the valve was only slightly open
Trimteck Solution	3” CL2500 OpGL Globe Control Valve Trim Material: 416SS+CVD-5B Bonnet: Extended Body Material: WC6



Reference Plants

Siemens Combined Cycle Plants

End User	Siemens Energy
	La Caridad I & II Twin 250MW Combined Cycle
Location	La Sonora, Mexico
Requirements	All Steam System Control & On/Off Valves
Trimteck's Scope of Supply	Blowdown Valves
	Condensate Hotwell Level Control Valves
	LP & HP Steam Bypass Valves
	LP & HP Recirculation Valves
	Steam Line Drain Valves
	Feedwater Control and Isolation Valves
	Sootblower Header Valves
	Attemperator Valves
	Steam Vent Valves
	Dump Valves

Iberdrola Biomass Plants

End User	Iberdrola
	Fort St. James & Merritt 80MW Biomass
Location	Fort St. James, BC, Canada
Requirements	All Boiler Control & On/Off Valves
Trimteck's Scope of Supply	Feedwater Valves
	Sky Vent Valves
	Feedpump Recirculation Valves
	Steam Line Drain Valves
	Economizer Bypass
	Attemperator Valves
	Steam Vent Valves
	Drum Level

Additional Trimteck Users – Power Industry

Abengoa Hidrogeno – Spain
AES – Argentina
Almussaib Thermal – Iraq
Cal Energy – USA
Calpine – Canada
Covanta Energy – USA
Dominion Virginia Power – USA
Echogen Power Systems – USA
ENELVEN – Venezuela
Pacific Gas & Electric – USA
PREPA – Puerto Rico
Rio Nogales Power Company – USA
Florida Power & Light – USA
GE-Hitachi Nuclear – USA
GE Energy – USA
La Paloma – USA
Minnesota Power – USA
Mt. Poso Cogeneration – USA
Niagara Generation – USA
Northern California Power Agency – USA
Tennessee Valley Authority – USA
Termocolon – Panama
Termoflores – Colombia
Xcel Energy – USA

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Optimux OpGL Globe Control Valve

Reliable. Rugged. Compact. Economical. Green.

Technical Specifications

Diameter	½’’-42’’: ANSI Class 150-600 1’’-24’’: ANSI Class 900-4500
Body Style	Globe, Angle, Three-way, Steam-jacketed, Y-body
Connections	Integral flanges, Socketweld, Buttweld
Materials	Carbon steel, Stainless steel, Chrome-molly, Alloy 20, Hastelloy B&C, Titanium, and others…
Bonnet Types	Normal, Extended, Cryogenic, Cool box extended,
Internals	Flow characteristics, equal percentage, linear, and quick-open. Seats available in metal or soft (for “bubble tight” shutoff)

- **Exceptionally tight shutoff Class V Metal-to-Metal**
- **High-thrust piston-cylinder actuator**
- **Available fugitive emissions packings and bellow seals**
- **Top-entry design facilitates maintenance**
- **Top-guided robust design offsets any oscillations**
- **Broad selection of trims available for each size**

High torque and triple offset design ensures zero leakage

General Characteristics

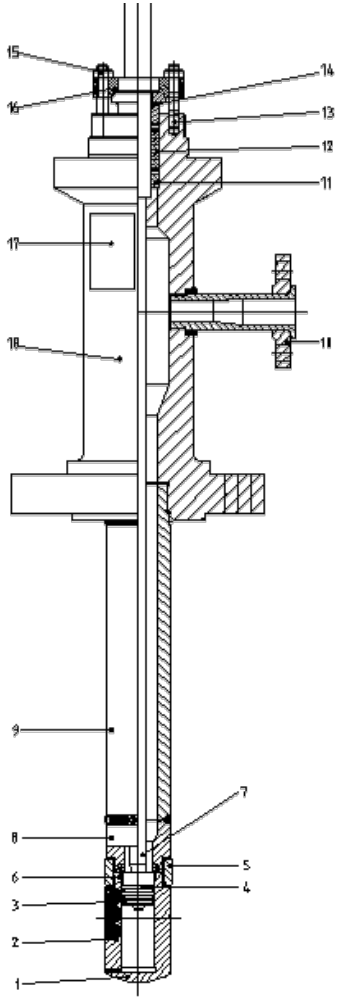
- Sealing ring uniformly wedges onto seat due to elasticity of composite materials
- Elasticity of sealing ring creates spring-like effect ensuring zero leakage
- Lack of body cavity impedes build-up of solids, unlike in Gate Valves
- High torque seal ensures persistent two-way zero leakage
- The OpTE right-angle rotation design assures zero friction between the seat and the disc
- Long life even under high repetition process cycles
- Easy maintenance
- ISO5752, ASME B16.10 and API609 face-to-face dimensions, allows for easy replacement of other high-performance butterfly and other type valves
- Fireproof
- Anti-blowout stem feature conforming to API609
- One-piece shaft connected to disc by key or pin-key combination, allows for differential temperature expansion

