Motor-Operated Valve Training Course

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Day 2 of 3

Agenda

- Day 1
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  3. MOV Design
  4. MOV Lessons Learned
  5. MOV Performance and Design Analysis

Agenda

- Day 2
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    11. Operating Experience and Notices

Agenda

- Day 3
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  13. Case Studies
  14. MOV Inspection Recommendations
  15. Sharepoint Web Site – Inspector Tools
  16. Special Topic: 10 CFR 50.69
  17. Roundtable and Q/A Session

6. MOV Actuator Control Design

Actuator Control

- In closing direction, Limitorque actuators typically controlled using close torque switch for gate and globe valves.
- In opening direction, Limitorque actuators bypass open torque switch for initial travel to avoid torque switch trip from pullout and flow initiation loads for gate and globe valves.
- In opening direction, limit switch control used to avoid stem striking bonnet backseat for rising-stem valves.
- Butterfly valves typically controlled by limit switch to avoid disc being pushed through seat. Some butterfly valves (such as triple offset valves) are designed to allow torque switch control.

Basic Limitorque Wiring Diagram

FIGURE REDACTED

Limitorque Wiring Diagram –Torque Switch Control

FIGURE REDACTED

Limitorque Wiring Diagram –Limit Switch Control

FIGURE REDACTED

Hot Short Issue

- In 1991, WNP-2 (Columbia) found that a fire in control room could cause hot shorts (short circuits between control wiring and power sources) for MOVs.
- If thermal overload protection absent, hot shorts could cause valve damage before reactor operator could shift control to remote panel.
- MOV control re-wired so torque and limit switches not bypassed by hot short.
- Other plants also identified this issue.
- IN 92-18, Potential for Loss of Remote Shutdown Capability during a Control Room Fire

Hot Short Issue
(continued)

- IN 99-17 (June 3, 1999), “Problems Associated With Post-Fire Safe-Shutdown Circuit Analysis”
- RIS 2004-03 (March 2, 2004), “Risk-Informed Approach for Post-Fire Safe-Shutdown Associated Circuit Inspections” (ADAMS Accession No. ML040620400) with Revision 1 issued on December 29, 2004.
- RIS 2005-30 (Dec. 20, 2005), “Clarification of Post-Fire Safe-Shutdown Circuit Regulatory Requirements” (ADAMS Accession No. ML053360069).
- NRC Fire Protection Inspection Report (Nov. 20, 2017) identified potential issues at Wolf Creek with control circuit fire damage that could energize closing coil while bypassing TS and LS (ML17325A098).

7. MOV Diagnostics

MOV Diagnostic History

- In early days, stroke time measurement was primary means for diagnostic testing of MOVs.
- MOVs typically passed stroke time tests although they might fail to operate under DP and flow conditions.
- MOVATS method developed to operate MOV in open direction for stem to strike load cell (equating spring pack displacement to output thrust).
- VOTES method used strain in valve yoke to estimate thrust delivered by actuator.
- MOVATS Torque-Thrust Cell was mounted between actuator and valve to measure torque and thrust.
- Other methods (such as motor current) also developed.

MOV Diagnostic Equipment Accuracy Evaluation

- In 1990, MOV Users Group (MUG) initiated program to validate accuracy of MOV diagnostic equipment.
- INL used load cell mounted on test stand to measure actuator output thrust.
- IN 1992-23 summarized results of testing program.
- In 1992, MUG released its final report.
- Methods that rely on spring pack displacement were found to have accuracy concerns.
- In response, vendors have moved to direct measurement of stem thrust and torque by Smartstems or stem-mounted strain gages.

Diagnostic Parameters

- Force
  - Stem strain (Strain gauge or Smartstem)
  - Yoke strain (VOTES)
  - Valve yoke/operator bolt or load washers
  - Calibrated C clamp
- Torque
  - Stem Strain (Strain gauge or Smartstem)
  - Spring Pack Displacement (MOVATS)
- Motor
  - Current
  - Power/power factor
- Control Switches
- Stem Position

Gate Valve Opening to Closing DP Stroke

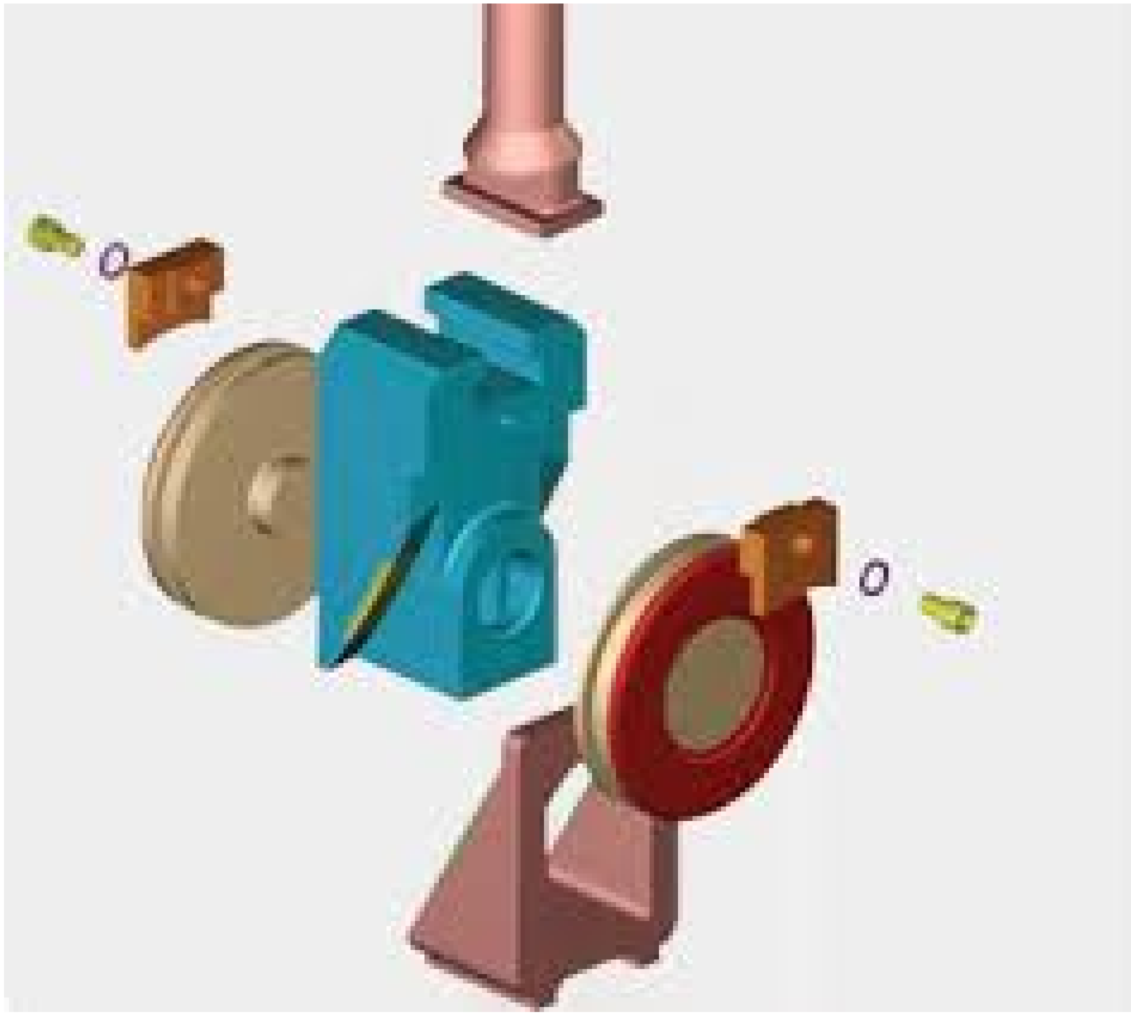
(stem rejection does not exceed packing force)

