



U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

9.1.5 OVERHEAD HEAVY LOAD HANDLING SYSTEMS

REVIEW RESPONSIBILITIES

Primary - Organization responsible for the review of new and spent fuel storage and handling

Secondary - Organization responsible for the review of design analysis and structural integrity

I. AREAS OF REVIEW

The primary organization reviews overhead heavy load handling systems (OHLHS) consisting of all components and equipment for moving all heavy loads (i.e., loads weighing more than one fuel assembly and its handling device) at the plant site for compliance with the requirements of General Design Criteria (GDCs) 1, 2, 4, and 5. The main emphasis in the OHLHS review is on critical load handling where inadvertent operations or equipment malfunctions, separately or in combination, could cause a release of radioactivity, a criticality accident, inability to cool fuel within the reactor vessel or spent fuel pool or could prevent safe shutdown of the reactor.

The specific areas of review are as follows:

1. The design layout, which shows the geometric arrangement of the handling equipment and important plant features, to determine whether the various handling operations can be performed safely.
2. The loads to be handled and the devices to be used in hoisting and moving the loads.
3. Compliance with general programmatic guidelines for design, operation, testing, maintenance, and inspection as specified in Section 5.1.1 of NUREG-0612.
4. Verification that one of these three safety guidelines is followed:

Revision 1 - March 2007

USNRC STANDARD REVIEW PLAN

This Standard Review Plan, NUREG-0800, has been prepared to establish criteria that the U.S. Nuclear Regulatory Commission staff responsible for the review of applications to construct and operate nuclear power plants intends to use in evaluating whether an applicant/licensee meets the NRC's regulations. The Standard Review Plan is not a substitute for the NRC's regulations, and compliance with it is not required. However, an applicant is required to identify differences between the design features, analytical techniques, and procedural measures proposed for its facility and the SRP acceptance criteria and evaluate how the proposed alternatives to the SRP acceptance criteria provide an acceptable method of complying with the NRC regulations.

The standard review plan sections are numbered in accordance with corresponding sections in Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants (LWR Edition)." Not all sections of Regulatory Guide 1.70 have a corresponding review plan section. The SRP sections applicable to a combined license application for a new light-water reactor (LWR) are based on Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)."

These documents are made available to the public as part of the NRC's policy to inform the nuclear industry and the general public of regulatory procedures and policies. Individual sections of NUREG-0800 will be revised periodically, as appropriate, to accommodate comments and to reflect new information and experience. Comments may be submitted electronically by email to NRR_SRP@nrc.gov.

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- A. Movement of the OHLHS is restricted by design or interlocks to areas away from stored fuel and equipment necessary for the safe shutdown of the reactor.
 - B. The consequences of a load drop have been evaluated to ensure that it could neither damage stored irradiated fuel to the extent that a significant off-site release would occur nor preclude operation of sufficient equipment to achieve safe shutdown.
 - C. The probability for a load drop is minimized by an overhead handling system designed to comply with the guidelines of NUREG-0554 and lifting devices that comply with American National Standards Institute (ANSI) N14.6 or an alternative based on American Society of Mechanical Engineers (ASME) B30.9. An overhead handling system that complies with ASME NOG-1 criteria for Type 1 cranes is an acceptable method for compliance with the NUREG-0554 guidelines.
5. Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC). For design certification (DC) and combined license (COL) reviews, the staff reviews the applicant's proposed ITAAC information associated with the structures, systems, and components (SSCs) related to this SRP section in accordance with SRP Section 14.3, "Inspections, Tests, Analyses, and Acceptance Criteria." The staff recognizes that the review of ITAAC cannot be completed until after the rest of this portion of the application has been reviewed against acceptance criteria contained in this SRP section. Furthermore, the staff reviews the ITAAC to ensure that all SSCs in this area of review are identified and addressed as appropriate in accordance with SRP Section 14.3.
6. COL Action Items and Certification Requirements and Restrictions. For a DC application, the review will also address COL action items and requirements and restrictions (e.g., interface requirements and site parameters).
- For a COL application referencing a DC, a COL applicant must address COL action items (referred to as COL license information in certain DCs) included in the referenced DC. Additionally, a COL applicant must address requirements and restrictions (e.g., interface requirements and site parameters) included in the referenced DC.

