UNITED STATES
NUCLEAR REGULATORY COMMISSION
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ENCLOSURE

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

INSERVICE PRESSURE TEST PROGRAM

TENNESSEE VALLEY AUTHORITY

SEQUOYAH NUCLEAR PLANT, UNITS 1 AND 2

DOCKET NOS. 50-327 AND 50-328

1.0 INTRODUCTION

Section 50.55a, "Codes and Standards," of 10 CFR Part 50 requires, in part, that safety-related components meet the requirements of Section XI of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (hereafter called "the Code"). In order to meet the requirements of this regulation, the Tennessee Valley Authority (TVA) has submitted to the NRC its first ten-year interval Inservice System Pressure Test (ISPT) program for the Sequoyah Nuclear Plant, Units 1 and 2 (SQN1 and SQN2). TVA's SQN1 and SQN2 ISPT program is prepared to meet the requirements of the 1977 Edition, Summer 1978 Addenda (77S78) of Section XI of the Code. This is the Code of record for SQN1 and SQN2.

Regulation 10 CFR 50.55a(g)(4) requires that Class 1, 2, and 3 components meet the requirements of the applicable edition and addenda of the code as defined by the regulations. Regulation 10 CFR 50.55a(g)(4)(iv) permits the use of portions of subsequent editions and addenda to the code for system pressure test requirements subject to the limitations of 10 CFR 50.55a(b) and subject to Commission approval.

Regulations 10 CFR 50.55a(a)(3)(i) and (ii) requires that proposed alternatives to 10 CFR 50.55a requirements may be used when the applicant has demonstrated that (i) the proposed alternatives would provide an acceptable level of quality and safety, or (ii) compliance with the specified requirements of this section would result in hardship or unusual difficulties without a compensating increase in the level of quality and safety.

The ISPT Program was originally submitted to NRC by TVA in its letter dated August 18, 1983. Revisions to the program were submitted in TVA letters dated March 10, 1986; September 3, 1987; January 11, 1988; and January 31, 1989. In its ISPT Program for SQN1 and SQN2, TVA also requested relief from the hydrostatic test pressure requirements of IWD-5223(a) of Section XI of the 1977 Edition, Summer 1978 Addenda of the Code for certain ASME Class 3 or equivalent piping and components. This is request for relief ISPT-1. The request for relief ISPT-1 is in TVA letters dated January 11, 1988 and January 31, 1989.

The staff issued its evaluation of the ISPT program in its letter dated December 26, 1989. In that letter, the Relief Request ISPT-1 was granted and the program was approved with one exception: the use of portions of certain articles in Section XI of a later Code than the Code of record. The later Code is the 1980 Edition, Winter 1981 Addenda (80W81) of the Code. In its letter, the staff stated that TVA had not justified using particular footnotes and subparagraphs from Section XI of the 80W81 Code in terms of 10 CFR 50.55a(a)(3) and 50.55a(g) for each instance. The staff requested further justification for the use of portions of the 80W81 Code.

TVA provided further justification for the use of portions of the 80W81 Code in its letter dated April 5, 1990. The staff has reviewed this further justification and its evaluation for each proposed use of a portion of the 80W81 Code is given in Sections 2.1 to 2.7 below.

2.0 EVALUATION

TVA has proposed to use definitions and footnotes from Section XI of the 80W81 Code for the following specific paragraphs in the 77S78 Code:

1. System Hydrostatic Test Boundary (IWA-5224),

2. Definition of Normal Reactor Operation (Footnote 4 in IWB-1000),

3. System Leakage Test Boundary (IWA-5221 and Footnote 1 for Examination Category B-P in Table IWD-2500-1),

4. System Hydrostatic Test Pressure for Class 2 and 3 (equivalent) Components (IWC-5222(a) and IWD-5223(a)),

5. Maximum Allowable Hydrostatic Test Pressure (IWA-5265 (b)),

6. Hydrostatic Test Pressure for Class 1 (equivalent) Systems (IWB-5222 (a) and (b)), and

7. Open-ended System and Components (Footnote 1 in IWC-5000).

In its July 12, 1990 submittal, TVA stated that the use of specific portions of the 80W81 Code for SQN's ISPT program does not constitute an alternative to the above listed paragraphs. Instead, portions of articles from the 80W81 Code are used to define terms in SQN's program (i.e., code of record, the 77S78 Code) by using generally accepted and more practical definitions of the later code in cases where there are no definitions provided in the 77S78 Code. It explained that (1) this approach is consistent with the principle of owner responsibility outlined in paragraph IWA-1400, (2) Paragraph IWA-7000 allows the use of all, or portions of, the requirements of later edition and addenda provided the differences are reconciled with the original requirements, and (3) the use of specific portions of later editions and addenda is also allowed through Code Interpretation XI-1-86-38R.

