Combined Cycle Gas Turbine Valves Issues and Options

Issues and options in valve selection and the merits of each . This segment is concentrated on steam and severe service

Slide sequence 12- Mogas , 27 Weir, 32 Pentair, 45 DFT, 50, Crane
56 Flowserve, 74 Rotork

Table of Contents

Overview

This webinar is part of a whole program to help end users select the best products and not the cheapest or familiar but obsolete

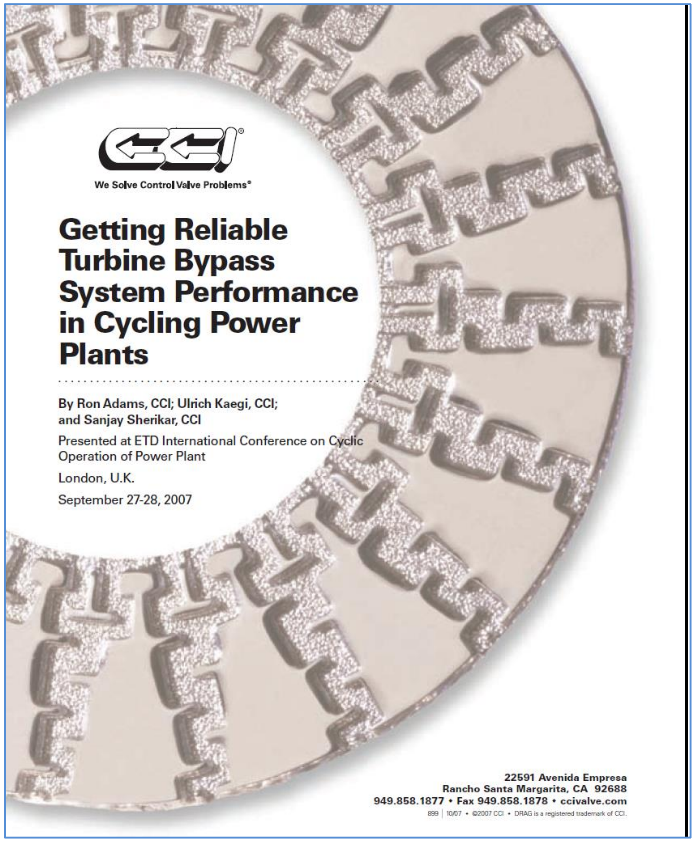
What we will try to accomplish today

- This is an introductory session to
  - Further define some of the issues and options
  - Identify niche experts who can help make the listings comprehensive and accurate
    - Independent niche experts who Mcilvaine will pay e.g., George Gorman of Valve Institute
    - Consultants who have unusual expertise
    - Staff people at end users with this expertise
    - Industry experts at valve and actuator companies
    - Experts at companies making the key components and systems e.g., Turbines, HRSG, UPW systems,
    - Association experts e.g., EPRI
  - Discuss the procedure to build up the program with case histories, white papers, and recorded presentations
  - Explain the collaboration with Combined Cycle Journal, Industrial Valve Summit, KCI Valve World, and others
  - Explain the whole program with the 4As operating system (Alerts, Answers, Analysis, Advancement) and the free access for any power plant
  - Pursue program to help valve suppliers with total solutions

CCJ reports turbine user group comments on valves

(Click here for hyperlink to documents)

- **Resource Title:** CCI Getting Reliable Turbine Bypass Performance in Cycling Power Plants
- **Location:** GdPS for CCGT Valve Selection
- **Keyword:** Turbine-Bypass
- **Discussion:** Contributing factors to problems in turbine bypass systems were traced to faulty control algorithms, over-sized spray water valves, leaking spray water lines, thermal shock, and improper system layout.


We Solve Control Valve Problems®

Getting Reliable Turbine Bypass System Performance in Cycling Power Plants

By Ron Adams, CCI; Ulrich Kaegi, CCI; and Sanjay Sherikar, CCI

Presented at ETD International Conference on Cyclic Operation of Power Plant

London, U.K.

September 27-28, 2007

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Total Valve Solutions

- The purchaser and supplier both benefit when the valve supplier offers a better solution rather than just a valve.
- A good example is the Pentair pulse jet valves for gas turbine intake filters.
- Pentair sells a solution not just a valve.
- The selection of filter media and design depends on the ability of Pentair to clean the media.
- So better valve systems allow consideration of different media and filter designs.
- The valve manufacturer needs to understand the process in order to provide the best solution.
- The same is true of fast start HRSGs and other processes.
- Mcilvaine has separate decision guides for even the nitrogen injection systems and the options for aqueous or anhydrous and the urea to ammonia which the Chinese prefer.

Determine how valves can enhance new design HRSG

- **[Rapid Startup Analysis of a Natural Circulation HRSG Boiler with a Vertical Steam Separator Design]**
- B&W PGG has introduced a new concept for a rapid start HRSG by, among other things, incorporating the use of one or more vertical steam separators instead of an HP steam drum.
- ***Revision Date:*** 2/3/2014
- ***Tags:*** 221112 - Fossil Fuel 化石燃料, Babcock & Wilcox, Vertical Separator, Heat Recovery Steam Generator, Heat Recovery

Emerson total solution with valve and silencer

- **Sky-vent system from Emerson ensures temperature control of turbine during startup**
- Valves within the sky vent system of a combined cycle power plant serve one of the more important control functions. During initial operation of the HRSG, these valves bypass steam (HP/HRH/LP) around the steam turbine to ensure that the unit doesn't come up to temperature too quickly. This is done as the process lines are warmed prior to admitting steam through the turbine bypass valves that dump to the condenser.
- ***Revision Date:*** 6/10/2014
- ***Tags:*** 221112 - Fossil Fuel 化石燃料, Emerson Process Management, Heat Recovery Steam Generator, Control Valve, Valve

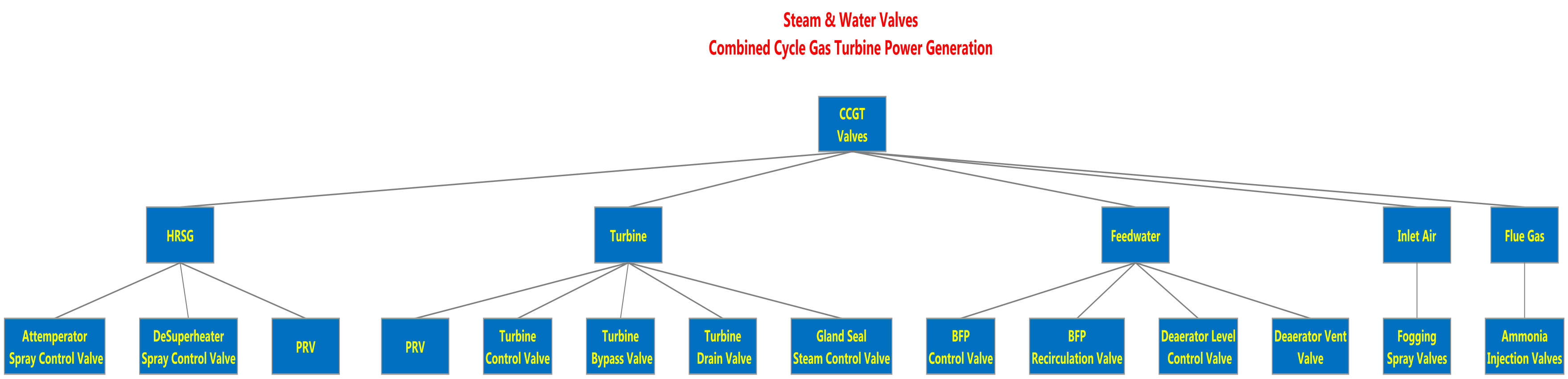
Program Outline

Users of this program on valves

- End-user power plants
- Consultants and engineering firms
- Suppliers of valves

Major Valve Systems

- HRSG
- Turbine
- Feedwater system
- Inlet Air (fogging)
- Flue Gas
- See illustration



Gas Turbine Decision Program

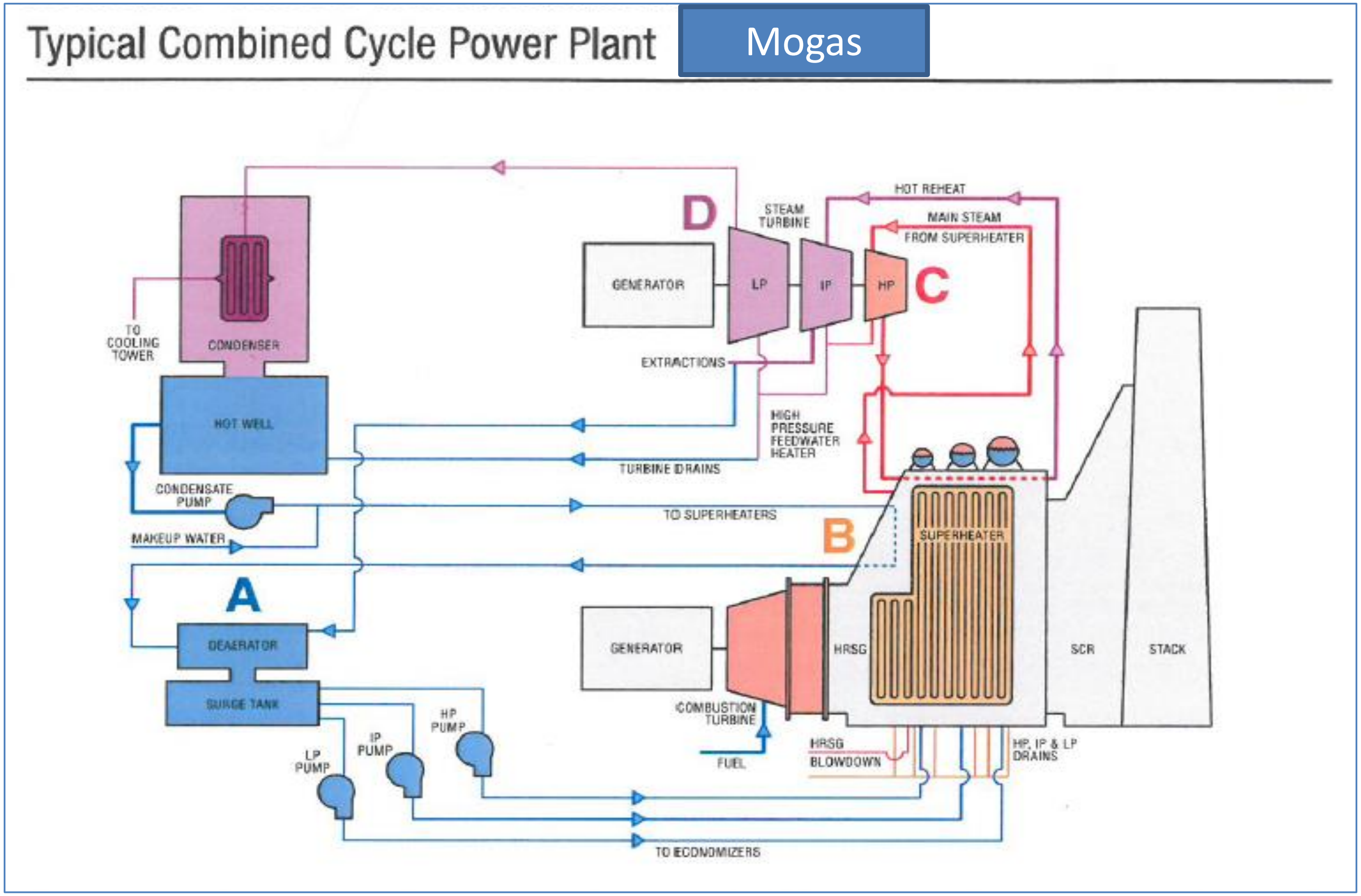
Subject	**Use**
Decision Orchard	A website with articles, analysis, recorded webinars, InterWEBviews™ and intelligence database which is continually updated (free to end users but not others)
Decision Guides	Route maps and summaries of decision paths for specific areas in the orchard
4As Operating System	The operating system for the decision orchard with **A**lerts, **A**nswers, **A**nalysis and **A**dvancement