Review Interfaces

Other SRP sections interface with this section as follows:

- 1. Sections 3.2.1 and 3.2.2: review of the seismic and quality group classifications for system components.
- 2. Sections 3.7.1 through 3.7.4, 3.8.4, and 3.8.5: review of the design analyses, procedures, and criteria for the ability of seismic Category I structures housing the system and supporting systems to withstand the effects of natural phenomena like the safe shutdown earthquake.
- 3. Sections 3.9.1 through 3.9.3: review of codes and standards applied to the design of components, piping and structures.
- 4. Section 3.10: review of the seismic qualification of Category I instrumentation and electrical equipment.
- 5. Section 17.5: review of the quality assurance program implementation.

The specific acceptance criteria and review procedures are contained in the referenced SRP sections.

II. ACCEPTANCE CRITERIA

Requirements

Acceptance criteria are based on meeting the relevant requirements of the following Commission regulations:

1. GDC 1 of Appendix A to 10 CFR Part 50 as to the design, fabrication, and testing of SSCs important to safety to maintain quality standards.
2. GDC 2 as to the ability of structures, equipment, and mechanisms to withstand the effects of earthquakes.
3. GDC 4 as to protection of safety-related equipment from the effects of internally-generated missiles (i.e., dropped loads).
4. GDC 5 as to the sharing of equipment and components important to safety.
5. 10 CFR 52.47(b)(1), which requires that a DC application contain the proposed inspections, tests, analyses, and acceptance criteria (ITAAC) that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the design certification is built and will operate in accordance with the design certification, the provisions of the Atomic Energy Act, and the NRC's regulations.
6. 10 CFR 52.80(a), which requires that a COL application contain the proposed inspections, tests, and analyses, including those applicable to emergency planning, that the licensee shall perform, and the acceptance criteria that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, the facility has been constructed and will operate in conformity with the combined license, the provisions of the Atomic Energy Act, and the NRC's regulations.

SRP Acceptance Criteria

Specific SRP acceptance criteria acceptable to meet the relevant requirements of the NRC's regulations identified above are as follows for the review described in this SRP section. The SRP is not a substitute for the NRC's regulations, and compliance with it is not required. However, an applicant is required to identify differences between the design features, analytical techniques, and procedural measures proposed for its facility and the SRP acceptance criteria and evaluate how the proposed alternatives to the SRP acceptance criteria provide acceptable methods of compliance with the NRC regulations.

1. Acceptance for meeting the relevant aspects of GDC 1 is based in part on NUREG-0554 for overhead handling systems and ANSI N14.6 or ASME B30.9 for lifting devices.
2. Acceptance for meeting the relevant aspects of GDC 2 is based in part on position C.2 of RG 1.29 and Section 2.5 of NUREG-0554.
3. Acceptance for meeting the relevant aspects of GDC 4 is based in part on position C.5 of RG 1.13.
4. Acceptance for meeting the relevant aspects of GDC 5 is embodied within the other acceptance criteria.

Technical Rationale

The technical rationale for application of these acceptance criteria to the areas of review addressed by this SRP section is discussed in the following paragraphs:

1. GDC 1 requires that SSCs important to safety be designed, fabricated, erected, and tested to quality standards.

GDC 1 applies to SRP Section 9.1.5 because it specifies that the OHLHS and equipment in and around the area of the OHLHS should be properly designed, fabricated, and installed to reduce the likelihood of a single failure. A failure that could cause the release of radioactive materials from damaged irradiated fuel, a criticality accident, or damage to essential safe-shutdown equipment could cause unacceptable radiation exposures.