FIGURE REDACTED

Stem to Stem Nut Thread Clearance

FIGURE REDACTED

Valve Stem T-Head Connection



Gate Valve Opening to Closing DP Stroke

(stem rejection exceeds packing force)

FIGURE REDACTED

Diagnostic Signature Set

FIGURE REDACTED

Diagnostic Trace Marking

FIGURE REDACTED

Opening Marks:

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Closing Marks:

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Rate of Loading Effects

(Load Sensitive Behavior)

FIGURE REDACTED

$$ROL = \frac{TST_{Static} - TST_{Dyn}}{TST_{Static}} * 100\%$$

$$ROL = \frac{200446 - 152681}{200446} * 100\%$$

$$ROL = 24\%$$

Globe Valve DP Trace

FIGURE REDACTED

Non-Locking Worm Gear Set Trace

FIGURE REDACTED

Motor Stall Trace

FIGURE REDACTED

Bent Stem Trace

FIGURE REDACTED

Bent Stem – Motor Current Trace

FIGURE REDACTED

Loose Yoke Assembly Trace

FIGURE REDACTED

Limitorque SB Actuator Opening Trace

FIGURE REDACTED

Limitorque SB Actuator Closing Trace

FIGURE REDACTED

Full Springpack Compression

FIGURE REDACTED

MOV Cyclic Loading

FIGURE REDACTED

MOV Cyclic Loading – Zoomed In

FIGURE REDACTED

Common Causes of Cyclic Loading

1) Misalignment of actuator to yoke bolting
2) Stem nut was bored off center
3) Actuators installed on horizontal or diagonal stems are likely to exhibit this due to weight of the actuator pressing down on the stem during operation

MOV Cracked Seat or Guide

FIGURE REDACTED

MOV Valve Guide Problems

FIGURE REDACTED

Partial MOV Diagnostic Stroke

- Some licensees perform partial valve strokes when collecting diagnostic data to evaluate MOV performance.
- Partial valve strokes might be helpful in evaluating specific aspects of valve performance, such as opening thrust under static conditions.
- Partial strokes will not identify flow effects that occur over the full valve stroke, such as disc tilting or gradual buildup of thrust and torque operating requirements.
- Partial strokes would not identify bent stem or packing gland issues.
- Licensees should justify use of partial valve strokes in evaluating MOV performance over full valve stroke.

8. MOV Design-Basis Capability

8.a MOV Design-Basis Capability Regulatory Requirements and Guidance

MOV Regulations

- 10 CFR Part 50, Appendix A, General Design Criteria (GDC)
- 10 CFR Part 50, Appendix B, Quality Assurance (QA) criteria
- 10 CFR 50.49 – Electrical Equipment Environmental Qualification
- 10 CFR 50.55a - ASME OM Code IST requirements and regulatory conditions
- 10 CFR 50.69 - Risk-informed treatment approach
- 10 CFR Part 50, Appendix S - Seismic Qualification

ASME QME-1-2007 and RG 1.100 (Revision 3)

- ASME updated ASME Standard QME-1 in 2007 Edition to incorporate lessons learned from MOV operating experience and testing for all power-operated valves (POVs).
- NRC updated Regulatory Guide (RG) 1.100 in Revision 3 to accept ASME QME-1-2007 with conditions to provide guidance for satisfying the NRC regulations for design-basis capability of mechanical equipment (including MOVs).
- ASME QME-1-2007 and RG 1.100 (Revision 3) discussed in detail later in this presentation.

RG 1.73

Qualification Tests for Safety-Related Actuators in NPPs (Revision 1, October 2013)

- Updated to endorse IEEE 382-2006
- References RG 1.89 for environmental qualification.
- Applicant or licensee responsible for qualifying actuator for its qualified life including design cycles.
- Environmental qualification should also address flow-induced vibration caused by acoustic resonance and hydraulic loading in reactor, steam, and feedwater systems.
- IEEE 382-2006 acceptable for environmental qualification of POVs per RG 1.100 with conditions.
- Equipment needs to be qualified for operational performance duration for each design-basis event.

RG 1.106

Thermal Overload Protection for Electric Motors on Motor-Operated Valves (Revision 2, February 2012)

- IEEE 603-2009 for thermal overload (TOL) circuitry.
- For valves required to function immediately during accident, TOL devices should be bypassed, but in service for testing.
- For valves that operate under normal conditions and automatically actuate, TOL devices should be in service normally, but bypassed under accident conditions.
- For valves that do not have an immediate function, TOL devices should be in service.
- All uncertainties should be in favor of completing action.
- Trip setting should conform to IEEE 741-2007.

Standard Review Plan Section 3.9.6 Functional Design, Qualification, and Inservice Testing of Pumps, Valves, and Dynamic Restraints

- SRP Section 3.9.6 provides guidance for NRC staff reviewing operating reactor licensing changes and new reactor applications
- Areas of Review:
  - Functional Design and Qualification of Pumps, Valves, and Dynamic Restraints
  - IST for Pumps, Valves, and Dynamic Restraints
  - Relief Requests and Alternatives to ASME OM Code
- ASME QME-1-2007 as accepted in RG 1.100 (Rev. 3)
- ASME OM Code as incorporated by reference in 10 CFR 50.55a

8.b ASME Standard QME-1, Qualification of Active Mechanical Equipment Used in Nuclear Power Plants

QME-1 Overview

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QME-1 Contents

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QME-1 Section QR
General Requirements

- REDACTED

QME-1 Section QV
Functional Qualification Requirements for Active Valve Assemblies for Nuclear Power Plants

- REDACTED

Subsection QV-7460
POV Functional Qualification

- REDACTED

Valve/Actuator Qualification Highlights

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Section QVG

Guide to Section QV: Determination of Valve Assembly Performance Characteristics

- REDACTED

Section QVG
(continued)

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ASME QME-1-2017

(published August 2017)

- REDACTED

8.c Regulatory Guide 1.100

Regulatory Guide 1.100 (Rev. 3)

Seismic Qualification of Electrical and Active Mechanical Equipment
and Functional Qualification of Active Mechanical Equipment
for Nuclear Power Plants

- NRC accepted ASME QME-1-2007 in Rev. 3 to RG 1.100 (September 2009) with regulatory positions:
  - Pump, valve, and dynamic restraint provisions provide reasonable approach for functional qualification
  - Nonmandatory appendices specified in procurement specifications become mandatory
  - Seismic qualification conditions
  - QME-1 also acceptable for manual valves.
- RG 1.100 (Rev. 3) satisfies GDC and GL 89-10 for MOV design-basis capability.