Periodic GTCC valve Mcilvaine Webinars

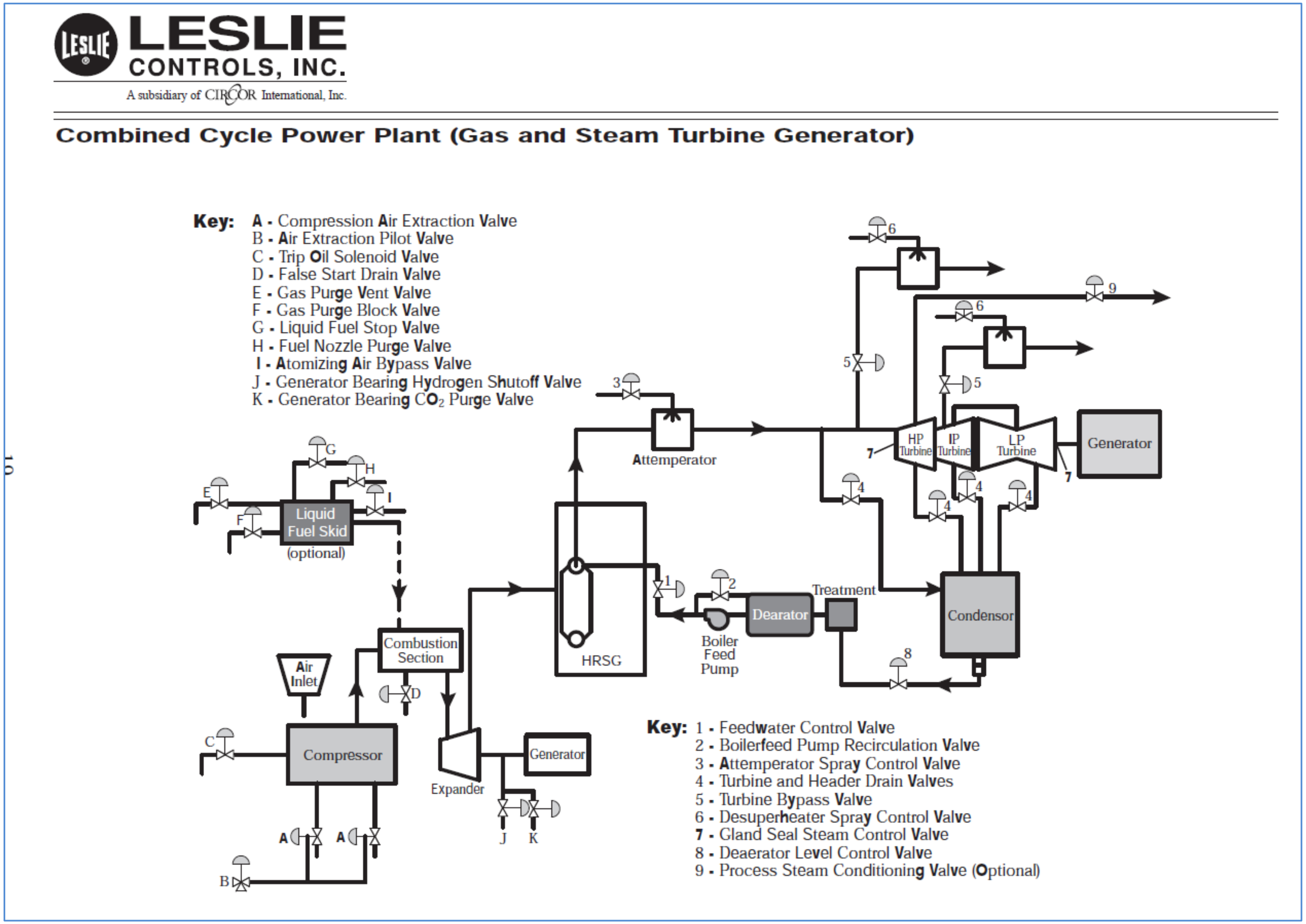
- **Valves for Power Plant Steam and Water Applications Webinar - Hot Topic Hour June 2, 2011**
- The speakers addressed issues for the various valve applications in power plant steam and water systems. Password: hth484
- ***Revision Date:*** 6/2/2011
- ***Tags:*** 221112 - Fossil Fuel 化石燃料, 221112 - Fossil Fuel 化石燃料, Crane Energy Flow Solutions, Weir Valves & Controls, CCI, Valve, Corrosion, Erosion, Vibration, Noise, Cavitation, Flow Control

Overview of CCGT Major Systems

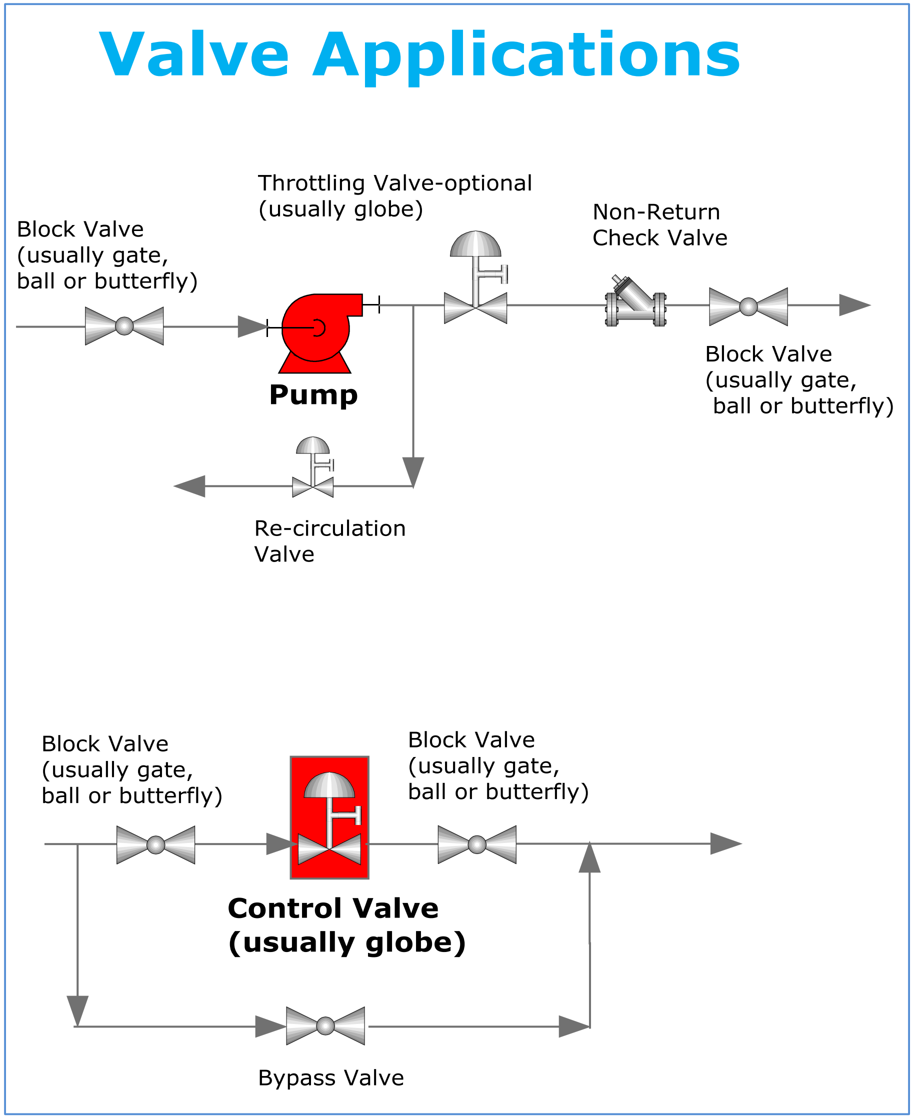
(Boiler Feed, HRSG, Turbine, Condenser, Flue gas, other systems)



Major Valves in CCGT Water & Steam Cycle



Common Valve Groupings in CCGT



Specific Issues and Evaluation Considerations

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**
Hazardous Fluid Handling	Double Block & Bleed (Ammonia)	**Hazardous fluids sometimes require double block & bleed compliant valves for maximum safety. Ammonia handling is one application in CCGT power plants.**
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**
SCR	Anhydrous, aqueous, or urea	**Ammonia for SCR NOx removal can be accomplished with anhydrous ammonia, aqueous ammonia, or urea with onsite ammonia production.**
Inlet Air	Fogging Control	**Generally advantageous in hot, dry climates to increase inlet air density and increase power output.**
Vent & Drain	Repair/Replace	**The economics of repairing or replacing worn valves**

Steam and Severe Service Valves

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
- *Is flow accelerated corrosion a problem with valves as it is with other components*

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

CCGT Severe Service Valve Requirements Relative To Coal Fired Power

- Valve requirements for CCGT power generation are similar in many respects to conventional coal-fired power plants
  - Many of the same valve types are required including pressure relief valves, turbine bypass valves, turbine drain valves, attemperator spray valves, recirculation valves, and others
  - Severe service conditions will apply involving high temperatures, high pressures, high delta P's, and other severe service conditions
  - More **"cycling"** of valves may be expected in CCGT plants due to load variations for plants that are not purely base-load plants, or for plants that serve as peaking plants or backup for renewable power including solar and wind. This creates a special set of thermal and mechanical issues unique to CCGT power plants.

What is Severe Service?

- High pressure drop (>1000 psi), where aggressive liquids become very erosive.
- High cycle applications including on/off service and constant modulation applications.
- Service with entrained water droplets such as wet steam and mixed phase applications.
- Any service that rapidly wears the valve trim causing a loss of seal or function.
- Valves which require frequent maintenance. This can be as often as every start-up cycle.

