WINTER 1999
SPOTLIGHT ON POWER

SOLUTIONS

CCI Helps Companies Achieve Increased MWe.

VALVES & CONTROL SYSTEMS

How To Improve Your Plant's Efficiency.

OPERATING POWER PLANTS efficiently is very important in the economics of power generation. Optimizing efficiency requires that all power plant systems function at peak performance over long term operation.

Control valves are the final control elements in any system process. Therefore, their performance affects plant efficiency directly. This is especially true of severe service control valves, which are a small fraction of all the control valves in a power plant. Recent experience suggests a potential for gain in plant performance of 2 to 5%, based on improving the performance of control valves.

Examples of Megawatt savings and gains are:

- **Taiwan Power Company, Kuosheng I & II:** 24 Megawatt gain was realized by replacing the main feedpump (MFP) recirculation valves.
- **Central Nuclear Vandellos:** Main feedwater control valves (MFCV) retrofitted with DRAG technology solved the control problems: a bonus while solving the control problems was a 2 Megawatt savings.
- **Commonwealth Edison, Quad Cities I and II:** 6 Megawatt gain was achieved by retrofitting the heater drain valves.
- **Salem Harbor Station, formerly New England Power:** A new DRAG feedwater control valve combined functions of the main flow control valve as well as the startup valve. The smoothness of control reduced the time for startup by two hours.
- **Tata Electric Company:** A new feedwater control valve replaced the old conventional valve to provide smooth control, reducing the time for startup by two hours and eliminating the potential for trips due to feedwater control problems during startup.

CCI has been solving severe service valve problems around the world for the past 30 years, sharing a depth of experience and unique expertise in severe service control valves and systems. As recognition of the role of control valves in improving power plant efficiencies grows, CCI continues to take the leading role in the application of correct technologies for severe service valve applications.

Main steam leaking from atmospheric vent valve.

The Critical Role of Severe Service Valves

Eliminating problems in severe service valves offers one of the quickest and most effective means of improving plant efficiency. Of the hundreds of control valves in any power plant, severe service valves are those subjected to tough operating conditions either all or part of the time. Although few in number, they pose challenges to maintenance and operation.

In most cases, problems are caused by the misapplication of general service valves in severe service duty. In severe operating conditions, such misapplications affect overall efficiency to a greater degree, compared to the entire valve population.

How Severe Service Valve Problems Affect Plant Efficiency

Even though key parameters are monitored in power stations, severe service control valves traditionally have not been included in the efficiency analysis. This may have been due to a combination of factors – their treatment only as "necessary evils" in control, poor recognition of their contribution to plant efficiency and, perhaps, a lack of systematic methods for quantifying their effect on efficiency. The net result is that control valves tend to be the most under-rated and ignored elements in power plant operation.

The visible effects of control valve problems most often include loss in production capacity, occasional plant trips, frequent maintenance, and safety concerns. In addition, valve problems can trigger other invisible costs, such as penalty in heat rate/high operating cost, longer startup time, and lower Unit availability.

The issue of control valve performance goes even further. Occasional transients that cause operating conditions beyond the normal range may cause collateral damage to other expensive plant equipment, such as turbines, heaters, and boiler tubes. Low flexibility in operation, e.g. part-load operation, or sliding pressure mode in fossil power plants may not be possible even when it is desirable.

Examples of Severe Service Control Valves

Examples of severe service control valve applications in the main power-generating loop in nuclear power plants include main feedpump (MFP) minimum flow control, feedwater control, turbine bypass, atmospheric dump and emergency heater drains. In addition, there are many other severe service valve applications in various systems in nuclear plants, such as residual heat removal (RHR), high pressure core injection (HPCI), service water, high pressure injection (HPI), reactor coolant system (RCS) and chemical volume control system (CVCS).

Examples of severe service control valve applications in fossil power plants include the boiler feedpump (BFP) minimum flow control, feedwater control, spraywater control, auxiliary steam control, heater drains, turbine bypass and startup valves.

In such severe service applications, typical symptoms observed include:

- Premature trim and body erosion due to lack of control of fluid velocity along the flowpath.
- Poor shutoff capability, resulting in further damage to the sealing surfaces.
- Poor process control.
- Poor dynamic response.

All of these problems can be eliminated by applying solutions which address the root cause directly.

