Ultrasonic Leak Detection

By Phillip Twaddle, Exelon Generation.

Phillip Twaddle

Phillip Twaddle works for Exelon Generation Corporate Engineering, where he has been the Component Programs Safety Relief Valve (SRV) Engineer for seven years. He has oversight responsibility for all Class 1/2/3 SRVs at seventeen Exelon Nuclear power plants.

Twaddle has a B.S. in Chemical Engineering from the University of Illinois at Champaign – Urbana, 1982.

The described innovation was a 2013 Equipment Reliability Award Winner.

Nuclear Energy Institute's Top Industry Practice (TIP) Awards highlight the nuclear industry's most innovative techniques and ideas.

The team members who participated included: Phillip Twaddle, Corporate Engineering Component, SRV Specialist, Exelon Generation; Rick Lack, Peach Bottom System Engineer, Exelon Generation; Dan Nugent, Limerick System Engineer, Exelon Generation; Marie Murphy, Limerick CMO Valve Engineer, Exelon Generation; Mike Desai, Corporate Engineering Welding Specialist, Exelon Generation; Steve Scheeren, Business Manager, Scientech; Brad Schulte, President, NWS Technologies.

Summary

Many Limerick (LGS) and Peach Bottom (PB) Target Rock (TR) 3-stage Safety Relief Valves (SRVs) over the past 10 years have passed the cold bar test after refurbishment only to develop leaks while in-service that require unscheduled maintenance outages to replace these same valves prior to a refuel outage. The MSRV as-left certification test is an ASME method called the cold bar test which is used as the current acceptance criteria for verifying that the refurbished valves have been repaired properly for installation in the Nuclear power plants during refuel outages. The cold bar test is inserted into the valve, and any steam leaking past the seat collects as drops of condensation on the surface of the cold bar. The cold bar test is a pass/fail test where the absence of water droplets on the metal surface of the cold bar is considered a pass. Since the cold bar test is a qualitative test, there is no information known about how close the valves were to becoming leakers.

The Curtiss-Wright Scientech ultrasonic leak detection sensors have been used in mechanical applications that monitor rotating equipment, such as pumps or impeller bearings on cruise ships. Phillip Twaddle was searching for a means to acquire quantitative test results on "seat tightness" during as-left certification testing of main steam TR 3-stage SRVs, and Phillip thought of and initiated an opportunity to use Scientech ultrasonics to test a PB TR 3- stage SRV with a severe leak that was removed during an unscheduled maintenance outage during 2008. Another PB TR 3-stage SRV with recently replaced pilot and 2nd stage seats was tested using Scientech ultrasonic as a Control of a "good" SRV per Phillip's request and the test results were satisfactory. The shear wave energy (SWE) test results that were recorded showed that a good TR 3-stage SRV with tight seats have much lower SWE values on all three seats than a bad TR 3-stage SRV with one or more bad seats that have much higher SWE values.

During the last 6 months of 2011 and 12 months of 2012, more than 96 main steam valves were steam tested using the Scientech ultrasonic sensors attached to the valves during as-left certification at NWS Technologies. The average SWE values and standard deviations were calculated for each seat after all three of the as-left certification lifts. These SWE data results are being compared to the average delay times and the cold bar test results.

The results of the Scientech test are being used in conjunction with the cold bar test results to determine if the refurbishment results are satisfactory or more repairs are needed.

Safety

The Scientech ultrasonic leak detection method will eliminate leaking TR 3-stage SRVs between the 2-year refuel cycles and allow the LGS Site Management to transition from shopping all 14 Target Rock 3-stage SRVs (100%) in each unit every refuel outage to only removing and refurbishing 7 Target Rock 3-stage SRVs (50%) in each unit every refuel outage. The cost saving of refurbishing 7 less TR 3-stage SRVs per year is equivalent to $750,000 savings/year and a reduction in dose of 7 TR 3-stage SRVs not refurbished each refuel outage times 7 person-rem is equal to 49 person-rem per year. The cost and dose savings is expected to be implemented within 2 years in conjunction with the Limerick EPU changes.

