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INTERIM REPORT

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1043 287

COMMENTARY ON "STRUCTURAL ISSUES ON INTERIM NEAR SURFACE STORAGE OF SPENT NUCLEAR MATERIALS"

by John P. Roberts[1]

FORWARD

Interim near surface storage of spent fuel in separate installations is not a new operation. However, in spite of expressed industry interest such storage has been licensed to date in only a single case for water basin storage at the General Electric Morris Operation at Morris, Illinois pursuant to Title 10, Code of Federal Regulations (CFR) Part 70, "Domestic Licensing of Special Nuclear Material." Since the storage of spent fuel was specifically licensed there in August 1974 with the Morris Operation functioning as an independent spent fuel storage installation (ISFSI), amendment to the existing license (SNM-1265) has been approved by the NRC to increase storage capacity from 100 TeU to 750 TeU of spent fuel. While the validity of NRC licensing of interim storage of spent fuel pursuant to 10 CFR Part 70 at the GE Morris Operation has been upheld in federal court,[1] the Commission has issued for public comment a proposed rule 10 CFR Part 72, "Storage of Spent Fuel in an Independent Spent Fuel Storage Installation (ISFSI)."[2] This has been drafted to explicitly cover interim storage of spent fuel in an ISFSI. It provides specific design criteria, siting criteria and other specific requirements for an ISFSI which are not stated in 10 CFR Part 70.

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In this discussion of William D. Woods's paper, "Structural Issues of Interim Near Surface Storage of Spent Nuclear Materials" we have attempted to include the results of continued effort that NRC staff members are expending in responding to comments received on the proposed 10 CFR Part 72 and in redrafting it for Commission approval. This is not to say that the comments expressed herein will represent the Commission's final judgment on the content of 10 CFR Part 72. They are simply the best guidance that we can as individual staff members express at this time. To the slight extent that they differ from statements the author has made in his paper this should not be seen as a reflection on his accuracy but as a result of the continued development of events.

1043 288

INTRODUCTION

The author has concerned himself in this paper only with structural issues related to storage of spent fuel in water basin type ISFSI. This is appropriate since water basin technology has been developed and practiced for light water reactor (LWR) spent fuel storage for over two decades, whereas dry storage of LWR spent fuel is only now being developed to a point where it may be utilized in installations licensed by NRC.[4] However, while we will limit this discussion to water basin storage, we note that dry storage is covered under 10 CFR Part 72 and design criteria for it are receiving greater staff consideration in response to comments on announced proposed 10 CFR Part 72. In addition dry storage technology for spent fuel other than LWR spent fuel has been developed in this country[5] and licensed in one case by the NRC at the Fort St. Vrain nuclear power plant.

In addressing the requirements expected to be included in 10 CFR Part 72 for a water basin type ISFSI it is well to recall that under 10 CFR Part 72 licensing of spent fuel is a one-step process. Thus, the environmental report and safety analysis report (SAR) submitted at the time of application must be complete. The SAR should be essentially a final SAR (FSAR) including the definitive design of the installation. The NRC reviewer must have sufficient information to be able to make a finding that, with regard to the principal structures and all systems important to safety, "the final design will conform to the design bases with an adequate margin for safety."[2] A deficient SAR will delay the licensing review.

The storage of spent fuel at an ISFSI is similar : basic function to that at a reactor basin including fuel receipt and handling by truck and/or rail cask. However, the age of the spent fuel received for storage (at least one year's decay time required) at an ISFSI has allowed some design requirements to be less stringent than those for storage of spent fuel with much shorter decay times at reactor basins. Structural requirements, with some important exceptions which the author has discussed, are generally the same as those for reactor basins. This is to be expected since the handling by crane of heavy casks and transfer to storage of spent fuel which remains highly radioactive results in essentially identical solutions and designs to ensure operational safety and to meet as low as reasonably achievable objectives with respect to radioactive material release and radiation levels.

DESIGN REGULATIONS AND GUIDES

Since publication of proposed 10 CFR Part 72 on October 6, 1978 for comment NRC staff have received some 70 letters embodying more than 600 separate comments on the proposed rule. Staff members are working to respond to and incorporate these comments, as applicable, into 10 CFR Part 72. In addition to Regulatory Guide 3.44,[6] which provides guidance on the format and content of the SAR to be submitted by an applicant, the staff has also worked with the ANS 57.7 Committee on a standard for design of an ISFSI.[7] This standard will be adopted by NRC staff with any necessary modification as an NRC ISFSI design regulatory guide. Similar efforts are underway with regard to an ISFSI siting guide with an NRC staff member working with the ANS-2.19 Committee. At this time the staff expects that 10 CFR Part 72 will be issued by the end of 1979 with the design guide closely following it. The siting guide will be available in the spring of 1980.