These requirements provide assurance that SSCs of the OHLHS will perform their functions safely.

2. GDC 2 requires that SSCs important to safety be designed to resist the effects of natural phenomena like earthquakes.

GDC 2 applies to SRP Section 9.1.5 because it specifies the natural phenomenon (i.e., earthquake) that must be considered in the design of the OHLHS. If not considered, an earthquake could overload OHLHS SSCs to the extent that it could cause an unsafe condition (e.g., a dropped heavy load in a critical area). The potential release of radioactive materials from damage to irradiated fuel, a criticality accident, or damage to essential safe-shutdown equipment could cause unacceptable radiation exposures. RG 1.29 position C.2 and Section 2.5 of NUREG-0554 provide guidance for meeting these requirements.

These requirements provide assurance that SSCs of the OHLHS will perform their functions safely.

3. GDC 4 requires protection for SSCs important to safety against the effects of internally-generated missiles.

GDC 4 applies to SRP Section 9.1.5 because GDC 4 specifies protection against the effects of internally-generated missiles (i.e., dropped loads). A dropped heavy load in a critical area could cause a release of radioactive materials, a criticality accident, or inability to cool fuel within the reactor vessel or spent fuel pool or could prevent safe shutdown of the reactor. Position C.5 of RG 1.13 provides guidance for meeting these requirements in spent fuel storage areas.

These requirements provide assurance that SSCs associated with the OHLHS will perform their functions safely.

4. GDC 5 requires that SSCs important to safety not be shared by nuclear power units unless such sharing can be shown not to significantly impair their ability to perform safety functions, including, in an accident in one unit, an orderly shutdown and cooldown of the remaining units.

GDC 5 applies because the OHLHS may be shared in multiple-unit plants. The OHLHS must be designed such that credible load handling events do not adversely affect the safe storage of irradiated fuel or the capability to shut down and cool down any operating unit at the site.

These requirements provide assurance that personnel working with the OHLHS work under adequately safe conditions with exposure to radiation within safe limits.

III. REVIEW PROCEDURES

The reviewer will select material from the procedures described below, as may be appropriate for a particular case.

These review procedures are based on the identified SRP acceptance criteria. For deviations from these acceptance criteria, the staff should review the applicant's evaluation of how the proposed alternatives provide an acceptable method of complying with the relevant NRC requirements identified in Subsection II.

The general objective of the review is to confirm that either the OHLHS has been designed for a highly reliable handling system or the potential consequences of a dropped load have been evaluated for acceptable consequences.

1. The licensee describes the physical arrangement of heavy load handling systems for stored fuel and safe shutdown equipment.
2. The licensee describes the loads to be handled by the systems and lifting devices to be used with those loads.
3. The licensee describes a heavy load handling program consistent with the NRC general programmatic guidelines for design, operation, testing, maintenance, and inspection of heavy handling systems. The intent is to reduce the probability and mitigate the consequences of an accidental load drop. The following guidelines should be implemented for heavy load handling in all areas of the facility housing safety-related SSCs:
 - A. Safe load paths should be defined for movement of heavy loads to minimize the potential for a load drop on irradiated fuel in the reactor vessel or spent fuel pool or on safe shutdown equipment. Paths should be defined clearly in procedures and equipment layout drawings.
 - B. Procedures should cover load handling operations for heavy loads in the proximity of irradiated fuel or safe shutdown equipment. Procedures should include (i) identification of required equipment, (ii) inspection and acceptance criteria, (iii) steps to be followed in handling load, (iv) the safe load path, and (v) other precautions.
 - C. Operators should be trained and qualified and conduct themselves in accordance with chapter 2-3.1 of ASME B30.2-2005, "Overhead and Gantry Cranes."
 - D. The crane should be inspected, tested, and maintained in accordance with chapter 2-2 of ASME B30.2-2005 "Overhead and Gantry Cranes" prior to use.
 - E. Special lifting devices should satisfy the criteria of ANSI N14.6 or, if special lifting devices are not used, slings should be selected to satisfy the criteria of ASME B30.9.
 - F. The crane should be designed to the criteria specified in CMAA-70, 2000 and Chapter 2-1 of ASME B30.2-2005.