Severe Service definition

Severe Service Definition

- Cavitation potential exists (Water Valves)
- High vibration / noise expected (Steam Valves)
- Flashing service
- $\Delta P/P1>0.5$
- Historical knowledge
- Needs continuous maintenance
- Plant manager knows about the valve

Severe Service = High Pressure Drop = High Velocity = ENEMY

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Severe Service Valves for GTCC

Summary

- Though small in number, severe service applications pose the highest challenges in the steam and water systems
- Each application should be reviewed and treated appropriately based on key application and process parameters
- Once severe service applications are identified the correct valve design needs to be applied to assure proper valve and plant performance
- ISA guidelines for sizing control valves are a great starting point: "Control Valves – Practical Guides for Measurement and Control" published by ISA

Babcock & Wilcox
Bailey
IMI
BTG
STI
FLUID KINETICS

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Combined cycle severe service applications

Common Severe Service Applications – Combined Cycle Power Plants

- Main Boiler Feedpump Recirculation
- Start-up & Main Feedwater Regulation
- Turbine Bypass Systems
- Attemperation & Spraywater Control
- Auxiliary Steam
- Vent Valves
- Condensate Recirc valves

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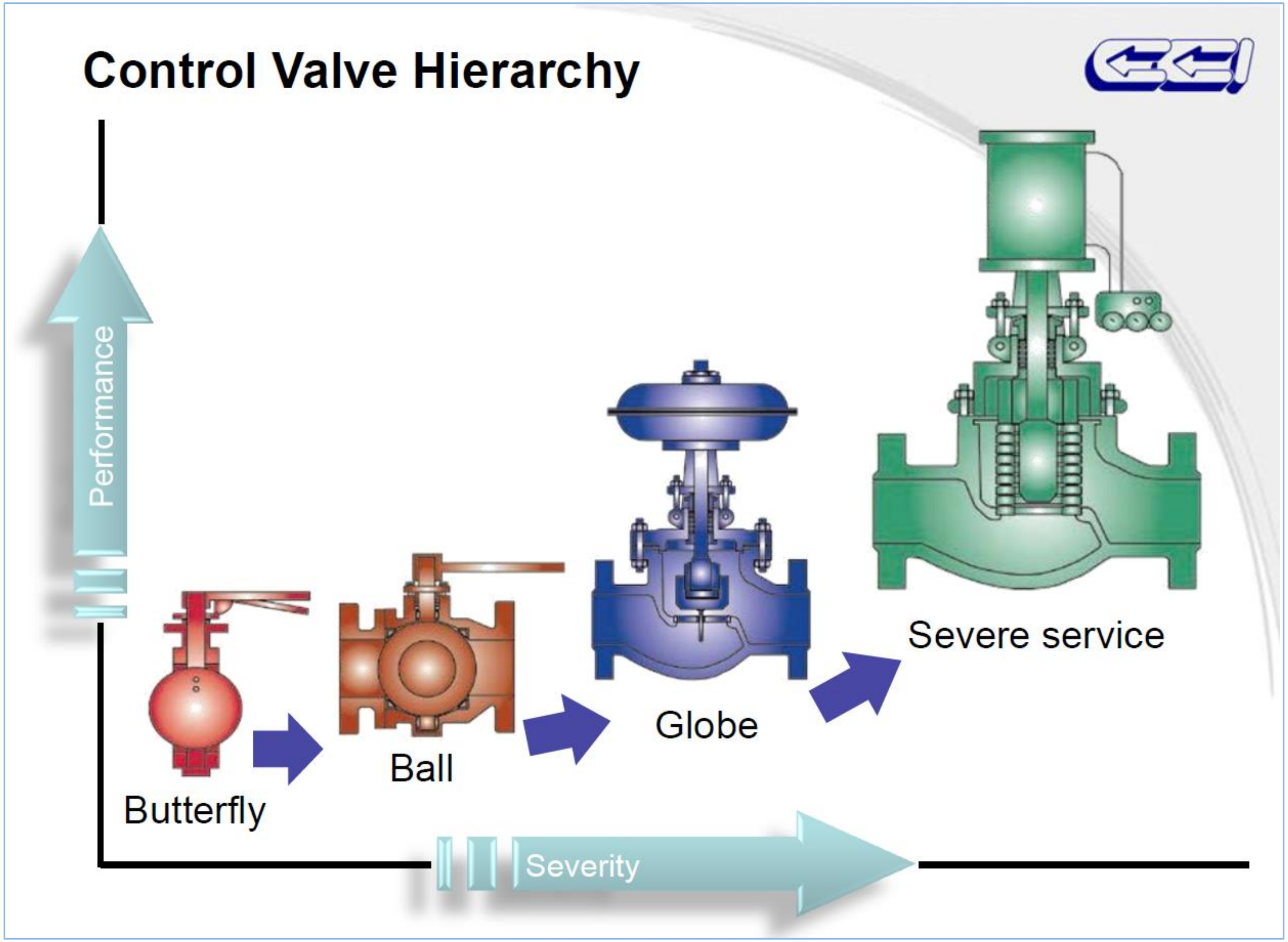
Severe Service Hierarchy for Control Valves



Who should specify HP valves?

- L&T is 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, inGujarat, India. The coal for the power plant is imported primarily fromIndonesia. The source of water for the power plant is seawater 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

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.

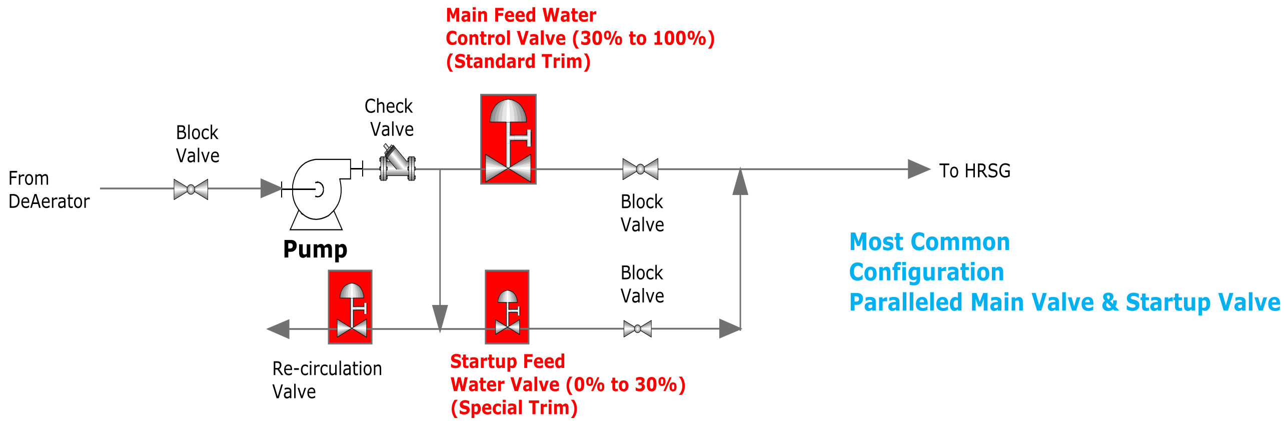
Unbalanced HRH valves are typically not used in this application because the actuation forces required for valves of this size would be too large for conventional pneumatic actuators. However, because tight shutoff is a design requirement, pilot-balanced trim is common. This design allows for the use 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.

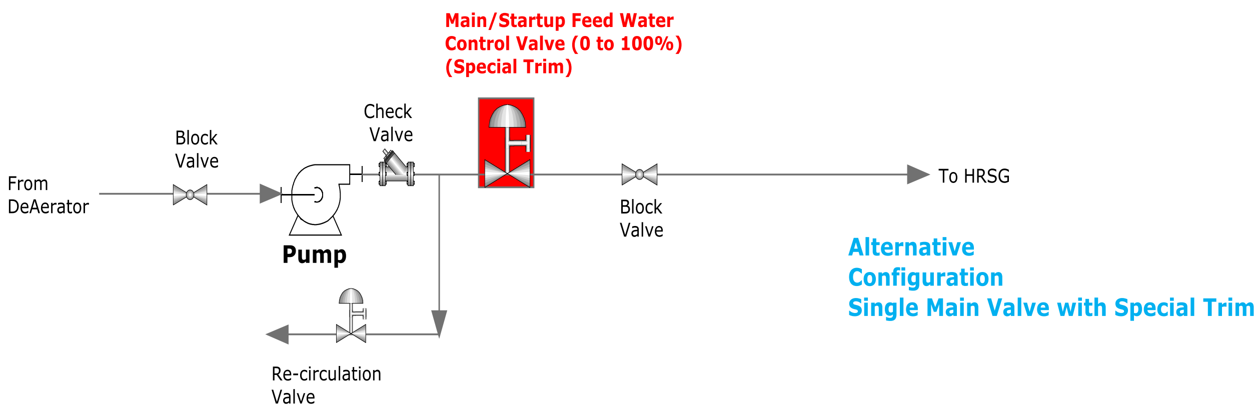
Special materials, tolerances, body/trim/bonnet arrangements, and flow paths (warming lines, for example) are used to address the thermal cycling issues that HRH valves must deal with, such as weld fatigue and internal reliability. Many designs have forsaken pneumatic actuators fitted with standard positioners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

Specific Issues and Evaluation Considerations

(Feedwater Valving)

Boiler Feed Valve Configurations





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

Preventing cavity overpressurization and thermal binding

- **Prevention of Valve Center Cavity Overpressurization and Thermal Binding: Key Concerns in Power Plant Design and Operation by Don Bowers, Weir Valves & Controls - Hot Topic Hour June 2, 2011**
- Donald Bowers, Vice-President, Sales & Marketing at Weir Valves & Controls, discussed the challenges of Center Cavity over Pressurization (CCOP) that can cause Pressure Locking (PL) and Thermal Binding.
- ***Revision Date:*** 6/2/2011
- ***Tags:*** 221112 - Fossil Fuel 化石燃料, 221112 - Fossil Fuel 化石燃料, Weir Valves & Controls, Valve, Corrosion, Erosion, Vibration, Noise, Cavitation, Flow Control

Specific Issues and Evaluation Considerations

(Center Cavity Over-Pressurization, CCOP)

Weir Power & Industrial Division - WVC USA 12

Prevention of Center Cavity Overpressurization & *Thermal Binding*

SUMMARY

- Prevention or elimination of center cavity overpressurization and/or thermal binding are key considerations in power plant operation.
- All valves with two seats are subject to CCOP and/or pressure locking
- There are a number of methods to guard against CCOP and pressure locking. Choose the most effective for your plant piping system needs.
- It is the Owner's (or designee) responsibility to identify the potential for CCOP and thermal binding.
- Because of design features, parallel slide valves are not subject to thermal binding.

- **Thank-you........**

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

Specific Issues and Evaluation Considerations

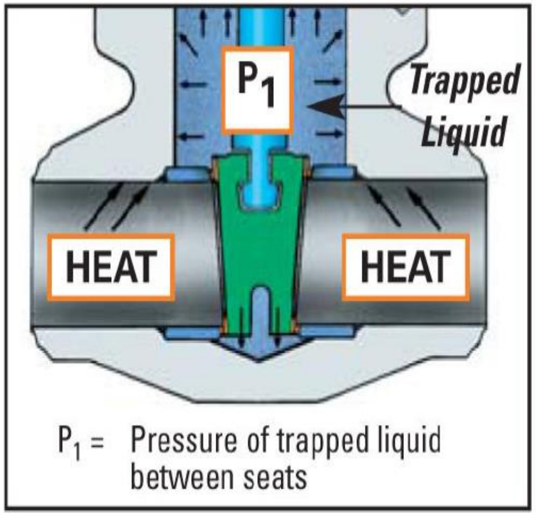
(Center Cavity Over-Pressurization, CCOP)

Prevention of *Center Cavity Overpressurization* & Thermal Binding

Center Cavity Overpressurization (CCOP) & Pressure Locking

Applicability and Definitions

CCOP may be defined as a build-up of pressure in the center cavity of a valve (having two seats) caused by the heating of fluid which has been trapped between the seating surfaces. Such pressure may make opening the valve more difficult, and in extreme cases, render the valve inoperable.



