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REGULATORY GUIDE

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CONCRETE RADIATION SHIELDS FOR NUCLEAR POWER PLANTS

A. INTRODUCTION

Section 20.101, "Exposure of Individuals to Radiation in Restricted Areas," of 10 CFR Part 20, "Standards for Protection Against Radiation," states that, subject to certain specific exceptions contained in that section, no licensee shall possess, use, or transfer licensed material in such a manner as to cause any individual in a restricted area to receive a dose in excess of the limits specified therein. Paragraph (c) of § 20.1 provides that licensees, in addition to complying with the requirements set forth in Part 20, should make every reasonable effort to maintain radiation exposures as far below the limits specified in that part as practicable. 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 design control, material control, special process control, and inspection and test controls. Appendix B also requires that activities affecting quality be accomplished under suitably controlled conditions. This guide describes some bases acceptable to the Regulatory staff for implementing the above requirements with regard to the design and construction of concrete radiation shields in nuclear power plants. The Advisory Committee on Reactor Safeguards has been consulted concerning this guide and has concurred in the regulatory position.

B. DISCUSSION

Subcommittee ANS-11, Radioactive Materials Handling Facilities and Specialized Equipment, of the American Nuclear Society has developed a standard presenting requirements and recommended practices for the construction of concrete radiation shielding structures and for certain elements of design that relate to problems unique to this type of structure. This standard was approved by the American National Standards Committee N101, Atomic Industry Facility Design, Construction, and Operation Criteria, and was subsequently approved by the American National Standards Institute (ANSI) on December 22, 1972 and designated ANSI N101.6-1972. The standard discusses aggregates, design of concrete mixtures and forms, placement of concrete, design and installation of penetrations, embedments, metal liners, and penetration plugs and also outlines testing and quality assurance provisions needed to verify that the desired quality of design and construction has been achieved. The standard does not include detailed treatments of structural design or determination of shield thickness, but does reference other standards covering structural design.

C. REGULATORY POSITION

The requirements and recommended practices contained in ANSI N101.6-1972, "Concrete Radiation Shields," [1] have generally been endorsed by Regulatory Guide 3.9 as acceptable for the construction of radiation shielding structures for hot laboratories, radiochemical plants, experimental facilities, and nuclear fuel fabrication plants. Although written primarily for these facilities, the requirements and recommended practices are also considered to be applicable to shielding structures for nuclear power plants subject to the following:

[1] Copies may be obtained from American Nuclear Society, 244 East Ogden Avenue, Hinsdale, Illinois 60521.

1. Section 2 of ANSI N101.6-1972 lists applicable documents which are intended to supplement the standard. These documents, appropriately applied by the user, do provide useful supplementary guidance. However, this endorsement of ANSI N101.6-1972 does not constitute a blanket endorsement of the contents of the documents referenced by the standard.

2. Section 4.2 of ANSI N101.6-1972 states tha when the documents referenced in Section 2 differ from project drawings and specifications, the project documents shall govern. This is acceptable provided the resulting margin of safety is not reduced below that intended by regulatory requirements or commitments made to regulatory authorities (such as in preliminary safety analysis reports).

3. Section 4.3.3 lists some applied loads to be considered. Concrete radiation shields for nuclear power plants should also consider steady-state and transient thermal loads, and loads due to postulated missiles.

4. Section 4.3.4 of ANSI N101.6-1972 states that, when using the working-stress method, where stresses are increased by temporary loads, the allowable stresses may be increased to those allowed for wind and earthquake forces. This is acceptable unless such credit is prohibited by regulatory or project criteria.

5. Section 4.8 of ANSI N101.6-1972 delineates special precautions to be observed in the construction of concrete radiation shields. Where metals are used as aggregate to increase the density of the concrete, th metal should be of such type that it will not cau hydrogen or other gases to be generated by reaction with the cement. The requirements of Section 4.8.4 should still be met, however, even if a nonreactive metal is used as aggregate.

6. Section 6.4 of ANSI N101.6-1972 does not explain how some of the variables which are used in the equations for bending moment and tensile stress are to be determined. Therefore, this section should not be used as a substitute for detailed thermal stress analysis in the design of reinforcement for control of thermal cracking (temperature reinforcement) in specific concrete radiation shields.

7. Section 8.7.1 of ANSI N101.6-1972 requires, in part, that reinforcing steel or other means be provided for transferring shear forces through a construction joint. Provision should also be made for adequate means of transferring other forces through the joint.

8. Section 9.3.4 permits the inspection of liner welds with liquid penetrant or magnetic particle methods. In addition, vacuum box testing would be considered an acceptable supplementary method of testing the liner welds for leak tight integrity.