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NRC Information Notice 2021-01 Update

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U.S. Nuclear Regulatory Commission

Motor-Operated Valve Users Group Meeting
January 2024

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Lessons Learned from Power-Operated Valve (POV) Inspections

POV Inspection Program

- On July 26, 2019, NRC issued Inspection Procedure (IP) 71111.21N.02, “Design-Basis Capability of Power-Operated Valves Under 10 CFR 50.55a Requirements”
- Inspection objective was to assess the reliability, functional capability, and design-basis of risk-important power-operated valves (POVs) at nuclear power plants.
- Training provided for inspectors in NRC Region offices.
- POV inspections began in January 2020, and were completed at the end of 2022.

POV Inspection Approach

- POV inspections focused on sample selection, scope, design, testing, maintenance, and corrective actions.
- POV inspections at each site included a sample of 8 to 12 POVs including:
  - Motor-Operated Valves (MOVs)
  - Air-Operated Valves (AOVs)
  - Hydraulic-Operated Valves (HOVs)
  - Solenoid-Operated Valves (SOVs)
  - Pyrotechnic-Operated (Squib) Valves
- Some inspections relied on partial remote means due to COVID-19 limitations.

POV Region Panels

- Draft findings from each POV inspection were presented to an NRC staff panel consisting of representatives from each NRC Region office and headquarters.
- POV Region Panel discussed each POV inspection finding in comparison to findings from previous POV inspections.
- Review by POV Region Panel provided confidence in consistency of NRC staff technical positions during POV inspections across NRC Regions.

POV Inspection Results

- POV inspections identified several Green Non-Cited Violations (NCVs) and numerous minor and licensee identified violations.
- NRC staff discussed lessons learned from POV inspections at several public and industry meetings.
- Information Notice (IN) 2021-01 (May 6, 2021), “Lessons Learned from U.S. Nuclear Regulatory Commission Inspections of Design-Basis Capability of Power-Operated Valves at Nuclear Power Plants,” summarized lessons learned from POV inspections in 2020.
- IN 2021-01, Supplement 1 (July 24, 2023) summarizes lessons learned from all POV inspections.

IN 2021-01, Supplement 1

- IST Program:
  - 10 CFR 50.55a requires licensees to develop an IST program to provide assurance of operational readiness of pumps, valves, and dynamic restraints in accordance with applicable edition and addenda of ASME OM Code, as incorporated by 10 CFR 50.55a
  - Ensure valves are properly included and categorized within scope of IST program, such as POVs with leakage limitation safety functions, remote-operated safety functions, or manual-operated safety functions.

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- POV Operating Requirements and Capability:
  - Properly determine operating requirements and actuator capability for POVs to perform their safety functions.
  - Appropriate parameters addressed when calculating valve operating requirements or actuator capability.
  - Justify POV parameters, such as valve friction coefficients, from outside sources.
  - Ensure valve-specific valve factors used if higher than generic valve factors with extent of condition review.
  - Increased thrust and torque requirements (sideloading) to operate globe valves under high-flow dynamic conditions.
  - Unwedging load is part of evaluation of POV capability to open to perform their safety functions.

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- POV Operating Requirements and Capability: (continued)
  - Specific POV design, including its valve, used in determining appropriate calculation assumptions.
  - Ensure normal operating loads that act simultaneously with seismic loads are addressed.
  - Ensure sufficient information and test data are developed to validate assumptions for rate-of-loading and load-sensitive behavior for plant-specific MOV applications.
  - Stem lubricant degradation can impact performance of MOV stem nuts, including the ball-screw design.
  - One-time stall torque limits for actuators intended to address structural capability of actuator rather than calculating performance capability.

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- JOG Program:
  - Most licensees committed to implement JOG Program on MOV Periodic Verification in response to GL 96-05.
  - Because of limited MOV test data and different methods used by licensees to evaluate test data, valve friction coefficients determined by JOG MOV Program do not represent a database that can be applied in general to calculate thrust and torque required to operate MOVs under design-basis conditions.
  - MOV test results collected by JOG participants only applicable to implementation of JOG MOV Program.

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- JOG Program: (continued)
  - Re-justify qualifying basis for MOVs following extensive maintenance (such as disassembly) to determine whether valves are susceptible to performance degradation.
  - JOG periodic verification test intervals are based on margin and risk ranking of each MOV within scope of JOG program, such that up-to-date POV risk rankings are important when implementing JOG program.

