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FUNCTIONAL SPECIFICATION FOR ACTIVE VALVE ASSEMBLIES IN SYSTEMS IMPORTANT TO SAFETY IN NUCLEAR POWER PLANTS

A. INTRODUCTION

Criterion 1, "Quality Standards and Records," of Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," requires, in part, that components important to safety be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed. Section III, "Design Control," of Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," to 10 CFR Part 50 requires, in part, that measures be established to ensure that regulatory requirements and the design basis for applicable structures, systems, and components are correctly translated into specifications, drawings, procedures, and instructions. This guide delineates a procedure acceptable to the NRC staff for implementing the Commission's regulations with respect to the detailed specification of information pertinent to defining operating requirements for valve assemblies whose safety-related function is to open, close, or regulate fluid flow in light-water-cooled nuclear power plants. This guide will be applied to active valve assemblies[1] in systems important to safety in light-water-cooled nuclear power plants. The Advisory Committee on Reactor Safeguards has been consulted concerning this guide and has concurred in the regulatory position.

B. DISCUSSION

The rules for construction of nuclear components given in Section III, "Nuclear Power Plant Components," of the ASME Boiler and Pressure Vessel Code[2] (the Code) do not, as indicated in NCA-2142(b) of the 1977 Edition, ensure operability of components in which mechanical motion is required. Since valve assembly[3] operability is necessary to ensure performance of some systems important to safety in nuclear power plants, the American National Standards Institute (ANSI) established a group to provide direction for development of the necessary standards that would provide assurance of the operability of valve assemblies. The first standard published as a result of that effort was ANSI N278.1-1975, "Self-Operated and Power-Operated Safety-Related Valves Functional Specification Standard."[2] This standard requires that a functional specification be prepared that (1) identifies the function of the valve assembly in systems important to safety and (2) delineates the set of conditions important to valve assembly operability.

ANSI N278.1-1975 establishes a consistent approach to specifying the minimum information needed to identify the requirements for function and operability of valve assemblies in systems important to safety. Although the standard has not been extensively used, it is apparent that it would be useful for any Quality Group A, B, C, or D valve assembly in systems important to safety. However, there are questions relative to whether this detailed functional specification is necessary for all (or for certain specified) valve assemblies in systems important to safety. It is anticipated that the breadth of application of this standard might develop gradually with user experience, quality group classification of a particular valve assembly, and valve assembly function within a given plant system. In this context, specifications would most likely evolve from systems analyses and, as such, could be compatible with applicable system safety criteria through appropriate use of limit range, maxima, minima, envelope of important parameters, or generally accepted approaches consistent with industry practice.

It is evident that a thorough process to identify specific valve assemblies that should have functional specifications

[1] As identified in accordance with Section 3.9.3.2 of Regulatory Guide 1.70, Revision 3, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants."

[2] Copies may be obtained from the American Society of Mechanical Engineers, United Engineering Center, 345 East 47th Street, New York, N.Y. 10017.

[3] A valve assembly is composed of the pressure-retaining parts of the valve body, internals, actuator, and functional accessories.

in accordance with this standard would be extremely difficult because of differing plant system characteristics. One desirable goal for initial application of the standard would be to provide a relatively wide spectrum of use covering several Quality Group classifications in order to develop adequate experience to determine a breadth of application for the standard. The NRC staff believes that "active" valve assemblies identified in accordance with Section 3.9.3.2 of Regulatory Guide 1.70, Revision 3, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants," are representative of such a spectrum as well as being very important to plant safety. Therefore, the staff proposes that the initial application of this standard should, as a minimum, encompass active valve assemblies in systems important to safety.

For use with this regulatory guide, the staff intends that active valve assemblies should be identified according to the guidance provided in Subsection II.2, "Pump and Valve Operability Assurance Program," of Section 3.9.3 of the Standard Review Plan. A proposed revision to the Standard Review Plan will also affect previous definitions of the term "active." The staff plans to use the following proposed definition:

> Active valves - valves that, during or following postulated accidents, must perform a mechanical motion in order to shut down the plant, maintain the plant in a safe shutdown condition, or mitigate the consequences of a postulated event. Safety and relief valves provided in accordance with the requirements of ASME Code Section III are specifically included.

