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GUIDANCE ON THE LICENSE APPLICATION, SITING, DESIGN, AND PLANT PROTECTION FOR AN INDEPENDENT SPENT FUEL STORAGE INSTALLATION

A. INTRODUCTION

An "independent spent fuel storage installation" (ISFSI) is a self-contained installation for storing spent fuel. It has its own support services and operates independently of any other facility; i.e., it is not a part of either a nuclear power plant or a fuel reprocessing plant. Such an installation is visualized as being capable of storing 1000 tons or more of spent light-water reactor fuel.

Licensed spent fuel storage installations historically have been integral parts of either fuel reprocessing plants or nuclear power plants. Such plants have been licensed under 10 CFR Parts 30, 40, and 70 in addition to 10 CFR Part 50.

An ISFSI, independent and separate from either a nuclear power plant or a fuel reprocessing plant, would be licensed under Parts 30, 40, and 70. An applicant for a license for an ISFSI meeting the requirements for a Part 70 license would automatically satisfy the requirements for a Part 30 and 40 license. Therefore, a license application for an ISFSI would be reviewed under the requirements of 10 CFR Part 70.

"Licensing and Regulatory Policy and Procedures for Environmental Protection," 10 CFR Part 51, sets forth the Atomic Energy Commission's policy and procedures for preparing and processing environmental impact statements and related documents pursuant to Section 102(2)(C) of the National Environmental Policy Act of 1969 (83 Stat. 852). Certain limitations on the Commission's authority and responsibility pursuant to the NEPA are imposed by the Federal Water Pollution Control Act amendments of 1972 (86 Stat. 816). These limitations are addressed in an Interim Policy Statement published in the Federal Register on January 29, 1973 (38 FR 2679).

Regulatory Guide 4.2, "Preparation of Environmental Reports for Nuclear Power Plants," is generally applicable as a guide for the preparation of an environmental report for an ISFSI. Subjects that are pertinent only to nuclear power plants are obviously not applicable, however, and subjects that are important to an ISFSI, such as spent fuel transportation, should be emphasized.

This guide discusses the license application, site evaluation, design, and plant protection of an ISFSI. It describes the measures acceptable to the Regulatory staff for meeting the requirements of 10 CFR Part 70. In addition, it identifies the information needed by the staff in its evaluation of an ISFSI application.

B. DISCUSSION

1. General Considerations

An ISFSI could be substantially larger than any existing spent fuel storage installation associated with either a nuclear power plant or a fuel reprocessing plant. The ISFSI could have an inventory of long-lived fission products and fissile materials greater than that in any existing nuclear reactor or presently projected fuel reprocessing plant.

An ISFSI will function solely in a protective custodial capacity, providing stable storage conditions pending some future disposition of the spent fuel. The fuel assemblies and their contents would not be changed by the activities conducted at an ISFSI.

While the spent fuel is in passive storage, decay heat and the modest pressure within the fuel tubes are the only driving forces for dispersing the relatively large inventory of radionuclides contained in 1000 tons or more of spent fuel.

The stored fuel elements should be protected from incidents or accidents resulting in massive ruptures of fuel elements, and the pool water level should be maintained. Leakers should have special handling, including encapsulation, to provide storage conditions equivalent to those for undamaged fuel elements.

It is assumed that the storage pools will be built below grade. The large heat capacity of the pools should allow adequate time to take corrective action in case of an emergency. Even in the event of an earthquake or other extreme natural phenomenon, sufficient cooling can be provided by emergency action in time to protect the health and safety of the public.

Storage pool water becomes contaminated with radionuclides from defective fuel elements and with activation products on the fuel surfaces. This material should be confined and treated for disposal.

Accident analyses should be based on the release of the volatile fission products contained in the stored fuel under defined accident conditions.

2. License Application

Because of the substantial quantity of contained radioactivity and the cooling requirements involved in an ISFSI, the review and evaluation of the engineered design and detailed safety analysis for the installation must be conducted prior to licensing. For this reason, a license application for an ISFSI should include a safety analysis report similar in scope and detail to the pertinent parts of a safety analysis report for a fuel reprocessing plant.

The licensing of an ISFSI would be a major Federal action within the meaning of the National Environmental Policy Act of 1969. Therefore an applicant should prepare an Environmental Report that can serve as the technical basis for an evaluation by the Commission of the potential environmental impact of the installation.

Detailed engineering plans should be filed with the license application and its supporting environmental report at least nine months before the start of construction activities.

A site evaluation should be provided to ensure that the natural characteristics of the site are sufficiently well known to provide the bases for the engineering design of the installation.

The applicant's safety analysis, environmental report, and security plan are fundamental to developing the basis for design of the installation. The license application should take into account all proposed normal operations, any credible off-standard conditions, and the existing potential for interaction between the installation and the site due to natural phenomena.

When a fuel storage pool is part of a reprocessing plant or a nuclear power plant, fuel storage pool operators are licensed under the provisions of 10 CFR Part 55. ISFSI operators should have a comparable level of training.

3. Site Selection

Site selection criteria should be based on the safekeeping of the relatively large inventory of radionuclides contained in the 1000 tons or more of spent fuel expected to be stored in the installation. The possibility of an uncontrolled release of radionuclides, driven by the energy available as decay heat and gases under pressure within the fuel cladding, should be considered in the design of structures, systems, and components and in plant siting. Together, these criteria should be the bases for the final engineering design and can only be suitably developed from a relatively complete knowledge of the physical characteristics of the candidate sites.