Velan Publication *VEL-PS*

WEIR POWER & INDUSTRIAL

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

Specific Issues and Evaluation Considerations

(Center Cavity Over-Pressurization, CCOP)

Prevention of *Center Cavity Overpressurization* & Thermal Binding

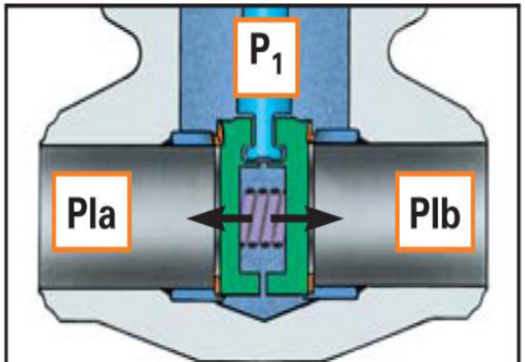
Center Cavity Overpressurization (CCOP) & Pressure Locking

Applicability and Definitions

Pressure locking may be defined as a decrease in upstream (Pla) and/or downstream (Plb) pressure, where the resultant increase in differential pressure (center cavity vs. upstream and/or downstream bores) is high enough to preclude the valve from opening.

ASME B16.34 (para. 2.3.3) assigns responsibility to the ***Owner or his designee*** to advise the Valve manufacturer of the potential for CCOP or pressure locking and specify a method to preclude occurrence.

These methods are as summarized herein.



P_1 = Pressure of trapped liquid between seats

Pla & Plb = Line pressures

Velan Publication *VEL-PS*

Application
Boiler Feed
Turbine Bypass
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Hazardous Fluid Handling
Two-Seated Valves
Inlet Air

Specific Issues and Evaluation Considerations

(Erosion/Corrosion Related Damage)

Velocity Related Damage Mechanisms

- <u>Cavitation</u> damage varies as a 5th to 6th power of velocity
- <u>Erosion</u> damage varies as a 2nd to 4th power of velocity
- Control valve <u>noise</u> varies as logarithmic with mach
- <u>Vibration</u> is caused by excessive fluid velocities & turbulence
- <u>Corrosion</u> is accelerated by velocity & fluid turbulence

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

Specific Issues and Evaluation Considerations

(Repair/Replace)

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

Specific Issues and Evaluation Considerations

(Repair/Replace)

Conclusions

This study revealed that the cost to repair this type of critical thermal valve is significantly lower than the cost to replace it after every cycle. The fact that Pentair's Yarway Welbond repairable valves can be repaired inline is an additional benefit. Repairing is also a more sustainable solution, as is reduces the total process cycle.

Initial Capital Cost	3
Valve	$1,600.00
Insulation	$225.00
Craft Labor (Welding)	$1,050.00
Non Destructive Examination	$150.00
Total	**$3,025.00**

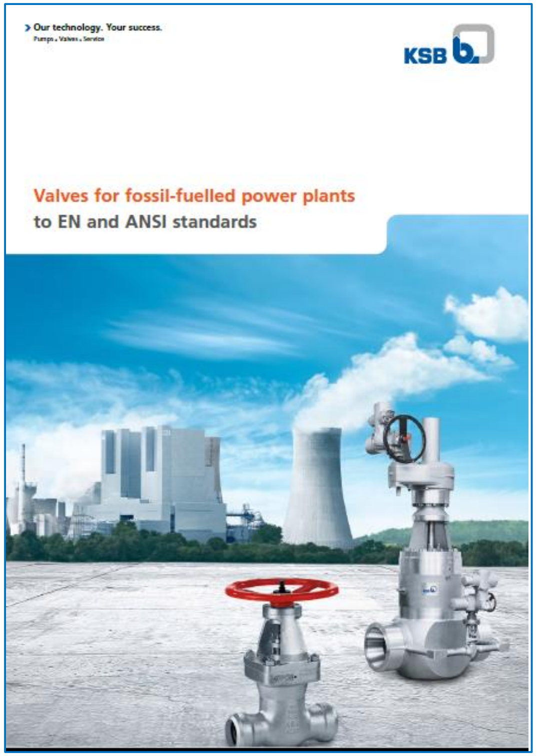
Repair Cycle 1	$380.00	**Replacement Cycle 1**	$3,025.00
Repair Cycle 2	$380.00	**Replacement Cycle 2**	$3,025.00
Repair Cycle 3	$380.00	**Replacement Cycle 3**	$3,025.00
***Tooling**	$2,700.00		
Total	**$3,840.00**	**Total**	**$9,075.00**

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

Additional Valve-Selection Resources

(Click here for hyperlink to documents)

- **Resource Title:** KSB Valves for Fossil Fueled Power Plants
- **Keyword:** Standards
- **Discussion:** The demands placed on components in power plant applications are immense. This is particularly the case for valves that are used to reliably shut off water and steam. These must withstand enormous heat and pressure and have to fulfill the exacting requirements of standards and codes such as DIN / EN, ASME / ANSI or IBR.



Select valve after you know pump feedwater pressure

- It is important to know pump performance details before selecting a control valve.
- With such high feedwater pressures comes the potential for valve cavitation.
- If the pump characteristics of head loss with increasing flow are not properly understood during the selection phase, it is likely that the control valves will experience cavitation damage.
- This occurs at the plug and seating surfaces of the valve and results in subsequent leakage.
- http://www.documentation.emersonprocess.com/groups/public/documents/articles_articlesreprints/d351097x012.pdf

Do not oversize feedwater valves

- To prevent oversizing feedwater valves, it is necessary to understand the impact of valve capacity on protecting the HRSG from drying out
- Slightly increasing the pressure drop across the valve will prevent the valve from being oversized.
- Retrofit trim packages that alter the performance characteristic of the valve can be supplied.
- If a change is made, it is important to ensure that a revised valve characteristic does not interfere with any DCS logic
- http://www.documentation.emersonprocess.com/groups/public/documents/articles_articlesreprints/d351097x012.pd

Specify tight shut off

- Require tight shutoff for feedwater valves
- ANSI (American National Standards Institute) and FCI (Flow Control Institute) have established criteria to denote leakage classes for control valves
- Class V shutoff is the typical recommendation for feedwater valves exposed to cavitating conditions. However, numerous drum-level valves have been specified by engineering contractors and HRSG OEMs with Class IV shutoff or less.
- While it doesn't appear to make much difference on the surface because the valve does not experience cavitating conditions on paper, not selecting a valve with Class V shutoff has significant impact on valve leakage..
- The need for tight shutoff becomes apparent during unit startup. While the CT is generating electricity and the steam system is warming up, the feedpumps are operating. At this time, flow is being recycled around the pump via the recirculation valves. Since the drum-level control valves are located just downstream of the feedpumps, they are exposed to the high inlet pressures that the recirculation valve experiences.
- http://www.documentation.emersonprocess.com/groups/public/documents/articles_articlesreprints/d351097x012.pd

Choices

options

- Single or dual valves for boiler feed
- Replacement or repair of hp bypass valves to address possible stellite delamination*
- Special purpose valves with enhanced cycling capability for turbine control
- Special block & bleed valves for hazardous fluids

Power points and authors

Topic	Reference
Boiler feed valving	Fisher Controls, Experitec
Stellite delamination	Kim Bezzant
Valve cycling	Conval
Hazardous fluids	CCJ OnLine

* If repairs are needed, or if you're buying a new valve, it would be prudent to specify a limit on base-metal dilution into the first layer of hard facing of between 10% and 20%, based on what investigators have learned to date. Minimizing base-metal dilution should reduce the hardness levels in the first layer of hard facing and reduce the potential for disbonding. Qualify a prospective valve supplier or repair services provider by specifying a demonstration to prove their welding process can minimize dilution.

Decision orchard (Click here for hyperlink to documents)

- **Resource Title:** EPRI Valve Maintenance Guides Developed for Combustion Turbine Combined Cycle Plants
- **Location:** GdPS for CCGT Valve Selection
- **Keyword:** Valve-Maintenance
- **Discussion:** As U.S. utilities curtail operation of older coal-fired plants, CTCC plants are increasingly being run at higher capacity factors, putting new stresses and pressures on plant equipment. This trend, in turn, requires crews to re-evaluate their inspection and maintenance practices. At the same time, advanced new equipment is finding its way into plants, adding greater complexity to the maintenance process

Valve maintenance guides developed for combustion-turbine combined-cycle plants

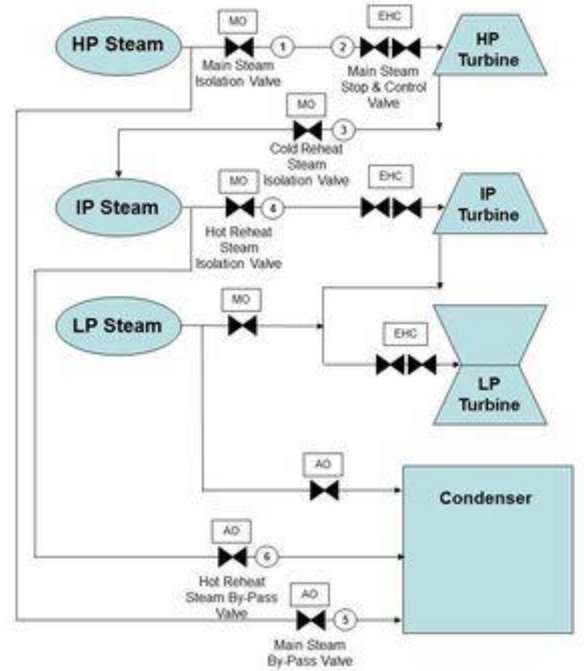
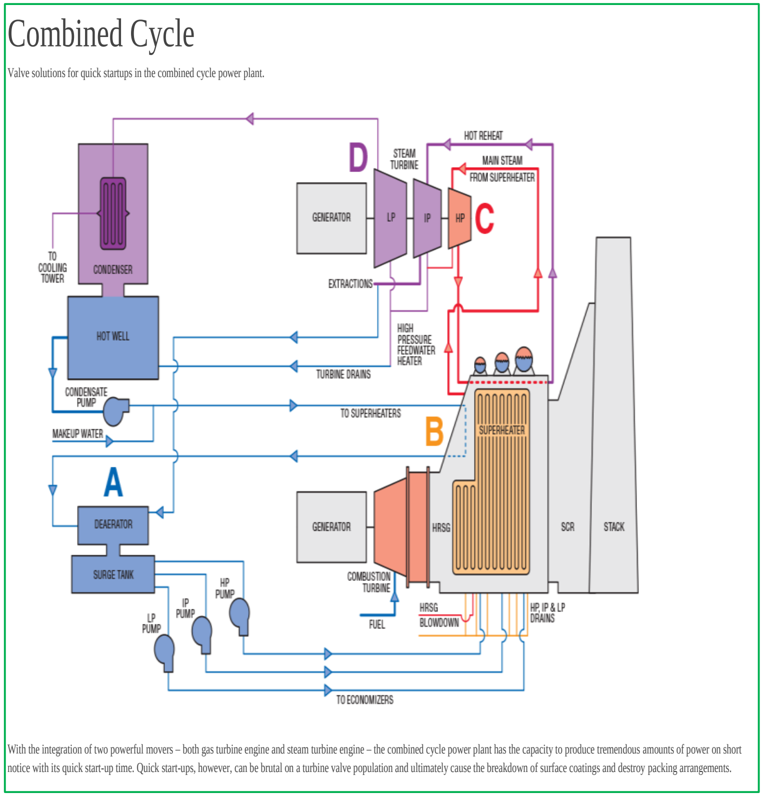


Figure 1.