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- ASME OM Code, Mandatory Appendix III:
  - Per 10 CFR 50.55a(b)(3)(ii), licensees implementing 2009 or later OM Code editions, as incorporated by reference in 10 CFR 50.55a, must meet MOV requirements in ASME OM Code, Appendix III.
  - For MOVs within JOG program scope, a licensee may rely on dynamic testing conducted as part of that program to satisfy requirement in Appendix III for a mix of static and dynamic testing.
  - Appendix III, as incorporated by reference in 10 CFR 50.55a, requires new MOVs to be demonstrated to be capable of performing their safety functions.

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- Licensee Commitments:
  - 10 CFR 50.55a(b)(3)(ii) supplements MOV requirements in ASME OM Code by requiring licensees to establish program to ensure MOVs continue to be capable of performing design-basis safety functions.
  - When implementing JOG MOV Program, MOV diagnostic test frequency is based on JOG program provisions within the Appendix III limits.
  - Licensees committed to implementing JOG MOV Program are expected to follow commitment process to modify JOG program test intervals or notify NRC in accordance with that process.
  - JOG MOV Program does not include grace periods for test intervals, which are years rather than refueling outages.
  - Change in MOV risk ranking, or adjustment to MOV capability margin based on performance data, can result in different diagnostic testing intervals under JOG MOV Program.

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- MOVs Outside JOG MOV Program Scope:
- JOG Topical Report MPR-2524-A indicates some MOVs are outside JOG MOV Program scope as JOG Class D valves.
- Licensees committed to implementing JOG MOV Program to satisfy GL 96-05 and are implementing JOG program as part of compliance with 10 CFR 50.55a(b)(3)(ii).
- Licensees need to establish methods to periodically demonstrate design-basis capability of JOG Class D valves.
- Not feasible to modify classification of JOG Class D valve to Class A valve, which is not susceptible to degradation by direct information, or JOG Class B valve, which is not susceptible to degradation by extension.

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- EPRI MOV Performance Prediction Methodology (PPM):
  - When evaluating MOVs using PPM, licensees need to address all applicable provisions when determining valve operating requirements.
  - JOG Topical Report MPR-2524-A and EPRI MOV PPM Topical Report TR-103237, as accepted in NRC safety evaluations, specify conditions for implementing these programs.
  - EPRI assumed that each valve is maintained in good condition for MOV PPM to remain valid for that valve.
  - MOVs classified as JOG Class A or JOG Class B need to be maintained in good internal condition to satisfy EPRI MOV PPM.
  - EPRI Type 1 warnings indicate potential valve damage when implementing MOV PPM.

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- EPRI MOV Performance Prediction Methodology: (continued)
  - Where EPRI MOV PPM is used as best available information, industry data should be monitored for those valves to identify information that might challenge this assumption.
  - For butterfly valves, calculated maximum transmitted torque is applied when evaluating acceptability of valve weak link and actuator ratings.
  - Globe valve model in EPRI methodology specifies provisions, such as guidance for when to use outside seat diameter, to calculate required operating thrust, as applicable.
  - EPRI guidance for evaluating MOV diagnostic test data obtained under static conditions (i.e., without differential pressure or flow) cannot be applied beyond its capability to predict MOV performance under dynamic conditions (i.e., differential pressure and flow).
  - Additional guidance on EPRI methodology provided in NUREG-1482.

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- Limitorque Actuator Structural Capability:
  - When evaluating Limitorque actuators for structural capability, justify increasing thrust ratings beyond original limits.
  - Limitorque Technical Update 92-01 evaluated Kalsi #1707C and approved its use to increase maximum allowable thrust for SMB-000, SMB-00, SMB-0, and SMB-1 up to 140% of original ratings, with conditions.
  - Limitorque indicated that licensees that participated in Kalsi study or possess Kalsi #1707C may apply 162% maximum thrust rating described in Kalsi report, with conditions.
  - Individual POV subparts need to withstand maximum thrust and torque that POV actuator can deliver (weak link).
  - Structural limits in ASME BPV Code not applicable to POV internal parts for MOV operational motion.
  - Proper bolt material and length are part of actuator weak link calculations.

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- POV Testing:
  - For POV diagnostic testing, ensure that:

    (1) POV tests properly conducted,

    (2) acceptance criteria for POV testing apply correct assumptions (such as actuator thrust limits),

    (3) proper evaluations of test data completed to demonstrate that POVs can perform their safety functions, and

    (4) records of evaluations maintained per plant procedures.
  - Computer software relies on appropriate values for parameters when conducting diagnostic testing to determine accurate thrust and torque values (such as proper stem material properties).
  - POV test acceptance criteria need to be properly translated from POV design calculations into test procedures.