The siting considerations for an ISFSI should include the structural engineering plant siting factors, the environmental effects of construction, the potential effects of plant effluents from normal operations, and the potential effects from off-standard conditions. Additionally, the potential for effects on the plant and fuel in storage that might be attributable to site characteristics or the environment should be reflected in the design of plant structures and equipment.

In general, safe storage of irradiated fuel is dependent on maintaining the integrity of the fuel cladding as the primary barrier to the release of radioactive materials. Fuel cladding is designed to withstand a far more severe environment in a reactor than in a storage installation. Therefore, under the low temperature conditions of static storage, the cladding provides an effective barrier to the escape of fission products and fissile materials into the storage facility. The installation should be designed to ensure that the integrity of cladding is not lost because of either mechanical damage or the effects of excessive temperature.

Historical information of public record concerning the regional and local meteorology, geology-seismology, and hydrology should be supplemented by on-site analyses to provide a basis for judgment specific to the candidate site. From these analyses the extremes of wind, snow, and ice loadings; the precipitation; the probable maximum flood; the design earthquake; the surficial and foundation geological structures; the topography; and any potential for landslides, liquefaction, or subsidence should be determined.

4. Design Considerations

The design considerations of an ISFSI are somewhat comparable to those for smaller facilities of the same type at a reprocessing plant. However, particular consideration may be needed for the ISFSI because of its size, existence as an individual entity without the backup of an associated facility, and loading of 1000 tons or more of spent fuel with a potential inventory of relatively long lived fission products in excess of 10^9 curies and with cooling requirements in excess of 10^7 Btu/hr.

The safe storage of irradiated fuel depends on maintaining the integrity of the fuel cladding as the primary barrier to the release of radioactive materials. The basic design consideration is the protection of the fuel cladding, not the protection of the pool structures. The ISFSI should be designed to ensure that the integrity of the cladding is not lost through mechanical disruption or excessive temperature.

An ISFSI would be licensed under the provisions of 10 CFR Parts 30, 40, and 70. Some provisions similar to those for plutonium processing plants would be appropriate for these installations. Two of these that are of particular importance are: (1) confinement components, systems, and structures important to safety should be designed and constructed to withstand natural phenomena and (2) quality assurance criteria such as those in Appendix B to 10 CFR Part 50 should be applied to safety-related structures, systems, and components.

a. Pool Integrity

The design earthquake is based on the assumption that the storage pools will be built below grade and designed with a high degree of resistance to ground motion. Furthermore, it is assumed that the storage pool or pools will be built either in impervious soils or with a secondary water containment envelope. The leak rate of such a containment envelope should be low enough that, in the event of a gross pool leak, makeup water could be supplied to the pool at a rate sufficient to keep the stored fuel adequately covered. During the design for ultimate decommissioning of the installation, consideration should be given to disposing of potentially contaminated soil or other fill materials between the pool exterior walls and the secondary pool water containment envelope.

Large spent fuel storage pools should be built as a series of separable modular units or with provisions for isolating sections of the pool when necessary. A maximum capacity of about 500 tons of spent fuel per pool module or section appears desirable.

b. Heat Dissipation

A 5000-ton ISFSI would be expected to have a cooling demand in the order of 5×10^7 Btu/hr or more. No difficulty is anticipated in dissipating this quantity of heat by conventional means. If evaporative coolers are used, a reliable water supply should be available for pool makeup water and cooling tower blowdown. Regulatory Guide 1.27, "Ultimate Heat Sink for Nuclear Power Plants," gives guidance on the degree of reliability required.

Certain designs of the installation and local site conditions may result in a need for the cooling system to be serviced by the emergency power supply system of the installation.

c. Ventilation

A fraction of the fuel assemblies received for storage at an ISFSI will presumably be "leakers," and some fuel assemblies may develop leaks later while in long-term storage. Such leakers should be encapsulated in a secondary container reasonably promptly. However, until they are encapsulated, some fraction of the contained volatile radionuclides would escape. In addition, cask unloading, decontamination, and other routine operations may result in airborne radioactive materials.

The ventilation system should be designed to protect the operators and to keep the activity levels in the personnel occupancy areas (and radioactive materials in gaseous effluents) as low as practicable and within the limits of 10 CFR Part 20.

d. Liquid Effluents

Radioactive liquid effluents should not be discharged to the natural area drainage system. If this is not feasible, the treatment system for liquid effluents discharged to unrestricted areas should ensure that the radioactivity in such effluents is as low as practicable and within the limits of 10 CFR Part 20.

e. Waste Treatment

Provisions should be made to render contaminated wastes into a form suitable for land burial or shipment to the planned Federal repository.

f. Accident Design Considerations

An ISFSI should be designed to preclude the following as credible accidents:

(1) Criticality

(2) Exposure of stored fuel through loss of shielding water

(3) Dropping of heavy loads on fuel

(4) Multiple massive ruptures of fuel elements by missiles

(5) Complete loss of cooling water

g. Storage Racks

Storage racks should be designed with adequate spacing to meet criticality requirements and be structurally compatible with seismic and missile protection design criteria.

5. Physical Protection

An ISFSI should be protected from acts of industrial sabotage that could directly or indirectly endanger the public health and safety by releasing radiation (airborne radioactive particulates rather than gaseous fission products). This protection should be achieved by establishing and maintaining a physical protection system as required by 10 CFR Part 73.

Further, interfacing the security organization and its functions with the plant should be considered. Identifying vital equipment, as defined in 10 CFR §73.2(i), and integrating physical protection considerations into the layout and design of the installation as early as possible should help preclude requirements for subsequent modification of the installation.

