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SPRAY POND PIPING MADE FROM FIBERGLASS-REINFORCED THERMOSETTING RESIN

A. INTRODUCTION

General Design 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 that structures, systems, and components important to safety be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed. Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," to 10 CFR Part 50 requires that measures be established to ensure materials control and control of special processes such as resin molding.

Section 50.55a, "Codes and Standards," of 10 CFR Part 50 requires that design, fabrication, installation, testing, or inspection of the specified system or component be in accordance with generally recognized codes and standards. Footnote 6 to § 50.55a states that the use of specific Code Cases may be authorized by the Commission upon request pursuant to § 50.55a (a)(2)(ii), which requires that proposed alternatives to the described requirements or portions thereof provide an acceptable level of quality and safety.

This guide describes a method acceptable to the NRC staff for implementing these requirements with regard to the design, fabrication, and testing of fiberglass-reinforced thermosetting resin (RTR) piping for spray pond applications. This guide applies to light-water-cooled and gas-cooled reactors. The Advisory Committee on Reactor Safeguards has been consulted concerning this guide and has concurred in the regulatory position.

*Lines indicate substantive changes from previous issue.

B. DISCUSSION

The ASME Boiler and Pressure Vessel Committee publishes a document entitled "Code Cases."[1] Generally, a Code Case explains the intent of rules in the ASME's Boiler and Pressure Vessel Code (the Code)[1] or provides for alternative requirements under special circumstances. Most Code Cases are eventually superseded by revisions to the Code and then are annulled by action of the ASME Council. Code Case N-155-1 (1792-1), referred to in this guide, is limited to Section III, Division 1, of the Code and is oriented toward design and fabrication of RTR piping. The Code Case does not prescribe a lower temperature limit, primarily because the American Society for Testing and Materials (ASTM) specifications do not contain a lower temperature limit, but RTR piping systems would normally be qualified for the intended service temperature condition.

It is planned that after Revision 2 of this guide is issued, the acceptability of future minor revisions to Code Case N-155 (1792) will be noted in Regulatory Guide 1.84, "Design and Fabrication Code Case Acceptability--ASME Section III Division 1." Major revisions to the Code Case will, however, result in a revision to this guide (1.72). Filament-wound structures have mechanical properties superior to fiberglass-filled laminates, and they are considered more desirable when intended for safety-related pressure components.

The Code Case obtains an allowable design stress from the hydrostatic design basis (HDB) strength as derived from either Procedure A

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

(cyclic) or Procedure B (static) of Specification ASTM D-2992, "Standard Method for Obtaining Hydrostatic Design Basis for Reinforced Thermosetting Resin Pipe and Fittings Procedures."[2] These procedures are intended to be used for general applications for Class 3 piping. For safety-related systems such as spray pond piping, a design factor of 6 is desired. Under some conditions, the qualification procedures may not result in a design factor of 6, and it is therefore necessary to perform an additional short-time cyclic and burst test to ensure that the desired design factor is obtained.

Failure is defined in ASTM D-2992 as either leaking, weeping, or bursting. Whichever of these occurs first defines failure.

General guidance for loading combinations relative to design limits for Class 3 piping may be found in Regulatory Guide 1.48, "Design Limits and Loading Combinations for Seismic Category I Fluid System Components." However, specific equations and limits from Code Case N-155 are not addressed in Regulatory Guide 1.48.

Normal commercial practice provides a weather-resistant coating to the exterior of RTR piping that will be exposed to weather conditions. Experience has shown that this practice provides adequate protection for the service considered in this guide. Distribution of resin is generally such that more resin is applied to the exterior of the pipe than to the interior, and part of the outer resin may have special properties to protect the underlying material from deleterious effects from sources such as ultraviolet radiation and weather. RTR piping has been used to distribute cooling water to nozzles in spray ponds. It is desirable to provide weather protection to such piping. However, the omission of an exterior protective coating would be acceptable for piping installed in covered but accessible trenches, provided the inservice inspection frequency is increased to require visual inspection for leaks of all such piping at least once every year.

Limited information is available on the effects of radiation on laminates (fiberglass and resin materials bonded together). However, short-time exposure tests have been made, and they showed no appreciable change in the tensile strength of the pipe test piece. For cooling water application, there appears little opportunity for radiation exposure, and the piping should be acceptable without additional testing. This guide does not address the acceptability of RTR piping for other systems. If RTR piping is considered for systems such as liquid radwaste systems where it may be exposed to long-term radiation, the laminates should be tested and qualified for the intended environment. Use of RTR piping for systems other than spray ponds would be considered on a case-by-case basis only.

