U.S. ATOMIC ENERGY COMMISSION

December 1973

REGULATORY GUIDE

DIRECTORATE OF REGULATORY STANDARDS

REGULATORY GUIDE 1.72

SPRAY POND PLASTIC PIPING

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, "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 function 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 assure materials control and control of special processes such as plastic 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. This guide describes a method acceptable to the Regulatory staff for implementing these requirements with regard to the design, fabrication and testing of fiberglass-reinforced thermosetting plastic 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.

B. DISCUSSION

The American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section X, "Fiberglass-Reinforced Plastic Pressure Vessels,"[1] specifies certain requirements associated with design and fabrication of plastic components. Although Section X excludes "vessels subject to Federal control, vessels subjected to pressures not exceeding 15 psig, and vessels having an inside diameter not exceeding 6 inches," it appears prudent to apply the design and fabrication provisions of Section X where fiberglass-reinforced plastic material will be used as a pressure barrier in safety-related systems for nuclear power plants. Section X distinguishes between vessels made with chopped fiberglass strands and vessels with a continuous filament-wound glass fiber as the reinforcing structure. Filament-wound structures have mechanical properties superior to fiberglass-filled laminates, and they are considered more desirable when intended for safety-related pressure components. Piping components should be made with continuous wound filaments of glass.

Fiberglass material will fail in a nonductile manner when strained in excess of approximately 3 percent. The design stress is therefore based on a design factor which is applied to the equivalent hoop stress as determined by a burst test. Although not directly comparable, the ASME Code, Section VIII, Division 1,[1] limits the design stress to 1/10 of the tensile strength for cast iron material, and the maximum allowable stress value in bending to 1-1/2 times that permitted in tension. Section X limits the maximum direct (membrane) stress due to any combination of loadings that are expected to occur simultaneously during normal operation of the vessel to 1/6 of the maximum membrane stress value, as determined from the burst test, and considering any additional membrane stresses caused by other test loadings in addition to the pressure loading. Some recent applications of thermosetting plastic piping have been for nuclear power plant spray ponds. The steady-state design pressure rating for these applications is

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

approximately 15 times the operating pressure and approximately 5 times the system design pressure allowing for startup pressure transients. Similarly, there is a margin of 3 to 10 on cyclic pressure ratings, based on 150×10^6 cycles (extrapolated from 15×10^6 test cycles).

Standard Specifications by the American Society for Testing and Materials (ASTM) [2] are used to establish minimum requirements for material properties and fabrication processes; however, selection of a design stress limit is deferred to the potential user of the specification. Regulatory Guide 1.48, "Design Limits and Loading Combinations for Category I Fluid System Components," indicates an acceptable loading combination that should be applied to the loadings indicated in subparagraph D-121(b) of Section X of the ASME Code. A design stress limit (membrane) of 1/10 of the maximum stress value, as determined by the burst test method, would be acceptable for regulatory position C.8.a. of Regulatory Guide 1.48, and a design stress limit (membrane) of 1/6 of the maximum stress value, as determined by the burst test method, would be acceptable for regulatory position C.8.b. of that guide.

Subparagraph D-140(c) of Section X requires a translucent weather-resistant coating to be applied to the exterior of plastic pressure vessels which will be exposed to weather conditions. 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. Plastic piping has been used to distribute cooling water to nozzles in spray ponds. It is desirable to provide weather protection to plastic piping, particularly when the piping is continuously submerged in water; 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.

There is limited information 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. If plastic piping is considered for systems where it may be exposed to long-term radiation, the laminates should be tested and qualified for the intended environment.

Metal pressure vessels and closed systems are provided with pressure relief valves or devices. Plastic piping systems should be provided with relief devices for similar applications. Where plastic 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, the integrity of the piping system should be protected by other means such as careful design or selection of spray nozzles to prevent their clogging and selection of pump delivery characteristics to prevent the piping pressure from exceeding the design pressure for the piping.

Industry experience with fiberglass-reinforced plastic pressure vessels and piping extends over 15 to 18 years of service experience during which the performance of fiberglass-reinforced plastic piping has been satisfactory. The life expectancy for properly installed piping is approximately 40 years, or the normal design life for presently planned nuclear power plants. Since plastic 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.

Inservice inspection requirements should be similar to those *proposed* for ASME Code, Section XI [1] for Class 3 [3] components. The extent of the inspection for Code Class 3 components is outlined in Regulatory Guide 1.51, "Inservice Inspection of ASME Code Class 2 and 3 Nuclear Power Plant Components," and it involves a visual inspection of the piping for evidence of unanticipated leakage and structural distress. Since the support of plastic piping may be sensitive, each inservice inspection of such piping should include all its supports.

C. REGULATORY POSITION

Safety-related piping components for spray ponds made from fiberglass-reinforced thermosetting plastic materials should comply with Section X of the ASME Code supplemented by the following:

1. Piping should be fabricated by the continuous filament-winding process.

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

3. The maximum direct (membrane) stress due to combination of loadings, Section X subparagraph D-121(b), should not exceed the following:

---

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

[3] Components classified as AEC Quality Group A, B, and C should conform to the requirements of the ASME Boiler and Pressure Vessel Code for Class 1, 2, and 3 components, respectively. (AEC Regulatory Guide 1.26 (Safety Guide 26), "Quality Group Classification and Standards").

a. 1/10 of the maximum stress values, as determined by the burst test method, for loading combinations indicated in regulatory position C.8.a of Regulatory Guide 1.48, and

b. 1/6 of the maximum stress values, as determined by the burst test method, for loading combinations indicated in regulatory position C.8.b of Regulatory Guide 1.48.

4. Plastic piping intended for systems with exposure to radiation should be qualified by testing to assure the long-term integrity of the piping material.

5. The requirement of Section X subparagraph D-140(c) may be omitted provided the inservice inspection is performed at least once every year.

6. 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.

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

8. Inservice inspection requirements for fiberglass-reinforced piping components should be in accordance with the proposed Addenda to ASME Code Section XI, for Code Class 3 components as outlined in Regulatory Guide 1.51. In addition, all pipe supports should be inspected. Inspection frequency for piping should be increased to once annually if a protective coating is omitted.