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- POV Testing: (continued)
  - Diagnostic equipment need to be installed and operating properly as part of POV testing and evaluation of results.
  - Operating requirements for valves apply throughout full valve stroke.
  - Fully complete POV test data evaluations to ensure parameters (such as valve friction coefficient or valve factor, stem factor, and rate of loading) are properly calculated and within acceptable range.
  - JOG MOV Program specifies valve friction values from testing need to be compared to JOG threshold values for valve friction to verify valve is operating consistent with results of JOG program assumptions.
  - Variation in valve performance can occur when relying on a single test to establish POV operating requirements.

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- POV Leakage Limitations:
  - Some POVs have leakage limitations past valve disk when closed.
  - MOVs can be set to fully close and meet leakage limitations when controlled by the torque switch.
  - MOVs with a safety function to close and be leaktight have more challenges when controlled by limit switch.
  - Need valid test or analysis demonstrating that MOV limit switch control setting under static conditions would achieve required leaktight performance when MOV is closed under dynamic conditions.
  - Leak rate requirements need to be addressed for MOVs with long closing torque switch bypass settings.
  - ASME OM Code as incorporated by reference in 10 CFR 50.55a requires documented program for leak-testing power-operated relief valves.
  - GL 79-46 provides recommendations for containment purge valves to close and seal under design-basis conditions, including seismic loads.

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- POV Qualification:
  - Justify POV qualification to perform design-basis safety functions, including functional, environmental, and seismic capability.
  - Preventive maintenance activities include replacing valve subcomponents within their specific qualified lifetime.
  - Environmental effects can affect POV performance when must remain functional for long time periods following LOCA or other conditions.
  - Limitorque qualified safety-related MOV actuators for 40 years or 2000 cycles, whichever comes first.
  - Licensees may extend actuator qualified life with adequate justification.
  - Justification for actuator qualified life extension includes assurance that environmental qualification requirements are not exceeded, and replacement frequencies or individual parts are established.
  - EPRI has guidance for extending qualified life of Limitorque actuators.
  - Radiation hot spots and ambient temperature conditions can impact service life for environmental qualification of a valve actuator.

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- MOV Stem-Disk Connections:
  - Operating experience with MOV stem-disk connections provided in IN 2017-03.
  - Boiling Water Reactor Owners Group (BWROG) prepared guidance to address potential failure of stem-disk connection in Anchor/Darling double-disk gate valves.
  - BWROG guidance includes specific provisions in assessing susceptibility for separation of stem-disk connection in Anchor/Darling double-disk gate valves, such as evaluating weak link of wedge pin under motor stall conditions.

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- Valve Position Verification:
  - ASME OM Code, ISTC-3700, requires valves with remote position indicators be observed locally at least once every 2 years to verify valve operation is accurately indicated.
  - 10 CFR 50.55a(b)(3)(xi) specifies supplemental position indication (SPI) requirements when implementing ASME OM Code, 2012 Edition (or later editions), ISTC-3700, for licensees to verify valve operation is accurately indicated by supplementing indicating lights with other indications, such as flow meters or other suitable instrumentation, to provide assurance of proper obturator position for valves with remote position indication within Subsection ISTC scope, including mandatory appendices and verification methods and frequencies.
  - 50.55a(b)(3)(xi) allows initial implementation extension as justified.
  - Additional information in Reactor Oversight Process meeting summaries (ML21041A409 and ML21047A290).

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- Valve Packing and Backseating:
  - Valve packing replacements or adjustments can cause anomalous behavior that might adversely impact valve performance.
  - A bent or damaged stem can cause packing loads to become more severe with valve operation.
  - On occasion, some licensees backseat the stem of a valve to limit packing leaks.
  - Need to conduct a detailed evaluation (including appropriate examination) of effects of backseating on valve bonnet and stem to verify structural integrity.
  - NUREG-1482 provides additional guidance to control the backseating process for a valve stem.

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- Use of POV Computer Software:
  - Need to perform complete verification and validation of POV computer software prior to implementation.
  - Need verification and validation for appropriate assumptions and data points.
  - Stroke time might be calculated improperly when computer data are used to measure MOV stroke time.
  - ASME OM Code specifies that valve stroke time begins with initiating signal and ends with completion of valve stroke.
  - Some computer data output does not include initial portion of stroke signal for calculating stroke time.
  - Important to update POV programs to address new computer software used in POV calculations.

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- MOV Thermal Overload Devices:
  - Thermal overload devices are installed in control circuitry for some MOVs to protect motor from damage due to an overload event.
  - Performance of thermal overload devices can impact safety function of MOVs if not evaluated periodically.
  - RG 1.106 (Revision 2) provides guidance for use of thermal overloads that reflects lessons learned from MOV programs.

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- MOV Throttling Operation:
  - Motors used to operate MOVs have limitations on operating time.
  - Limitorque specifies cooldown times for frequent operation of MOV motors.
  - Evaluate impact of motor heat-up on capability of MOVs with design-basis safety functions to throttle system flow.