As the author has noted, Subpart F "General Design Critera" of 10 CFR Part 72 includes design criteria for structure, system and components important to safety. The remainder of the installation is designed in accordance with appropriate standards or codes.[7] The natural phenomena whose effects structures important to safety must be designed to withstand are included in 10 CFR 72.72 "Criteria for Overall Requirements." These are: earthquakes, tornadoes, lighting, hurricanes,

1043 292

floods, tsunami, and seiches. Guidance provided in Regulatory Guide 3.44 is included in Section 3, "Structural and Mechanical Safety Criteria." These include: tornado loadings, water level (flood design), seismic design, snow and ice loadings, combined load criteria and subsurface hydrostatic loadings.

Important to the design of an ISFSI are the quality standards applied in concert with other criteria. In 10 CFR §72.72. it is now stated that:

> "Structures, systems and components important to safety shall be designed, fabricated, erected and tested to quality standards commensurate with the importance to safety of the function to be performed."

The quality assurance program to be applied to effect this follows the criteria set out in Appendix B "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants" of 10 CFR 50 "Domestic Licensing of Production and Utilization Facilities." Further guidance for the applicant can be found in American National Standard Institute standard ANSI 46.2, Revision 1, "Quality Assurance Program Requirements for Post Reactor Nuclear Fuel Cycle Facilities," which is now being reviewed for endorsement by NRC staff.

SPECIAL DESIGN CONSIDERATIONS

Natural phenomena are necessarily site dependent and, as the author notes, the effects of these lead to special design considerations. In Regulatory Guide 3.44, Chapter 2 "Site Characteristics" and Chapter 3 "Principal Design Criteria" state in detail natural phenomena and the design criteria to be used to prevent structural failure. Guides and standards available to the applicant are specified in these chapters and in Chapter 6 of the ANS 57.7 standard (see in particular Section 6.2 "Spent Fuel Storage Racks" and Section 6.7 "Buildings."). It should be noted that, while natural phenomena are site dependent, it is possible to a degree to develop a design that envelopes the parameters of natural phenomena. Such a standardized design in a topical report[8] has been submitted and has received letters of approval from NRC staff for its conceptual design[9] and allowing referencing of sections of the topical report[10] in any site specific application.

The "Supplementary Information" provided in the Federal Register notice for proposed 10 CFR Part 72 emphasized the choice of a "sound site."[2] This approach could minimize the necessity to design against nat phenomena and could lead to lower costs in construction of an ISFSI with, of course, no lessening of safety standards. With regard to resistance to the effects of tornado and other wind related phenomena the structures of an ISFSI are required to be "designed to prevent massive collapse of building structures or dropping of heavy objects onto the stored spent fuel due to building structural failures caused by high winds, tornadoes or hurricanes,"[11] but protection against tornado missiles is not required. In this context it should be noted that the storage pool itself will be constructed substantially below grade. While this is not a requirement of 10 CFR Part 72, it is included in the ANS 57.7 standard which assumes that an ISFSI storage pool would be operated with its "water level at or near grade."[12] Any proposed construction of a storage pool above grade could raise related design questions such as need for tornado missile protection. The author has noted the applicable NRC Regulatory Guide 1.76 "Design Basis Tornado for Nuclear Power Plants" which may be used with ASCE Paper No. 3269 "Wind Forces on Structures" for transforming velocities from tornado winds into effective pressures.

Since the publication of proposed 10 CFR Part 72, comment has resulted in reconsideration of the approach to seismic requirements proposed. As a result, the design earthquake for an ISFSI water basin is expected to be "based on the seismic and geologic criteria for nuclear power plants given in Appendix A to Part 100 of this Chapter, except that a minimum value of 0.2g shall be assumed for the vibratory accelerations at the foundations of such structures."[11] Regulatory Guides 1.60, "Design Response Spectra for Seismic Design of Nuclear Power Plants," 1.61, "Damping Values for Seismic Design of Nuclear Power Plants" and 1.92, "Combining Modal Responses and Spatial

Components in Seismic Response Analysis" remain applicable. The present seismic requirement is the same as that which is to be applied to a nuclear power plant and is consistent with an Advisory Committee on Reactor Safeguards suggestions for such plants.

Since we are discussing 10 CFR Part 72 requirements that are evolving out of continuing staff work in responding to comments on Part 72, we wish to reiterate that these changes have not received full NRC staff review as yet and certainly do not represent the Commission. What we are stating is simply our best guidance based on the continuing development of the requirements of proposed 10 CFR Part 72.

With regard to potential flooding the recommendation is made in Chapter 2 of Regulatory Guide 3.44 to provide evidence that the selected site is a flood-dry site as defined in ANSI 170-1976 "Standards for Determining Design Basis Flooding for Power Reactor Sites." If the site cannot be shown to be flood free, an applicant is advised to follow the procedure of Regulatory Guide 1.59 "Design Basis Flood for Nuclear Power Plants" in an evaluation. In Chapter 3 of Regulatory Guide 3.44 the applicant is requested to discuss design loads and to relate design criteria to the data developed from his evaluation.