Proposed Revision 4 to RG 1.100

- On February 27, 2019, NRC issued proposed Revision 4 to RG 1.100 for public comment.
- Proposed Revision 4 to RG 1.100 endorses ASME QME-1-2017 rather than QME-1-2012 because of significant updates in 2017 standard.
- No new conditions proposed for pump or valve functional qualification provisions in ASME QME-1-2017.
- Proposed Revision 4 clarifies Nonmandatory Appendix QV-B on static side load testing for seismic qualification of valves.
- Final issuance planned for fall 2019.

8.d Generic Letter 89-10 and Related Generic Communications

Bulletin 85-03

Motor-Operated Valve Common Mode Failures During Plant Transients due to Improper Switch Settings

- Requested licensees to test high-pressure safety-related MOVs under design-basis DP and flow conditions.
- Supplement 1 clarified scope to all MOVs in specified systems and to address potential mispositioning.
- Static testing primarily conducted.
- Implementation results indicated about 8% of MOVs might not have operated under design-basis conditions.
- Results supported development of GL 89-10 to expand scope to all safety-related MOVs.

Generic Letter 89-10

Safety-Related Motor-Operated Valve Testing and Surveillance

- Requested licensees to verify design-basis capability of safety-related MOVs:
  - Review MOV design bases
  - Establish MOV switch settings
  - Dynamically test MOVs where practicable
  - Verify settings every 5 years and following maintenance
  - Improve corrective action and trending MOV problems.
- Licensees requested to complete GL 89-10 in 5 years or three refueling outages (RFOs).

GL 89-10 Supplements

<u>Supplement 1</u> (June 13, 1990): Provided results of GL 89-10 workshops in fall 1989.

<u>Supplement 2</u> (Aug. 3, 1990): Allowed additional time for incorporation of Supplement 1 into GL 89-10 programs.

<u>Supplement 3</u> (Oct. 25, 1990): Accelerated review of isolation valves in high pressure coolant injection (HPCI), reactor core isolation cooling (RCIC) system, and reactor water cleanup (RWCU) system in response to MOV tests.

GL 89-10 Supplements
(continued)

<u>Supplement 4</u> (Feb. 12, 1992): Deleted mispositioning from GL 89-10 scope for BWR plants.

<u>Supplement 5</u> (June 28, 1993): Addressed MOV diagnostic equipment accuracy.

<u>Supplement 6</u> (Mar. 8, 1994): Provided results of several GL 89-10 workshops including guidance on grouping and pressure locking.

<u>Supplement 7</u> (Jan. 24, 1996): Deleted mispositioning from GL 89-10 scope for PWR plants.

GL 89-10 Activities

- NRC staff conducted inspections using Temporary Instruction (TI) 2515/109 to evaluate GL 89-10 program development, implementation, and completion.
- NRC closed out GL 89-10 typically through inspections.
- GL 89-10 implementation involved several million dollars at each NPP.
- Following implementation, Boiling Water Reactor Owners Group (BWROG) reported at a public meeting an acceptable cost/benefit analysis based on resolution of numerous MOV deficiencies by GL 89-10 programs.

Generic Letter 95-07

Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves

- Pressure locking (PL) of flexwedge gate valve or parallel disc gate valve occurs when pressurized fluid in bonnet prevents valve opening.
- Thermal binding (TB) of flexwedge or solid wedge gate valve caused by mechanical interference between valve disc and seat.
- Requested licensees to address potential PL/TB of power-operated gate valves.
- NRC reviewed licensee submittals and prepared safety evaluation (SE) for each NPP.

Generic Letter 96-05

Periodic Verification of Design-Basis Capability of Safety-Related Motor-Operated Valves

- Requested licensees to develop programs to periodically verify MOV design-basis capability.
- 98 reactor units committed to implement Joint Owners Group (JOG) Program on MOV Periodic Verification.
- Callaway, Fort Calhoun, Palisades, and San Onofre 2/3 reviewed separately.
- SE prepared based on submittals and commitments.
- Sample GL 96-05 inspections conducted at Callaway, Palisades, Peach Bottom, San Onofre, Seabrook, Saint Lucie, Summer, Turkey Point, and Vermont Yankee.

9. MOV Preservice Testing and Inservice Testing

9.a MOV PST and IST Regulatory Requirements and Guidance

10 CFR 50.55a
(as of July 18, 2017)

- ASME OM Code, 1995 Edition through 2012 Edition, incorporated by reference with conditions.
- 50.55a(b)(3) includes conditions:
  i. ASME Standard NQA-1 acceptable where supplemented by Appendix B of 10 CFR Part 50 as necessary
  ii. Periodic verification of MOV design-basis capability required, and Appendix III to OM Code acceptable with conditions
  iii. New Reactors:
     - Periodic verification of POV design-basis capability
     - Check valve bi-directional testing
     - Flow-induced vibration monitoring
     - RTNSS treatment
  iv. Appendix II check valve condition monitoring
  v. Subsection ISTD for snubbers

10 CFR 50.55a
(continued)

- (b)(3) continued:
  - vi. Manual valve 2-year exercise interval
  - vii. Use of Subsection ISTB (2011 Addenda) prohibited
  - viii. Use of Subsection ISTE requires 50.55a(z) alternative
  - ix. Use of Subsection ISTF (2012 Edition) requires Appendix V
  - x. OM Code Case OMN-20 acceptable
  - xi. Valve position indication supplemented beginning with OM Code, 2012 Edition.
- (f)(4) requires augmented IST for safety-related pumps and valves not ASME BPV Code Class 1, 2 or 3.
- (f)(4)(i) and (ii) requires latest OM Code incorporated by reference 12 months before fuel load for initial 10-year IST interval and 12 months before successive IST intervals.

Proposed 50.55a Rulemaking

- ASME OM Code 2015 and 2017 Editions incorporate by reference with conditions.
- OM Code (2017) includes AOV Appendix IV (AOVs).
- Deletion of Check Valve Appendix II condition for 2017 Edition because of Code improvements.
- Satisfy Code edition incorporated by reference in 50.55a 18 months before fuel load for initial 10-year IST program and 18 months before successive 10-year program.
- Transfer of IST Program Plan submittal requirement from ASME OM Code to 10 CFR 50.55a
- Issued for public comment in November 2018 and final issuance planned for December 2019.