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- Actuator Handwheel Operation:
  - Some licensees rely on actuator handwheel to manually operate MOVs to perform important functions.
  - Evaluate handwheel for proper sizing and good working condition in demonstrating that MOV can perform its safety function.
  - Improperly operating a valve by its manual handwheel can result in excessive handwheel torque that can damage the actuator and valve.

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- Preventive Maintenance and Modifications:
  - Determine proper lubrication interval for each MOV stem to address potential grease degradation.
  - MOVs in non-normal positions can cause maintenance issues.
  - Grease leakage into limit switch compartment might interfere with electrical operation of actuator wiring.
  - MOV oriented with disk in horizontal plane can lead to abnormal performance of gate valve from increased disk and guide wear.
  - Modifications to prevent pressure locking, such as drilling hole in disk, can have long-term consequences (e.g., one-way valve).
  - 10 CFR 50.59 applicable to pressure-locking modifications for MOVs.
  - Degradation of magnesium rotors in motors can adversely impact MOV performance.
  - Missing or damaged external and internal parts of motors and actuators can impact POV operational readiness or qualification.

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- Corrective Action:
  - Ensure that appropriate corrective actions in accordance with plant procedures are implemented when:

    (1) POV test results fall outside of specified acceptance criteria,

    (2) POV performance anomalies are observed, such as abnormal diagnostic traces or valve friction degradation, or

    (3) mechanical problem with POV is identified, such as manual declutch lever malfunction.
  - ASME OM Code as incorporated by reference in 10 CFR 50.55a includes corrective action requirements for POVs together with 10 CFR Part 50, Appendix B.
  - Overload events when testing or operating POVs need to be addressed in accordance with licensee's corrective action program, manufacturer recommendations, and 10 CFR Part 50, Appendix B.

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- POV Records:
  - Follow procedures for maintaining records associated with POV qualification, testing, operation, maintenance, and corrective action, in accordance with quality assurance requirements in 10 CFR Part 50, Appendix B.
  - As part of QA program, POV performance needs to be monitored with reports prepared in accordance with plant procedures to identify any adverse indications.

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- IST Programs and Technical Specifications:
  - Nuclear power plant licensees are required to meet NRC regulations in both 10 CFR 50.36 and 10 CFR 50.55a.
  - Following criteria in 10 CFR 50.59(c)(1), licensees need to prepare a license amendment request to revise technical specifications when making changes to POV parameters (such as main steam isolation valve accumulator pressure) as part of IST program.

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- IST Programs and 10 CFR Part 50, Appendix J:
  - ASME OM Code, as incorporated by reference in 10 CFR 50.55a, allows licensees to follow leak testing intervals for containment isolation valves in accordance with Appendix J in certain instances.
  - Licensees might perform POV static testing to meet containment leakage testing requirements in 10 CFR Part 50, Appendix J.
  - 10 CFR 50.55a(b)(3)(ii) requires that MOV design-basis capability be justified periodically.
  - POV leakage requirements might be specified in final safety analysis as part of IST program description in addition to 10 CFR Part 50, Appendix J, requirements.

IN 2021-01, Supplement 1 Conclusion

- NRC staff discussed POV findings in detail with licensees.
- Licensees took action to address the POV findings.
- Many issues determined to be minor because of capability margin available for specific POVs.
- Issues might have been more significant where less POV capability margin was available.
- Some licensees initiated long-term activities to address POV findings as part of corrective action programs.
- NRC staff suggests that licensees review the IN and consider actions to identify and address similar issues.

POV Inspection Summary

- Implementation of IP 71111.21N.02 for POV inspections was successful in meeting the inspection objectives and maintaining consistency across NRC Region offices.
- POV inspections identified many lessons learned that licensees should address in providing reasonable assurance of the design-basis capability of POVs to perform their safety functions.

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QUESTIONS?

Acronyms

- ASME: American Society of Mechanical Engineers
- BPV: Boiler and Pressure Vessel
- BWROG: Boiling Water Reactor Owners Group
- CDF: core damage frequency
- CFR: Code of Federal Regulations
- COR: Code of Record
- decaBDE: Decabromodiphenyl Ether
- EPA: U.S. Environmental Protection Agency
- EPRI: Electric Power Research Institute
- GL: Generic Letter
- IN: Information Notice
- IST: inservice testing
- JOG: Joint Owners Group
- LERF: large early release frequency
- LOCA: loss of coolant accident
- MOV: motor-operated valve
- NRC: U.S. Nuclear Regulatory Commission
- OM: Operation and Maintenance
- POV: power-operated valve
- PPM: Performance Prediction Methodology
- PST: preservice testing
- RG: Regulatory Guide