The evaluations for each of the above listed requirements in the 77S78 Code are as follows:

2.1 System Hydrostatic Test Boundary (IWA-5224)

TVA proposed that the identification of hydrostatic test pressurization boundaries shall be in accordance with Paragraph IWA-5224 of the 80W81 Code.

77S78 Code

The 77S78 Code does not specifically address this subject. However, the 77S78 Code states the following in IWA-5211:

> IWA-5211 Test Description - The pressure retaining components within each system boundary shall be subject to system pressure tests under which conditions visual examination, VT2, is performed in accordance with IWA-5240 to detect leakages. The required system pressure tests and examinations, as referenced in Table IWA-5210-1, may be conducted in conjunction with one or more of the following system tests or operations:
>
> (a) a system leakage test ...
>
> (b) a system hydrostatic test ...
>
> (c) a system inservice test ...
>
> (d) a system hydrostatic test ...
>
> (e) a system pneumatic test ...

Proposed 80W81 Code

IWA-5220 Test Pressurization Boundaries[1]

IWA-5224 System Hydrostatic Test Boundary

(a) The boundary subject to test pressurization during a system hydrostatic test [IWA-5211(d)] shall be defined by the system boundary (or each portion of the boundary) within which the components have the same minimum required classification and are designed to the same primary pressure rating as governed by the system function and the internal fluid operating conditions, respectively.

(b) Systems which share safety functions for different modes of plant operation, and within which the component classifications differ, shall be subject to separate system pressure tests of each portion of the system boundary having the same minimum required component classifications.

(c) Systems designed to operate at different pressures under several modes of plant operation or post-accident conditions shall be subject to a system pressure test within the test boundary defined by the operating mode with the higher pressure.

[1] The boundary limits are generally defined by the location of the safety class interface valves within the system.

(d) Where the respective system primary pressure rating on the suction and discharge side of system pumps differ, the system test boundary shall be divided into two separate boundaries (such as suction side and discharge side test boundaries). In the case of positive displacement pumps, the boundary interface shall be the first shutoff valve on the discharge side of the pump.

Staff Evaluation

The 77S78 Code does not specify how a large complex piping system may be divided to pressure test portions of the system. The defining of test pressurization boundaries in a specified, systematic framework as to classification, function, and fluid conditions that is widely used in the industry will provide a level of quality and safety equal to or better than the present unspecified, arbitrary manner of defining pressure test boundaries. All related requirements of the 77S78 Code are met as this definition does not change the test conditions required. The staff concludes that the use of IWA-5224 of the 80W81 Code to identify hydrostatic test pressurization boundaries is acceptable.

2.2 Definition of Normal Reactor Operation (footnote 4 in IWB-1000)

TVA proposed that "normal reactor operations" be defined by Footnote 4 in IWA-1000 of the 80W81 Code.

77S78 Code

In the 77S78 Code, this definition is not used in conjunction with Class 1 components. The definition is present in the Class 2 portion of the 77S78 Code in Footnote 2 of IWC-1220(a). It is used with Class 2 components to define normal reactor operations for the purpose of defining which components are subject to functional pressure testing.

Proposed 80W81 Code

Footnote 4 in IWB-1000 states that normal conditions include operating conditions during reactor startup, operation at power, hot standby, and reactor cooldown to cold shutdown conditions. Test conditions are excluded.

