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New Reactors and New Engineering Programs for Motor-Operated Valves

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Abstract

Several new reactors are currently under construction in the USA. Based on current construction schedules, Watts Bar 2 will be the first new reactor to go online for commercial generation since Watts Bar 1 was issued its operating license in 1996. New engineering programs will be going online with new reactors like Watts Bar 2. The startup of these new engineering programs is not without its own set of challenges. One of the programs has undergone a significant transformation since the last nuclear power plant started commercial operation in terms of industry implementation methods and regulatory requirements.

In 1996, the NRC issued Generic Letter 96-05 to communicate issues related to periodic verification (PV) of motor-operated valves (MOVs) and to request action by operating commercial power reactors to establish an MOV PV program. Subsequently, the regulations were revised to include a requirement to have an MOV PV program in Title 10, “Energy,” of the *Code of Federal Regulations* (10 CFR) 50.55a(b)(3)(ii). Generic Letters 89- 10 (on MOV surveillance and testing) and 96-05 have been closed and today stand as historical references. Their provisions do not directly apply to new reactors, but there are many lessons available from MOV PV programs at operating sites in terms of safety, implementation, and cost.

There is only one consensus standard available to describe the requirements for an acceptable MOV PV program. This is contained in the ASME’s *Operation and Maintenance of Nuclear Power Plants* (OM Code) as Mandatory Appendix III. The U.S. Nuclear Regulatory Commission (NRC) previously endorsed this approach as a Code Case and is preparing a proposed change to 10 CFR 50.55a to incorporate by reference the ASME OM Code edition that includes Appendix III. This paper conveys the technical complexities and financial concerns faced by plant staff in making the right technical decisions for new program implementation at a new reactor in the USA.

Introduction

The nuclear power industry has not brought very many new reactors online over the last two decades. Tennessee Valley Authority is the only company that has active construction permits under the 10 CFR Part 50 licensing regulatory framework. Southern Nuclear Operating Company and South Carolina Electric & Gas are the only licensees currently building new power plants under the 10 CFR Part 52 licensing process. New reactor Watts Bar 2 is undergoing the final phases of construction. This will mark the first time a new reactor will go online for the commercial generation business since Watts Bar 1 was issued its operating license in 1996. Several new engineering programs will be going online during the startup phase for these new reactors. The startup of these new engineering programs is not without its own set of challenges.

One of these programs has undergone a significant transformation since the last nuclear power plant was licensed for commercial operation in terms of industry implementation methods and regulatory requirements. This paper conveys the technical complexities and financial concerns faced by the plant staff in making technical decisions for new program implementation at a new reactor.

MOV Design-Basis Verification

The original need for design-basis verification of safety-related MOVs at nuclear power plants in the USA was specifically communicated through Generic Letter 89-10 in response to inadequacies identified in 1989 in the capability of safety-related MOVs at operating nuclear power plants. In 1996, the NRC issued Generic Letter 96-05, which requested that operating commercial power reactors establish an MOV PV program. Essentially, it described the need for verification of the design-basis capability of safety-related MOVs on a periodic basis. Subsequently, the NRC regulations were revised to include a requirement to have an MOV PV program in 10 CFR 50.55a(b)(3)(ii). The nuclear industry responded to Generic Letter 96-05 with a Joint Owners Group (JOG) Motor-Operated Valve Periodic Verification Program. The JOG shared resources to produce a comprehensive study of certain MOVs that the NRC used as part of its review to close out Generic Letter 96-05 programs at each then-operating nuclear power plant.

The NRC review of the Generic Letter 89-10 and 96-05 programs has been closed and today those generic letters stand as historical references. Their provisions do not directly apply to new nuclear power plants and there are no commitments requiring the implementation of the processes described by the JOG document. Although there are no direct requirements from these closed generic letters for plants under construction, there are many lessons available from the existing programs that could be used by new power plants. These programs were developed to address the issues identified in the generic letters with significant engineering effort. They can be looked to for the most effective methods in terms of safety, implementation logistics, cost, and meeting regulatory expectations. The JOG document provides information that is useful for developing a new MOV PV program as well, but it was written for programs that were already in existence using test results from specific valves. Beyond this information, there is very little available in terms of guidance that spells out how to implement a brand-new MOV PV program.