Robust, Reliable, and Flexible

Technical Specifications

Diameter	2’’-24’’
ANSI Class	150, 300, 600, 900, 1500, 2500
Body Styles	Trunnion-Mounted, Floating, Three-piece, Two piece, Tide-entry, Top-entry, Forged, Cast
Connections	Integral flanges, Socketweld, Buttweld
Materials	Carbon steel, Stainless steel
Bonnet Types	Normal, Extended, Cryogenic
Certifications	NACE, API 6D, API 607 & 6FA Fire Safe
Trim Options	Full-port, V-Segmented, and Severe Service

Reliable Quality and Customizability



Technical Specifications

Types	Variable Area/Multiple Nozzle, Variable Area/Spring-Assisted, Fixed Nozzle, Fixed Nozzle/Ring Style
ANSI Class	Up to ANSI 2500
Flow Characteristics	Linear, Equal Percentage
Min/Max Delta P across Nozzle	1 bar/80bar
Materials	Carbon steel, Stainless steel, Chrome Moly, 17-4 pH, Inconel, Stellite
Bonnet Types	Normal, Extended, Cryogenic
Certifications	NACE, PED
Options	Integral and separate water control valve

HPP2500 Alphateck - Pneumatic Positioner

Optimux HPP2500 Alphateck Pneumatic Positioner

Technical Specifications

Type	Pneumatic	Electropneumatic
Input Signal	3 to 15 psi	4 to 20 mA
Supply Pressure	30 to 150 psi	
Hysteresis	1.0% F.S.	
Repeatability	0.5% F.S.	
Max Flow Capacity	11 SCFM @ 60 psi	
Air Consumption	0.25 SCFM @ 60 psi	0.31 SCFM @ 60 psi
Pneumatic Connections	¼-18 NPT female connection	

- **Characterized cam operation**
- **Easy adjustment and calibration**
- **Built-in dampers and gauge ports**
- **Corrosion-resistant**

HPP4500 - Intrinsically Safe Smart Digital Positioner

Optimux HPP4500 Digital Positioner

Technical Specifications

Type	Digital
Input Signal	4 to 20 mA
Minimum Current Signal	3.8 mA
Output Characteristics	Linear, Equal Percentage, Quick Open, configurable to 16 points
Power requirements	8.5 V
Max Impedance	500Ω/20 mA Dc
Enclosure	NEMA 4X, IEC IP66
Safety Certification	Intrinsically Safe Ex ia IIC T6/T5
Digital Communication	HART®
Digital Display	LCD
Weight	3.3 lbs (1.5 kg)

- **Auto Setup**
- **Flexibility in installation**
- **High reliability**
- **One model for multiple characterizations**

HPP4000 - Explosion Proof Smart Digital Positioner

Optimux HPP4000 Digital Positioner

Technical Specifications

Type	Digital
Input Signal	4 to 20 mA
Feedback Signal	4 to 20 mA
Output Characteristics	Linear, Equal Percentage, Quick Open, configurable to 16 points
Max Impedance	500Ω/20 mA Dc
Enclosure	NEMA 4X, IEC IP66
Safety Certification	Explosion Proof Ex d IIC T6
Digital Communication	HART®
Digital Display	LCD
Air Consumption	Below 2LPM @ 20 psi, 3 LPM @ 100 psi
Auxiliary Switches	Dual limit switches
Repeatability	+/- 0.3% F.S.