NUREG-1482

Guidelines for Inservice Testing at Nuclear Power Plants (Revision 2)

- Describes regulatory basis for IST programs.
- Provides guidance for development of IST programs:
  - Scope
  - IST program documentation
  - Preconditioning
  - Specific valve guidance
  - Specific pump guidance
  - New reactor IST programs
- Future update underway based on revised ASME OM Code and recent and proposed 50.55a rulemaking.

Draft Revision 3 to NUREG-1482

- Valve IST guidance considered for updating include:
  - Current 50.55a incorporation by reference of 2012 Edition of OM Code and conditions
  - Proposed 50.55a incorporation by reference of 2015 and 2017 Editions of OM Code and conditions (Revision 3 to be issued after final rule published)
  - IST program scope
  - IST augmented program
  - MOV Appendix III scope
  - Active versus passive valves
  - Impractical versus Impracticable
  - IST program assesses operational readiness

9.b ASME OM Code

ASME OM Code

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Subsection ISTA: General Requirements

- REDACTED

Subsection ISTB: Inservice Testing of Pumps in Pre-2000 Plants

- REDACTED

Subsection ISTC: Inservice Testing of Valves

- REDACTED

Subsection ISTD: Preservice and Inservice Examination and Testing of Dynamic Restraints (Snubbers)

- REDACTED

Subsection ISTE: Risk-Informed IST of Components

- REDACTED

Subsection ISTF:
Inservice Testing of Pumps in Post-2000 Plants

- REDACTED

ASME OM Code Appendices

- REDACTED

ASME OM Code Appendix III

Preservice and Inservice Testing of Active Electric Motor-Operated Valve Assemblies in Light-Water Reactor Power Plants

REDACTED

Appendix III

REDACTED

Example OM Code Cases

- REDACTED

OM Code Cases OMN-1 and 11

- REDACTED

Regulatory Guide 1.192 (Rev. 1)

Operation and Maintenance Code Case Acceptability, ASME OM Code

- RG 1.192 (Rev. 1) incorporated by reference in 50.55a
- Code Cases in RG 1.192 incorporated into 50.55a may be applied without requesting relief or alternatives.
- Accepts OMN-2, 5, 6, 7, 8, 13, 14 and 16 with no conditions.
- Accepts OMN-1, 3, 4, 9,11, and 12 with conditions.
- OMN-1 conditions are:
  - Evaluate diagnostic test interval adequacy not later than 5 years or 3 RFOs from initial implementation
  - CDF and LERF from extending high risk MOV exercise interval must be small and consistent with Safety Goal Policy Statement
  - Risk-ranking methodologies may be used other than OMN-3.

Revision 2 to RG 1.192

- Code Case Rulemaking issued in 83 FR 2331 (Jan. 17, 2018) incorporates by reference RG 1.192 (Rev. 2) in 10 CFR 50.55a
- In addition to Code Cases in Rev. 1 to RG 1.192, Revision 2 accepts OMN-15 (R2) and 17 without conditions and OMN-16 (R1), 18, 19 and 20 with conditions.
- RG 1.192 (Revision 2) accepts Code Case OMN-20 for all OM Code editions and addenda incorporated by reference in 10 CFR 50.55a

Proposed Revision 3 to RG 1.192

- On August 16, 2018, NRC issued proposed Code Case Rulemaking (83 FR 40685) to incorporate by reference Revision 3 to RG 1.192 in 10 CFR 50.55a.
- Revision 3 to RG 1.192 updates acceptance of OM Code Cases with conditions up to 2017 Edition of Code.
- OMN-16 (R2) and OMN-21 accepted without conditions.
- Code Case OMN-20 accepted for all OM Code editions and addenda incorporated by reference in 50.55a
- Final rulemaking issuance planned for late 2019.

9.c Periodic Verification

10 CFR 50.55a(b)(3)(ii)
(as of July 18, 2017)

- Licensees must comply with MOV testing provisions in ASME OM Code, and establish program to ensure that MOVs continue to capable of performing design basis safety functions. Licensees implementing Appendix III shall:
  - Evaluate adequacy of MOV diagnostic test intervals not later than 5 years or 3 RFOs from initial implementation.
  - Ensure that potential increase in CDF and LERF is acceptably small when extending exercise intervals for high risk MOVs.
  - Categorize MOVs using OMN-3 or accepted risk-ranking method.
  - Verify that stroke time of MOVs specified in plant Tech Specs satisfies plant safety analysis assumptions when exercising.
- Appendix III with conditions satisfies 10 CFR 50.55a and GL 96-05 for MOV periodic verification.

JOG Program on MOV Periodic Verification

- Licensees developed JOG program to provide industry-wide approach for implementation of GL 96-05.
- JOG program included three phases:

(1) interim plan of static diagnostic testing of safety-related MOVs at frequency based on risk and margin;

(2) JOG testing program to evaluate valve degradation where each licensee performed three static and dynamic diagnostic tests on two selected valves over 5-year period with minimum of 1 year between tests; and

(3) long-term plan of static diagnostic testing and, where necessary, dynamic diagnostic testing based on JOG evaluation of valve data from 5-year testing program.

NRC Staff Initial Review

- JOG submitted initial topical report MPR-1807 on August 12, 1997, describing JOG Program on MOV Periodic Verification.
- NRC prepared safety evaluation dated October 30, 1997, on MPR-1807.
- NRC specified conditions and limitations that were addressed in the 2006 SER.

JOG Testing

- JOG program tested over 150 gate, globe, and butterfly valves in various applications, such as treated water, untreated water, hot water, cold water, and steam.
- Test results concluded that valves perform the same when they share same attributes, such as valve type, fluid application, disk to seat material, disk to body material, and bearing material.
- JOG program assigned MOVs to four classes (Class A, B, C, and D).

JOG MOV Classes

- Class A valves within JOG scope not susceptible to degradation in operating requirements based directly on JOG testing or suitable bases discussed in JOG program.
- Class B valves within JOG scope not susceptible to degradation in operating requirements based on JOG testing extended by analysis or engineering judgment to configurations and conditions beyond those tested.
- Class C valves within JOG scope susceptible to changes in required thrust or torque based on JOG test results.
- Class D valves outside JOG scope but within GL 96-05 scope.

JOG Topical Report on MOV Periodic Verification Program

- JOG submitted MPR-2524 on Feb. 27, 2004 (ADAMS No. ML040720092)
- Describes long-term MOV periodic verification recommendations.
- Addresses potential degradation of required thrust or torque for gate valves, butterfly valves, balanced disk globe valves, and unbalanced disk globe valves.
- JOG program does not cover potential degradation in actuator output thrust or torque.
- Each individual licensee is responsible for potential degradation of actuator capability.

NRC Safety Evaluation on JOG MOV Program

- NRC accepted in Safety Evaluation (SE) dated September 25, 2006 (ML061280315).
- JOG program is acceptable approach to address GL 96-05 issues with SE conditions.
- Proposed 6-year implementation schedule is reasonable provided licensees address operability issues in accordance with NRC regulatory requirements.
- Licensees expected to notify NRC of deviations from JOG program (including implementation schedule) in accordance with GL 96-05 commitments.