Decision orchard

(Click here for hyperlink to documents)

- **Resource Title:** Mogas Ball Valves for Power Generation Severe Service Applications
- **Location:** GdPS for CCGT Valve Selection
- **Keyword:** Delamination
- **Discussion:** With the integration of two powerful movers – both gas turbine engine and steam turbine engine – the combined cycle power plant has the capacity to produce tremendous amounts of power on short notice. Quick start-ups, however, can be brutal on a turbine valve population and ultimately cause the breakdown of surface coatings. MOGAS understands the unique challenges of the combined cycle plant and has done extensive research to better understand how the thermal power cycle affects turbine valve components. It was realized that the mechanically bonded coatings, such as HVOF applied Chrome Carbide, had a tendency to crack and flake off causing leak-by and possibly lock-up. Innovations were then made to fuse our coating to the base material creating a metallurgical bonded coating. Since this, we have enjoyed flawless performance and extended longevity.



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.

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

- http://www.powermag.com/desuperheating-valves-take-the-heat/

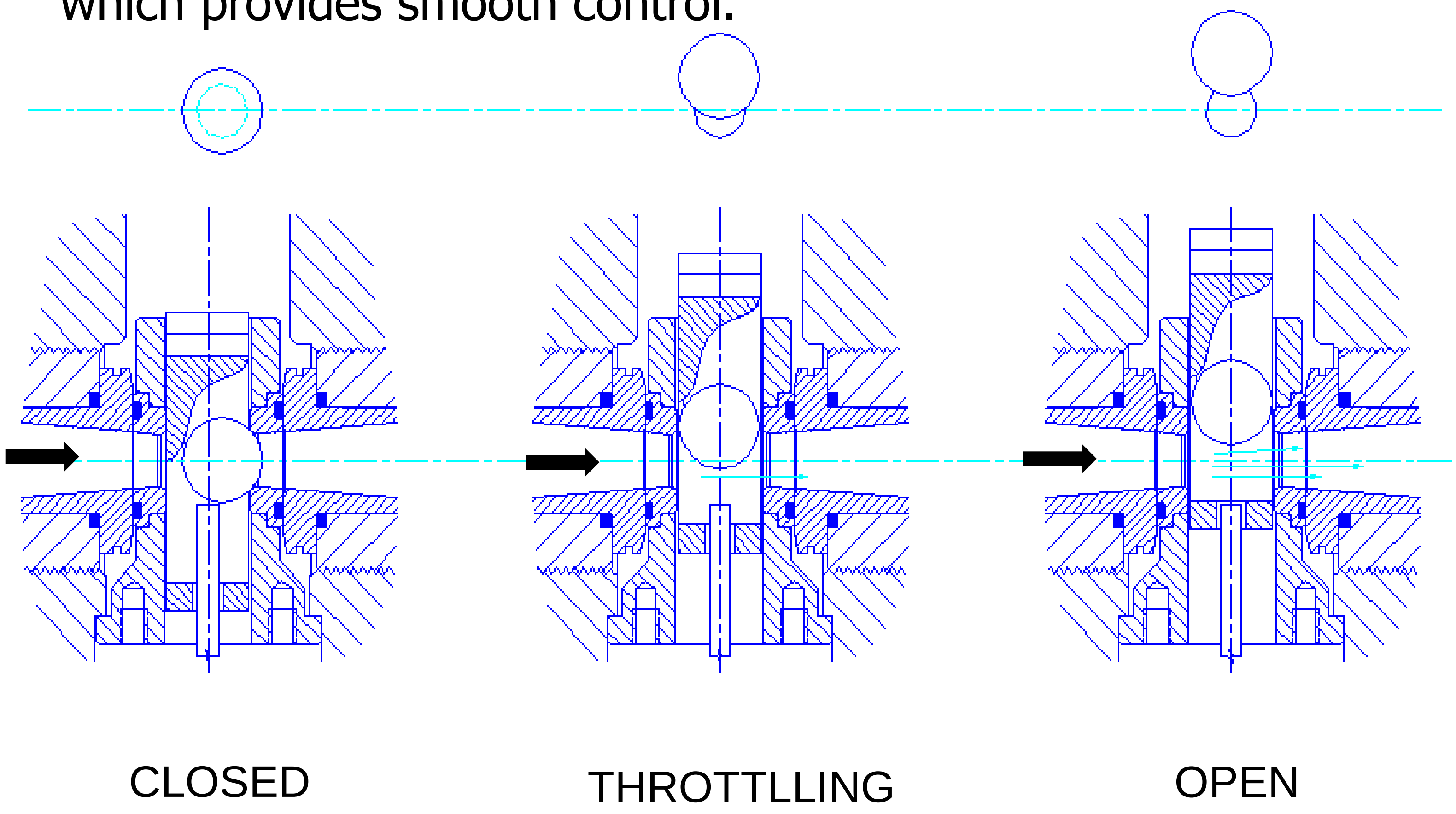
Steam Valve options

Severe Service Applications

- Feedwater Pump Recirculation
- Feedwater Control
- Drum Level Control
- DA Level Control
- Reheat Spray
- Superheat Spray
- Auxiliary Steam

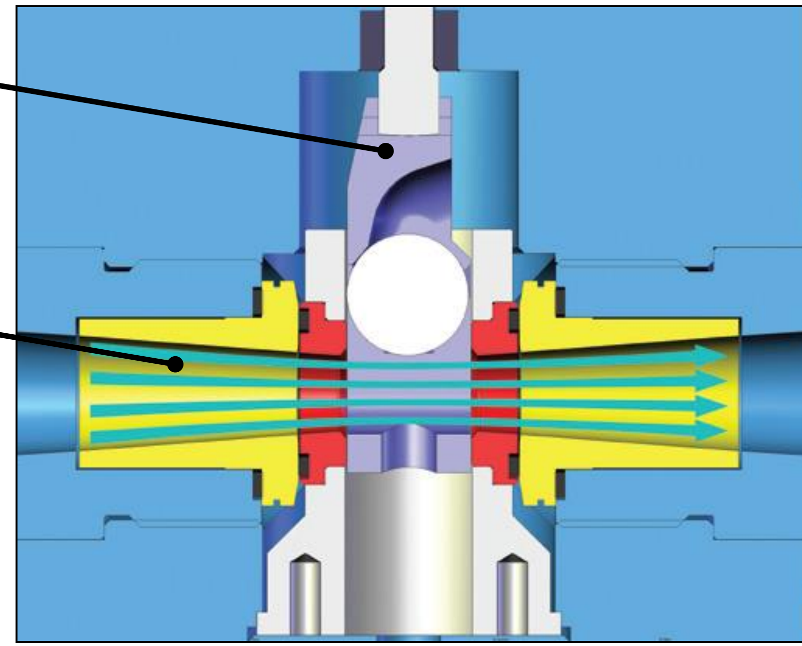
DFT Control Valves - Flow Characteristics

Fluid is controlled by moving the Ball in and out of the flow stream. The moving Ball creates a variable eclipsed orifice which provides smooth control.



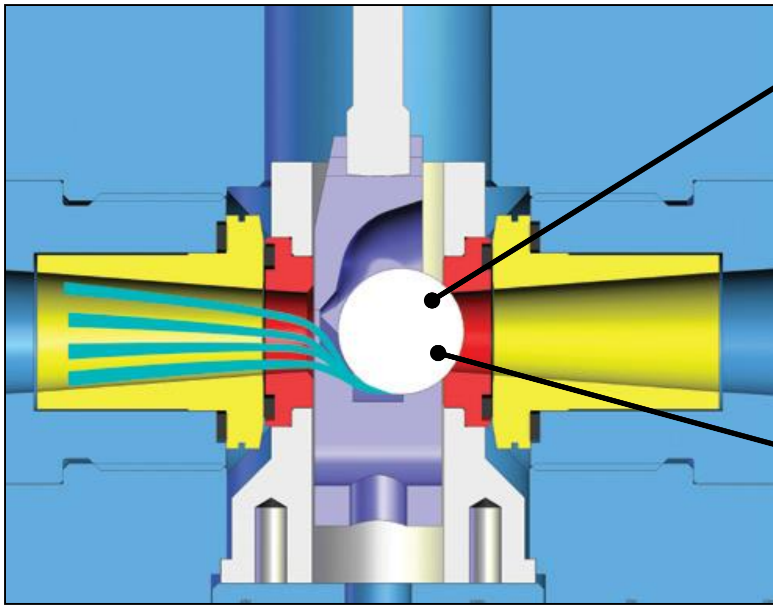
DFT Control Valve - Open Position

- The Cage lifts the Ball completely out of flow for a full unobstructed opening.
- Straight-thru flow path. No turns within valve body.
- In this position, the Valve operates as a true venturi.



DFT INC

DFT Control Valve - Shut Off

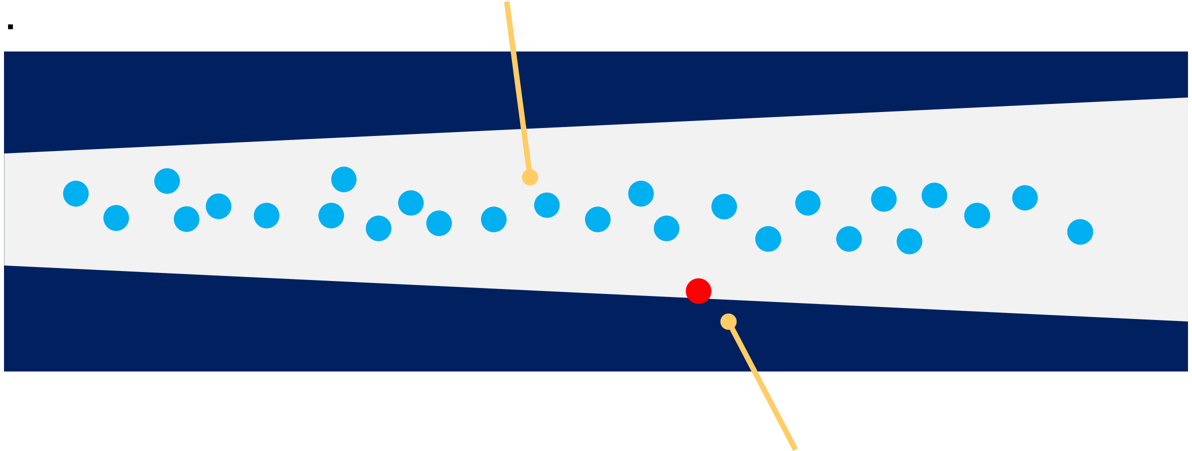


- Upstream pressure pushes the Ball into a lapped downstream Seat face, which yields high unit loading for exceptionally tight closure.
- The Ball changes positions each time the valve is cycled, which results in a new seating surface each time it closes.

DFT - Cavitation Control

As the velocity decreases in the valve's exit nozzle the pressure increases (or recovers) and the vapor bubbles collapse. This is known as cavitation.

Unlike tortuous path designs, DFT valves manage cavitation by the bubbles forming at the lowest pressure and highest velocity…the center of the fluid stream. The collapse is within the hydraulic barrier…



not on metal surfaces, which can destroy the valve.