Site location is important with respect to the availability of timely and significant assistance from local law enforcement authorities (LLEAs) in the event of attempted industrial sabotage. A progressively larger onsite guard force will be needed as the distance of the nearest significant LLEA increases. In particular, licensees who possess or use SNM are required by 10 CFR Part 73 to take certain actions to protect the installation against industrial sabotage. The particular actions applicable to a spent fuel storage installation are prescribed in §73.50, which requires:

a. A physical security organization including a supervisor, qualified armed guards, and written security procedures.

b. Physical barriers, including multiple barriers and monitored intervening clear areas and isolation zones.

c. Detection and alarm systems, with annunciators in two continuously manned central alarm stations and self-checking and tamper-indicating capability.

d. Access controls to limit entrance of personnel, vehicles, and packages into protected and vital areas, including use of metal and explosives detectors, random searches, badging system, escorts, and appropriate keys, locks, and combinations.

e. Communication systems, including continuous communication between each guard and the central alarm station, capability to request assistance from the LLEA, two-way radio voice communication, conventional telephone service, and independent power source.

f. Liaison with local law enforcement authorities capable of providing assistance to the licensee's security organization in the event of a security threat.

g. Testing and maintenance of security equipment.

Section 73.40 requires submission of a security plan to the Commission for approval. Such security plans consist of two parts. Part I should discuss vital equipment, vital areas, and isolation zones. It should also demonstrate how the applicant plans to comply with the requirements of 10 CFR Part 73 cited above. Part II should list tests, inspections, and other means to be used to demonstrate compliance with such requirements.

C. REGULATORY POSITION

1. License Application

The applicable regulatory requirements are in the following parts of 10 CFR:

19 – Notices, Instructions and Reports to Workers; Inspections

20 – Standards for Protection Against Radiation

30 – Rules of General Applicability to Licensing of Byproduct Material

40 – Licensing of Source Material

51 – Licensing and Regulatory Policy and Procedures for Environmental Protection

70 – Special Nuclear Material

71 – Packaging of Radioactive Material for Transport and Transportation of Radioactive Material Under Certain Conditions

73 – Physical Protection of Plants and Materials

The applicant should provide:

a. An emergency plan consistent with 10 CFR §70.24(a)(2), such as Annex B which is currently routinely incorporated in Part 70 licenses. A copy of Annex B is attached as Appendix A to this guide.

b. A quality assurance program consistent with 10 CFR Part 50, Appendix B. A description of the program and current status of project design and procurement activities should be included in the license application. A copy of the applicant's Quality Assurance Manual covering design and procurement should be submitted to the appropriate Regulatory Operations Regional Office 30 days before the license application.

c. Design criteria consistent with those in the proposed 10 CFR Part 50, Appendix P, "General Design Criteria for Fuel Reprocessing Plants."*

d. Design criteria consistent with those in Sections I and II of the proposed 10 CFR Part 50, Appendix Q, "Design Criteria for the Protection of Fuel Reprocessing Plants and the Licensed Material Therein."*

e. A two-part security plan consistent with 10 CFR §73.50.

f. Information sufficient to demonstrate the financial qualifications of the applicant to carry out the activities for which the license is sought.

g. Financial information pertinent to the proposed decommissioning plan.

h. A site evaluation based on the factors, to the extent applicable to an ISFSI, identified in §100.10(b), (c), and (d) of 10 CFR Part 100. This evaluation should contain an analysis and evaluation of the major structures, systems, and components of the installation that bear significantly on the acceptability of the site for its intended use.

i. A summary description and discussion of the installation, with special attention to design and operating characteristics, unusual or novel design features, and principal safety considerations.

j. The principal design features for the installation, including:

(1) The principal design criteria for the installation. (See proposed Appendix P to 10 CFR Part 50 for guidance.*)

(2) The design bases and the relation of the design bases to the principal design criteria.

(3) Information relative to materials of construction, general arrangement, and approximate dimensions sufficient to provide reasonable assurance that the final design will conform to the design bases with an adequate margin for safety.

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*39 FR 26293, July 18, 1974.

k. An analysis and evaluation of the design and performance of structures, systems, and components of the installation, including its supporting services, with the objective of assessing the risk to the public health and safety resulting from the operation of the installation and including determination of:

(1) The margins of safety during normal and abnormal conditions anticipated during the life of the installation.

(2) The adequacy of structures, systems, and components provided for the mitigation of the consequences of accidents, including natural phenomena events.

l. An identification of the variables, conditions, or other items that are determined to be the probable subjects of license conditions for the installation.

m. An identification of any items requiring research or development to confirm the adequacy of their design; an identification and description of the research or development program that will be conducted to resolve any safety questions associated with the planned installation and its operation; and a schedule of the required programs showing that such safety questions will be resolved before completion of construction of the facility.

n. The technical qualifications of the applicant to engage in the proposed activities and his personnel training program.

o. A description of the instrumentation and control systems and of the auxiliary and emergency systems.

p. A description of radioactive waste handling, treatment, and disposal systems.

q. A description of the means for controlling and limiting radioactive effluents and radiation exposures to plant personnel to levels that are as low as practicable and well within the limits set forth in 10 CFR Part 20.

r. An estimate of the quantities of each of the principal radionuclides expected to be released in gaseous and liquid effluents to unrestricted areas during normal operations.

s. An identification of a spectrum of design basis incidents (DBIs) due to industrial sabotage, the possibility of which reasonably exists although the likelihood may be small. The plant design and security system should be evaluated in terms of adequacy to preclude or to minimize the danger to the public that may ensue in the event of a design basis incident. A "design basis incident" in this case is a postulated credible incident and the resulting conditions for which security related equipment meets its functional objectives. Examples of security related incidents include a credible armed intrusion, breach of a protective barrier, or malfunction of security equipment.

t. A description of systems used to clean up and make up pool water, with particular emphasis on the capacity of these systems to handle the volumes involved and both soluble and insoluble radionuclides.

u. A description of plans for preoperational testing of the installation.