NRC JOG Safety Evaluation
(continued)

- Final implementation will require classification of safety-related MOVs based on physical construction, application, service condition, and design test information.
- Once classified, valves will be placed into final test matrix based on risk and margin.
- For valves (or their operating conditions) outside JOG (Class D valves), licensees responsible for developing separate MOV periodic verification program that satisfies GL 96-05.
- Licensees expected to notify NRC of plans to periodically verify design-basis capability of JOG Class D MOVs.

1997 SER Conditions Update

A: JOG submittal of final TR satisfies 1997 SER condition.

B: BWROG and WOG MOV risk ranking acceptable.

C: Licensee responsible for satisfying GL 96-05.

D: Licensee responsible for addressing JOG Class D MOVs.

E: Licensee responsible for MOV operability and Part 21.

F: Licensee responsible for adequate margin until next test.

G: Licensee responsible for application of uncertainties.

H: Licensee responsible for actuator output capability.

I: Potential impact of static test prior to dynamic test resolved.

J: Preliminary test frequency recommendations resolved by final JOG test frequency table.

JOG Safety Evaluation Followup

- On Dec. 11, 2006, JOG submitted MPR-2524-A (ML063470526 and ML063490199).
- On June 20, 2007 (ML071730468), JOG submitted revised pages to MPR-2524-A with corrected design data for a JOG-tested valve.
- On Sept.18, 2008, NRC issued final SE (ML082480638) on revised pages to MPR-2524-A.
- NRC staff closed review of GL 96-05 program at each nuclear power plant based on plant-specific evaluation.
- Extension beyond JOG test frequency must be justified by 10 CFR 50.59 evaluation while exceeding ASME OM Code test frequency requires 50.55a(z) approval.

JOG Commitment

- Licensees committed to implement JOG program in written responses to GL 96-05.
- NRC letter dated July 20, 2018, to NEI on Surveillance Frequency Control Program notes “regulatory commitments” are defined in NEI 99-04, “Guidelines for Managing NRC Commitment Changes,” (ML003680088) as “an explicit statement to take a specific action agreed to, or volunteered by, a licensee and submitted in writing on the docket to the NRC” (SECY-00-045 & RIS 2000-17).
- Licensee commitments to implement the JOG program in GL 96-05 responses are regulatory commitments.
- Changes to JOG commitments need to satisfy approved regulatory commitment change process (see LIC-105 at ML16190A013).

RIS 2011-13

Followup to Generic Letter 96-05 for Evaluation of Class D Valves under Joint Owners Group MOV Periodic Verification Program

- Acceptable methods to address JOG Class D valves:
  - If no MOVs outside JOG scope, do not notify NRC.
  - If applying Code Case OMN-1, do not notify NRC.
  - If not applying Code Case OMN-1, licensees required by 50.55a(b)(3)(ii) to establish program to ensure MOVs capable of performing design-basis safety functions, and follow administrative procedures for notifying NRC of GL 96-05 commitment changes.
- ASME OM Code, Appendix III, incorporated by reference in 50.55a with conditions will satisfy GL 96-05 for safety-related MOVs, including JOG Class D valves.

RIS 2000-03

Resolution of Generic Safety Issue 158: Performance of Safety-Related Power-Operated Valves Under Design Basis Conditions

- Close-out of GSI 158.
- AOV JOG program acceptable with NRC comments.
- NRC will monitor licensee activities to ensure that POVs capable of performing safety-related functions under design-basis conditions.
- Attachment provides successful POV program attributes.

Attributes of Successful POV Program

- Maintenance rule scope for POV program.
- Verify POVs in non-safety position can return if operable.
- Verify use of GL 88-14 on AOV instrument air supply.
- Evaluate MOV risk ranking methodologies for applicability.
- Focus initial efforts on safety-related active high-risk POVs.
- Verify methods for predicting POV operating requirements using MOV lessons learned or specific POV dynamic diagnostic testing.
- Justify method for predicting POV actuator output capability by test-based program.
- Address applicable weak links of actuator, valve, and stem.
- Ensure QA program coverage.

Attributes of Successful POV Program
(continued)

- Provide sufficient diagnostics.
- Specify if dynamic or static diagnostic testing needed.
- Ensure post-maintenance testing verifies capability.
- Ensure POV maintenance procedures incorporate valve lessons learned.
- Upgrade training to incorporate lessons learned.
- Apply feedback from plant-specific and industry information.
- Establish quantitative (test data) and qualitative (maintenance and condition reports) trending of POV performance with detailed review following each RFO.

9.d Valve Position Indication

ASME OM Code, ISTC-3700 Position Verification Testing

- REDACTED

Federal Register Notice 7-18-2017

(82 FR 32934)

- Operating experience revealed that indicating lights and stem travel are not sufficient to satisfy ISTC-3700 to verify that valve operation is accurately indicated.
- 10 CFR Part 50, Appendix A, requires that where generally recognized codes are used, they shall be identified and evaluated to determine their adequacy, and supplemented as necessary.
- NUREG-1482 emphasized licensees responsible for developing and implementing method to verify valve operation accurately indicated as required by ISTC-3700.
- 10 CFR 50.55a(b)(3)(xi) to supplement ISTC-3700 begins with 2012 Edition of ASME OM Code to allow additional time for compliance.

Information Notice 2012-14

Motor-Operated Valve Inoperable Due to Stem-Disc Separation

- In Oct. 2010, Browns Ferry Unit 1 Low Pressure Coolant Injection (LPCI) outboard injection valve failed to open.
- Licensee discovered tack welds between disc and skirt of 24-inch Walworth angle globe valve had failed, and lower disc separated from upper disc skirt and lodged in seating area.
- LPCI valve with active close safety function was not included in GL 89-10 and GL 96-05 programs.
- Valve modifications nullified original valve design-basis capability established in GL 89-10 without appropriate method for re-establishing valve design basis, and did not meet 10 CFR 50.55a(b)(3)(ii).

Information Notice 2017-03

Anchor/Darling Double Disc Gate Valve [DDGV] Wedge Pin and Stem-Disc Separation Failures

- In Feb. 2017, LaSalle County Station Unit 2 high-pressure core spray (HPCS) injection isolation valve (Anchor/Darling 12-inch DDGV) would not open because of stem-disc separation from excessive wear of valve stem threads and shear failure of the wedge pin.
- In Oct. 2012, Browns Ferry Unit 1 high-pressure coolant injection (HPCI) steam isolation valve (10-inch Anchor/Darling DDGV) failed leak test because wedge pin failed, and a disc retainer fell between valve discs.
- In July 2017, Flowserve issued update to 2013 Part 21 notices issued by Flowserve and TVA.
- NRC and industry initiated generic action.

