DRAG® valves give Kuosheng a 24 MWe boost

Leaking feedwater recirculation valves at Taiwan Power's second nuclear station, Kuosheng, had for many years cut into the plant's efficiency and reduced output. By replacing them with DRAG® valves from Control Components Inc (CCI), the station generating capacity was boosted by 24 MWe with the bonus of a significant reduction in maintenance costs.

by T R HO

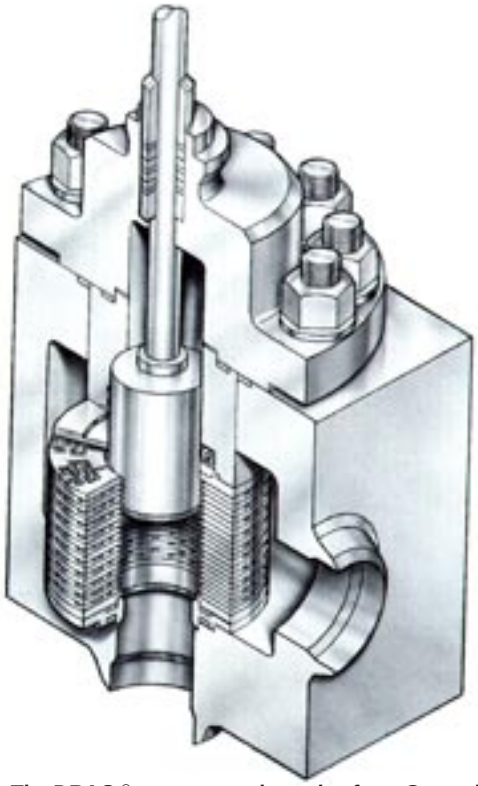
Since starting up in 1981, the Kuosheng station has only been achieving an operating capacity of 973 MWe from each of its two 985 MWe BWR units. In researching ways to increase output, T R Ho, superintendent at the station, and his engineers, discovered some major problems and inefficiencies with its feedwater recirculation valves. In each unit, feedwater is circulated in a closed loop by a feedwater pump which is driven by a steam turbine. The pump takes water from the condensers through the feedwater heaters and boosts the pressure to 1200 pst (85 kg/cm2). In order to protect the pump when the feedwater flow requirement is less than the minimum permissible flow through it, a recirculation system is used to return a portion of the high pressure flow back to the condenser. When the plant was built, the feedwater recirculation systems in each unit were installed with two-stage, cage-type valves. According to Ho, they found that the conventional design of these valves made them inadequate for the severe-service application for which they were being used. "These valves were unable to handle the high pressure drop from 1200 psi (85 kg/cm2) to vacuum and the extreme temperature conditions which occurs during operation," said Ho. "As a result of this, every time we used these valves, we would experience extreme cavitation in the valves, excessive noise problems, and erosion in the downstream piping."

LEAKING VALVES LOWER OUTPUT

Because of the severe cavitation problems and trim erosion due to flashing, the feedwater recirculation valves experienced severe leaking. "When we compared the rate of the feedwater flow to the condensate flow, we noticed a significant difference," explained Ho. "This told us that we were losing energy due to leakage of the valves. We initiated a watch on the system, and whenever the difference passed a certain point, we would isolate the valves, and repair them on-line. This process consisted of grinding or welding the erosion and cavitation areas, and replacing the worn parts.

This gave us a temporary solution, but within a few months, the power level would drop again, and we'd have to go through the whole process all over." Kuosheng allocated additional maintenance hours to the valve problem, but its primary concern was the amount of power production it was unable to generate. The excessive leaks cut into the plant's efficiency, both through direct energy loss, and by not being able to feed the reactor the full rated flow. "Even with system pressures such as ours, when the valves are shut they are expected to hold drop-tight against leakage," noted Ho "However, these conventional valves would not hold leak-tight, and within a very short time they were leaking again. This severely impacted our power production, affecting our ability to produce power reliability."

The Kuosheng 2 reactor feedwater pump.



The DRAG® severe-service valve from Control Components Inc uses a unique patented stacked-disk design.

