Technical paper:

Benefits of reducing seating area on valves in pure water systems

Reducing valve seats on in-body gate and check valves in pure water nuclear plant systems is a relatively simple procedure which can save nuclear utilities a substantial amount of personnel radiation dose and money, while contributing to a reduction in system voiding.

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Due to power demands many energy companies are forced to run their power plants close to maximum capacity for more energy output by implementing power uprates and upgrades to multiple systems (e.g. turbines, steam generators, exciters etc). Power uprates change the system dynamics of a plant, causing it to run at higher efficiencies and increased capacity factors than in the past. For example if a plant undergoes a power uprate and increases its power output by 20%, in essence they are producing 1/5th of the power generated if a new plant were to be constructed.

Of course with every upside there is usually a downside. Uprates increase system pressures and place tighter tolerances on components and materials in the systems, changing the criteria for which the plants need to run. With that said, engineers are now monitoring components much more closely. When the majority of plants were designed from the 1960's – 1980's the valves and piping systems were designed to be suited for a large range of applications, pressures and temperatures that were applicable for the plants at that time. One particular criterion that was of little to no concern when plants were operating at lower capacities was the need to vent air from liquid piping systems where it should be a strictly liquid only system. Therefore system voiding has been a growing concern in correlation with power uprates. One need in particular is to maintain nuclear safety related systems in their designed configuration i.e. water solid "no voids" requiring valves to perform with no seat leakage. Very small leaks may have existed for many years but remained undetected due in part to plants not operating at capacity. These undetected voids in the system which act as accumulators are now making noise industry wide and notice has been taken. The consequences of voiding in safety related systems could include pump seal failure, pump impeller cavitations and in severe cases gas binding resulting in pump failure. Also valve seat leakage from one water solid system to another is of great concern. When a seat leaks from a higher pressure system into a lower pressure system it can result in voids in the pipeline which will cause over pressure conditions effecting relief valves to lift. Two traditional resolutions to seat leakage are to replace and/or repair valve internals which involves a great deal of dose (the amount of exposure a person receives from radiation), maintenance time and cost. Of course these circumstances are sometimes not avoidable due to the higher tolerances on the installed base of the valve component.

Logistics

Valve seats can leak for many reasons, whether it is the seating surfaces not mating correctly, the packing or gaskets deteriorating or incorrect loading of the seals and fasteners, just to name a few. We will focus on the seat leakage issue caused by wide seating areas. Valve manufacturers in the United States are required to meet stringent design codes, pressure, temperature, Cv (flow) and seat leakage classifications by institutions such as but not limited to ASME (American Society of Mechanical Engineers), ANSI (American National Standards Institute), MSS (Manufacturers Standardization Society) and API (American Petroleum Institute) for a variety of industrial flow process applications. Being that valves can be placed in a variety of applications in the flow process industry, there are some instances where the valve manufacturers find themselves in an unavoidable gap where the valve is not functioning to its best ability due to the standards, codes and regulations the manufacturers are required to meet. Solid pure water higher pressure systems are an example of pipeline systems where gate and check valves may not perform as a leak free valve which can contribute to voiding/cavitation. On most gate and check valves the seat widths typically have a large area of seat contact

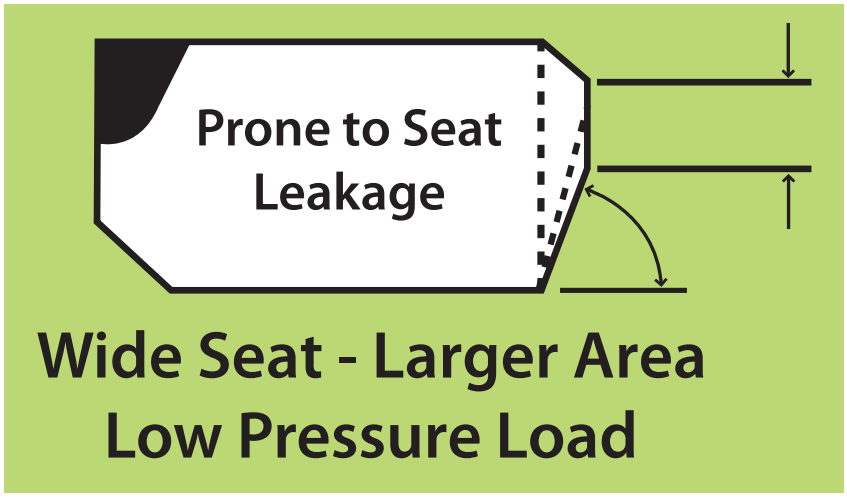

Figure 1

which can result in immediate seat leakage if enough differential pressure (DP) is not present to assist the loading of the disc onto the seat (see Figure 1). Therefore valves are removed from the system and replaced with NEW valves having the same wide seat design that resulted with seat leakage in the previous valve. In some cases there is a seat leakage improvement, but after the valve is subject to the system media and the seat wears from cycling and general maintenance/lapping, in due time the seat will leak resulting in no long term solution. As the valve is maintained the flat seat lapping/grinding process on the hard face will result in a widening of the valve seat. On gate valve seats, this removal of hard face causes the wedge to drop lower between the seats; simultaneously the "beveled" outside diameter of the seat becomes less distinct resulting in a wider seat increasing leakage from the valve seat. Also, there is a proclivity that seat damage will occur across the entire seat width instead of only damaging the original narrow seating surface if the in-body seats had more of a "beveled" outside and/or inside diameter. The sum of the above lapping/maintenance factors is that maintenance time is increased because more seat material will need to be removed during valve lapping, reducing the life of the valve.