10 CFR 50.55a(b)(3)(xi)

- When implementing ASME OM Code, 2012 Edition, ISTC-3700, licensees shall verify that valve operation is accurately indicated by supplementing valve position indicating lights with other indications, such as flow meters or other suitable instrumentation, to provide assurance of proper obturator movement.
- 50.55a(b)(3)(xi) requires licensees to supplement their valve IST programs (including MOVs) to provide assurance of proper valve position indication.
- 50.55a condition can help address MOV stem-disc separation issue.

IST versus Technical Specifications

- IST and Tech Specs have had overlapping requirements.
- Enforcement Guidance Memorandum 12-001 and RIS 2012-10 addressed misapplication of grace periods.
- Tech Spec Task Force (TSTF) developed TSTF-545 and deleted IST from Standard Tech Specs.
- NRC letter on 12-11-2015 approved TSTF-545.
- NRC letter on 2-14-2018 withdrew EGM-12-001 and relied on Code Case OMN-20 for IST grace periods.
- NRC withdrew RIS 2012-10 in FRN on 3-13-2018.
- RG 1.192 (Revision 2) accepts Code Case OMN-20 for all Code editions incorporated by reference in 10 CFR 50.55a.
- IST grace periods from Code Case OMN-20 have been included in ASME OM Code (2017 Edition).

10. MOV Inspection Issues

GL 89-10 Inspection Results IN 1992-17

- Administration:
  - Some licensees did not ensure adequate management oversight.
- Scope:
  - Some licensees needed to improve justification for excluding MOVs from GL 89-10 scope.
- Design-Basis Review:
  - Some licensees failed to identify worst-case conditions.
  - Some licensees only focused on differential pressure without addressing other parameters.
  - Licensees need to ensure generic studies are applicable.

GL 89-10 Inspection Results
IN 1992-17

- MOV Sizing and Setting:
  - Improper use of outdated VFs
  - Justify SFC assumptions and lubrication effects
  - Justify LSB and ROL assumptions
  - Consider ambient temperature effects on motor output and thermal overload sizing
  - Justify applicability of industry VF databases
  - Consider inertia in maximum torque switch settings
  - Demonstrate applicability of actuator capability studies
  - Demonstrate applicability of generic motor curves
  - Justify removal of conservatisms (such as application factor)
  - Consider torque switch repeatability
  - Consider MOV diagnostic equipment uncertainty

GL 89-10 Inspection Results IN 1992-17

- MOV Sizing and Setting (continued)
  - MOV calculation issues because of incorrect spring packs, incorrect nameplates or procurement documents, and variation in spring pack performance
  - Consider impact on manual clutch release
  - Justify degraded voltage assumptions consistent with licensing commitments (for example, assumptions for voltage starting point, cable current, thermal overload device resistance, MOV stroke time effects, and locked-rotor power factor)
  - Documentation of MOV switch settings
  - Ensure QA control of MOV setting changes
  - Justify MOV maximum settings above manufacturer recommendations with 10 CFR 50.59 review

GL 89-10 Inspection Results IN 1992-17

- DP/Flow Testing:
  - Need to thoroughly evaluate ability to test under design-basis or maximum achievable conditions
  - More thrust required than typical 0.3 VF
  - Weaknesses in procedures for conducting DP/flow testing, acceptance criteria for evaluating MOV capability, and process for incorporating test results into calculation methodology
  - Address MOV operability following testing
  - Improper discarding of test data without careful evaluation
  - Lack of coordination among licensees
  - Grouping might be affected by performance differences among similar valves
  - MOVs closed on limit need to satisfy leakage limitations.

GL 89-10 Inspection Results IN 1992-17

- Periodic Verification:
  - Licensees have not justified tests under static conditions to demonstrate periodic design-basis capability verification
  - Cleaning and lubricating valve stem before periodic verification inconsistent with demonstrating capability at end of test interval
- MOV Failures, Corrective Actions, and Trending
  - Weaknesses in evaluating MOV failures and deficiencies
  - Root cause analyses of MOV problems not thorough
  - Licensees attempting to improve MOV trending
- Schedule
  - Some licensees had not made adequate progress
  - NRC staff accepted limited extensions of GL 89-10 schedule.

GL 89-10 Inspection Results IN 1997-07

- Thrust/torque requirements for nondynamically tested MOVs
  - Reduction of VF based on valve size, DP, and fluid temperature without sufficient test data
  - Difficulty in justifying MOV capability based on unsupported assumptions for gate, globe, and butterfly valves
  - EPRI updating MOV application guide to provide improved guidance
- Use of industry valve information
  - Some MOV testing under dynamic conditions not practicable
  - Licensees obtaining performance information from EPRI MOV PPM and other sources
  - Need to demonstrate applicability to industry sources
  - Need to address EPRI predicted potential valve damage

GL 89-10 Inspection Results IN 1997-07

- Justification for SFC and LSB assumptions
  - Some assumptions inadequate based on plant data
  - SFC and LSB may vary based on stem lubricant, lube frequency, environmental conditions, and manufacturing tolerances
  - Plant-specific data most applicable
  - Staff conditions on EPRI SFC and LSB assumptions
  - LSB is bias or bias/random error, not only random uncertainty
- Grouping of MOVs
  - Some licensees did not justify small testing sample
  - Need to accommodate VF variation
  - Some MOV variation may be justified to allow sufficiently large group size

GL 89-10 Inspection Results IN 1997-07

- Degraded voltage calculations
  - Some licensees had not fully justified grid voltage assumptions (such as using full grid voltage rather than degraded grid relay setpoint)
- Justification for weak link analyses
  - Inadequate weak link justification
  - Strengthening one part (such as motor pinion key) might shift weak leak to another part
- Analytical evaluation of pressure locking of gate valves
  - Some licensees relying on analytical approaches rather than test-based justification
  - Assumption of overly optimistic high actuator efficiencies, high valve bonnet leakage, and low bonnet pressure increase

GL 89-10 Inspection Results IN 1997-07

- Evaluation of test data
  - Some licensees not thoroughly evaluating test data to ensure results are reliable
  - Data trace anomalies might reveal valve or actuator damage
  - Some licensees had not justified test data extrapolation
- Tracking and trending of MOV problems
  - Weakness in MOV tracking and trending methods
  - Some methods highly informal.

Example MOV Appendix B Violations

- Criterion III (Design Control): failure to incorporate design basis into MOV operating requirements
- Criterion V (Instructions): failure to specify adequate test acceptance criteria
- Criterion VI (Document Control): failure to provide adequate control of MOV switch settings
- Criterion XI (Test Control): failure to perform testing in accordance with procedures or review test data
- Criterion XII (M&TE): failure to calibrate M&TE
- Criterion XVI (Corrective Action): failure to implement adequate corrective action

Limitorque Inspection Results

- IR 99900100/2011-201, April 22, 2011 (ML1111016960)
  - Part 21 Violations and Part 50, Appendix B Nonconformances
  - Criterion III-Design Control: calculation software not verified
  - Criterion IV-Procurement Document Control: Appendix B not imposed on calibration services
  - Criterion V-Instruction: Uncontrolled procedure for TS quality check
  - Criterion VII-Control of Purchased Material: Non-Appendix B supplier MTRs accepted and Appendix B compliance not evaluated
  - Criterion XI-Test Controls: TS test not initiated at setting of 1 per AP1000 specification
- NRC letter dated September 29, 2011 (ML112650760) finds Limitorque letters responsive to IR 2011-201.