Staff Evaluation

This proposed definition defines what conditions must be considered in applying the provisions of IWA-5224 discussed in Section 2.1 above. This definition is a necessary support of the first alternative in that it defines the valve positions for Class 1 systems, and the corresponding pressures for portions of these systems under various plant conditions. This proposed definition, in conjunction with the previous proposal discussed in Section 2.1, will provide an acceptable level of quality and safety. The staff concludes that the use of Footnote 4 in IWB-1000 of the 80W81 Code to define "normal reactor operations" is acceptable.

2.3 System Leakage Test Boundary (IWA-5521 and footnote 1 for Examination Category B-P in Table IWB-2500-1)

TVA proposed to define the pressure retaining boundary for ASME Class 1 (equivalent) systems during system leakage tests by IWA-5221 and Footnote 1 for the Examination Category B-P in Table IWB-2500-1 of the 80W81 Code.

77S78 Code

The 77S78 Code did not specifically address this subject. However, the Code states the following in IWA-5211:

IWA-5211 Test Description:

The pressure retaining components within each system boundary shall be subject to system pressure tests under which conditions visual examination, VT-2, is performed in accordance with IWA-5240 to detect leakages. The required system pressure tests and examinations, as referenced in Table IWA-5210-1, may be conducted in conjunction with one or more of the following system tests or operations:

(a). . ., etc.

Table IWA-5210-1, for Class 1 c[illegible]on[illegible]ts, the examination category is specified to be Table IWB-2500, Category b[illegible]ootnote 1 of this table:

(1) Entire pressure retaining boundary of the reactor coolant system is subject to system pressure test in accordance with IWA-5000 with the exceptions specified in IWA-5214 when pressure tests are conducted for repaired, replaced or altered components.

Proposed 80W81 Code

IWA-5221 System Leakage Test Boundary:

The boundary subject to test pressurization during a system leakage test [IWA-5211(a)] shall extend to the pressure retaining components within the system boundary containing pressurized reactor coolant under the plant mode of normal reactor startup.

Table IWB-2500-1, Footnote 1 for Examination Category B-P:

(1) The pressure retaining boundary during the system leakage test shall correspond to the reactor coolant system boundary with all valves in the normal position which is required for normal reactor operation startup.

The VT-2 examination shall, however, extend to include the second closed valve at the boundary extremity.

Staff Evaluation

The 77S78 Code requires that the entire pressure retaining boundary of the reactor coolant system to be subject to an IWA-5000 system pressure test when system pressure tests are conducted except after repairs, etc. There are

numerous situations where the normal positions of the system valves are such that application of (or direct proof of) the required pressure in one test to all components of the reactor coolant pressure boundary could not be obtained. This requirement would require the use of special procedures to place valves in abnormal positions, and to disassemble check valves in series between class boundary valves and the pressure source in order to achieve compliance. The excessive interference with system integrity as the result of recovering from any such special procedures would render the system pressure test invalid. This proposed definition provides an acceptable level of safety and quality and all of the required tests would be accomplished. The staff concludes that the use of IWA-5221 and Footnote 1 for the Examination Category B-P in Table IWB-2500-1 in the 80W81 Code to define the pressure retaining boundary for ASME Class 1 (equivalent) systems during system leakage tests is acceptable.

2.4 System Hydrostatic Test Pressure for Class 2 and 3 (equivalent) Components (IWC-5222(a) and IWD-5223(a))

TVA has proposed to use IWC-5222(a) and IWD-5223(a) of the 80W81 Code to determine the system hydrostatic test pressure for Class 2 and 3 (equivalent) components.

77S78 Code

IWC-5222 System Hydrostatic Test:

(a) The system hydrostatic test pressure shall be at least 1.10 times the system pressure P_{sv} for systems with Design Temperature of 200°F (i.e., 93°C) or less, and at least 1.25 times the system pressure P_{sv} for systems with Design Temperature above 200°F (i.e, 93°C). The system pressure P_{sv} shall be the lowest pressure setting among the number of safety or relief valves provided for overpressure protection within the boundary of the system to be tested.

Proposed 80W81 Code

IWC-5222 System Hydrostatic Test:

(a) The system hydrostatic test pressure shall be at least 1.10 times the system pressure P_{sv} for systems with Design Temperature of 200°F (93°C) or less, and at least 1.25 times the system pressure P_{sv} for systems with Design Temperature above 200°F (93°C). The system pressure P_{sv} shall be the lowest pressure setting among the number of safety or relief valves provided for overpressure protection within the boundary of the system to be tested. For systems (or portions of systems) not provided with safety or relief valves, the system design pressure P_d shall be substituted for P_{sv}.