Zero tolerance

In order to find a long term solution we took a "narrow" approach and utilized a valve repair tool to reduce the valve seats in correlation with the DP. Narrowing the seating area on in-body seats of gate and check valves in pure water systems produces a tighter mating seal between the disc and in-body seat by increasing the pressure distribution on a smaller seat area (see Figure 2). In most cases the narrow seat will completely rectify seat leakage especially with the DP assisting the seat load. We figured if the same concept was an acceptable design feature for globe/plug valves with the plug having a slight offset degree then it would work on gate and check valves. We highly recommend to perform this seat reduction procedure on gate and check valves within the pure water systems in a nuclear power plant such as RCS (Reactor Coolant System), MUW (Make Up Water), de-mineralizer, feedwater, seal injection and any secondary cooling system, but NOT on raw water applications.

To mention one of many valve candidates we chose a safety-related 18" gate valve in the Decay Heat System from First Energy's Davis Besse Plant as the subject valve. The radiation area was about 30 MR/hr. The DP on the downstream seat is 40 lbs and 2150 lbs on the upstream side. On the downstream side a relief valve would consistently lift (open) from the leakage past this valve. The plan was to either replace the gate valve or replace the valve internals during the next outage. Replacing the valve internals was the less attractive option that was considered due to the high dose budget and length of time the repair would take. The outage planner estimated that it would amount to 10% of the dose budgeted for the entire outage for the replacement or repair of this valve alone. Replacing the valve would have also involved procuring a new safety related valve, welding it back in line and lapping the seats from any distortion that may have resulted in the installation and welding of the new valve. The high dose associated with this repair required all options to be considered; there was no guarantee that the repair would be successful and it could possibly cause more issues than the initial seat leakage. The Valve Maintenance Supervisor had a contingency plan and contacted Dupill Group for accessibility of the 3 degree accessory to be used in conjunction with the Larslap lapping tool they already owned. Since the supervisor had a great deal of experience within the plant, plant system and a vast knowledge of the valve(s) history; he strongly recommended that the best decision was to narrow the valve seat and repair the valve in line using the LarsLap 3 degree accessory.

The complete refurbishment entailed two experienced craftsmen, totaled 14 hours which included actuator removal, disassembly, bonnet removal, seat

Figure 2

Three degree angle grinding on the outside diameter of an in-body valve seat.

modification, inspection and re-assembly. After two full cycles of plant operation the valve is completely leak free. Total dose for the job was about 840MR for the complete task. The valve was tested with 0 and 2400 lb DP. It was estimated to have saved about 9% of the planned dose for that outage just by modifying the seat width rather than replacing the valve. Zero seat leakage was attained by simply establishing a 3 degree angle on the ID and OD of the in-body seats. The alternative was to replace the safety-related gate valve, which was estimated to have been much more dose and money for the overhaul and cost of the valve.

Reducing the seating area by establishing a 3 degree angle on the outside diameter on in-body valve seat results in a leak free seal on gate and check valve seats because there is more pressure distribution on a smaller area of the seats accommodating both high and low pressure sealing. This relatively simple seat repair procedure will save the nuclear utilities a substantial amount of dose, money, and contribute to reduction in system voiding in solid pure water systems insuring that design confirmations are maintained

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About the authors

Tim Calvert began his valve career as a mechanic 28 years ago with First Energy Nuclear Operating Corporation (FENOC) at the Davis Besse Nuclear Power Station. Through noticeable mechanical skills, Tim advanced his role to Lead Mechanic into the 1990's and eventually became the master mechanic for Davis Besse Maintenance department. Tim now leads Davis Besse's Nuclear valve maintenance teams as the Valve Maintenance Supervisor and Outage planner.

Curt Dupill has provided valve product and service solutions for the nuclear power, process control, defense, and industrial markets for almost 15 years with Dupill Group. Through education, sales, service and field experience from valve component, valve repair tool, valve test equipment OEMs etc, he has developed industry recognized Valve 101, Valve maintenance, and Advanced valve repair training programs. Curt has held a wide range of technical valve related service and managerial positions for Dupill Group over the last 15 years and is now US Nuclear Sales Manager for Automatic Valve Corporation.