Present Requirements

The NRC regulations in 10 CFR 50.55a(b)(3)(ii) contain a requirement for periodic MOV design-basis verification at each nuclear power plant. The *Federal Register* (FR) notice (64 FR 51370, dated September 22, 1999) describing the establishment of this regulation discussed the use of ASME OM Code Case OMN-1 to satisfy the regulatory requirement in 10 CFR 50.55a(b)(3)(ii) and the recommendation in GL 96-05 for periodic verification of the design-basis capability of MOVs to perform their safety functions. The volume of information generated for MOV test programs since the issuance of Generic Letter 89-10 can be overwhelming. These components have perhaps had more attention, studies, and engineering resources expended on them than any other component type during the commercial operating period of the nuclear industry. One would assume this large amount of information would ease the burden of establishing an MOV design-basis verification program. However, the sheer volume of all this information to someone with little exposure to this unique corner of the nuclear industry is overwhelming and the source of a lot of confusion. The question of what is really required for an MOV testing program can be the source of great debate for new nuclear power plants.

ASME has developed guidance for implementing an MOV PV program. For example, ASME OM Code Case OMN-1 provides guidance for a program that can be used to periodically verify the design-basis capability of MOVs through testing and diagnostics. In Regulatory Guide (RG) 1.192, "Operation and Maintenance Code Case Acceptability, ASME OM Code," the NRC accepted the use of ASME Code Case OMN-1 as an alternative to quarterly MOV stroke-time testing and diagnostics. In RG 1.192, the NRC accepted the use of ASME Code Case OMN-1 as an alternative to quarterly MOV stroke-time testing provisions specified in the ASME OM Code. ASME incorporated Code Case OMN-1 in the ASME OM Code as Mandatory Appendix III in the 2009 version of the ASME OM Code. The latest version of Appendix III is contained in the 2012 Edition of the ASME OM Code. Using the consensus standard for the MOV design-basis verification program offers the advantage of having implementation guidance that the regulatory authorities find acceptable and intend to mandate in the future.

Implementation Logistics

One of the challenges faced by the staff at new nuclear power plants is a disconnect between the test programs developed in response to Generic Letter 89-10 and the ASME OM Code. An October 2013 revision to NRC Inspection Procedure (IP) 62708, “Motor-Operated Valve Capability,” provided new insight with respect to what is expected for MOV Programs. One key area describes four ways in which licensees previously satisfied the requirement to demonstrate MOV design-basis capability. The following discussion from that document describes what the NRC staff historically found acceptable for use in demonstrating MOV design-basis capability:

1. Dynamic flow testing with diagnostics of each MOV where practicable. Although the valve factor derived from the test data might be low because of minimal valve operating history or recent maintenance that exposed the Stellite valve material to air, the dynamic testing provided assurance that the valve performance was predictable. The licensee needs to consider an appropriate increase in the valve factor during its design-basis evaluation and setup based on test data from similar valves.
2. Application of the Electric Power Research Institute (EPRI) MOV Performance Prediction Methodology (PPM). This method was initially developed for those valves that could not be dynamically tested. The PPM required internal measurements to provide assurance that the valve performance was predictable. The NRC staff later accepted the use of the PPM even where dynamic testing for an MOV was practicable.
3. Where valve-specific dynamic testing was not performed and the PPM was not used, the staff accepted the grouping of MOVs that were dynamically tested at the plant to apply the plant-specific test information to an MOV in the group. Using plant-specific data allowed the licensee to know the valve performance and maintenance history and helped provide confidence that the valve performance was predictable.
4. The least preferred approach (with the most margin required) was the use of valve test data from other plants or research programs because the licensee would have minimal information regarding the tested valve and its history. In such cases, the NRC inspector should perform an available capability evaluation of the MOV to provide confidence that the MOV had sufficient capability margin considering the uncertainties in the source of the data.