Cost Savings

There has been an unscheduled maintenance outage to replace a leaking Target Rock 3-stage SRV at either Peach Bottom or Limerick each year for the past five years: 2008 -PB, 2009 -PB, 2010-PB, 2011-LGS, and 2012-LGS (2 valves at once). Using the Scientech ultrasonic leak detection method should save $7,000,000/year for the next four years = $28,000,000.

Innovation

The Scientech ultrasonic leak detection method has never been used to quantitatively determine the acceptability of refurbished valves. This application

(Continued on page 44)

Ultrasonic Leak...

(Continued from page 43)

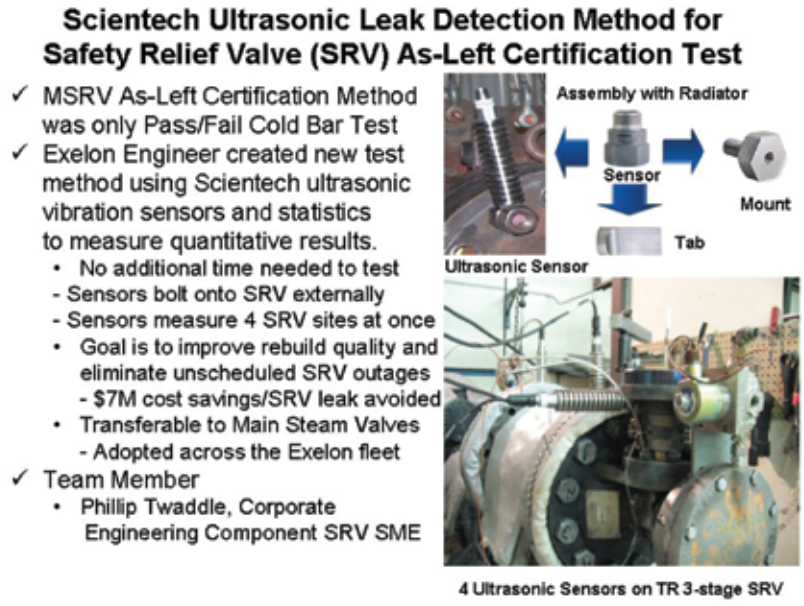
was conceived by Phillip Twaddle and a patent application was submitted in 2012. The shear wave energy (SWE) values predict leak performance after installation into the nuclear power plant. I have discovered the acceptance range for Target Rock 3-stage SRVs – the pilot, the 2nd stage, and the main seats have different ranges of acceptability. This technology has also been used successfully on Crosby pressurizer safety valves (PSVs), Dresser Electromatic relief valves (ERVs), and Dresser power operated relief valves (PORVs). These valves have slightly different acceptance ranges than the Target Rock 3-stage SRVs. Since the SWE data results have been collected on ninety-six main steam valves during as-left certification over the last 18 months, the test results are conclusive that the Scientech test results are an effective tool to specify a statistically based acceptance limit called the Upper Control Limit (UCL), which means that valves that are as-left certified with Scientech values below the UCL should perform leak free for two operating cycles.

Productivity/Efficiency

The productivity performance was seen through not requiring a shutdown due to poor valve performance. The Scientech SWE test results are the best available technology for predicting leak-free valve performance for the next two 2-year refuel cycles. There is a direct correlation between a steam leak rate and the quantity (range covers two orders of magnitude) of the Scientech SWE values recorded.

Transferability

The use of Scientech SWE values to determine valve acceptance following refurbishment or fabrication of new valves is applicable throughout the nuclear industry. Exelon has tested 96 main steam valves after refurbishment: Crosby PSVs – Byron Station Units 1 & 2 (BY), and Braidwood Station Units 1 & 2 (BR); Electromatic Relief Valves (ERVs) – Quad Cities Station Units 1 & 2 (QC) , Dresden Station Units 2 & 3 (DR), PB, and LGS; Dresser PORVs and PSVs – TMI; and Target Rock 3-stage SRVs – DR, QC, PB, and LGS. The technology is transferable to other nuclear companies, valve rebuilders, and valve manufacturers.



Reference Chart -Ultrasonic Sensor photograph and 4 Ultrasonic Sensors.

Contact: Phillip Twaddle, Exelon Generation, telephone: (630) 657-3866, email: phillip.twaddle@exeloncorp.com. ■