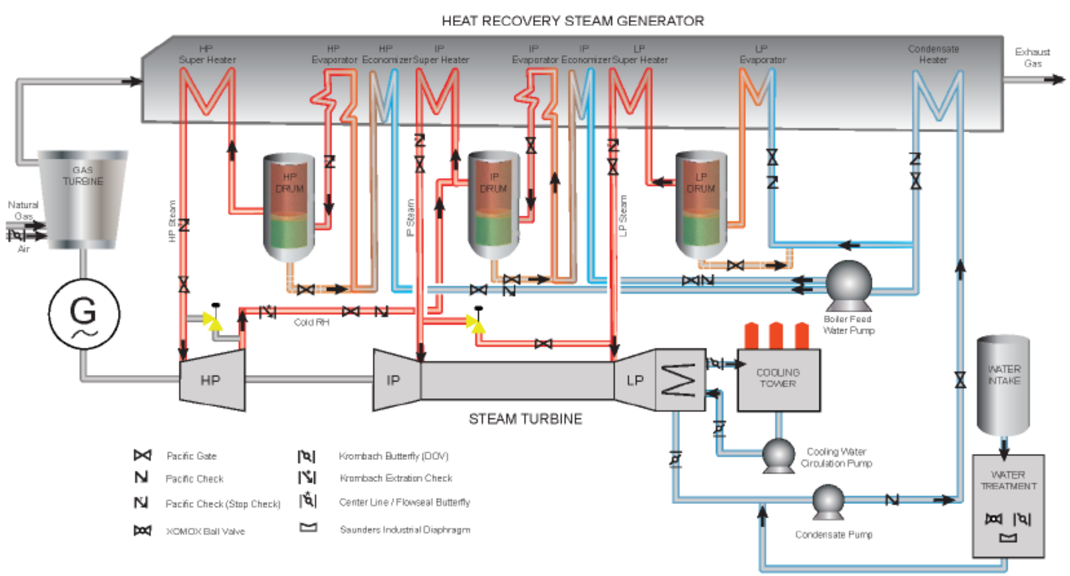
Gas PowerApplications

Combined Cycle Power Plant

- Market conditions demand faster online times, increasing the severity of gas turbine starts.
- This in turn increases the thermal transients, with higher gas turbine acceleration and higher gas flows, at increased temperatures feeding the HRSG.
- Every time the plant is cycled, the CT, HRSG, ST, steam lines and auxiliary components undergo drastic thermal and pressure stresses.
- This can quickly damage the equipment, and dramatically accelerate the wear and tear on valves.

- Increasing cyclic conditions (on/off and load following) in today's combined cycle power plants are quickly increasing the demand, and the stress, being placed upon the equipment – particularly high pressure valves.
- Key High Pressure Applications:
  - Drums
  - Superheater
  - Reheater
  - Steam Turbine
  - Feed Water Distribution
  - Economizers

Combined Cycle Power Plant



Pacific Valves are designed specifically to last in the worst cyclic conditions of today's, and tomorrow's, thermal power applications.

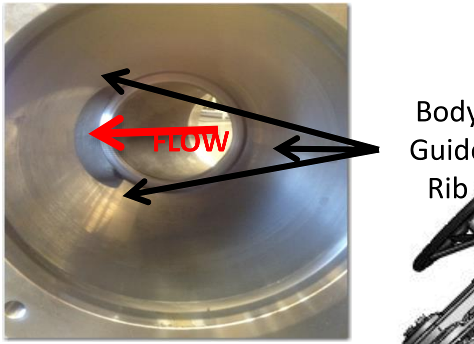
Pacific Pressure Seal

Y-Globe Stop-Check Valve

Cracking of Guide Ribs is a Widespread Concern

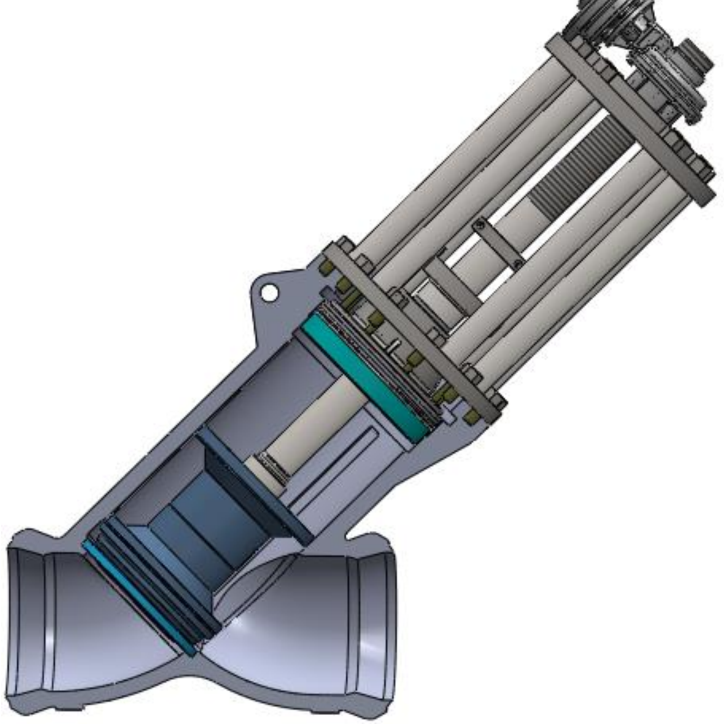
- An issue which is becoming more prevalent in combined cycle power plant applications is cracking of the body guide ribs in Y-Globes due to the number of thermal cycles and thermal transient conditions
- Pacific's guide rib design is such that the guides are located at 4, 8, 12 o'clock, outside of the flow path, providing a unique solution for combined cycle power plant applications

Pacific®



Features:

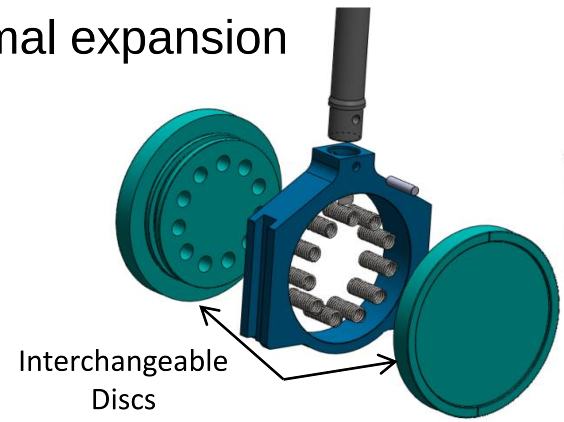
- Full-port, full flow body design enables best-in-class flow (C_v) and the lowest pressure drop in the industry
- Integral, hard-faced body guides provide consistant and accurate movement across the entire valve stroke

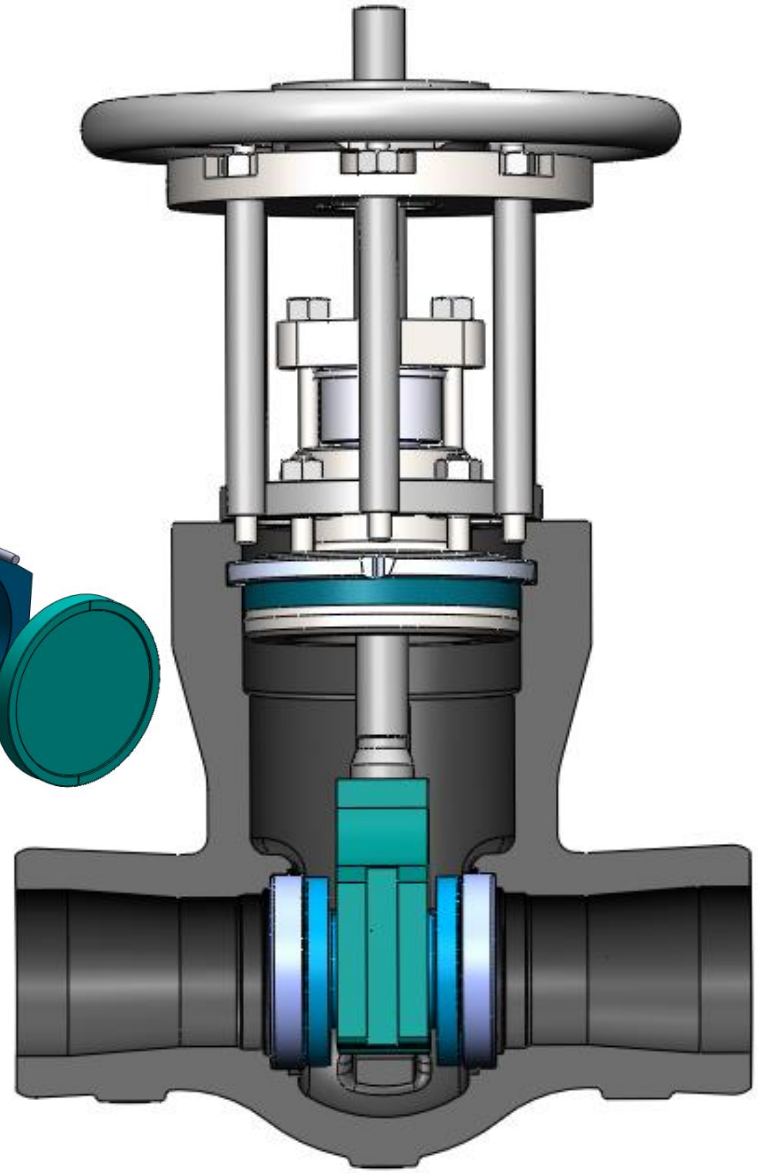


Pacific Pressure Seal

Parallel Disc Gate Valve

- Pacific Valves is a one-stop solution for high pressure valves used in Combined Cycle Power Plants
- Hardfaced seating surfaces provide high cycle capability in very high differential pressure services.
- Position seating eliminates stress and potential binding due to thermal expansion of the stem.





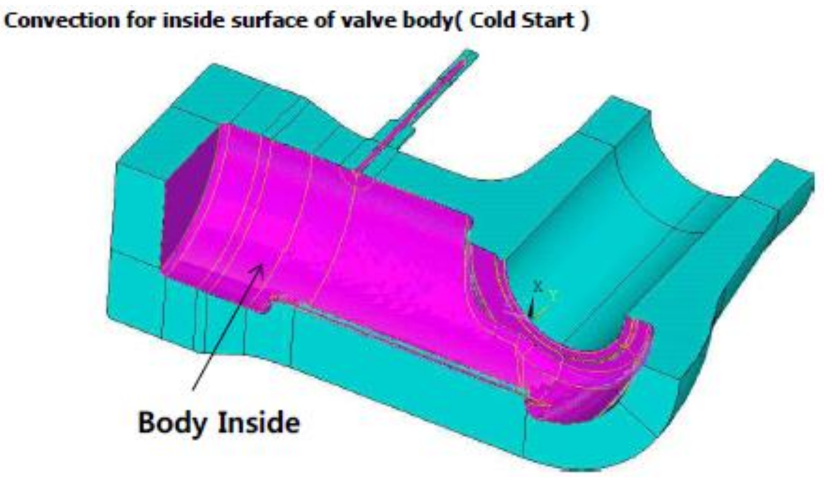
Features:

- Parallel disc design eliminates thermal binding and is capable of zero leakage
- Spring-loaded discs are self-aligning, reducing actuator torque requirements
- Interchangeable discs enable versatility during maintenance

Pacific Forged Gate, Globe & Check Product Design:
Near Net Shape-Style

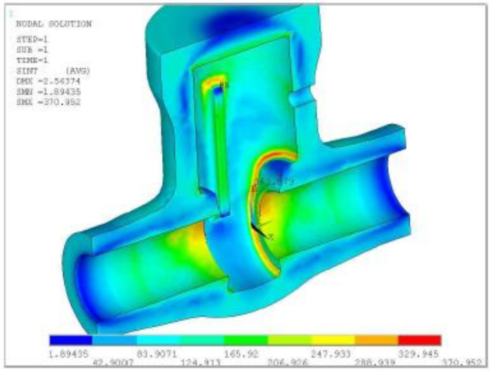
Near Net-Shape, Pressure Seal

- Developed in collaboration with Siemens – a multi-year development project
- Design goal: Develop a forged valve that can last for 20 years (expected plant life-cycle)
- Siemens has approved this design to last 20 years (life cycle of their plants).