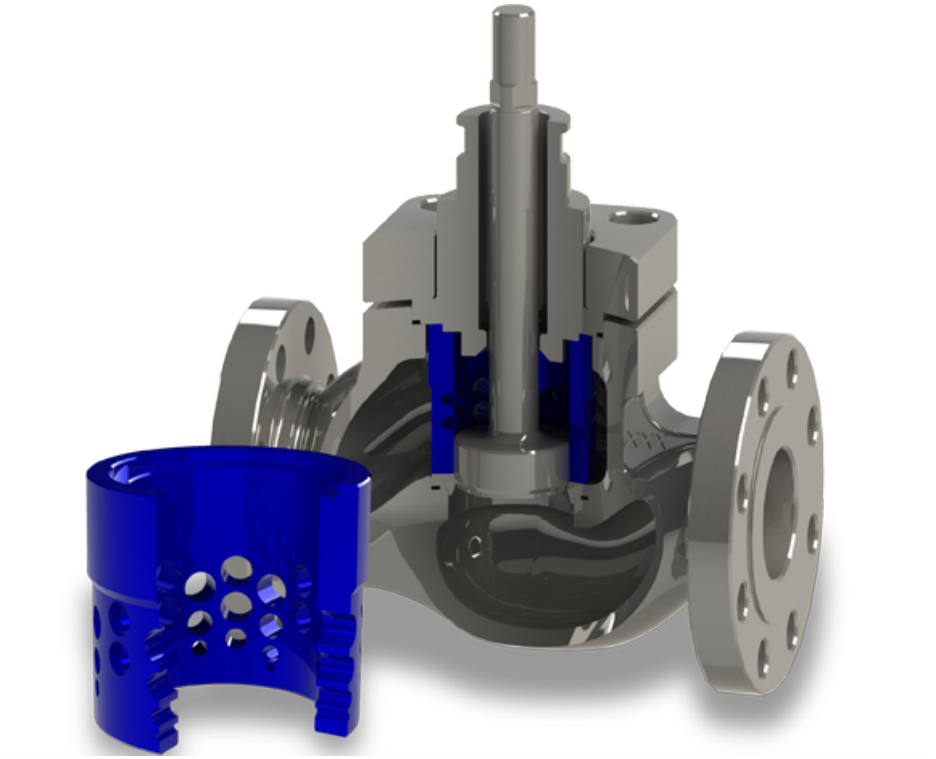
- **Auto Calibration**
- **Variable orifices minimize hunting**
- **Corrosion resistant**
- **One model for multiple characterizations**

ST-1 Single Stage Anti-Cavitation Trim

ST-1 trim is a cost-effective single-stage trim that minimizes cavitation damage to valve and piping by diverting the location and controlling the concentration of imploding vapor bubbles to an area away from metal parts.

Technical Specifications

Type	ST-1 Single Stage Trim for Mild Cavitation
Base Valve	Optimux OpGL Globe or Angle Body
Size Range	1” to 24”
C_V Range	1.5 to 1,000
Flow Direction	Flow Over
Pressure Stages	1
Features	• Tolerates Sigma as low as 1.2 • Can be characterized • Cost-effective