It appears that component standards usually concentrate on accomplishing a single goal such as providing pressure boundary integrity even though it may be necessary to address a relatively broad subject matter that could include materials properties, design rules, testing rules, and certification requirements in order to meet the desired goal. An example of this approach is Section III of the Code. Similarly, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," of the Code provides, as one of several goals, rules for inservice testing of valve assemblies, while ANSI N278.1-1975 is directed toward operability of valve assemblies in systems important to safety. It is therefore evident that the complete spectrum from construction[4] through operability to inservice testing of a valve assembly is covered by separate codes and standards even though there is a necessary relationship among them. Hence, the staff believes that (1) there is a need for a set of comprehensive requirements to provide the detailed documentation that serves as the basis for construction, assurance of operability, inservice testing, and applicability of and relationship among the separate standards and (2) there should be both technical compatibility and consistent requirements for similar issues among the documents that make up the set of comprehensive requirements.

Accordingly, those valve assemblies that are classified as ASME Code Class 1, 2, or 3 (Quality Groups A, B, and C, respectively, as identified in Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants") are relatively amenable to meeting a set of comprehensive requirements. One approach to aid in providing this set of requirements would be to include the functional specification requirements of ANSI N278.1-1975 with the Design Specification requirements of NCA-3250 in Section III of the Code. Also, it appears advisable, at least for Class 1, 2, and 3 valve assemblies, that the functional specification recognize and reference certain relationships such as those pertaining to the use or applicability of Section XI and Code Case N-62-2, "Internal and External Valve Items." Although the few active valves in systems important to safety that are classified as Quality Group D in Regulatory Guide 1.26 (those that use the ANSI B31.1.0[2] standard) may not have the desired specific relationship between the functional specification and the document that serves as the basis for construction (the Design Specification of ASME Code Class 1, 2, and 3 valves), there is still a need for a set of comprehensive requirements.

C. REGULATORY POSITION

The requirements delineated in ANSI N278.1-1975 (1) are generally acceptable to the NRC staff for functional specifications of active valve assemblies whose operability must be ensured and (2) provide an adequate basis for complying with those requirements of Criterion 1 of Appendix A and Section III of Appendix B to 10 CFR Part 50 relating to the correct translation into specifications, as supplemented or modified by the following:

1. Applicability and Relationship With Other Standards

a. The scope of ANSI N278.1-1975, as stated in Section 1 of the standard, should be supplemented to include active manually operated valve assemblies in systems important to safety.[5]

b. The phrase design specification relationship, used in Section 2 of the standard to indicate an interrelationship with other codes and standards, should be broadly interpreted to include a document that contains sufficient detail to serve as a "complete basis for construction" and may, as appropriate, be called an equipment specification, procurement specification, or some similar term that includes the Design Specification required by the ASME Code. However, when valve operability is a requirement, the functional specification required by N278.1-1975 should be provided either as part of, or concurrent with, the controlling document that serves as the "complete basis for construction." For ASME Code Class 1, 2, and 3 valves, the "Valve

[4] As defined in Section III of the Code, "construction" is an all-inclusive term comprising materials, design, fabrication, examination, testing, inspection, and certification required in the manufacture and installation of items.

[5] Manually operated valves are those that are operated physically by an operator. Power-operated valves may be manually controlled by an operator or automatically controlled.

Design Specification" identified in Section 2 of N278.1-1975 should be that required by NCA-3250, "Provision of Design Specifications," of Subsection NCA, "General Requirements," of Section III of the Code.

c. The valve functional specification should meet the following requirements in the ASME Code:

(1) It should be uniquely identified and referenced in the Design Specification in accordance with NCA-3252(a) (6) of Section III of the Code.

(2) It should reference the applicable Design Specification to permit identification of both documents.