Limitorque Inspection Results

- IR 99900100/2012-201, October 25, 2012 (ML12292A067)
  - Part 21 Violation and Part 50 Appendix B Nonconformances
  - Criterion II-QA Program: Test personnel proficiency not maintained
  - Criterion III-Design Control: Head cap screws from commercial supplier not verified
  - Criterion X-Inspection: QC personnel disassembled LS gear
  - Criterion XVI-Corrective Action: Extent of condition evaluation not performed for software error; Report not prepared for gear defect; and Customer complaints not addressed
- NRC letter dated January 30, 2013 (ML13029A772) finds Limitorque letters responsive to IR 2012-201.

Limitorque Inspection Results

- IR 99900100/2018-201, March 7, 2018 (ML18043A150)
  - Nonconformance to Criterion III (Design Control) and Criterion VII (Purchased Material and Services) related to commercial grade dedication process including failure to ensure material composition for DC motor shafts and to identify motor torque as critical characteristic of DC motors procured from commercial supplier.
  - Nonconformance to Criterion XVII (QA Records) related to missing records for commercial-dedicated fasteners.
  - Nonconformance to Criterion X (Inspection) related to receipt inspection records failing to include evidence of material testing of commercially-dedicated hardware and fasteners.
  - Flowserve Letter dated April 17, 2018 (ML18109A036) describes corrective action to be implemented in response to nonconformances.

11. OpE Findings and Notices

Limitorque Actuator Model SMB-000

- Operating experience and inspection reports examined over last 15 years.
- Several events involving SMB-000 Leaf Style Torque Switch.
- Majority of instances noted dirty and/or high resistance on contacts.
- Many failures occurred shortly after maintenance activity.
- Typical failure is valve stops mid-stroke.
- Limitorque re-designed torque switch and stopped manufacturing old leaf style switch.

Degraded Stem Lubricant

- In 2009, 5 instances of MOV failures due to stem lubricant degradation.
- Stem lubricant degradation can affect efficiency of actuator torque conversion; thus reducing margin
- Licensees responsible for addressing MOV actuator output and potential degradation.
- NRC staff issued IN 2010-03 to alert licensees on importance of assessing lubricant performance relating to preventive maintenance (PM) intervals, maintenance practices, environmental conditions, safety margins, and surveillance testing.

Degraded Stem Lubricant

- Common Factors that lead to degraded stem lubricant:
  - Inappropriate PM interval
  - Inadvertent mixing of non-compatible greases which accelerates degradation
  - Stem / Stem-Nut not properly cleaned of old grease prior to application of new grease

Commanche Peak 2 LER 4462012001R00

- On April 11, 2011, surveillance on PORV block valve noted close stem thrust did not meet design.
- Failure was due to inadequate stem lubrication.
- Stem had not been cleaned and lubricated in over 10 years.
- PM steps to clean and lubricate specified as “Not Applicable” because inaccessible.
- Licensee Event Report (LER) review determined that PORV block valve had likely been inoperable longer than allowed by Tech Specs.

MOV Motor Experience

- As discussed in NRC information notices, MOV motors have experienced various deficiencies over the years.
- Inadequate environmental qualification (IN 1986-02)
- Motor pinion and key failures (IN 1985-22, IN 1988-84, IN 1990-37, IN 1994-10, and IN 1996-48)
- High temperature output reduction (IN 1993-74)
- Motor brake issues (IN 1993-98)
- Motor starter failures (IN 2006-03)
- Magnesium rotor degradation (IN 1986-02, IN 2006-26, and IN 2008-20).

Magnesium Motor Rotor Degradation

- IN 1986-02, 2006-26 and 2008-20 alerted licensees to MOV failures by magnesium motor rotor degradation.
- Failures due to oxidation and corrosion from exposure to high humidity and temperatures.
- Failure mechanisms include galvanic corrosion, general corrosion, and thermally induced stress.
- Number of failures illustrate need for adequate PM.
- BWROG Valve Technical Resolution Group developed guideline "Inspection of Motor Operated Valve Limitorque AC Motors with Magnesium Rotors"

MOV Recent Trends

- Data reviewed over recent years
- License Event Reports
- Greater than Green findings
- Inspection reports
- 10 CFR Part 21
- REDACTED

MOV Recent Trends
(continued)

- REDACTED

MOV Recent Trends
(continued)

- Operating Experience (OE) data received by NRC staff involve high importance events (LER, Part 21, Inspection Reports, Notice of Violation, etc.)
- 5-year window review of MOV performance = 40 events
- REDACTED

MOV Recent Trends

(continued)

- REDACTED

MOV Contact Failures

- REDACTED

MOV Contact Failures

(continued)

- REDACTED

MOV Lubricant Issues

- REDACTED

MOV Lubricant Issues

(continued)

- REDACTED

MOV Stem-Disc Separation

- REDACTED

MOV Stem-Disc Separation
(continued)

- REDACTED

MOV Stem-Disc Separation
(continued)

- REDACTED

MOV Stem-Disc Separation
(continued)

- REDACTED

MOV Obturator Movement and Failure Study

- MOV valve failure study – examined 30+ years of failures
- Study performed to support recommended changes in ASME OM Code, Mandatory Appendix III
- Study examined all failures of:
  - Gate
  - Globe
  - Butterfly
- Study focused on failed valves in IST program

MOV Study – Gate Valves

- Stem-Disc failures are sudden and typically discovered immediately.
- Stem separation evident by observing stem rotating (gate valve design that use internal guides as anti-rotation).
- Open/close stroke can appear normal if valve is set up on limit control.
- For close stroke, majority of valves set on torque switch trip.
- Light indication would look normal, but motor would continue to run until thermal overloads open.

MOV Study – Globe Valves

- Stem-Disc failures more difficult to identify
  - Most designs use flow under the seat
  - Valve could operate like a stop check valve
- Many globe valve failures were due to:
  - Tack welds breaking
  - Disk nuts backing off
  - Worn threads giving out
- Common indicators of valve failure:
  - Changes in stroke time (noted in diagnostic trace)
  - Changes in valve travel
  - Erratic valve stroke

MOV Study – Butterfly Valves

- Shaft/Disc separations typically sudden and discovered immediately.
- Typical failures were in pin to shaft area where tack welds broke allowing them to back out.
- On valves set up with torque switch trip, light indication would look normal, but motor would continue to run until thermal overloads open.