4. The licensee describes a method for satisfying one of the following criteria:
- A. Mechanical stops or electrical interlocks to prevent movement of heavy loads over irradiated fuel or in the proximity of equipment essential for safe shutdown (i.e., a single load drop should not disable redundant trains of a system necessary for safe shutdown).
 - B. The licensee demonstrates by analysis that:
 - i. Releases of radioactive material from damage to spent fuel based on calculations involving accidental dropping of a heavy load would be equal to or less than 1/4 the limits of 300 rem thyroid, 25 rem whole body as stated in 10 CFR Part 100.
 - ii. Damage to fuel or fuel storage racks from a dropped heavy load would not cause a configuration of the fuel causing K_{eff} to exceed .95.
 - iii. Damage to the reactor vessel or spent fuel pool from a dropped load would not cause water leakage that uncovers the fuel.
 - iv. Damage to equipment will be limited in redundant or safe shutdown paths with no loss of safe shutdown functions.
 - C. The likelihood of failure is extremely low due to a single failure-proof handling system. A single failure-proof handling system consists of the following two elements:
 - i. The crane should be designed to the criteria of NUREG-0554. Cranes designed to the criteria of ASME NOG-1 2004 for a Type 1 crane are acceptable under the guidelines of NUREG-0554 for construction of a single failure-proof crane. Consistent with Paragraph 10 of NUREG-0554, a quality assurance program should cover the procurement, design, fabrication, installation, inspection, testing, and operation of the crane. The program should include at least the following elements: (1) design and procurement document control; (2) instructions, procedures, and drawings; (3) control of purchased material, equipment, and services; (4) inspection; (5) testing and test control; (6) non-conforming items; (7) corrective action; and (8) records.
 - ii. The lifting devices should be selected to satisfy either of the following criteria:
 - (1) A special lifting device that satisfies ANSI N14.6 should be used for recurrent load movements in critical areas (reactor head lifting, reactor vessel internals, spent fuel casks). The lifting device should have either dual, independent load paths or a single load path with twice the design safety factor specified by ANSI N14.6 for the load.
 - (2) Slings should satisfy the criteria of ASME B30.9 and be constructed of metallic material (chain or wire rope). The slings should be either (a) configured to provide dual or redundant load paths or (b) selected to support a load twice the weight of the handled load.

5. For review of a DC application, the reviewer should follow the above procedures to verify that the design, including requirements and restrictions (e.g., interface requirements and site parameters), set forth in the final safety analysis report (FSAR) meets the acceptance criteria. DCs have referred to the FSAR as the design control document (DCD). The reviewer should also consider the appropriateness of identified COL action items. The reviewer may identify additional COL action items; however, to ensure these COL action items are addressed during a COL application, they should be added to the DC FSAR.

For review of a COL application, the scope of the review is dependent on whether the COL applicant references a DC, an early site permit (ESP) or other NRC approvals (e.g., manufacturing license, site suitability report or topical report).

6. For review of both DC and COL applications, SRP Section 14.3 should be followed for the review of ITAAC. The review of ITAAC cannot be completed until after the completion of this section.

IV. EVALUATION FINDINGS

The reviewer verifies that the applicant has provided sufficient information and that the review and calculations (if applicable) support conclusions of the following type to be included in the staff's safety evaluation report. The reviewer also states the bases for those conclusions.