(3) It should meet those portions of the filing requirements of NCA-3256 that call for a copy to be filed at the location of the installation and made available to the enforcement authorities having jurisdiction over the plant installation.

d. The functional specification prepared in accordance with N278.1-1975 for valve assemblies classified as Quality Group D in Regulatory Guide 1.26 should be cross-referenced with the document that serves as a "complete basis for construction" (see Regulatory Position 1.b of this guide).

e. When the Valve Design Specification for ASME Code Class 1, 2, and 3 valve assemblies requires use of ASME Code Cases such as N-62-2, the functional specification should consider this aspect, and usage should be consistent with Regulatory Guide 1.84, "Design and Fabrication Code Case Acceptability, ASME Section III Division 1," and Regulatory Guide 1.85, "Materials Code Case Acceptability, ASME Section III Division 1."

2. Specific Considerations

a. Section 3.1, "Valve Application Characteristics," should be supplemented by the following:

(1) "Manually operated valves" (see Regulatory Position 1.a) as a separate item to the listing.

(2) The functional specification should identify the relationship or correspondence between the "application characteristics" of the subject standard and the Valve Categories A, B, C, and D in IWV-2200 of Subsection IWV, "Inservice Testing of Valves in Nuclear Power Plants," of Section XI of the Code.

b. Section 3.2, "Structural Requirements," should be supplemented by the following:

(1) The interdependence and number of cycles, if applicable, of time, temperatures, pressures, and dynamic loading resulting from plant transients.

(2) The time relationship between applied seismic loadings and other concurrent loadings.

(3) The frequency response spectra for the operating basis earthquake and the safe shutdown earthquake as well as other potential forcing functions such as those from attached piping, pumps, restraints, or other equipment as applied to valves.

(4) The maximum static and dynamic differential pressure (considering all plant operating conditions) that exists across the closure device, including potential water hammer, for which valve assembly operation is to be ensured.

c. Section 3.3, "Operational Requirements," should be supplemented by the following:

(1) The first paragraph should be supplemented to require that the desired position of the valve assembly in the event of loss of actuator power be specified, e.g., fail open, fail closed, fail as is.

(2) In item e of Section 3.3.1, "Operating Conditions," the phrase "Normal and Abnormal Plant Operation" should be interpreted to include the events covered by plant "Operational Modes (Condition),"[6] and by the Transient and Accident Classification of Chapter 15, "Accident Analysis," of Regulatory Guide 1.70. The functional specification should state whether the specific valve assembly safety function applies to events defined in the plant Operational Modes (Condition) or in the Transient and Accident Classification. The specification should also indicate whether the actual valve assembly operation (open, close, or regulate fluid flow) occurs during or after the specified event.

(3) Instead of item e of 3.3.2, the following should be used: "e. motor power and duty requirements, including stall current."

(4) Instead of Section 3.3.2.1, "Electrical Power for Valve Actuators and Control Elements," the following should be used:

> "Electrical power shall be identified as AC (single phase or three phase) or DC. Applicable voltage and frequency operating ranges shall be specified."

(5) In Section 3.3.3, "Environmental Conditions," the terms "normal" and "abnormal" environmental conditions should be interpreted to mean the environmental conditions that will exist as a result of specified plant conditions. The term "environmental conditions" should be interpreted to include both the environment external to the valve assembly and that of the controlled fluid inside the valve assembly.

d. Section 3.4, "Seat Leakage Limits," should be supplemented, as applicable, by the following:

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[6] As defined in the Standard Technical Specifications for Westinghouse, Combustion Engineering, and Babcock and Wilcox Pressurized Water Reactors. The Standard Technical Specification for General Electric Boiling Water Reactors uses the word "Condition" rather than "Modes."

(1) The leakage limits identified in paragraph b of this section should include identification of fluid, temperature, and differential pressure for which the limit applies.

(2) If valve assembly function requires a limit on overall leakage (e.g., leakage in addition to that of the main seat, such as stem packing and flange), such overall leakage limit should be specified in this section.

D. IMPLEMENTATION

Except in those cases in which an applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the method described in this guide will be used in the evaluation of (1) construction permit applications, (2) standard reference system preliminary design applications (PDA) or Type-2 final design applications (FDA-2), and (3) licenses to manufacture that are docketed after July 1, 1981, except those portions of a construction permit application that:

a. Reference an approved standard reference system preliminary or final design (PDA or FDA), or an application for approval of such design.

b. Reference an approved standard duplicate plant preliminary or final design (PDDA or FDDA).

c. Reference parts of a base plant design qualified and approved for replication.

d. Reference a plant design approved or under review for approval for manufacture under a Manufacturing License.

