

Exelon Insights and Actions

NRC Public Meeting - June 29 2017

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Agenda

- Timeline
- LaSalle Unit 2 HPCS Injection Valve Event Description
- LaSalle and Exelon Fleet Initial Actions
- Exelon Fleet Extent of Condition and Nuclear Events Report Fleet Action (NER NC-17-008-Y)
- LaSalle Unit 2 HPCS Injection Valve Failure Analysis, Insights and Actions
- LaSalle Unit 1 HPCS Injection Valve Extent of Condition
- Exelon Industry Engagement
- Exelon Key General Insights

Timeline

- Oct 2012 Browns Ferry U1 HPCI Inboard Steam Isolation Valve Leakage (LLRT) Failure
- Feb 2013 Flowserve 10CFR Part 21 notification for Anchor-Darling Double Disc Gate Valves
- Mar 2013 Exelon OPEX Response (Issue Report #1484815)
- Apr 2013 BWR Owners Group Topical Report BWROG-TP-13-06 Revision 0
- Dec 2016 BWROG-TP-16-1-112 Revision 1 (incorporated OE into previously BWROG-TP-13-06)
- Feb 2017 LaSalle U2 High Pressure Core Spray Injection valve (2E22-F004) stem-disc separation
- Mar 2017 Exelon Nuclear Event Report (NER) NC-17-008-Y Revision 0
- May 2017 BWROG-TP-16-1-112 Revision 2 (incorporated LaSalle OE)
- Jun 2017 Exelon MOV Program Fleet Governance Revised
- Jun 2017 BWROG-TP-16-1-112 Revision 3 (incorporated Flowserve input)
- Jun 2017 Information Notice 2017-03, ADDDGV Wedge Pin and Stem-Disc Separation Failures
- Jun 2017 LaSalle Root-Cause evaluation U2 HPCS Injection valve failure
- Jun 2017 LaSalle Unit 1 HPCS Injection valve (1E22-F004) Inspection and Repair
- Jul 2017* Flowserve 10CFR Part 21 notification update
- Aug 2017* BWROG-TP-16-1-112 Revision 4

(* - Scheduled)

LaSalle Unit 2 HPCS Injection Valve - Event Description

- February 2017, LAS U2 High Pressure Core Spray Injection valve (2E22-F004) failed to open
- Failure of the wedge pin and wedge threads – stem/disc separation
- BWROG and Fleet governance were followed prior to the failure
- An anomaly in a prior diagnostic test was reasonably attributed to other conditions in the valve
- Stem Rotation checks were reported to be at end of acceptable range ($\sim 10^\circ$)

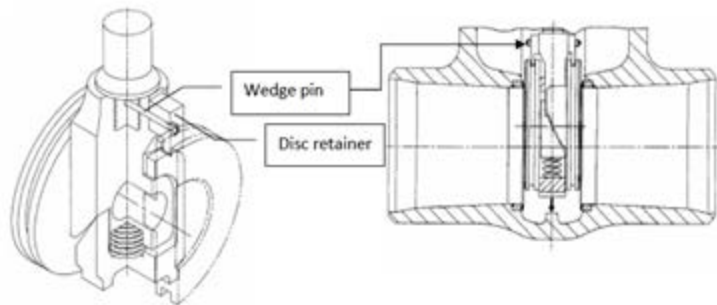


Figure 1: Typical Stem – Disc Assembly

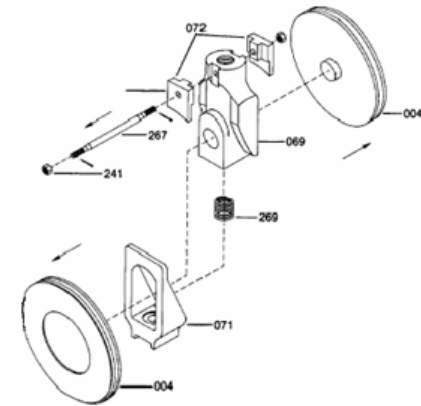


Figure 2: Stem – Disc Assembly Exploded View

LaSalle Unit 2 HPCS Injection Valve – Initial Actions

- Unit 2 HPCS Injection Valve repairs completed in March 2017
- Operability Evaluation developed to assess potential extent of condition
- Removed Parts were quarantined and issued offsite for failure analysis (slide 6)
- Yellow (Action Required) Nuclear Event Report issued to the Exelon fleet (slide 5)
- Root Cause Investigation conducted
- Detailed Diagnostic Trace Analysis performed by Kalsi Engineering
- Detailed Engineering Failure Analysis performed by MPR Associates
- Wedge pin margin calculations performed by Kalsi Engineering for Operability Review
- Maintenance Outage Scheduled to Address Unit 1 HPCS Injection Valve Extent of Condition

LaSalle Unit 2 HPCS Injection Valve – Exelon Fleet Actions

- Issue Exelon Nuclear Event Report (NC-17-008-Y) (complete)
- Revise BWROG guidance (complete BWROG TP-16-1-112, R2 & R3)
- Revise fleet MOV Program Governance to address revised BWROG guidance and accelerated actions required by NER NC-17-008-Y (complete)
- Re-evaluate initial fleet Part 21 responses and assess EOC (complete)
- Schedule repair of susceptible critical and program MOVs per BWROG Guidance (in progress)
- Perform diagnostic testing and stem rotation checks until repairs are made (in progress)
- Expedite delivery of stem/disc replacement parts (in progress)
- Develop plans for non-critical, non run to maintenance MOV's (in progress)