The author also discusses wind and snow loadings and loadings in combination including hydrostatic and live loads. These are considered in Chapter 3 of Regulatory Guide 3.44. Standards are are also cited in Chapter 6 of the ANS 57.7 design standard.

FUNCTIONAL AREA DESIGN CONSIDERATION

An ISFSI is simply a warehouse for interim storage of spent fuel. As such it is almost a static system and generally has a long response time to events. For example, should operating systems for cleaning or cooling the storage pool water cease functioning, the time available to take corrective action extends from many hours to days or weeks. Only during the process of receipt of (and later shipment away of) spent fuel by the ISFSI is there a high degree, relatively speaking, of activity. During such activity the potential for operating error exists. However, this potential is reduced by the stringent requirements on spent fuel shipping cask design in 10 CFR Part 71 "Packaging of Radioactive Material for Transport and Transportation of Radioactive Material Under Certain Conditions" and by operating procedures, systems and components of the ISFSI which are designed to preclude accidents. While §72.73 "Criteria for Nuclear Criticality Safety" and §72.75 "Criteria for Spent Fuel and Radioactive Waste Storage and Handling," lay out general requirements, these must be applied.

Structures outside the cask unloading area and the storage pool area would not generally fall under the definition in 10 CFR Part 72 of "structures, systems, and components important to safety." Procedures or design should preclude in an ISFSI the spent fuel cask from being raised to a height greater that 30 feet.[13] A cask drop analysis for

1043 290

the cask unloading pool to examine the consequences is expected in any ISFSI storage application SAR. The extent of crane travel and rate of crane travel should, of course, be such that the wall and gate separating a cask unloading pool from a storage pool are not subject to significant damage by a potential cask drop accident. Provision should be made to ensure the gate is secured in a closed position during any cask movement operation.

Spent fuel must be kept in subcritical configurations at all times. As stated in 10 CFR §72.73. "Criteria for Nuclear Criticality Safety,"

> "All handling, transfer and storage systems shall be designed to be maintained subcritical and to ensure that no criticality accident can occur unless at least two unlikely (i.e., very low probability) independent, and concurrent or sequential changes have occurred in the conditions essential to nuclear criticality safety."

The racks for storage of spent fuel under water may be designed to maintain control of nuclear criticality by favorable geometry or by the use of permanently fixed neutron absorbing materials. (Material in water solution is not acceptable in normal operation.) However, since spent fuel which is stored in an ISFSI has a decay time of one year or more and is potentially capable of being cooled by convection and radiation in air in the event of loss of cooling water,[13,14] rack design for an ISFSI should be such as to allow for such air cooling as a potential emergency measure. The cask unloading pool and storage pool are designed to withstand the design earthquake, and the storage racks must be so designed also.

The stainless steel liner of the cask unloading pool and of the storage pool is needed to prevent leakage of pool water. Design stress and strain limits for liners are discussed in Chapter 6 of the ANS 57.7 design standard.

We note that since an ISFSI storage pool will be constructed below grade it is likely to be relatively shallow, that is, approximately 30 feet deep. (The G.E. Morris Operation basins are about 29 feet deep.) Such a shallow depth effectively precludes the movement of spent fuel assemblies over assemblies in place in storage racks since an inadequate height of water shielding would be available for such movement.[16]

The remaining areas of the installation which are not defined as "important to safety" are, as the author notes, required to meet industrial standards. These are detailed in the ANS 57.7 design standard and in Regulatory Guide 3.44 to a lesser degree.

In summary I have discussed structural and related issues of ISFSI from a licensing and standards viewpoint paralleling the effort of the author. While doing so I have tried to cover additional areas and to make clear to the reader the use and usefulness of 10 CFR Part 72 and the guides being developed in association with it. A great deal of credit belongs to those serving on the ANS 57.7 Committee and the ANS-2.19 Committee who have worked to develop standards in the absence of a final 10 CFR Part 72. Their work will assist our NRC staff to adopt their standards with whatever modification may be necessary, as regulatory guides in a much shorter time than would otherwise be the case.

We have also attempted, where development has continued, to point out changes which may be reflected in proposed 10 CFR Part 72 as a result of comments received. However, no final action has been taken with respect to Part 72, and thus any statements deviating from Part 72 as published for comment are our opinions as individuals and do not, necessarily represent the opinion of the NRC staff as a whole or the Commission. To the same extent our opinions expressed with regard to future regulatory guides are solely our own.

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9. Letter from R. W. Starostecki, Chief, Fuel Reprocessing and Recycle Branch, USNRC to S. B. Jacobs, Chief Licensing Engineer, Stone and Webster Engineering Corporation, dated July 12, 1978. Available in USNRC Public Document Room under Project M-1.

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1043 301

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