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SUCCESSFUL MANAGERS FOCUS ON CONTROL VALVE PERFORMANCE IN PLANT BETTERMENT PROGRAMS.

Areas for Performance Gain with Optimum Control Valve Performance

There are four major areas for preventing losses using optimum control valve performance.

1. DIRECT ENERGY LOSS DUE TO LEAKAGE: CV leakage has a direct impact on the heat rate and efficiency of the Unit. In applications such as the turbine bypass valves, emergency heater drain valves, main steam drain valves, and boiler feedpump recirculation valves (shut tight during normal operation), any leakage means loss of energy from the system.

2. EFFICIENCY PENALTY DUE TO LEAKAGE: In applications such as the attemperator spray valves in fossil-fired power plants, the leakage flow causes the steam temperature to drop. As a result, the boiler must be fired harder to raise the steam temperature to the set value. This causes a penalty in heat rate and loss in efficiency.

3. REDUCTION OF ENERGY LOSS IN VALVES: The basic mechanism in valves for process control requires pressure drop. This pressure drop results in loss of available work, directly and indirectly. Any reduction of this loss means more work is available from the system. By managing the valve pressure drop from a system perspective, the efficiency of the plant can be improved at full-load and part-load conditions. Often, this optimization results in reduced stresses on other expensive equipment in the power plant, as well.

4. AVAILABILITY: Improved availability means higher production, i.e. more MW-hours. Good control valve performance can increase availability in more ways than one, such as shorter startup and shutdown time, and elimination of load limitations attributable to control valve non-performance.

Estimating Potential for Improvement

Quantifying the potential for improvement is an important step in any system to realize the full benefits. Generally, the efficiency losses due to individual valve applications are small, but together they add up to a significant value. Every power plant is unique in some ways and therefore, the methods for estimation of these losses must be applied judiciously. More importantly, these methods must inspire confidence in the resulting estimates based on reasonable assumptions and experience.

Case – MFP recirculation valve

One of the simplest calculations to perform is the estimation of MWe loss due to leakage caused by damage to the sealing surface. The following case involved a main feedpump (MFP) recirculation valve in a pressurized water reactor plant. This case demonstrates the method itself, and imparts a sense of the magnitude of such a loss.

The cage from the MFP recirculation valve after one cycle of operation is shown below. Measurements of the damage to the sealing surface indicate its total cross-sectional area to be 0.087 sq. in.

Damaged trim from main feedpump (MFP) recirculation valve showing areas of damage on the sealing surface. The depth and width of individual damage locations were measured to arrive at an equivalent leakage area.

The corresponding flow capacity (CV) through the damaged area, i.e., the leakage rate = (0.087 sq.in.) (31) = 2.7

For upstream flow conditions of 1150 psig and 431°F, and condenser pressure downstream,

Typical valve trim damage due to cavitation/erosion/vibration in severe service applications.

Leakage flow:
$Q = (Cv)(DP/G)1/2 = 83.1$ gpm,

where G is the specific gravity. This translates to approximately 35,100 lbs./hour of leakage. The loss of energy from the cycle due to leakage is easily determined. The enthalpy upstream is known from process conditions to be 409.7 Btu/lbm; the enthalpy of the condensate is 69 Btu/lbm.

Therefore, the estimated energy loss is = (35,100 lbs/hour)(409.7–69) = 3.9 MW-thermal.

This is loss per valve. At 33% overall efficiency, the loss in electrical power is 1.3 MWe. Since there are 2 valves per Unit, the total loss is 2.6 MWe for the Unit.

This estimate is in line with the experience at PSE&G, Hope Creek, which reported a gain in 2 MWe by replacing the leaky MFP recirculation valves!

If the typical damage is known from previous maintenance history, it can be used directly in the same manner. In some circumstances, a judgment call based on past results in similar experiences may be the best possible input. Needless to say, the quality of the assumptions is reflected in the results.

Experience in the Industry

The correct application of technologies in severe service control valves has yielded significant benefits. For example, a survey of once-through supercritical fossil plants showed that plants with "velocity control" DRAG® technology in their severe service valves for the start-up system (SUS) experienced negligible losses, whereas plants with conventional valves suffered noticeable loss in generation capacity, plus the heat rate penalty. In the nuclear industry, the application of DRAG technology in the main feedwater control (MFCV) and turbine bypass (TB) valve applications has removed many long-standing reliability problems, resulting in higher production.