MOV Study – All Valves

- Many failures were due to poor maintenance
  - Loose mounting bolts
  - Insufficient staking of locking keys
  - Poor interface between valve and actuator
  - Valve assembled incorrectly
  - Incorrect actuator settings

MOV Study – Recommendations

- Maintain full cycle exercise once per refuel cycle with maximum interval to be not greater than 24 months.
- During exercise, measure valve stroke time diagnostically and compare against established reference.
- During exercise, measure valve stroke travel.
- During exercise, observe evidence of changes in obturator position (e.g., pressure, flow, level, and temperature)

MOV Study – Recommendations
(continued)

- During exercise, observe valve operation locally paying attention to:
  - Valve stem operation
  - Valve operator interface
  - Overall operator action
- During exercise, look for abnormal operation such as:
  - Valve stem rotating
  - Loose actuator
  - Loose valve/operator interface
  - Erratic valve stroke
  - Unusual sounds

MOV Motor T-Drains

- Are T-drains required on motors installed on actuators located inside containment?
- IEEE Std 382-1972, “IEEE Trial Use Guide for Type Test of Class I Electric Valve Operators for Nuclear Generating Stations”
  - Draft standard developed to provide direction for establishing type test that will yield data which verifies that Class I electric valve operators for nuclear power stations can meet their design basis performance requirements
  - This draft standard was later incorporated into IEEE Std 323-1974, “IEEE Standard for Qualifying Class IE Equipment for Nuclear Power Generating Stations”

MOV Motor T-Drains

(continued)

- RG 1.73 endorsed IEEE Std 382-1972, with conditions, in January 1974.
- RG 1.89 endorsed IEEE Std 323-1974, with conditions, in November 1974.
- Plants built after 1974 needed to implement guidance noted in these regulatory guides.
- In mid-1970s, in response to petition from Union of Concerned Scientists, NRC initiated actions to confirm environmental qualification of electrical equipment required to perform safety function under postulated accident conditions.

MOV Motor T-Drains

(continued)

- Results of NRC initiative discussed in IE Circular 78-08, dated May 31, 1978
  - Plants needed to examine installed safety-related EQ equipment and ensure appropriate documentation of qualification to function under postulated accident conditions
  - Specific guidance in IEEE 323-1971 and 1974 as augmented by RG 1.89
  - Circular later supplemented by Bulletin 79-01, “Environmental Qualification of Class IE Equipment,” which requested that licensees re-review EQ program as described in Circular 78-08.

MOV Motor T-Drains

(continued)

- Limitorque performed additional testing and documented results in report B0058, “Limitorque Valve Actuator Qualification For Nuclear Power Station Service Report B0058 Tests Conducted Per IEEE 382-1982, 323-1974, and 344-1975,” dated 1/11/1980
  - REDACTED

MOV Motor T-Drains
(continued)

- REDACTED

MOV Motor T-Drains

(continued)

- REDACTED
- Industry contested violations by providing analysis showing MOVs would operate to safety position before encountering conditions that would require use of T-drain.

MOV Motor T-Drains

(continued)

- REDACTED

MOV Motor T-Drains
(continued)

- REDACTED
- Related documents on this issue:
  - Generic Letters 85-15, 86-15, and 88-07
  - NUREG-0588, "Interim Staff Position On Equipment Qualifications Of Safety-Related Electrical Equipment”
  - IEEE 382-1972 (ADAMS ML032200228)
  - IEEE 323-1974 (ADAMS ML032200206)

Thermal Overload Protection

- Typical MOV motors are intermittent duty, high torque design.
- Prolonged operation can generate heat high enough that can damage motor internal wiring.
- Thermal overload protection for MOVs can be categorized as:
  - thermal overload relays, usually housed in motor starter
  - temperature-sensing elements that are embedded in motor windings (not typical but can be requested via manufacturer)
- Do you have to test these devices periodically?

Thermal Overload Protection
(continued)

- Yes – For devices that are connected as part of MOV circuitry (Question 21 in GL 89-10 Supplement 1, “Results of Public Workshops” (ADAMS ML031140169)
- Guidance provided in:
  - RG 1.106, “Thermal Overload Protection for Electric Motors on Motor-Operated Valves”
  - IEEE 741-2007, “Standard Criteria for the Protection of Class 1E Power Systems and Equipment in Nuclear Power Generating Stations”
  - IEEE 603-2009, “Standard Criteria for Safety Systems for Nuclear Power Generating Stations”
  - IEEE 1290-2015, “Guide for Motor-Operated Valve Motor Application, Protection, Control, and Testing in Nuclear Power-Generating Stations”

OpESS 2010-01

- REDACTED

OpESS 2012/02 (Revision 1)

- REDACTED

Limitorque Switch Material Change

- Limitorque Technical Update 01-01 discussed material color change from Brown to Black in non-metallic portions of torque and limit switches for SMB, SB, and SBD actuators.
- Limitorque analyzed material change and approved use of black material as acceptable interchangeable alternate to brown material.
- Limitorque indicated that previous EQ and seismic test reports are applicable to black material.
- In January 2018, NRC inspectors found no issues with Limitorque qualification of new material (ML18043A150).
- Referred to as Fibrite or Fiberite.
- Brown or Black Fibrite is acceptable in MOVs.

Motor Environmental Qualification Issue

- Region II inspection (ML18024A566) at Vogtle Units 1 and 2 identified potential issue with environmental qualification of motors outside containment with Class B insulation.
- Discrepancy identified between EPRI and Limitorque reports regarding motor temperature aging.
- Westinghouse performed EQ testing described in WCAP-8587 (June 1981) and approved in NRC SE (Sharepoint and Microfiche 21389:348 to 21390:083).
- Westinghouse EQ testing demonstrated 40-year qualification of motors in mild environment.
- Licensees should address motor qualification if plant life extension planned.

NRC Information Notice 2018-04

- On February 26, 2018, NRC issued IN 2018-04, “Operating Experience Regarding Failure of Operators to Trip the Plan When Experiencing Unstable Conditions.”
- IN 2018-04 alerts licensees to several reactor events where operators failed to take timely action.
- Events involved operators misinterpreting procedures, failing to adhere to procedure requirements, or failing to recognize incomplete or faulty procedures.
- Some of the events related to valve performance.
- This information may be helpful to prepare for events related to MOV performance and failures.

Load Following Impacts

- Some licensees are considering adjusting the operating conditions to provide for “load following” of the nuclear power plant.
- Load following might result in additional or more frequent MOV operating cycles.
- Limitorque qualifies its MOVs to perform 2000 cycles over their operating life.
- MOV motors must have a sufficient cooldown period during multiple operating cycles.
- MOVs need sufficient internal and external lubrication for their operating conditions.
- Licensees need to consider the impact on MOV operating life and performance for load following conditions.

EPRI Report on MOV Life Extension

- REDACTED

Advanced Reactors

- Light water reactors will continue to use power-operated valves (including MOVs) similar to the current design.
- Advanced reactors with new cooling methods such as molten salt might employ new components to control flow in a different manner.
- NRC is evaluating new GDCs for those new reactor types.
- ASME is evaluating changes to the OM Code to address potential new types of components to control flow that previously were referred to as pumps and valves.

Questions?

Background Slides

REDACTED