Features

- Contoured shape minimizing variance in wall thickness, and subsequent thermal stress during plant cycling conditions
- Non-LCC F91 & F92 standard material options (other materials available)
- 100% RT on welds standard
- Easy access to seat rings and critical welds during assembly



Test Parameters / Design Acceptance Criteria

- Lifetime of Thermal cycling (hot, warm, and cold start), Load Changes, and Trip Scenarios
- Min/max cyclic pressures
- Maximum wall temperature variation based on design
- Material stress analysis
- Material fatigue life

Design has been tested extensively to withstand the most extreme cyclic plant conditions, including min/max temperature and pressure variations, sustained over expected plant life **Valve is designed to last the life cycle of the plant.**

NozChek Nozzle-type Check Valve

Non-slam Check for Boiler Feed Pump Discharge

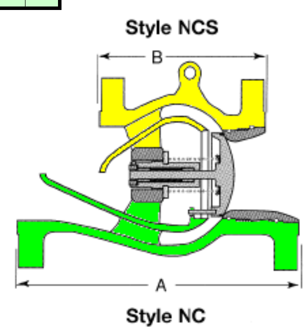
- NozChek is a great solution for Boiler Feedwater Pump Discharge, *especially* for today's high-cycle power market:
  - Prevents Flow Reversal and Water Hammer
  - Very Low Pressure Drop; reduced energy costs
  - Short stroke length assures minimal wear and long life in high-cycle applications

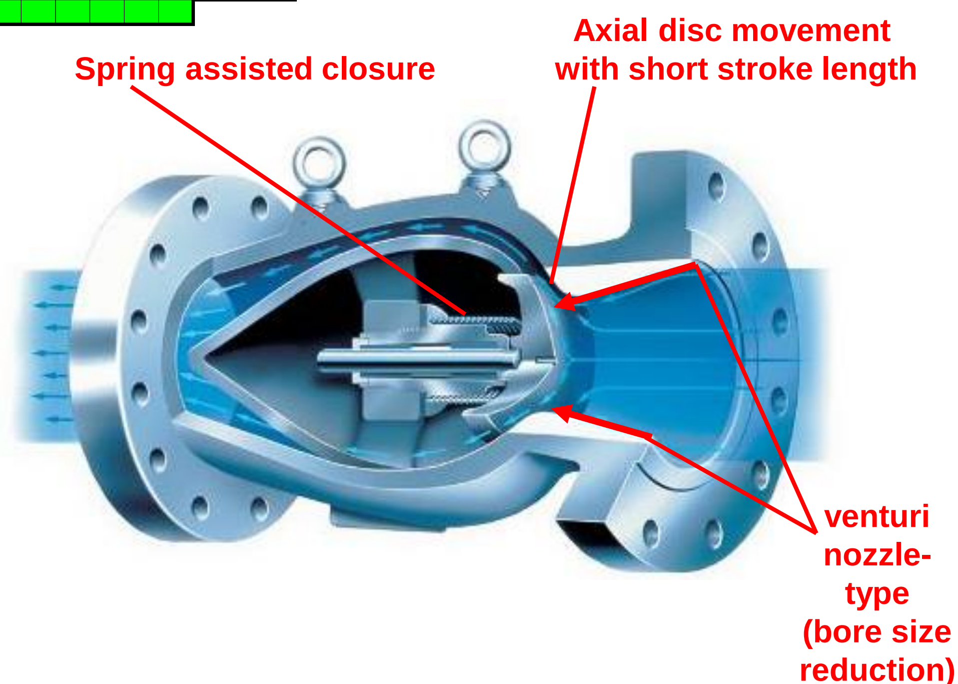
Short Pattern NOZ-CHECK

Pressure \ Size (in.)	2	3	4	6	8	10	12	14	16	18	20	24	30	36	38	40	42	44	46	48	50	52	54	56	58	60	64	68	72
150#																													
300#																													
600#																													
900#																													
1500#																													
2500#																													

SHORT PATTERN, Face to Face "B"
to… Manufacturer standard

STANDARD / LONG PATTERN, Face to Face "A"
to… API 6D





Standard / Long Pattern NOZ-CHECK

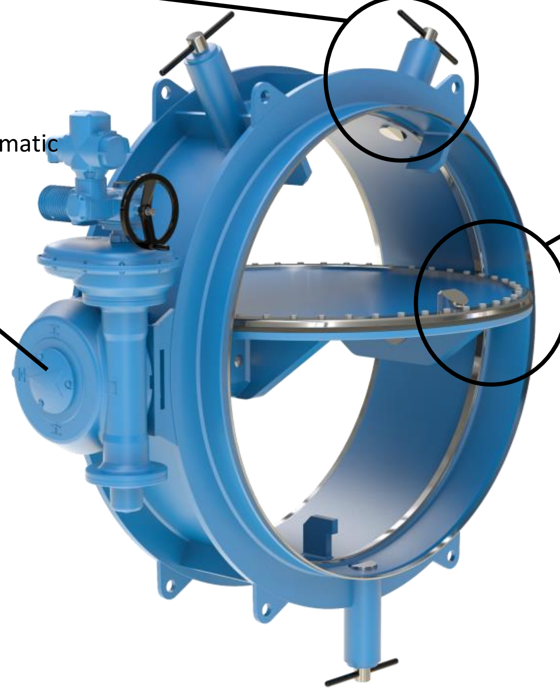
Pressure \ Size (in.)	2	3	4	6	8	10	12	14	16	18	20	24	30	36
150#														
300#														
600#														
900#														
1500#														
2500#														

Krombach Double-Offset Butterfly Valve

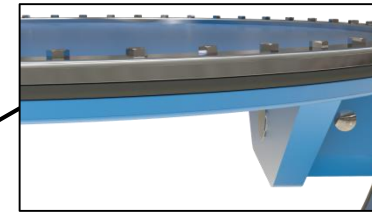
Large-bore valve for Circ Water and Condenser Applications

Optional mechanical man-safe locking device

Top mounting flange in accordance with ISO 5211:
Suitable for manual gear, electric, hydraulic and pneumatic actuation.



Replaceable / adjustable sealing element



Sealing element is carried on the disc for easy adjustment and replacement

DN [mm]*	NPS [inch]*	PN 2,5	PN6	PN10	PN16	PN25
700	28	■	■	■	■	■
750	30	■	■	■	■	■
800	32	■	■	■	■	■
900	36	■	■	■	■	
950	38	■	■	■	■	
1000	40	■	■	■	■	
1050	42	■	■	■	■	
1150	46	■	■	■	■	
1200	48	■	■	■	■	
1250	50	■	■	■	■	
1300	52	■	■	■	■	
1350	54	■	■	■		
1400	56	■	■	■		
1500	60	■	■	■		
1600	64	■	■	■		
1650	66	■	■	■		
1800	72	■	■	■		
1950	78	■	■	■		
2000	80	■	■	■		
2100	84	■	■	■		
2200	88	■	■	■		
2250	90	■	■	■		
2400	96	■	■	■		
2550	102	■	■			
2600	104	■	■			
2700	108	■	■			
2800	112	■	■			
2850	114	■	■			
2900	116	■	■			
3000	120	■	■			
3200	128	■	■			
3400	136	■	■			

Other size ranges, materials or designs available on request

Due to the fabricated design we can meet different design standards i.e. alternative face to face dimensions / pipe connections in accordance to different standards like AWWA/ ASME / DIN

	ASME
Size range	**28" to 136"**
Pressure rating	**PN2,5 - PN25**
Temperature range*	**NBR: 14°F to 180°F**
	EPDM: -0°F to 220°F
	FKM: -4°F to 392°F
Body Types	**Double Flange /**
Connections	**ASME B16.47 / AWWA**
Face to Face	**DIN/ASME/AWWA**

Typical Valves for Combined Cycle Units (FlowServe)

I  low Globe (Stop) Valve

I  l Cover Piston Check Valve

I  e for MSIV and MFIV Service

I  l Bonnet - Globe (Stop-Check) Valve

I  lve® - Stop Valve

I  ne Control Valve

I  0 Control Valve

I  Stage Nozzle Control Valve ZK 29

 Bimetallic Steam Trap BK 212HT

Is it the globe valve design or the seal gasket and packing which prevents leaks?

- A two year old power plant originally chose a competitor's globe and gate valves. However, the Plant Engineering Department wasn't satisfied with the valves. By October of that year the valves had pressure seal gasket and packing leaks, forcing the plant to replace the faulty valves.

  Having used Conval's CLAMPSEAL® globe valves at other power plants in the past, they turned to Conval. Their Conval sales representative informed them about the Conval Swivldisc® Gate valve; the valves were replaced and the problem was solved permanently.

Fuel Valves

Valve bypass eliminates liquid fuel nozzle coking

- **Coking Eliminated with JASC Solution- Schyler McElrath**
- JASC solutions for gas turbine back up liquid fuel systems are operating at better than 98% reliability and availability. As turbine efficiency continues to rise and combustion hardware maintenance intervals increase, fuel control technology must also continue to improve. Innovations such as the water cooled liquid fuel check valve, water cooled 3-way purge valve, combining valve and Smart Fluid Monitor were designed to provide options which are appropriate for any gas turbine system application or operational parameter
- ***Revision Date:*** 6/2/2014
- ***Tags:*** 221112 - Fossil Fuel 化石燃料, Jansen’s Aircraft Systems Controls (JASC), Valve, Flow Control

Fuel control valves-

- **Woodward Supplies Gas Control Valves for Heavy Frame Gas Turbines**
- Woodward supplies gas control valves for heavy frame gas turbines. Fuel control valves are available in several sizes with either hydraulic or electric actuation. The integrated valve/actuator contains options for high-temperature applications, hydraulic or electric trips, and a variety of flow capacities. A separate valve is available to control the system fuel pressure upstream from the main control valves.
- ***Revision Date:*** 1/20/2014
- ***Tags:*** 221112 - Fossil Fuel 化石燃料, Woodward, Actuator, Valve, Flow Control

Materials

Better alloys being used in steam valves

- Materials used in the manufacture of steam turbine valve components have to withstand many stress cycles of steam flow, pressure and temperature changes. Operating pressures and temperatures have increased for new power plants in both subcritical and ultracritical units. Plant loads now go up and down continuously on a daily basis. Materials have to be reliable and resistant to oxidation, solid particle erosion (SPE) and be able to withstand excessive mechanical stresses for long periods of time. More plants are getting retrofitted with better alloy materials on their valves to extend inspection cycles.
- http://www.energy-tech.com/ram/article_ec2bd2c4-c1cb-11e4-8165-d39ac5fbbf38.html

9-12% martensitic popular but nickel alloys are expensive

- The 9 – 12 percent Cr martensitic alloy steels, were developed to match new boiler steam temperatures. Valve components such as stems and seats are greatly affected if the right alloys are not used. Nickel based alloys are promising to be adequate but are expensive. Valve heads, stems, seats and bushings should be oxidation resistant and also resistant to contact or sliding wear during operation. Weld deposition of thick layers of wear resistant material as an overlay coating for valve stems and bushings is a cheaper way to retrofit or repair existing valves.
- http://www.energy-tech.com/ram/article_ec2bd2c4-c1cb-11e4-8165-d39ac5fbbf38.html