CCI's approach to increasing power plants' efficiency

CCI takes a diverse approach in identifying potential improvements in a plant's operation. It has evolved from experience in solving severe service valve problems, which requires substantial knowledge and understanding of the systems.

CCI has appointed a dedicated group to study power plants for efficiency improvement. The group is comprised of qualified professionals who have many years of proven experience in the CV and power generation industry.

THE PROCESS IN A CCI STUDY INCLUDES:

- On-site visit.
- Review and evaluation of the plant cycle.
- Discussions with plant personnel in the efficiency, operations and maintenance departments.
- Study of available data regarding plant's history.
- Identification of specific control valve problems and their impact on plant efficiency.

THE CCI SOLUTION INVOLVES:

- Offering generic solutions, specifications and budgetary estimates.
- Outlining strategies for implementing solutions.
- Providing technical support during implementation of solutions.
- Lending technical support for verification of projected performance gain.

Finally, performance improvement in a power plant can be achieved through many different approaches. However, experience to date makes a compelling case for putting the economic focus on control valves in order to achieve performance gains.

To quote the Chief Engineer of a large utility in his address to plant managers, "…it is not a question whether or not you can afford DRAG® technology, rather a simple fact that you cannot afford *not* to have it in severe service valves."

Written by Sanjay V. Sherikar, Ph.D., P.E.

Why the CCI SteamJet™ is the Preferred Turbine Bypass Solution.

AROUND THE WORLD, companies are recognizing CCI's SteamJet Turbine Bypass System as the superior solution. **Florida Power & Light** recently awarded a multi-million dollar contract to CCI for SteamJet™ turbine bypass control valves and related CCI products, which are to be used in their Ft. Myers, Florida re-powering project.

The goal in developing the SteamJet system was to combine CCI's exclusive DRAG valve multi-stage pressure reduction technology with trans-sonic, steam-assisted desuperheating into one lightweight, efficient package. The package is roughly the same size as conventional steam conditioning valves.

CCI achieved this ambitious goal by employing several technological advancements, including thermally compensated trim, which is designed to allow different parts to grow at their respective thermal expansion rates without binding into each other. By rendering the valve impervious to binding and cracking problems associated with thermal shock, CCI solved a challenge for combined cycle and cogeneration power stations, which cycle frequently.

The SteamJet nozzle is another advancement that has put CCI ahead of its competitors in steam-assisted design. With the SteamJet, a small amount of steam is extracted (without external piping) and accelerated to supersonic velocity by means of a convergent/divergent nozzle.

STEAMjet™

STATE-OF-THE-ART TURBINE BYPASS™

Pressurized Seat™ Plug
Low actuator loads and outstanding shut-off per MSS-SP-61 isolation valve specification.

Easy to Service Seat
No welding or grinding.

Full Thermal Compensation Design
Impervious to thermal shock for high cycle duty.

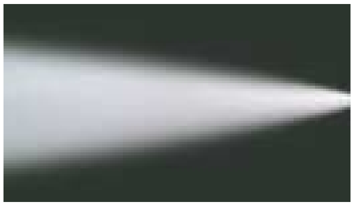
Multi-Stage DRAG® Control Element
Low noise and low vibration.

SteamJet™ Desuperheating Nozzle
Supersonic atomizing steam and "compound swirl" plume shaping.

ISA Design Criteria Help Assure Quality.

With every proposal submitted to customers, CCI now includes a 20-page *ISA Guide Compliant Specification* for control valves. Based on the recently published *ISA Practical Guide to Control Valves*, this specification gives our customers a precise industrial perspective on what standards to follow in the selection of control valves. More importantly, customers can make decisions based on criteria objectively demonstrating that CCI valves are made to the highest recognized quality standards in the industry.

At the divergent portion of the nozzle, water is injected into the flow stream. The high velocity of the atomizing steam and the recovery waves send a great deal of energy into the water as the fluid decelerates, atomizing the water into an extremely fine mist.



SteamJet™ plume density provides superior atomization.