Staff Evaluation

This proposed use of the 80W81 Code is a necessary support of the proposed definition discussed in Section 2.1 above. It defines the pressure for portions of the reactor coolant pressure boundary when there are no safety or relief valves in a given portion of a system subject to pressure tests. The

proposed paragraphs from the 80W81 Code account for subsystems which do not have a pressure relief valve upon which to base the test pressure of the subsystem. The staff concludes that the use of 80W81 Code paragraphs IWC-5222(a) and IWD-5223(a) to allow the use of design pressure in place of the lowest relief valve set pressure for Class 2 and 2 systems is acceptable.

2.5 Maximum Allowable Hydrostatic Test Pressure (IWA-5265(b))

TVA proposed the use of IWA-5265(b) of the 80W81 Code to establish the maximum possible hydrostatic test pressure because there is no guidance in the 77S78 Code.

77S78 Code

The 77S78 Code did not address the increase in hydrostatic pressure due to static head. IWA-5212(a) requires that the test conditions specified in IWA-5000 shall be met. These articles simply define the required test pressures. Guidance concerning practical limitations on the actual test pressure are not given.

Proposed 80W81 Code

IWA-5265 Location

(a) . . .

(b) When testing a group of components or a multi-component system, the pressure measuring instrument or sensor shall be connected to any point within the pressure boundary of the components or system such that the imposed pressure on any component, including static head, will not exceed 106 percent of the specified test pressure for the system.

Staff Evaluation

The use of the 80W81 Code addresses the increase in pressure due to the static head which is not addressed in the 77S78 Code. Where low design pressure systems have significant elevation differences, the use of the 106 percent limit on the test pressure at the low point in a system can result in a pressure at the highest elevation point being less than the specified test pressure. This is acceptable based upon the following reasons.

(a) The systems' piping design pressures (i.e., the system safety and relief valve pressure settings and the specified test pressures) were based on anticipated accident conditions at the lowest elevation point and took into consideration the expected elevation ranges of the systems.

(b) Where system designs did not specifically include an assumed elevation change, the piping design pressure included sufficient margin to accommodate the actual elevation changes.

(c) During an accident, the elevation change would be present and the actual pressure experienced at the highest elevation would be less than that seen at the lowest elevation by a factor of the static head difference. This would be the same pressure difference seen during the system hydrostatic pressure test.

Addressing the effect of hydrostatic head pressure in pressure systems, particularly in low pressure systems, is a basic engineering principle and is required by the piping codes. Considering hydrostatic head pressure in determining hydrostatic test pressure will provide a level of quality and safety equal to or better than the present 77S78 Code. Piping designs of the vintage at SQN did not consider hydrostatic pressure testing and some instruments and components have pressure limits only equal to the operating pressure. The hydrostatic test pressure would overpressurize these instruments and components, possibly damaging them. All related requirements other than the modification of the hydrostatic test pressure of the respective editions of the Code are met as this definition does not change any other test condition required by either edition. Accordingly, this proposed alternative requirement will provide an acceptable level of quality and safety. The staff concludes that the use of IWA-5265(b) of the 80W81 Code to establish the maximum possible hydrostatic test pressure is acceptable.

2.6 Hydrostatic Test Pressure for Class 1 (equivalent) Systems (IWB-5222 (a) and (b), and Table IWB-5220-1, Footnote 2)

TVA proposed that the test pressure for Class I (equivalent) systems be determined by IWB-5222(a), IWB-5222(b), and Footnote 2 of Table IWB-5220-1 of the 80W81 Code.

77S78 Code

IWB-5222 System Hydrostatic Test:

(a) The system hydrostatic test shall be conducted at a test pressure of 1.10 times the system nominal operating pressure, P_o, that corresponds with 100 percent rated reactor power except when the test is conducted at temperatures above 100°F (38°C) to meet the requirements of IWB-5230.

(b) The system hydrostatic test may be conducted at the reduced test pressure of Table IWB-5220-1 to meet the requirements of IWB-5230.