Incolloy 901 for stems and bushings with stellite overlay

- Trend for valve materials is to use nitride material, Incolloy 901, and nitrided 422 stainless steels for stems and bushings to reduce oxide scale build up. Boiler exfoliation from superheat and hot reheat tubes present a challenge to valves and often require that valve stems be equipped with nitrided materials and also chrome-carbide-coated materials. Stems can also have a Stellite weld overlay for protection. Wear and oxidation resistant materials are used in bushings because of the close tolerances between the stem and bushings.
- Advantages of using Incolloy stems and Stellite bushings to reduce oxidation growth over time, compared to conventional 12Cr alloys currently used in valve parts.
- http://www.energy-tech.com/ram/article_ec2bd2c4-c1cb-11e4-8165-d39ac5fbbf38.html

coatings

Materials experts and niche knowledge

- Mutama K.R., Steam Turbine Valve Testing, Inspection and Maintenance to Avoid Turbine Overspeed Events; Proceedings of ASME 2011, Power2011-55150
- EPRI Report: U.S. Steam Turbine Valve Metallurgy Guide; 1016786, Final Report, March 2009
- Special Metals Corporation; Product Handbook of High-Performance Alloys Part 1 pages 2-34.
- Specials Metals Corporation; Nimonic alloy 901

- *Dr. Kuda R. Mutama Ph.D., is the engineering manager for TS Power Plant, part of Newmont Nevada Energy Investments, where he is responsible for plant technical*

Thermal spray coatings for ball valves

- Metal seated ball valves are replacing globe, gate, angle, and plug valves as process streams continue to increase in both pressure and temperature.
- Praxair Surface Technologies offers a variety of thermal spray coatings that increase the life and improve the performance of metal seated ball valves. These wear-resistant coatings, which are applied to the mating surfaces of balls and seats, provide a solution to the wear issues facing ball valve manufacturers and users.
- http://www.praxairsurfacetechnologies.com/na/us/pst/pst.nsf/0/9F52857EF3AB6F9C852576A5006E6B8C/$file/P9084_ball_valve_coatings_hr.pdf

Velan Secureseal Valves employ hard coatings

- Hard coatings can address, galling, abrasion, erosion, spaliation/debonding and fatigue
- Key properties are hardness, high temperature hardness, bond, porosity, toughness
- Applications are electroplating, PTA, HVOF, APS, and S&F, diffusion, CVD
- New coatings from Velan are an HVOF carbide coating that maintains hardness at 1000F which is suited for high cycle applications, a K-type nickel based coating and V-type coating of tungsten carbide
- *Two articles submitted by Luc on 6/3/2015 but not yet posted*

Specific Issues and Evaluation Considerations

(Stellite Delamination)

- Stellite liberation from large valves installed in high-pressure (HP) and hot reheat (HRH) steam systems serving F-class combined cycles has emerged as an important industry concern. Tight shutoff of parallel-slide gate and non-return globe valves has been compromised in some cases, based on feedback from plant personnel; steam-turbine components also have been damaged.
- EPRI has established a committee on "Cracking and Disbonding of Hardfacing Alloys in Combined-Cycle Plant Valves" to dig into the details. The work, funded by several sponsors, began early this year. John Shingledecker (jshingledecker@epri.com), the technical manager for this program, said the project timeline is estimated at 14 months. The first formal review of industry experience is incorporated into the program for the upcoming EPRI Fossil Materials and Repair Program Technology Transfer Week, June 24-28, in Destin, Fla.
- Owner/operators, valve manufacturers and service organizations, and other interested parties expect one outcome of the R&D effort will be a more reliable process for the bonding of stellite to discs, seats, and slides for valves subjected to steam temperatures approaching 1100F, as well as to rapid quenching caused by improperly operating desuperheaters and/or drain systems. The solution also may require changes to current industry inspection, operating, and maintenance procedures

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

Steam valve stellite delamination

- **NV Energy Coping with Stellite Delamination**
- CCJ editors participated in a round table with NV Energy personnel to discuss the first gas-turbine major inspection at its Walter M Higgins Generating Station. Higgins is a 2 x 1 combined cycle powered by 501FD2 gas turbines from Siemens Energy Inc. The roundtable covered a number of issues including large steam valves.
- ***Revision Date:*** 2/11/2014
- ***Tags:*** 221112 - Fossil Fuel 化石燃料, NV Energy, Siemens, Valve, Gas Turbine, Delamination, Flow Control, Combined Cycle Journal, USA

Actuators

Pneumatic or Hydraulic actuators for hot reheat bypass valves

- Selecting hydraulic actuators instead of pneumatic actuators for critical desuperheating valve applications is one way to address cycling-related problems. Since oil is incompressible, performing the same response calculations as before, but this time for a hydraulic actuator, yields much better results: a dead time of just 0.00164 seconds and piston jumps in increments of just 0.00423, or 0.0564% of span.
- Switching from pneumatic to hydraulic actuators virtually eliminates the lag in response to a control signal change and reduces jump to an insignificant level. Hydraulic actuation systems can be tuned for very fine setpoint control (down to 0.1% of span). In general, they feature very fast stroking speeds, 100% duty modulating service, unparalleled frequency response (millisecond dead times), immunity to dynamic instability and friction, and almost immeasurable overshoot.
- But there are downsides to going with hydraulic actuators. Conventional hydraulic actuators have a reputation for being maintenance and reliability nightmares, and they cost much more than their pneumatic cousins. What's more, hydraulic systems require motors to run 24 hours a day, as well as an extensive network of very high pressure hydraulic tubing and fittings that may leak. Plant owners and builders tend to avoid hydraulic systems for those reasons, preferring instead to specify advanced pneumatic positioner technology, regardless of its performance limitations

- http://www.powermag.com/desuperheating-valves-take-the-heat/

Pneumatic or hydraulic for HRH

(Boiler Feed, HRSG, Turbine, Condenser, Flue gas, other systems)

Pneumatic or Hydraulic actuators for hot reheat bypass valves

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Electric Actuators

- Electric Actuators
- Rotork has a line of all-electric, compact modulating actuators known as the Continuous Duty Modulating Failsafe Electric Actuator. The Rotork CVA is suited for almost all linear, quarter-turn control valve applications requiring precise position control and continuous modulation.
- The electric actuator features a failsafe function, allowing the operator to program the actuator to lock in one of four positions if there is a loss of power.
- The CVA does not require the infrastructure (piping/tubing to distribute compressed air) needed to operate a pneumatic actuator. What's more, it is significantly more accurate, Kundin said.
- The move toward electric actuators has led to the creation of more digital networks for controlling these types of actuators. But the transition has been slow
- http://www.power-eng.com/articles/print/volume-118/issue-8/features/valves-actuators.html

Pneumatic and Hydraulic Actuators

- Pneumatic Actuators
- While many pneumatic actuators have remained unchanged, except for the addition of smart positioners, there have been some new innovations in pneumatic actuation. A number of piston and rotary actuators have been creeping into power plants, which primarily have used diaphragm actuators on control valves.
- Pneumatic actuators equipped with smart positioners now functionally compete with electric actuators in terms of fail-in-position operation on loss of signal at significantly less cost.
- Hydraulic Actuators
- Hydraulic actuators are increasingly popular because of their ability to achieve high torque. Some companies offer a linear actuator that can be modified for rotary action through a gearbox. The device has been around for more than a decade and offers a digitally stepped servomotor pump to provide higher positioning accuracy than pneumatic actuators.
- Hydraulic actuators have even been used to position small turbine control valves. The actuator is connected to a nearby smart programmable electronic box with an umbilical cable. Configuration and calibration is made easy through this box, which can be mounted away from the process for convenient access.
- http://www.power-eng.com/articles/print/volume-118/issue-8/features/valves-actuators.htm

Actuators - hydraulic failure

- The valve actuator is essential in operating steam turbine valves. The valve control function is part of the D-EHC control system. Modern actuators use electrohydraulic control (EHC) oil from a skid at a pressure of approximately 2,400 psi supplied to the actuator spring with a servo mechanism and LVDT for valve position
- Some power plants are reporting premature failure of valve actuators. In order for a valve to completely shut, three things have to function properly to stop the flow of steam to the turbine to prevent an overspeed event. (i) The valve trip mechanism has to work properly, regardless of whether it is mechanical or digital. (ii) The valve stem should not stick to the bushings and should seat properly to shut off steam flow completely. (iii) The actuator has to function properly to allow proper movement or stroke of the valve stem to seat the valve disc to the seat completely.
- http://www.energy-tech.com/ram/article_ec2bd2c4-c1cb-11e4-8165-d39ac5fbbf38.html

Actuator spring disc failure

- Valve actuators should last at least four to five years before any major maintenance becomes necessary. During a scheduled annual overspeed test in 2012 at TS Power Plant the MSV valve failed to close, even though the turbine had tripped. The MSV valve was at 23 percent open following the turbine trip, then went down to 8.1 percent open after more than 24 hours (Figures 6 and 7). The CV and the RSV/IV shut the flow of steam completely and prevented the turbine from spinning out of control. A review of the historical operating data going back six months revealed that the MSV had not been closing completely during the previous trips. In all cases, the CV prevented the turbine from overspeeding. It was discovered that the MSV actuator had spring discs that had completely rusted or corroded, causing the actuator to fail, as shown in Figure 8. The MSV actuator was later rebuilt. This was a very close call for the plant. The lesson from this is to inspect actuators at the time of valve inspection, even though there might not be any sign of trouble. Many plants are now on an aggressive rebuilding schedule to avoid incidences like this
- http://www.energy-tech.com/ram/article_ec2bd2c4-c1cb-11e4-8165-d39ac5fbbf38.html

Young and Franklin electric actuator

- Advances in the design and manufacturability of electrically powered actuators have allowed for the replacement of hydraulically actuated control valves and guide vanes on heavy duty class combustion turbines. Asset owners and operators benefit from reduced life cycle cost, improved component reliability, and in many cases interrelated components can be eliminated, thereby improving system reliability.

- The hydraulic valve product is mature, but to ensure their reliability frequent maintenance must be performed on a 24,000 hour cycle minimum. Lack of maintenance causes unpredictable control performance such as start-fails, forced trips, trips during controlled shutdowns and loss of flame during transitions. Hydraulic oil leaks of worn seals and vulnerable fittings create slip and fire hazards. On-site work includes messy filter changes, replacement of lube-oil varnish plagued servos and safety trip relays, unverified adjustment of valve stem packings, and re-calibration. Off-site work is typically a time-zero overhaul of the valve and actuator at 48,000 hour intervals.

- Y&F set out to develop the EMA (electric motor actuator) product line with asset owners and operators in mind. Specifications were based on real world duty cycles, operating conditions and owner/operator inputs while meeting or exceeding original equipment performance metrics. Development testing was based on the most stringent requirement of each category. All products were designed to fit into the same envelope or smaller than existing hydraulic products and are suitable for many OEM turbine makes. Retrofit projects can be completed within typical outage duration with minimal on-site modifications required.

- The Y&F EMA product line is designed for a 96,000 hour time-zero overhaul cycle.

- Owner/operators benefit from improved reliability and realize maintenance budget gains by eliminating the recurring costs associated with lube oil powered hydraulic actuators.

- http://www.power-eng.com/articles/print/volume-118/issue-4/features/valves-actuators-the-path-to-greater-efficiency-performance.html