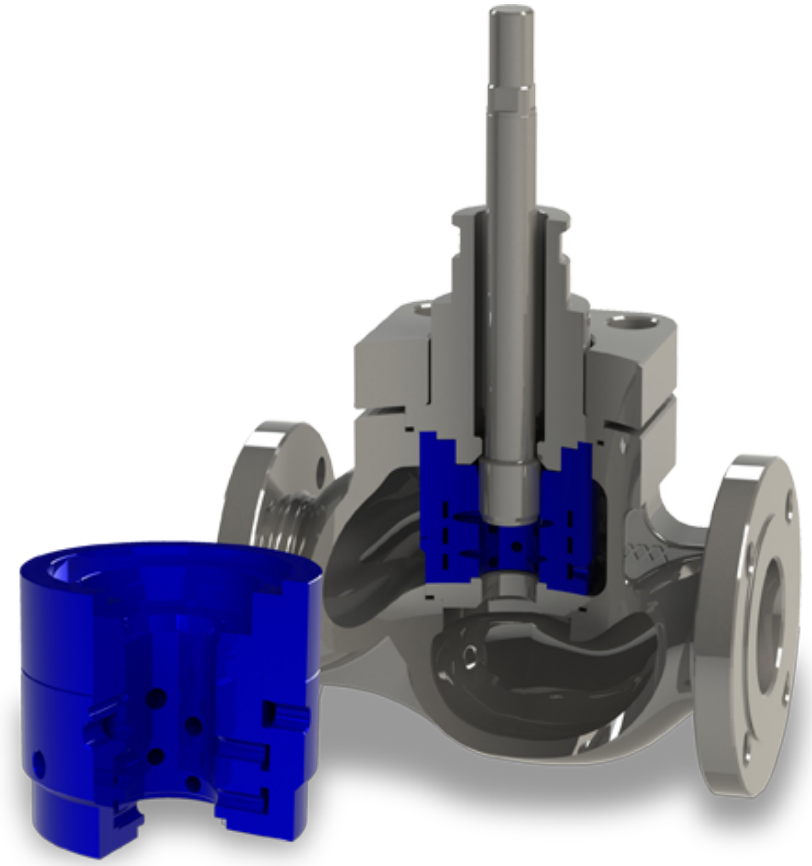


ST-2 Multi-Stage Anti-Cavitation Trim

By reducing pressure through a series of restrictive channels and expansion areas, ST-2 Multi-Stage trim not only eliminates cavitation damage, but it often prevents cavitation from occurring altogether.

Technical Specifications

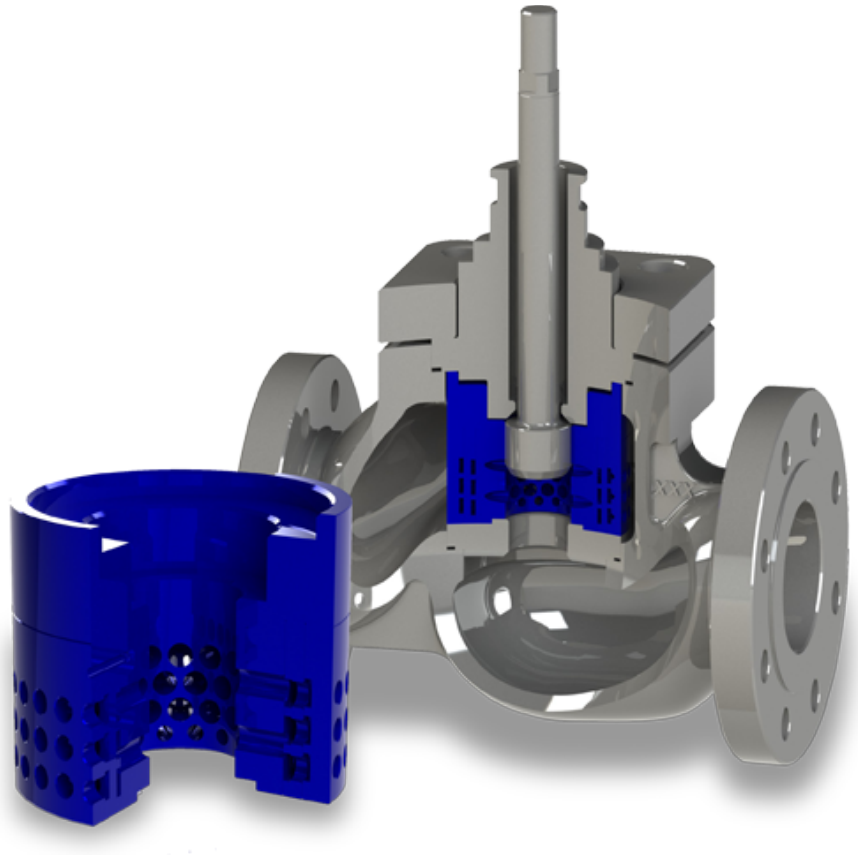
Type	ST-2 Multi Stage Trim for Cavitation
Base Valve	Optimux OpGL Globe or Angle Body
Size Range	1” to 32”
C_V Range	6 to 720
Flow Direction	Flow Over
Pressure Stages	2 to 6
Features	• Tolerates Sigma as low as 1.001 • Eliminates mild to moderate cavitation • Controls effects of heavy cavitation • Custom-engineered for optimization and characterization of flow according to application requirements – including dirty service



ST-3 Noise Attenuation trim works to reduce control valve noise in a broad spectrum of gas applications.