CCI discovered that a swirl or spin could be induced in the mist by extracting an even smaller amount of steam, and introducing it through small holes drilled at a compound angle at the very exit of the divergent portion of the nozzle. The effect of this is to shape the mist into a plume, which does not impinge directly on the pipe, but disperses it in a very even fashion. Laboratory tests demonstrated the significance of this small design feature. Based on testing of the SteamJet nozzle vs. other steam-assisted designs on the market, CCI believes its water atomization and mixing capability is unmatched in the industry.

The first SteamJet units were built as engineered specials (H.P., I.P., and L.P.), and installed throughout Asia, the U.K., and continental Europe, with additional engineered special designs scheduled to be in service in Australia in the near future. Noise, pressure, and temperature control measurements have produced outstanding results.

Recently, CCI implemented an extensive value-engineering program on the SteamJet, focusing on the H.P. turbine bypass for combined cycle and cogeneration power plants. There are two basic product configurations: one for H.P. bypass to cold reheat, and the other for H.P. bypass to condenser applications. A simplified design reduced weight and the parts count, making the product easier to maintain, and more competitive.

The SteamJet design, with pilot-operated trim, is to be used with high-speed, high-accuracy pneumatic actuators. Both the unit and the actuator achieve outstanding shut-off per MSS-SP61 (block valve specification) as standard.

As with all DRAG valves, the disk stack, or cage, is custom-designed for the number of stages required and the characteristic desired. The units will achieve up to a 50–1 rangeability, and the SteamJet nozzles are selected per application. A variety of inlet and outlet connections are available.

Anchored with DRAG technology, the SteamJet is the finest velocity control valve trim in the world, capable of eliminating excessive noise and vibration. It is one of the reasons why **Black & Veatch, FP&L's Engineer Constructor,** recommended CCI's SteamJet and other advanced DRAG® technology products for severe service valves and related state-of-the-art equipment. The valves will help the re-powered Ft. Myers plant adjust electric generation more effectively to meet changing load demands.

High-performance SteamJet™ internal parts are easy to maintain, efficient, and durable.

Custom Solutions from CCI

Mitsubishi Heavy Industries Chooses CCI As Their Global Supplier For Turbine Bypass Systems

ON **APRIL 8, 1999, Mitsubishi Heavy Industries (MHI)** and CCI representatives met in Japan to sign a three-year global purchase agreement. A team of CCI sales, engineering, and manufacturing personnel in three countries worked over 18 months to provide MHI with turbine bypass valve solutions that meet or exceed the company's expectations.

High performance, reliable products and support come with the CCI Drag and Sulzer Valve® names, assuring MHI of the best technical solution in the industry.

This recent success is one more example of how CCI has earned a reputation as the industry's premium turbine bypass supplier.

Pictured left to right.
Seated: Mr. Saitoh, CCI K.K.
Mr. Yamahigashi, Manager, Overseas Procurement Center, MHI
Standing: Mr. Uozumi, CCI K.K.
Mr. Yoshida, Manager, Group 1 Overseas Procurement Center, MHI
Mr. Hata, Assistant General Manger, Materials Department, MHI

CCI Selected To Provide Units For New Nuclear Power Plant in Lianyungang, China

CCI HAS BEEN AWARDED a $15 million contract to provide eight main steam valve units to serve the first two 1000-MWe, Russian-designed type NPP91/WWER at the **Lianyungang Nuclear Power Plant (LNPP)**, to be built in Lianyungang, China, north of Shanghai. The selection was made jointly by the Jiangsu Nuclear Power Corp. (JNPC) and the China Nuclear Energy Industry Corp. (CNEIC).

According to Stuart Carson, CCI's President, "This substantial order represents the growing international recognition of the superiority of our many severe service valve types, each specifically designed for a wide variety of applications in the fossil fuel and nuclear power industries, the oil and gas industry, the pulp and paper industry, and many others."

Four of the main steam valve units will serve each of the two new 1000-MWe NPP units. Each main steam valve unit is made up of five valves: A nominally 23-inch (580 mm) system-medium operated, globe-type, main-steam-isolation valve; a quick-acting pressure-reducing valve with up-stream isolating valve; and two safety relief valves which operate sequentially.

A typical main-steam-isolation valve similar to those in the eight main steam valve units being provided by CCI for units 1 and 2 of the new Lianyungang Nuclear Power Plant in China.

We Solve Control Valve Problems

CCI DRAG®

SULZER Valves

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