LaSalle Unit 2 HPCS Injection Valve – Failure Analysis

- Insufficient load (thrust) carrying capacity of the shrink fit stem collar
- Multiple closing high load cycles (axial thrust and torque)
- Eventual wedge pin shear failure
- Wedge and stem thread wear
 - Adhesive wear (i.e., galling)
 - Aggressive abrasive wear
- Axial shear failure of degraded wedge threads
- Contributing was the lack of pre-load with insufficient capacity of the stem collar and pin assembly

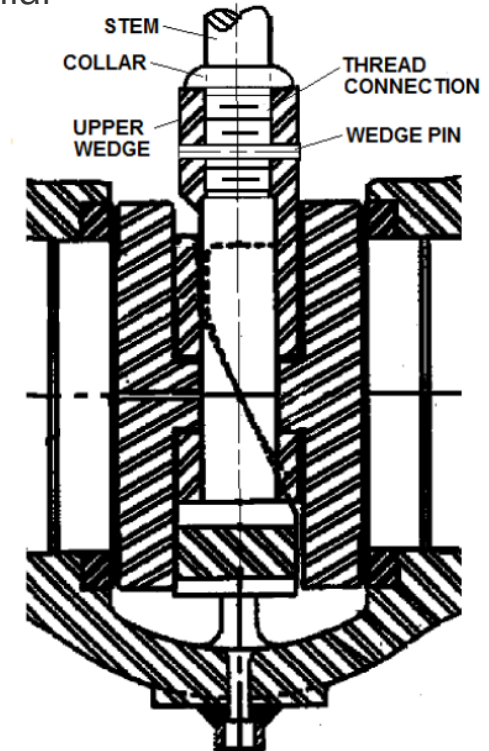


Figure 3: Stem-To-Wedge Connection

References:

1. MPR Report 2101-0022-RPT-001, Rev. 0
2. Exelon PowerLabs Report LAS-28310, Rev. 1, dated May 30, 2017

LaSalle Unit 2 HPCS Injection Valve – Insights and Actions

Insights:

- Vulnerability and risk/consequences of failure should be factored into monitoring and repair plans
- Stem rotation checks should be performed using instruments with sufficient accuracy to support trending
- Trace differences should be thoroughly analyzed based on recent industry experience
- Structural assessment of wedge-pin connection should assume highest applied torque during time in service, which may differ from current set-up
- Weak-Link analyses of Anchor Darling Double Disc Gate Valves should fully assess the stem-wedge assembly including the thrust collar
- Replacement stems should be of the integral one-piece design

Next Actions:

- Provide input to Flowserve to update Part 21 Notification to include vulnerabilities with press-fit stem collars
- Work with BWROG to revise topical report to incorporate
 - LAS Unit 1 HPCS inspection and LAS Unit 2 HPCS insights
 - Flowserve Part 21 update
- Coordinate industry communications through NEI
- Finalize repair plans to address Exelon fleet extent of condition

LaSalle Extent of Condition: Unit 1 HPCS Injection Valve

- Exelon voluntarily entered into a LaSalle Unit 1 Maintenance Outage on June 22, 2017
- Inspection and Repair of the susceptible Unit 1 High Pressure Core Spray (HPCS) Injection Valve
 - ✓ Prior Diagnostic Trends SAT, No Issues
 - ✓ Prior Stem Rotation SAT, Within tolerance
 - ✓ As-Found Diagnostics SAT, No Anomalies
 - ✓ As-Found Stem Rotation SAT, Within tolerance
 - ✓ In-body Visual Inspection SAT, No Anomalies
 - ✓ Collar – Wedge Gap SAT, No Clearance
 - ✓ Detailed Inspection In Progress
- Internal component replaced with upgraded materials and improved installation practices
 - ✓ Integral One-Piece Stem
 - ✓ Vendor Applied Pre-Torque
 - ✓ High Strength Wedge Pin
- All PMT and Leak-Rate Test SAT
 - ✓ As-Left Diagnostics SAT, No Anomalies
 - ✓ As-Left Stem Rotation SAT, Within tolerance



Fig. 4: U1 Internals (As-Found)



Fig. 5: U1 Collar (As-Found)

Exelon Industry Engagement

Exelon is Committed to Providing Timely and Effective Solutions to the US Nuclear industry

- Leadership in Key Industry Groups (BWROG and NEI)
- Active Involvement with Industry and External Stakeholder Groups
- Operating Experience continuously reviewed and challenged for insights
- Timely incorporation of lessons learned into industry guidance
 - 2016 BWROG Guidance Revision: Industry Operating Experience
 - 2017 BWROG Guidance Revisions: Exelon Operating Experience
- Drive innovation to improve problem identification and trending
- Maintain healthy relationships with vendors and specialty engineering firms
 - Flowserve BWROG Guidance Endorsement
 - MPR / Kalsi Flowserve Stem Collar Failure Evaluation
 - Diagnostic Trends and Margin Reviews

Key General Insights

- Timely resolution based on safety significance and consequence of failure
- Timely industry guidance updates
- Bias for action versus monitoring and trending
- Risk mapping of vulnerabilities

INPO 10-005 Technical Conscience Principle #1 “Leaders challenge decisions and corrective actions that result in degraded operating, design, or safety margins”

INPO 15-011 Risk Management “A consequence biased approach is applied to risk determination”.....”unacceptable end states regardless of probability, must be eliminated”

Questions?