Metal pressure vessels and closed systems are provided with pressure relief valves or devices for protection against overpressure. Where RTR piping systems are used for open-ended systems such as the cooling water distribution for spray ponds, the relief valve provisions may be omitted. However, it is desirable to protect the integrity of the piping by other means such as selection of spray nozzles to prevent their clogging or selection of pump delivery characteristics to prevent the piping pressure from exceeding the design pressure for the piping.

Industry experience with fiberglass-reinforced resin pressure vessels and piping extends over 20 to 23 years of service experience during which the performance of fiberglass-reinforced resin piping has been satisfactory. Industry claims that the life expectancy for properly installed piping is at least 40 years, the normal design life for presently planned nuclear power plants. Since RTR piping applications will be limited to temperatures less than 65°C (149°F), except for occasional transients to 100°C (212°F), there is little need for applying insulation to such piping. Hence it should be left bare to make the piping readily accessible for inspection.

Since the NRC staff is allowing only 10^5 cycles for qualification testing of the piping, special precautions should be taken to ensure that the design assumptions are not exceeded.

The preoperational testing program should include tests of the installed piping to ensure absence of vibration due to weather conditions or water flow that may fatigue the piping beyond values assumed in the design of the system.

Inservice inspection requirements should be similar to those in ASME Code, Section XI,[1] for Class 3 components.[3] The inspection for Code Class 3 components involves a visual inspection of the piping for evidence of unanticipated leakage and structural distress. Since the support of RTR piping may be sensitive, each inservice inspection of such piping should include all its supports.

C. REGULATORY POSITION

Safety-related spray pond piping components made from fiberglass-reinforced thermosetting

[2] Copies may be obtained from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.

[3] Components classified as NRC Quality Group A, B, and C should conform to the requirements of the ASME Boiler and Pressure Vessel Code for Class 3 components (NRC Regulatory Guide 1.26, "Quality Group Classification and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants").

resin should comply with ASME Code Case N-155-1 (1792-1) supplemented by the following:

1. The design temperature for spray pond piping should be 100°C (212°F).

2. The allowable design stress should be the value obtained from the minimum HDB (hydrostatic design basis) in Table 3611-1 of Code Case N-155-1 (Procedure A or B) or the value determined as one-sixth of the stress obtained from a short-time burst test for the pipe being qualified, whichever is lower. The short-time burst strength should be determined by bursting the pipe (ASTM D-1599-74 using free-end mounting) after it has been exposed to 10^5 pressure cycles from atmospheric to design pressure.

3. The value of "K" in equation 9 of paragraph 3652.2 should be limited to 1.2 unless it can be demonstrated that with the use of a large value of K the functional capability of the system will not be impaired during upset and emergency conditions.

4. The following items should be identified:

a. The physical location of the system in relation to other safety-related systems,

b. The design and service loads, and

c. The value of "B" to be used in equation 1 of paragraph 3641.1, together with justification for its selection.

5. Pressure-relief devices may be omitted for piping systems that are open-ended and for which the system pressure is limited by other means (such as nonclogging spray nozzles and self-limiting pump characteristics) to design pressure.

6. RTR piping should be uninsulated or uncovered and installed under conditions that make it readily accessible for inspection.

7. Preoperational and inservice inspections should be as follows:

a. During the preoperational testing period, tests should be made to verify that the piping is free of vibration induced by weather conditions or water flow that could fatigue the piping prematurely.

b. Fiberglass-reinforced piping components should be inspected in accordance with ASME Code, Section XI, for Code Class 3 components.[3] In addition, all pipe supports should be inspected.

c. Inspection frequency for piping should be increased to once annually if an exterior weather-resistant coating is not provided.

D. IMPLEMENTATION

The purpose of this section is to provide information to license applicants and licensees regarding the NRC staff's plans for using this regulatory guide.

This guide reflects current NRC staff practice. Therefore, except in those cases in which the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the method described herein is being and will continue to be used in the evaluation of submittals in connection with operating license or construction permit applications until this guide is revised as a result of suggestions from the public or additional staff review.