The author is the Superintendent of the Kuosheng station of Taiwan Power

RESEARCH LED TO CCI VALVES

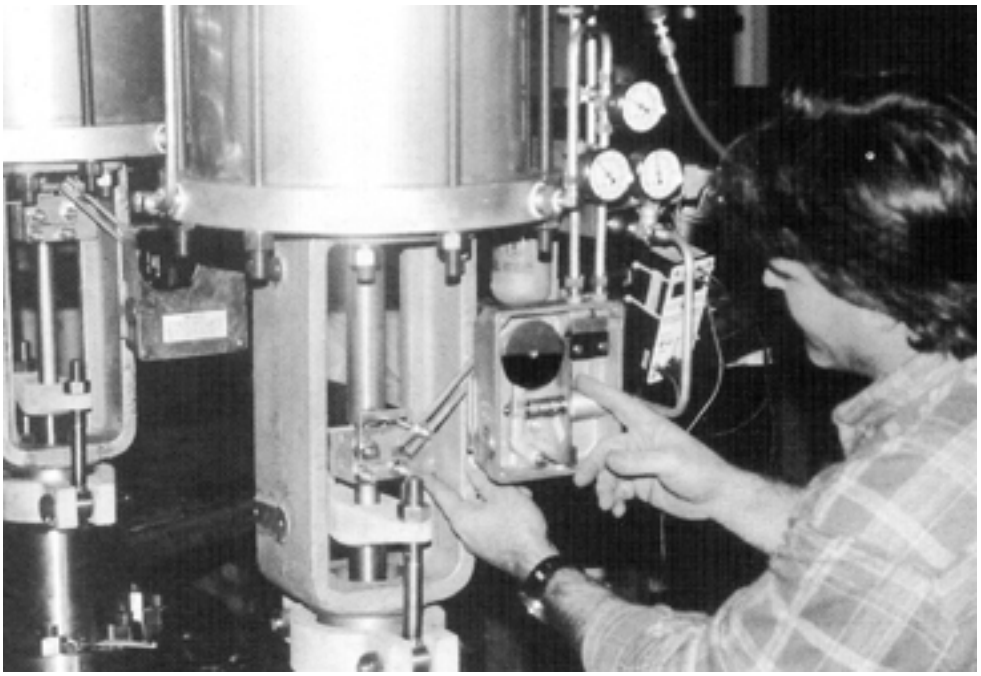
In January 1991 Kuosheng assigned a special design team to research available anti-cavitation valves. The team checked other nuclear power plants with a similar design to see if they had similar problems and how they solved them.

The team found that most plants were simply lix ing with the problem, though Ho believed that none of them had as severe cavitation and leakage as Kuosheng. Engineers at one of the plants, however, mentioned that they had solved their cavitation problems with considerable success using a specialized severe-service valve with a multi-staged velocity-control trim. The engineers recommended that the design team look into these valves, which are manufactured by CCI.

Taiwan Power contacted CCI in the spring of 1992 to inquire about our advanced valve technology. We visited their station to review the feedwater system and 5000 presented a solution to the valve problem. We provided them with a design and plan for manufacturing a reactor feedwater-pump recirculation-valve that would break down water pressure in applications that had a pressure drop as high as 5000 psi (352 kg cm2) to vacuum. As the Kuosheng system operated well below that level, we were confident that these valves would do the job.

The key to CCI's DRAG valve is its ability to control fluid velocities through the trim. Velocity is controlled by forcing the process fluids through a tortuous path of right-angle turns in a stacked-disk trim (see diagram, see also articles in NFl July and January 1994 and July 1993). It is the resistance provided by these turns that allows the precise control of the fluid velocities, maintaining the velocities at safe levels, regardless of the pressure drop.

The DRAG feedwater recirculation valves for Kuosheng feature eighteen pressure-drop stages to keep the trim velocity to less than 40 ft s (12 m s). By keeping the fluid velocities below this level, the fluid is not allowed to drop below its vapour pressure. This prevents flashing and the formation of bubbles which results in cavitation. In addition, the new valves also eliminate trim and body erosion and reduce the excess noise and vibration that results from cavitation. The new valves also avoid the need for downstream orifices, because the high pressure drop is handled within the valve.



CCI field service engineer checking the valve assembly on the new feed-water recirculation valves at Kuosheng nuclear plant.

VALVE REPLACEMENT EXPERIENCE

The new valves were installed in the second unit in March 1993 and in unit one in the October. At the same time, the plant also replaced the downstream pipes which were badly eroded from the excessive cavitation and trim leakage caused by the original valves. To date, no problems have occurred with the new valves.

In summing up the experience, Ho stated: "As a direct result of installing the new valves, we experienced a power increase of 12 MWe from each of the two units. We attribute this directly to the performance of the DRAG valves. The valves have eliminated cavitation, along with the effects of trim erosion, and erosion of downstream piping due to flashing and vibration. The new valves also remain leak-tight, modulate automatically and open reliably every time when needed. In case of a power failure to the valve operator, the valve will also open automatically.

"The most significant benefit of the new valves, is that each unit is now generating a total of 985 MWe instead of 973 MWe. This additional 24 MWe translates directly into increased profits for the plant. This performance reflects well on everyone involved with the project."

The Kuosheng station (2 X 985 MWe BWRs) is the second of Taiwan Power's three operating nuclear plants. Located on the northern coast of Taiwan, the plant began operating in 1981.

A maintenance bonus

In addition to increasing plant output, the new CCI valves are helping to reduce maintenance costs at Kuosheng. "After we installed the valves and compared the difference between the feedwater flow and the condensate flow of the system," explained station superintendent T R Ho, "we found that it is within the normal operational difference. This means that the new valves are not leaking. What's more, this zero-leakage has stayed constant for us over the past year which means that we do not have to go in and do maintenance on the valves. Before, it would only be a matter of weeks before we would have to conduct repairs on the valves. Even so, our attempts to fix the valves only restored the power temporarily; it wasn't long before the problems would resurface and cause us to do repair work again. With the new valves, this effort is no longer necessary. This has allowed us to assign the maintenance personnel to other areas of the plant that also need attention.

"At first, we did not consider the maintenance costs to be significant, when comparing them to the amount of lost revenue resulting from the leakage. The cost of parts and labor is minimal compared to losing even one megawatt of capacity. On the other hand, when we calculate the cost of continually repairing the valves, we discovered that over time, the cost of maintenance far exceeded the cost of replacing them. In retrospect, this more than justified the expense of installing the new valves."

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