The discussion in IP 62708 describes these 4 areas as having different levels of acceptability in meeting Generic Letter 89-10. As indicated, the approach in item 4 was the least preferred approach and requires a followup verification on the part of the NRC inspector using the document for an audit. The guidance described in this section of IP 62708 is for MOV Programs developed in response to NRC Generic Letter 89-10, which is cited in the segue discussion preceding the list. It is not clear from IP 62708 whether methods 2 through 4 would apply to ASME OM Code MOV design-basis test programs.

Clearly, the intention of ASME OM Code Mandatory Appendix III was to allow credit for the completion of test activities under Generic Letter 89-10. Article III-3100 of Appendix III to the OM Code says, “Requirements for a design-basis verification test are specified in applicable regulatory documents. Testing that meets the requirements of this Mandatory Appendix but conducted before implementation of this Mandatory Appendix may be used.” New nuclear power plants may not have to perform MOV testing in direct response to Generic Letter 89-10 or 96-05. As previously described, these Generic Letters are closed out and no longer describe any requirements. The only regulatory requirement issued in place of these two Generic Letters is the short description in 10 CFR 50.55a(b)(3)(ii), which states:

> “Motor-Operated Valve testing. Licensees shall comply with the provisions for testing motor-operated valves in OM Code ISTC 4.2, 1995 Edition with the 1996 and 1997 Addenda, or ISTC-3500, 1998 Edition through the latest edition and addenda incorporated by reference in paragraph (b)(3) of this section, and shall establish a program to ensure that motor-operated valves continue to be capable of performing their design basis safety functions.”

The *Federal Register* notice (64 FR 51370, dated September 22, 1999) describing this rule change discusses the use of ASME Code Case OMN-1 in developing an MOV PV program to satisfy the regulatory requirement in 10 CFR 50.55a(b)(3)(ii) and the recommendation in GL 96-05. The discussion regarding the four methods that the NRC staff historically found acceptable for use in demonstrating MOV design-basis capability under Generic Letter 89-10 is described in IP 62708 (and IP 73758, “Part 52, Functional Design and Qualification, and Preservice and Inservice Testing for Pumps, Valves and Dynamic Restraints,” for 10 CFR Part 52 plants).

A limited amount information describes what is allowed or disallowed for the implementation of an MOV PV test program at a new reactor being constructed under 10 CFR Part 50. Watts Bar 1 commenced operation in 1996 when Generic Letter 96-05 was in place. The inservice testing (IST) Program at Watts Bar 2 will not be using the MOV Program to meet 10 CFR 50.55a(f) requirements. Watts Bar has a commitment to use the JOG document for their MOV PV program at both units. The decision to follow the guidance of the JOG program at Watts Bar Unit 2 is based on a negotiated regulatory commitment to maintain unit fidelity. Because the MOV Program already exists at Unit 1 and it is following the guidance of the JOG document, this is the best approach for the site.

While this approach makes sense for Watts Bar, the same can’t be said at other sites currently under construction. In that the NRC regulations are being updated to mandate the implementation of the edition of the ASME OM Code that requires Appendix III, planning for the use of ASME OM Code Appendix III would be the most effective approach to meet 10 CFR 50.55a(b)(3)(ii). Based on the projected completion of construction in the 2017 to 2019 timeframe at the Vogtle and V.C. Summer sites, there is a strong possibility that the regulations will be revised by then to require the version of ASME OM Code that uses the new Appendix III for MOV testing. At the present time, these sites are planning on using ASME Code Case OMN-1, which is equivalent to the requirement described in Appendix III of the 2009 Edition of the ASME OM Code.

It is expected that certain valves will be unable to be tested in place under design-basis conditions using the lessons learned from the Generic Letter 89-10 testing campaigns. The requirements of Article III-3100(c) in Appendix III to the ASME OM Code for a design-basis verification test describe the acceptable methods that can be used if it is impracticable to perform an MOV verification test under design-basis conditions. This ASME article allows the use of analytical techniques. Although the ASME description does not explicitly say so, it allows techniques such as those described by IP 62708 as methods 2, 3 and 4. The table below is for a vintage pressurized-water reactor two-unit site that is similar to Watts Bar. The entries in the Method column correspond to those methods described by IP 62708 as allowed under Generic Letter 89-10.