Technical Specifications

Type	ST-3 Noise Attenuation Trim
Base Valve	Optimux OpGL Globe or Angle Body
Size Range	1” to 32”
C_V Range	1 to 3220
Flow Direction	Flow Under
Pressure Stages	1 to 6
Features	• Effective attenuation of up to 30 dBA of noise • 1 or 2 stage cartridges fit a standard OpGL without modification



ST-4 Stacked Disc Anti-Cavitation & Noise Abatement Trim

ST-4 Stacked Disc trim is a powerful solution designed to tackle the most severe pressure drops while reducing sound levels and eliminating the effects of cavitation.

Technical Specifications

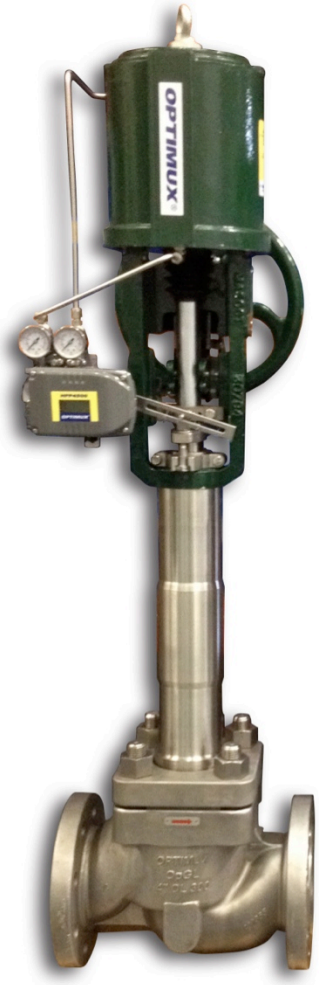
Type	ST-4 Stacked Disc Trim
Base Valve	Optimux OpGL Globe or Angle Body
Size Range	1.5” to 38”
C_V Range	4 to 4000
Flow Direction	Flow Under
Pressure Stages	2 to 10
Features	• Tolerates Sigma as low as 1.001 • Eliminates cavitation • Tolerant of dirty services • Noise attenuation up to 30 dBA • Custom-engineered for optimization and characterization of flow according to application requirements

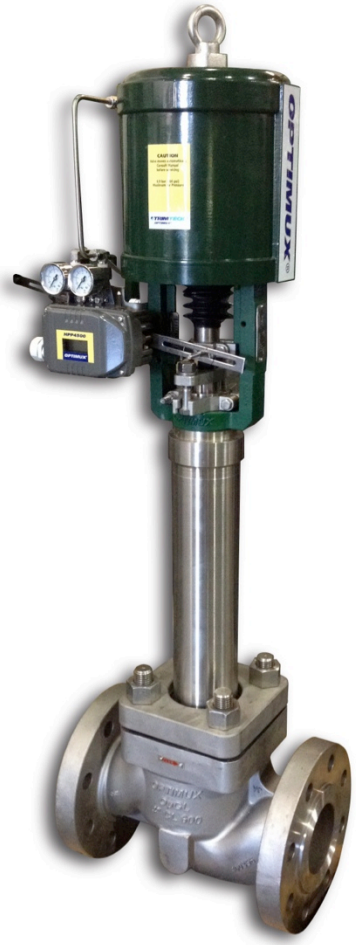
TRIMTECK®
OPTIMUX™

Trimteck produces cryogenic and high temperature variations of nearly all valve styles, and is renowned for extremely high-quality extended bonnets for the entire spectrum of high and low temp applications

Customers Include:

- *The Linde Group*
- *NASA Stennis Space Center*
- *NASA Marshall Space & Flight Center*
- *Tianjin Gas Jinran Thermal Power Co.*
- *CNGC China*





OpGL-XT Fabricated Body Valves

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Thank you for your attention, and please visit trimteck.com for more information