This guide will also be used as the basis for evaluating new systems important to safety and replacement valve units ordered after July 1, 1981, for plants that are operating or under construction.

VALUE/IMPACT STATEMENT

Background

Valve assemblies (i.e., pressure-retaining portions of the valve, its internals, its actuator, and attached functional accessories) installed in nuclear power plants have experienced numerous malfunctions in the past. Licensee Event Reports (LERs) show that these malfunctions occur at a frequency that is cause for concern. Approximately 3440 LERs were received over the period from 1969 to July 1, 1980. The origin of valve assembly malfunctions varies widely; however, one of the major problems that was recognized at the valve operability meeting held with industry on November 20, 1972, is that equipment specifications are deficient in defining the application and the environmental and loading conditions for valve assemblies in nuclear power plants. As a result of the 1972 meeting, effort on developing valve operability standards was initiated under the auspices of the American National Standards Institute Committee N45. Subsequently, this standards development responsibility was transferred to B16 Subcommittee H. The first of these standards to be published was ANSI N278.1-1975, "Self-Operated and Power-Operated Safety-Related Valves Functional Specification Standard." The regulatory guide endorses that standard with suggested supplemental guidance.

Value

Although ANSI N278.1-1975 provides requirements important for adequate definition of valve assembly application and operating conditions, the standard, by itself, will not provide complete assurance of valve assembly operability. It is anticipated that the most important contributions from ANSI N278.1-1975 will be realized when subsequent standards, which are currently being developed to address such topics as valve assembly functional qualification and production testing, are in place to provide a set of requirements covering various aspects of valve assembly operability. However, endorsement of ANSI N278.1-1975 as supplemented by the regulatory position of the guide will provide a uniform basis and approach for specifying the functional requirements and operability considerations for any particular valve assembly that has a safety-related function.

The guide also emphasizes the need for a set of comprehensive requirements covering construction, operability, and inservice testing of active valve assemblies in systems important to safety.

Impact

The impact of this regulatory guide is expected to be rather limited because licensees are committed to a program to demonstrate valve assembly operability in accordance with Sections 3.9.3.2 and 3.9.6 of Regulatory Guide 1.70, Revision 3, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants." Additionally, all applicants are cognizant of NRC staff positions on valve assembly operability as identified in Regulatory Guide 1.48, "Design Limits and Loading Combinations for Seismic Category I Fluid System Components," and Sections 3.9.3 and 3.9.6 of the Standard Review Plan. It is therefore evident that the proposed guide does not introduce a new or additional safety subject.

However, ANSI N278.1-1975 was published approximately 5 years ago, and there are indications that it has not been extensively used. It appears that the question of which valve assemblies should meet the standard determines the potential impact. Since the staff recommends initial application of the standard to active valve assemblies, which are addressed in Section 3.9.3.2 of Regulatory Guide 1.70, the impact should be restricted to situations where specific deficiencies exist in individual applicant equipment specifications.

A thorough process to identify additional active valve assemblies in systems important to safety that should have functional specifications in accordance with ANSI N278.1-1975 would require extensive staff time because differing plant system characteristics make it difficult to establish generic groups. The term "safety-related" affects this process because Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants," refers to Quality Groups A, B, C, and D for safety-related components. However, it may not be desirable or necessary to have all the detail required in the standard for all valve assemblies that may be classified in accordance with Regulatory Guide 1.26. Another potential area of concern relates primarily to purchasing valve assemblies by a licensee or its agent. Application of the specification requirements of this standard to preselected valve assemblies could adversely affect current purchasing procedures depending on whether purchasing is done individually or in groups of valve assemblies.

Recommendations

The staff intends to apply the guide initially to active valve assemblies. The guide would be acceptable for use with all valve assemblies in systems important to safety, but application to other than active valves should be at the discretion of the licensee because of the potential impact on current procedures. Experience acquired through use of the standard with active valve assemblies will provide guidance for wider application in the future.

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