Table 1. Similar PWR MOV Grouping

Method	Basis Description	Totals
1	Differential Pressure Tested Actual Valve	49
2	PPM	34
3	Grouped with other Valve Tested	33
4	Testing Differential Pressure Data Obtained from Other Nuclear Power Plants	103
		219

A little less than a fourth of the valves could be tested in place in a manner that would now meet ASME OM Code Appendix III using Method 1. Because a new nuclear power plant could perform testing during the startup phase without fuel loaded or inaccessible areas because of radiation, there is the possibility that a few more valves may be testable, but it is expected that the fraction of valves tested using Method 1 will be less than one-third. Method 2 describes a means of verification by computer modeling that the NRC has found acceptable. This method was found to be conservative in that it underestimates the real design-basis capability of an MOV. However, as can be seen on the chart, this method can be used for only 34 out of 219 MOVs at the similar site.
A similar population of 33 MOVs was grouped with a like valve that was tested by a

design-basis simulation method. In this case, the valves were tested without the dynamic conditions present, and then an extrapolation was performed to show how these valves would perform under design-basis conditions using the test results from a like valve. Nearly half of the valves in the similar site's MOV PV program are addressed using Method 4, which is the most uncertain of those found acceptable in the past. The use of Method 4 requires the most significant expenditure of engineering resources to properly justify acceptability.

Besides the population shown in Table 1, a small number of valves were allowed to be excluded from Generic Letter 89-10 programs. ASME OM Code Appendix III describes these as ball, plug, and diaphragm valves. These quarter-turn valves typically have significant margin; therefore, ASME included an allowance to use an engineering evaluation of operating experience to verify design-basis capabilities.

10 CFR Part 52 Plants

The licensing of new nuclear power plants under 10 CFR Part 52 includes the NRC review of the description of the IST and MOV operational programs before issuance of a combined license (COL). The review includes evaluation of the description of the functional design and qualification and IST and MOV testing programs provided in the COL Final Safety Analysis Report, together with information incorporated by reference from the design certification documentation. These descriptions of the IST and MOV operational programs incorporate lessons learned from operating experience and GL 89-10 and 96-05 testing programs. In these program descriptions, the use of ASME Code Case OMN-1 is specified as part of the development of the MOV periodic verification program. The IST and periodic verification programs for other power-operated valves at nuclear power plants licensed under 10 CFR Part 52 incorporate lessons learned from the MOV Programs. The NRC staff review of the description of the IST and MOV operational programs is described in the applicable safety evaluation report for each COL issued to date.

The design certification documentation for new nuclear power plants being licensed under 10 CFR Part 52 requires the application of ASME Standard QME-1-2007, "Qualification of Active Mechanical Equipment Used in Nuclear Power Plants," which the NRC accepted with specific provisions in Revision 3 to RG 1.100, "Seismic Qualification of Electrical and Active Mechanical Equipment and Functional Qualification of Active Mechanical Equipment for Nuclear Power Plants." ASME QME-1-2007 incorporates lessons learned from operating experience and testing programs in provisions for the functional qualification of power-operated valves to be used in nuclear power plants. IP 73758 (dated April 2013) includes inspection guidance for periodic verification of the design-basis capability of safety-related MOVs in new nuclear power plants licensed under 10 CFR Part 52. The NRC staff is planning to conduct inspections of the development of the IST and MOV testing operational programs during construction of the new nuclear power plants licensed under 10 CFR Part 52.

Conclusion

Establishing a new engineering program at a new nuclear power plant is a project with unique challenges. Because of the number of regulations, codes and industry initiatives, establishing an MOV Program could be one of the most complicated of these programs to implement. Mandatory Appendix III to the ASME OM Code contains provisions that make it compatible with past regulatory decisions regarding acceptable practices. Understanding this relationship is very important when bridging the gap between past industry practices for the implementation of an MOV PV program and the present regulatory requirements that must be met.

The NRC's communication about the future requirements in this area provides useful insight to the owner of a nuclear power plant transitioning from the construction phase to the commercial operation phase. Based on these factors, it makes sense from both an economic and safety perspective to use OM Code Appendix III for establishing procedures that implement an MOV PV program. The use of the consensus standard eliminates much of the uncertainty about practices that may or may not be acceptable to regulatory authorities and industry auditors.