The OHLHS includes all components and equipment for the handling of all heavy loads at the plant site over the lifetime of the facility. After review of the applicant's proposed design criteria and design bases for the OHLHS, the staff concludes that the design of the OHLHS and supporting systems complies with NRC regulations as set forth in GDCs 1, 2, 4, and 5. This conclusion is based on the following findings:

1. The requirements of GDC 1 are met as to the design, fabrication, erection, and testing of critical portions of the OHLHS because they are built in accordance with an acceptable quality assurance program.
2. The requirements of GDC 2 are met as to protection against the effects of earthquakes because the handling system satisfies position C.2 of RG 1.29. In meeting Criterion 2, cranes that may handle loads over spent fuel or safe shutdown equipment are designed to satisfy Section 2.5 of NUREG-0554.
3. The requirements of GDC 4 are met as to prevention of internally generated missiles that could prevent safe shutdown or cause an unacceptable release of radioactivity, a criticality accident, or inability to cool the fuel in the reactor vessel or spent fuel storage pool. To meet Criterion 4 the applicant has followed general programmatic guidelines for safe handling of heavy loads and has protected stored fuel and safe shutdown equipment with either constraints on the motion of heavy loads, barriers demonstrated by analysis to withstand a load drop, or a highly reliable OHLHS in compliance with the guidelines of NUREG-0554. The application of ASME NOG-1 2004 criteria for Type 1 cranes to the design of the OHLHS is an acceptable method for satisfying the guidelines of NUREG-0554.
4. The requirements of GDC 5 are met because the licensee has followed general programmatic guidelines and has protected stored fuel and safe shutdown equipment with load motion constraints, barriers demonstrated by analysis to withstand load drop, or a highly reliable OHLHS.

For DC and COL reviews, the findings will also summarize the staff's evaluation of requirements and restrictions (e.g., interface requirements and site parameters) and COL action items relevant to this SRP section.

In addition, to the extent that the review is not discussed in other SER sections, the findings will summarize the staff's evaluation of the ITAAC, including design acceptance criteria, as applicable.

V. IMPLEMENTATION

The staff will use this SRP section in performing safety evaluations of DC applications and license applications submitted by applicants pursuant to 10 CFR Part 50 or 10 CFR Part 52. Except when the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the staff will use the method described herein to evaluate conformance with Commission regulations.

The provisions of this SRP section apply to reviews of applications submitted six months or more after the date of issuance of this SRP section, unless superseded by a later revision.

VI. REFERENCES

1. 10 CFR Part 50, Appendix A, GDC 1, "Quality Standards and Records."
2. 10 CFR Part 50, Appendix A, GDC 2, "Design Bases for Protection Against Natural Phenomena."
3. 10 CFR Part 50, Appendix A, GDC 4, "Environmental and Dynamic Effects Design Bases."
4. 10 CFR Part 50, Appendix A, GDC 5, "Sharing of Structures, Systems and Components."
5. RG 1.13, "Spent Fuel Storage Facility Design Bases."
6. RG 1.29, "Seismic Design Classification."
7. NUREG-0554, "Single-Failure-Proof Cranes for Nuclear Power Plants."
8. NUREG-0612, "Control of Heavy Loads At Nuclear Power Plants."
9. NRC Inspection Manual Chapter IMC-2504, "Construction Inspection Program - Non-ITAAC Inspections," issued April 25, 2006.
10. ANSI N14.6-1993, "Radioactive Materials - Special Lifting Devices for Shipping Containers Weighing 10 000 Pounds (4500 kg) or More."
11. ASME B30.2-2005, "Overhead and Gantry Cranes - Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist."
12. ASME B30.9-2003, "Slings."
13. ASME NOG1-2004, "Rules for Construction of Overhead and Gantry Cranes."

PAPERWORK REDUCTION ACT STATEMENT

The information collections contained in the Standard Review Plan are covered by the requirements of 10 CFR Part 50 and 10 CFR Part 52, and were approved by the Office of Management and Budget, approval number 3150-0011 and 3150-0151.

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