2. Site Selection

a. General

The site should meet the following general conditions:

(1) There should be no slopes close enough to the proposed installation to be a landslide hazard. Alternatively, the slopes should be engineered to remain stable with a conservative factor of safety under both static and dynamic conditions.

(2) Capable faults* should be sufficiently remote to prevent surface movements on the main strand or any splay in the site area.

(3) Foundation material should be unweathered bedrock or other material with a low liquefaction potential.

(4) There should be no potential for differential subsidence such as that associated with karst topography, solution cavities, differential compaction, or man's activities (such as fluid withdrawal from the subsurface and extraction of minerals). Karst topography need not necessarily eliminate a site from consideration if the applicant can show that the potential for sudden collapse can be eliminated by remedial work.

b. Geology

Information should be provided to show that site conditions meet the above criteria. This information can be obtained from literature reviews and on-site field investigations such as the following:

(1) A visual inspection of the site and study of rainfall, geologic structure, and topography can provide information to show that there is no landslide hazard to the fuel storage installation. Detailed investigations may be required to determine stability under dynamic (earthquake) loading conditions.

(2) The absence of capable faults and the stability of the foundation material can be determined by reviewing literature and confirming geotechnical site investigations. The site investigations may vary from programs involving a simple visual examination for a site with completely exposed bedrock foundation material to programs that require trenching and stripping for sites with bedrock covered by a thin (up to 15 ft) layer of unconsolidated material. Sites with deep soil will require more detailed programs, including but not limited to trenching, stripping, drilling, hydrologic testing, laboratory and field testing of soil properties, and geophysical surveys.

Onsite investigations may reveal fractures. If so, conclusive evidence should be presented to demonstrate that the fractures have not been displaced or are not capable faults.

(3) The absence of a potential for sudden subsidence can be determined from the literature review and

*See 10 CFR 100 Appendix A for a definition of capable faults.

on-site investigations. Investigations will reveal whether or not the site is underlain by limestone, dolomite, gypsum, or other soluble material that can result in karst topography. If such material is known to underlie the site, then onsite examinations can be expected to reveal the potential for sudden subsidence. Possible indicators of such a potential would be the presence of sink holes, solution cavities, caves, and underground drainage.

If the site is in a mining or oil producing area, a review of the records of the Federal and State agencies responsible for monitoring oil and mining activities or other activities such as waste disposal or removal of fluids from the subsurface can be expected to provide the information needed to determine whether such activities have affected the site to the extent that they have produced a potential for sudden subsidence. Should such a potential be indicated, a more detailed investigation should be performed.

c. Seismology – Design Earthquake

(1) General Seismic History

A full review of the seismic history of the region in which the site is to be located should be made to identify earthquakes that have taken place in historic time and that could affect the selection of a Design Earthquake. All earthquakes within the same tectonic province as the site (or adjacent tectonic province to the site if near a border) should be examined for location, size, reliability of data, and effect on the site. Tectonic maps should be used to define the tectonic province(s) of significance to the site.

(2) Specific Seismic History

Historic earthquakes that may have affected the site itself should also be considered. All those that resulted in or are projected to have had an intensity of IV or greater at the plant site should be included in the consideration. (Intensity IV earthquakes can be determined by a review of the U. S. Coast & Geodetic Survey, National Oceanographic and Atmospheric Administration, and U. S. Geological Survey literature.)

All earthquakes with an epicentral intensity of V or greater should be shown in a table. This table should include the following estimated or measured data:

(a) Earthquake magnitude or highest intensity;

(b) Location of the epicenter or region of highest intensity;

(c) For earthquakes with intensities of VII or greater at the site, an estimate of the resulting intensity or acceleration and duration of ground shaking at the site.

An appropriate time span should be considered for various intensity levels if a statistical analysis is applied.

It should be recognized that there may be appreciable differences between the characteristics of the material underlying the epicentral location and the characteristics of the region of highest intensity. In developing the table of historic earthquakes and their effect at the site, allowance should be made for any such differences.

(3) Definition of Design Earthquake

The ISFSI "design earthquake" is an earthquake event that has a reasonably high probability of occurrence based on studies of historic seismicity and structural geology.

(4) Determination of the Design Earthquake

In evaluating historic seismicity and regional structural geology, the historic earthquakes identified from the above investigations should be associated with tectonic structures to the extent practical.

If historic earthquake data indicate a high incidence of earthquakes along only a particular portion of a tectonic structure, the probability of similar earthquakes in the future should be assumed uniformly throughout the same segment of the tectonic structure. (Where geologic evidence indicates that the structure is a major, continuous, through-going structure with significant displacement, a more conservative assumption may be appropriate.) These earthquakes should be used in determining the maximum vibratory motion at the site that could be caused by an earthquake related to the tectonic structure.

Correlation of tectonic structure and historic seismicity may not be possible because (a) there is insufficient data or (b) seismicity appears uniform over a network of tectonic structures or cannot be correlated with specific structures. If so, the seismicity should be identified with the tectonic province in which it is reported.

(5) Selection of a Design Earthquake

In view of the limited consequences of seismic events in excess of those used as the basis for seismic design, it appears appropriate that the design earthquake developed from the above information should be such as to have a predicted recurrence interval of about once in a thousand years.

d. Meteorology

While an elaborate continuing program of monitoring and measuring on-site meteorological phenomena comparable to that for a fuel reprocessing plant should not be necessary, the consequences of the release of airborne radioactivity under both normal and accident conditions should be determined by the applicant. Regulatory Guide 1.23, "On-Site Meteorological Programs," provides guidance for the basic elements of a suitable program.

The meteorology program should be commensurate with the postulated modes (release height and duration) of releases of airborne radionuclides under normal and accident conditions, as determined by the applicant and confirmed by the staff. Guidance is given in Regulatory Guide 1.23 (Safety Guide 23), "Onsite Meteorological Programs."

Presentation of long-term historical records of the extremes of temperature, precipitation, wind, snow, and ice, and their resultant loading parameters, should be included to aid in evaluating the design bases. Additionally, site-safety considerations require that the joint frequency distribution of wind direction, velocity, and stability be sufficiently well known to demonstrate with confidence the probable dispersion of airborne effluents. Representative (preferably onsite) data and conservative atmospheric diffusion models such as those presented in Regulatory Guide 1.3, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident for Boiling Water Reactors," may be used to estimate the dispersion of airborne effluents.

The occurrence of extreme weather phenomena such as hurricanes, tornados, water spouts, and violent thunderstorm activity should be considered as part of the site safety analysis to provide the essential technical basis for site selection and installation design. The tornado history in the area should be evaluated and applied to the analysis of safety as a potential source of missiles. Regulatory Guide 1.76, "Design Basis Tornado for Nuclear Power Plants," is applicable to an ISFSI. Also applicable is WASH 1300, "Technical Basis for Interim Regional Tornado Criteria." The data applicable to the selected site in these documents should be used in developing the missile protection design bases.

The consequences of accidents due to extreme weather conditions including missiles should be evaluated based on (1) a postulated release of a justifiable fraction of the stored available inventory of volatile radionuclides in the spent fuels that have experienced the minimum decay time since reactor shutdown for which the ISFSI is designed and (2) expected adverse atmospheric diffusion conditions. The techniques in Regulatory Guide 1.25 (Safety Guide 25), "Assumptions Used for Evaluating the Potential Radiological Consequences of a Fuel Handling Accident in the Fuel Handling and Storage Facility for Boiling and Pressurized Water Reactors," are applicable to this evaluation.

e. **Hydrology**

The overriding considerations from the standpoint of hydrology are the potential interactions of the ISFSI and the natural water bodies, surface, and ground associated with the site. Direct communication between the fuel storage environment and surface or ground waters should be precluded. Such communication can generally be presented through controlled circulation of coolant water and retention, cleanup, and controlled release of potentially contaminated waste waters.

Appropriate site selection can limit the potential for flooding. A high ground site above historical flood plains is more suitable than a site at lower elevation. The applicant should identify a design basis flood for the purpose of evaluating the safety of the selected site; the design of structures, equipment, and components essential to the protection of the public health and safety; and the possible consequences of a flood equal to the Probable Maximum Flood or of floods caused by means of comparable risk other than precipitation. The Probable Maximum Flood or the controlling flood conditions characteristic of the region and site should be considered in evaluating site safety.

At locations near large surface bodies of water, the occurrence of tsunami and seiches should be considered. The historical basis for assumptions should be documented, along with the estimated consequences of such phenomena. General information requirements on this subject are discussed in Regulatory Guide 1.59, "Design Basis Flood for Nuclear Power Plants."

Cooling water discharges such as those caused by cooling tower blowdown to surface waters are regulated under the Federal Water Pollution Control Act Amendments of 1972 (86 Stat. 816). The applicant should determine what present and proposed regulations are applicable to the selected site. Section 401(a)(1) of the Act requires, in part, that any applicant for a license for an installation such as an ISFSI provide the AEC with certification from the State that any discharge will comply with applicable effluent limitations and other water pollution control requirements. In the absence of such certification, no license can be issued by the AEC unless the State fails or refuses to act within a reasonable period of time.

The applicant should make conservative calculations of the dispersion and dilution capabilities and potential contamination pathways of the groundwater environment of the proposed installation under operating and accident conditions. Applications for a license for an ISFSI at sites that are in areas with a complex groundwater hydrology should include assessment of potential impacts on the groundwater system. Similar assessments should be made for sites located over major aquifers that are used for domestic or industrial water supplies or for irrigation water.

f. **Water Supply**

Water from surface or groundwater sources should be suitable, both in quality and quantity available, for use by the ISFSI on a uninterruptible basis. The need to maintain a depth of high quality shielding/coolant water conditioned to control corrosion, algae growth, and scale deposition is fundamental to the operational safety of an ISFSI. The availability of highly dependable supplies of high quality water is therefore a primary consideration for site selection.

Guidance on methods for ensuring reliability of the water supplies for normal and emergency use is available in Regulatory Guide 1.27, "Ultimate Heat Sink for Nuclear Power Plants," and Section 2.4 of Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants." The engineering design description should delineate the bounds of the water supply systems and provide details concerning volume, transfer capability, alternative sources, pumping capability, redundant equipment and components, operating procedures, and maintenance plans.

Water use and the resulting commitment of natural resources should be addressed in the applicant's environmental report.

g. Site Evaluation Considerations

(1) Design Features

Normal operations of an ISFSI should not result in the release to the unrestricted area of contaminated liquid effluents containing radioactive materials in concentrations exceeding the ALAP design objectives for light-water-cooled nuclear power plants.*

The structure enclosing the fuel storage pool should have an appropriate ventilation and filtration system to limit the release of gaseous and entrained particulate radioactive materials under normal operating conditions to quantities that will not exceed the ALAP design objectives for light-water-cooled nuclear power plants.*

The heating, ventilating, and air conditioning system should provide for controlled leakage of air from the fuel storage pool and the cask handling areas under all normal and off-standard operating conditions. The structure enclosing these areas need not be designed to withstand extremely high wind loadings, but leakage should be suitably controlled under all conditions of fuel transfer and storage. The design of the ventilation and filtration system should be based on experience in similar facilities and on the assumption that the cladding on a fraction of the stored fuel might be breached as a result of an accident. The inventory of radioactive materials available for leakage from the building should be based on the average fuel characteristics used for the design basis fuel.

The use of a closed-circuit shielding/coolant water system is assumed. This is a prudent means of limiting the risk of releasing radioactive material to the unrestricted area. Drains, permanently connected systems, and other features that by maloperation or failure could cause loss of coolant that would uncover fuel should not be installed or included in the design. Systems designed for maintaining water quality and quantity should be designed so that any maloperation or failure in those systems from any cause will not cause the fuel to be uncovered.

*WASH 1258, Volumes 1 and 2. "Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion 'As Low as Practicable' for Radioactive Material in Light-Water-Cooled Nuclear Power Plant Effluents."

Reliable and frequently tested pool water monitoring equipment should be provided to provide alarm both locally and in a continuously manned location if the water level in the fuel storage pool falls below a predetermined level or if there is a high local radiation level. The high radiation level instrumentation should automatically actuate the pool water filtration system.

Similarly, reliable and frequently tested air monitoring equipment should be provided to alarm both locally and in a continuously manned location if the activity level in air from the storage pool areas exceeds preset limits or if high radiation levels are detected. An automatic interlock with the high radiation level instrumentation should actuate the ventilation confinement system.

(2) Off-Standard Conditions

The full range of conditions outside the normal operating modes should be considered off-standard conditions. For the purpose of this guidance, off-standard conditions are considered to be bounded by normal operations on the one hand and design basis accidents on the other.

(a) Process Deviations

The applicant should provide a comprehensive safety analysis that takes into account the full range of tasks and the conditions to be preserved for safe operation. Engineering estimates of the potential hazards and consequences that may be associated with operating outside the bounds of normal conditions should be included. The analysis should determine the safe operating range of critical unit operations, identify potentially controllable off-standard conditions or design features, and establish actions appropriate for mitigating the consequences of off-standard conditions.

(b) Loss of Power

Loss of power is a site-safety-related off-standard condition of potentially serious consequences. Circulation and cooling requirements will probably require continuous pumping capability. Ancillary systems for safety and security should provide continuous instrument, lighting, alarm, and ventilation control power. Availability of reliable primary power to essential systems is a basic consideration for site selection. Redundant systems for alternative power sources or auxiliary systems such as diesel generator installations can support the primary power source.

(3) Natural Phenomena

The site-safety analysis provides a technical basis for design criteria considerations of plant-site interactions. The potential actions between the natural environment and man-made structures are factors in site selection that should influence engineering judgments in choosing among design alternatives.

(a) Meteorology

Site-safety considerations require that meteorological parameters such as wind direction, velocity, atmospheric stability, and the joint frequency of occurrence be known well enough to demonstrate that the joint dispersion of gaseous and particulate effluents will be predictable within the bounds of conservative models conventionally used for analyzing the radiological consequences of accidental releases of radioactive materials.

(b) Hydrology

If pool water leaks to the ground, adequate time should be available to sink survey wells for any monitoring that might be considered necessary after the leak occurs and the region to be monitored is defined. In addition, strategically located inspection wells should be sunk at the time of construction to check for subsurface water movement and possible outleakage.

h. Exclusion Area, Low Population Zone, Population Center Distance

The applicant should determine the exclusion area, low population zone, and population center distance using a method analogous to that given in § 100.11 of 10 CFR Part 100. This procedure involves an estimate of:

(1) The potential risk from the most severe upper limit accident and

(2) Dose rates at various points downwind due to the passage of the resulting radioactive cloud (under conservative atmospheric dispersion conditions).

No minimum values have been established for the size of the exclusion area, distance to the outer boundary of the low population zone (LPZ), or population center distance. Past practice has usually been to establish the population center distance as being at least 1 1/3 times the distance from the installation to the outer boundary of the LPZ. Typically, the distance to the boundary of the LPZ is about 3 miles.

The applicant should identify industrial, military, or other installations in the area with which the ISFSI may potentially interact.

i. Accident Analysis

The considerations of normal operations, off-standard conditions, design basis accidents, and natural phenomena provide part of the technical basis for assessing the suitability of structures, equipment, and components relative to candidate sites. The accident analyses complement and supplement the other analyses by considering the possible effects of events that are characteristically infrequent, sudden, and potentially serious incidents. Such events include:

(1) Leaking fuel assemblies,

(2) Fire,

(3) Loss of coolant or cooling capability,

(4) Dropped fuel assembly shipping cask during cask handling operations,

(5) Missile penetration of the storage building with fuel damaged in storage,

(6) Natural phenomena,

(7) Very low probability accidents (such as aircraft crashes).

The applicant should perform detailed engineering analyses of such accidents and their calculated potential effects in terms of radiation dose commitment to individuals and populations within the region that might be affected. Such analyses will provide the technical basis for judging the suitability of the selected site and the proposed plant design.

3. Design Considerations

The ANSI draft standard N305, Revision 7, dated November 8, 1974,* "Design Objectives for Highly Radioactive Solid Material Handling and Storage Facilities in a Reprocessing Plant," is applicable to an ISFSI with the following exceptions and clarifications:

"Section 2, Glossary of Terms":

The terms "Operating Basis Earthquake" (OBE) and "Safe Shutdown Earthquake" (SSE) are not applicable to an ISFSI. Rather, the term Design Earthquake as defined in Section C.2.c. of this document is applicable.

"Section 3, Structural Criteria":

"3.1.2.2 Missiles" – The missiles of interest are those that could rupture fuel within the pool or could damage equipment or structures that could fall into the pool and potentially rupture stored fuel.

In addition, the Regulatory staff considers the following design requirements to be applicable:

a. The design should preclude cask handling cranes passing over the fuel storage pools.

b. The building itself need not be designed to withstand high winds, provided critical equipment is protected.

c. The design basis for the ventilation system should be defined. This definition should include a description of the emergency air cleanup system used to accommodate ruptured fuel. Calculations should be based on the design basis fuel characteristics.

d. The heat removal system pumps, heat exchangers, and associated piping should be protected from credible accidents and have a backup power supply. However, if the applicant can show that under emergency conditions the pool structure can stand the stresses imposed, that the consequences of any loss of normal cooling capability will not lead to excessive radiation doses, and

*Copies of this draft standard may be obtained from the American Institute of Chemical Engineers, 345 E. 47th St., New York, N.Y. 10017.

that there is an assured source of pool makeup water. cooling by boiling of the pool water is acceptable and the cooling system need not be protected from accidents. The makeup system should be capable of withstanding any credible accident or a backup water system capability should be provided. If the backup system is not permanently installed, the applicant should show that the time required to implement the system's use is less than the time required for hazardous conditions to develop. If the pool structure cannot withstand the stress of water boiling, the cooling system should be designed and built to withstand any credible site-related natural phenomena. The makeup coolant water system should be equally reliable.

e. Onsite radioactive waste treatment facilities should be provided. These facilities should be designed to render all site generated wastes into a form suitable for interim storage and ultimate final disposal.

f. Provisions should be made for (1) receipt of casks under abnormal circumstances, such as loss of coolant, and (2) expected cask maintenance, repair, and modification activities.

g. A cask drop analysis should be made. This analysis indicates the need to provide a shock absorber in the bottom of the cask unloading pool (CUP).

h. The storage pools should be of modular design. Each module should have a maximum capacity of about 500 tons of spent fuel.

4. Physical Protection

Some of the guidance on physical protection provided in Regulatory Guides 5.7, 5.12, 5.20, and 5.30 is applicable to an ISFSI. Regulatory Guide 5.7, "Control of Personnel Access to Protected Areas, Vital Areas, and Material Access Areas," is applicable for those parts related to material access areas (i.e., sections D.2, D.3, and D.5.b). Regulatory Guide 5.12, "General Use of Locks in the Protection and Control of Facilities and Special Nuclear Materials," and Regulatory Guide 5.20, "Training, Equipping, and Qualifying of Guards and Watchmen," are applicable in their entirety. Regulatory Guide 5.30, "Materials Protection Contingency Measures for Uranium and Plutonium Fuel Manufacturing Plants," is generally applicable except for those parts regarding emergency protection measures that affect activities appropriate only to material access areas.

a. Vital Areas and Vital Equipment

Several specific areas at an ISFSI should be designated vital areas because of their importance for protection against sabotage:

(1) The cask unloading area should be a separate pool connected by a canal to the main storage pool system. The unloading pool should be designated a vital area.

(2) The spent fuel storage area should be designated a vital area. It includes the pool system consisting of the water containment structure and the supporting auxiliary systems used to maintain appropriate radiation shielding and cooling. Vital equipment in this area includes the nuclear fuel in storage, fuel storage racks, radiation monitoring and alarm systems for fuel cladding leakage, pool water leakage detection system and liquid level monitors, pool water loss makeup and cleanup systems, decay heat removal system, ventilation and confinement system, and emergency systems for purposes such as fire protection.

(3) The onsite auxiliary power supply system, regardless of its location, is considered vital.

(4) The onsite central alarm stations should be designated vital areas. Vital equipment in these areas includes communication equipment; primary control and annunciation equipment for alarms; metal and explosive detectors; card-key readers; closed circuit television; and an independent power supply system (i.e., backup or emegency power).

b. Physical Protection Design Criteria

(1) The design of an ISFSI should be based on the physical protection criteria set forth for fuel reprocessing plants in proposed Appendix Q to 10 CFR Part 50.*

(2) The design, fabrication, erecting, and testing of structures, systems, and components important to physical protection of the facility should be conducted in accordance with an acceptable quality assurance program, as outlined in 10 CFR Part 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants."

(3) The concept of isolation (e.g., automation, remote handling, and controlled access) should be incorporated into the design. The isolation should limit access to vital areas or equipment to only those individuals who require access for essential purposes or for performance of duty.

(4) The location and arrangement of equipment in a vital area should be evaluated with respect to the need for the equipment to be contained in that location and the capability for regular testing and inspection. Equipment other than process or vital equipment should not be located in a vital area.

(5) Equipment used to store, transfer, or protect material or to protect the plant should be designed to facilitate maintenance and testing so that compliance with applicable regulations and license conditions can be verified.

(6) The double barrier concept, controlled access, monitored isolation zones, designation of vital areas, and the use of keys, locks, and combinations should be integrated into the facility layout and design.

(7) Isolation zones should be monitored to provide timely detection of intrusion and to permit

*39 FR 26293, July 18, 1974.

subsequent guard action and notification of the local law enforcement agencies (LLEA).

(8) Isolation zones and clear areas between barriers should be illuminated to at least 0.2 foot-candle.

(9) The design for access control of personnel, packages, and vehicles through physical barriers should include provisions for verifying identity and authority, alarming emergency exits, operating unmanned exits, searching packages and individuals upon entering, and detecting firearms, explosives, or incendiary devices.

(10) The design should preclude simultaneous handling of shipments of irradiated fuel and receipt of materials other than irradiated fuel in a single area.

(11) The facility should be designed to permit continuous surveillance of occupied vital areas and alarming of unoccupied vital areas.

(12) The facility should provide backup means such as emergency power and redundant hardware. It should accommodate alternative procedures to provide continued protection in such events as power failure, equipment malfunction, or individual guard incapacitation.

(13) Alarm systems should be designed to meet performance and reliability characteristics described in §73.50(d)(1).

(14) Communications equipment for use by plant personnel and the LLEA should be designed with appropriate redundancy and flexibility, as described in §73.50(e)(1) through (4).

c. Security Plan

A two-part security plan should be submitted with a license application for an ISFSI. As a minimum, the following elements should be addressed:

(1) Security force equipment, organization, responsibilities, and procedures.

(2) Integration of security provisions with the site and installation layout.

(3) A description of the physical protection features of the installation.

(4) Security areas, including those protected by physical barriers and isolation zones; vital areas and equipment.

(5) Access monitors and controls for personnel, vehicles, and packages; a badge system; access authorization and registration; personnel escort; and the use of keys, locks, and combinations.

(6) Surveillance systems, including intrusion and detection alarms.

(7) Central alarm and communication systems.

(8) Response capability assessment and followup for alarms and threats.

(9) Availability of assistance from local law enforcement agencies.

(10) Testing and inspection of security related equipment and devices.

(11) Maintenance of control records.

(12) Security audit program.

D. IMPLEMENTATION

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

Except in those cases in which the applicant proposes an alternative method for complying with specified portions of the Commission's regulations, the methods described herein will be used in the evaluation of license applications docketed after January 1, 1975.

APPENDIX A

ANNEX B to 10 CFR Part 70, Licenses
"Emergency Plan"

MINIMUM REQUIREMENTS FOR LICENSEE'S PLANS FOR COPING WITH RADIATION EMERGENCIES

The licensee shall develop and maintain an emergency plan and implementing procedures for coping with radiation emergencies which shall include, but not necessarily be limited to, the following:

1. An organization for coping with radiation emergencies, in which specific authorities, responsibilities, and duties are clearly defined and assigned. The methods used to assure that persons assigned specific authority and responsibility are initially qualified and are periodically trained so that they can continue to properly fulfill their duties should be specified. The means of notifying persons assigned to the organization in the event of an emergency and the means of notifying appropriate local, state, and Federal agencies so that emergency action beyond the site boundary may be taken should be specified.

2. A list of employees of the licensee (by position), other than those assigned to the emergency organization, who have any special qualifications for coping with emergency conditions. A similar list shall be made of other persons whose assistance may be needed. The special qualifications of these employees and persons shall be specified. All of the foregoing lists shall be available to the individuals responsible for directing the action necessary to cope with the emergency.

3. The actions planned to protect the health and safety of individuals and to prevent damage to property both within and outside the site boundary in the event of various types of emergencies that can be anticipated, i.e., internal accidents such as criticality, fire, and explosions, and natural occurrences such as floods, tornadoes, and earthquakes. This should include the means for determining: (i) the magnitude of the release of radioactive materials, including guidelines for evaluating the need for notification and participation of local, state and Federal agencies, and (ii) the type and extent of protective action to be taken within and outside the site boundary to protect health and safety and prevent damage to property.

4. The post-accident recovery and reentry actions including guidelines for implementing these actions which shall include (i) corrective actions that may be necessary to terminate or minimize the consequences of the accident, (ii) criteria for plant reentry, (iii) securing the accident area from inadvertent or unauthorized reentry, (iv) and resumption of operations.

5. Procedures for notifying and agreements to be reached with local, state, and Federal officials for the early warning of the public and for appropriate protective measures should such measures become necessary or desirable.

6. Provisions for maintaining up to date: (i) the organization for coping with emergencies, (ii) the procedures for use in emergencies, and (iii) the lists of persons with special qualifications for coping with emergency conditions.

7. The specifications for emergency first aid and personnel decontamination facilities, including:
   (i) Identification of individuals directly involved in the accident;
   (ii) Equipment at the site for personnel monitoring;
   (iii) Facilities and supplies at the site for decontamination of personnel;
   (iv) Facilities and medical supplies at the site for appropriate emergency first aid treatment;
   (v) Arrangements for the services of a physician and other medical personnel qualified to handle radiation emergencies; and
   (vi) Arrangements for transportation of injured or contaminated individuals to treatment facilities outside the site boundary.

8. Arrangements for treatment of individuals at treatment facilities outside the site boundary.

9. Provisions for testing, by periodic drills, of radiation emergency plans to assure that employees of the licensee are familiar with their specific duties. Provisions for participation in the drills by other persons whose assistance may be needed in the event of a radiation emergency shall be included.

10. The provisions for the training of persons other than employees of the licensee whose assistance may be needed in the event of a radiation emergency.

11. Provisions for maintenance and storage of emergency equipment, considering the various types of accidents that can be anticipated, also, the performance criteria of the various types of equipment.

The licensee's *emergency plan* shall consist of a document providing the objectives and the bases for the actions to be taken to cope with various types of accidents which affect, or threaten the health and safety of the general public, employees of the licensee or other persons temporarily or permanently assigned to the facility. It should specify the objectives to be met by the implementing procedures and should assign organizational and individual responsibilities to achieve such objectives.

Emergency procedures shall consist of a document defining in detail the implementation actions and methods necessary to achieve the objectives of the emergency plan for each set of circumstances considered in the emergency plan. To the extent possible these two documents should be separated.