Proposed 80W81 Code

IWB-5222 System Hydrostatic Test:

(a) The system hydrostatic test may be conducted at any test pressure specified in Table IWB-5220-1 corresponding to the selected test temperature, provided the requirements of IWB-5230 are met for all ferritic steel components within the boundary of the system (or portion of system) subject to the test pressure (see IWA-5245).

(b) Whenever a system hydrostatic test is conducted in which the reactor vessel contains nuclear fuel and the vessel is within the test boundary, the test pressure shall not exceed the limiting conditions specified in the plant Technical Specifications.

Table IWB-5220-1, Test Pressure Footnote 2:

2) Linear interpolation at intermediate test temperatures is permissible.

Staff Evaluation

The 80W81 Code allows for the interpolation between the values for temperature and pressure in Table IWB-5220-1. Through interpolation, the system hydrostatic test may be conducted at a lower temperature and corresponding higher pressure than that allowed in the 77S78 code. The 77S78 Code provides for test temperatures to be conducted in steps of 100°F with test pressure reduced two percent per step. This alternative will provide an equivalent or higher level of safety and quality in that the pressure test conducted in accordance with the 80W81 Code will more likely detect flaws of fracture significance if present because of the lower temperature and higher pressure. Accordingly, an acceptable level of quality and safety will be provided by this proposed use of the 80W81 Code. The staff concludes that the use of IWB-5222(a), IWB-5222(b), and Footnote 2 of Table IWB-5220-1 of the 80W81 Code to determine the test pressure for Class 1 equivalent systems is acceptable.

2.7 Open-ended Systems and Components (Footnote 1 in IWC-5000)

TVA proposed to define "open-ended systems" by Footnote 1 in Note d of Paragraph IWC-5222 of the 80W81 Code.

77S78 Code

IWC-5222 System Hydrostatic Test:

(a) ...

(b) ...

(c) For the purpose of the test, open ended portions of a suction or drain line from a storage tank extending to the first shutoff valve shall be considered as an extension of the storage tank. For open ended portions of discharge lines in nonclosed systems (such as containment spray header), any test that demonstrates unimpaired flow shall be acceptable in lieu of a system pressure test.

Proposed 80W81 Code

(d) For open ended[1] portions of discharge lines beyond the last shutoff valve in nonclosed systems (e.g., containment spray header), demonstration of an open flow path test shall be performed in lieu of the system hydrostatic test.

[1]Open ended signifies free discharges that dissipate the transported fluid directly to the open atmosphere (i.e., inside or outside containment structure). As an example, piping terminating in spray devices is considered open ended.

Staff Evaluation

TVA's proposed definition is prompted by the conditions in their plant where the last valve in open-ended systems is administratively held and/or locked open either by mechanical means or by removal of power from the valve motors. These valves are required to be in the locked oper position by NRC 10 CFR 50 Appendix A requirements. To require these valves to become operational to perform these tests would cause a degradation in the safety and quality of the affected systems in that there is always the possibility that a valve could remain operable and be closed, or left closed after pressure testing because of 77S78 Code requirements. Acceptance of the proposed definition would provide an acceptable level of quality and safety. The staff concludes that the use of Footnote 1 to Note d of Paragraph IWC-5222 of the 80W81 Code to defined "open-ended systems" is acceptable.

3.0 CONCLUSIONS

Based on the review described above, the staff concludes that the use of the portions of the 80W81 Code listed in Sections 2.1 to 2.7 are acceptable. The portions of the 80W81 Code being used by TVA in the ISPT Program are in accordance with 10 CFR 50.55a(g)(4)(iii); contain no other related code requirements affecting their use in this ISPT Program; and provide an acceptable level of quality and safety at SQN. The use of these portions of the 80W81 Code is to clarify the Code of record and not to provide alternative requirements to that given in the Code of record. Therefore, relief from the Code of record is not needed to allow the use of these portions of the 80W81 Code. The staff also concludes that the program meets the code requirements authorized by law and will not endanger life or property, or the common defense and security and is otherwise in the public interest.

Any additional program changes such as revisions or additional requests for relief should be submitted for staff review and should not be implemented prior to review and approval by the staff.

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Dated: