9 ACCEPTANCE TESTS AND MAINTENANCE PROGRAM EVALUATION

9.1 Review Objective

The objective of this U.S. Nuclear Regulatory Commission (NRC) acceptance test and maintenance program evaluation is to verify that the acceptance tests for the packaging, as documented in the application, meet the requirements of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 71, "Packaging and Transportation of Radioactive Material." This review will also verify that the maintenance program, as documented in the application, is adequate to assure packaging performance while in service.

9.2 Areas of Review

The NRC staff should review the application to verify that it adequately describes the package and includes adequately detailed drawings. In general, the staff should review the following information to determine the adequacy of the package description:

- acceptance tests
    - visual inspections and measurements
    - weld examinations
    - structural and pressure tests
    - leakage tests
    - component and material tests
    - neutron-absorber and moderator tests
    - shielding tests
    - thermal tests
- maintenance program
    - structural and pressure tests
    - leakage tests
    - component and materials tests
    - neutron-absorber and moderator tests
    - shielding tests
    - thermal tests
    - miscellaneous tests

9.3 Regulatory Requirements and Acceptance Criteria

This section summarizes those sections of 10 CFR Part 71 relevant to the review areas this standard review plan (SRP) chapter addresses. Table 9-1 provides a relationship between the relevant regulatory requirements and the areas of review. The NRC staff reviewer should refer to the exact language in the regulations.

Table 9-1 Relationship of Regulations and Areas of Review for Transportation Packages					
Area of Review	10 CFR Part 71 Regulations				
	71.31(c)	71.37(b)	71.85 (a)(b)(c)	71.87(b)(g)	71.93(b)
Acceptance tests	●	●	●	●	●
Maintenance program	●	●		●	●
Note: The bullet (●) indicates the entire regulation as listed in the column heading applies.					

9.3.1 Acceptance Tests

Before first use, each packaging must be subject to appropriate acceptance tests to verify that it was fabricated in accordance with its approved design and that its performance will meet the regulatory requirements of 10 CFR Part 71 and be consistent with the package's evaluations.

The application should discuss the package acceptance tests to be performed and the acceptance criteria to demonstrate structural, containment, shielding, criticality safety, and heat transfer performance.

The applicant should examine the components in accordance with appropriate codes and standards (see SRP Chapters 1, "General Information Evaluation;" 2, "Structural Evaluation;" and 7, "Materials Evaluation").

The applicant should perform leakage testing of the packaging in accordance with the American National Standards Institute (ANSI) N14.5, "Radioactive Materials—Leakage Tests on Packages for Shipment."

The applicant should conduct acceptance testing of lifting trunnions in accordance with NUREG-0612, "Control of Heavy Loads at Nuclear Power Plants," issued July 1980, ANSI N14.6, "Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4500 kg) or More for Nuclear Materials," or other appropriate code specification.

9.3.2 Maintenance Program

The maintenance program should include periodic testing requirements, inspections, and replacement criteria and schedules for replacements and repairs of components on an as-needed basis.

The maintenance program should be adequate to assure that the packaging will perform as intended throughout its time in service.

9.4 Review Procedures

The NRC reviewer should ensure that the application specifies appropriate acceptance tests and maintenance program for the package. Some information may be contained in the application appendices. The tests and programs specified in the Acceptance Tests and Maintenance Program section of the application are usually incorporated by reference into the certificate of compliance (CoC) as conditions of package approval. For additional guidance on specific package types, refer to the appropriate section of Appendix A, "Description, Safety

Features, and Areas of Review for Different Types of Radioactive Material Transportation Packages," to this SRP.

9.4.1 Acceptance Tests

The acceptance tests review is based in part on the descriptions and evaluations presented in the General Information, Structural Evaluation, Thermal Evaluation, Containment Evaluation, Shielding Evaluation, Criticality Evaluation, Materials Evaluation, and Operating Procedures sections of the application and follows the sequence established to evaluate the packaging against applicable 10 CFR Part 71 requirements. Examples of application information flow into and within the acceptance tests review are shown in Figure 9-1.

Acceptance tests should address tests required by regulation (e.g., a pressure test as defined in 10 CFR 71.85(b), by industry code/consensus standard [e.g., the ASME Boiler and Pressure Valve (B&PV) Code, the American National Standards Institute (ANSI)], and those particular to the design. The specificity of the information may vary but should include test details (e.g., test conditions and methods, acceptance criteria, sensitivity, repeatability) and should be sufficient to determine whether the test will provide the information needed to evaluate the adequacy of the packaging.

The level of detail provided in the application may be related to whether the test is defined by a code. For example, radiographic examination of welds that are defined and controlled by the ASME B&PV Code; therefore, the application does not need to include those details. In addition, other tests, such as leakage tests, may need to be described in more detail to ensure that the test setup and equipment are appropriate for the package seal design and the allowable leakage rate.

Verify that the application specifies that applicable tests (described below) are to be performed before the first use of the packaging. Information presented on each test should include, at a minimum, a description of the test, the test procedure, and the acceptance criteria. Confirm that the application identifies the established codes, standards, and specific provisions of the quality assurance (QA) program used in all aspects of the packaging testing.

Each package must be fabricated in accordance with the drawings listed in the CoC.

NUREG/CR-3854, "Fabrication Criteria for Shipping Containers," issued March 1985, provides additional guidance on acceptance tests.

9.4.1.1 Visual inspections and measurements

Ensure that the application indicates that visual inspections are performed to verify that the packaging was fabricated and assembled in accordance with the drawings referenced in the CoC and other items specified in the CoC. Verify that the application directs that the dimensions and tolerances specified on the drawings are confirmed by taking measurements.

9.4.1.2 Weld examinations

Verify that the application indicates that weld examinations are performed to verify fabrication in accordance with the drawings, codes, and standards specified in the application to control weld quality. Verify that the application directs that the location, type, and size of the welds are

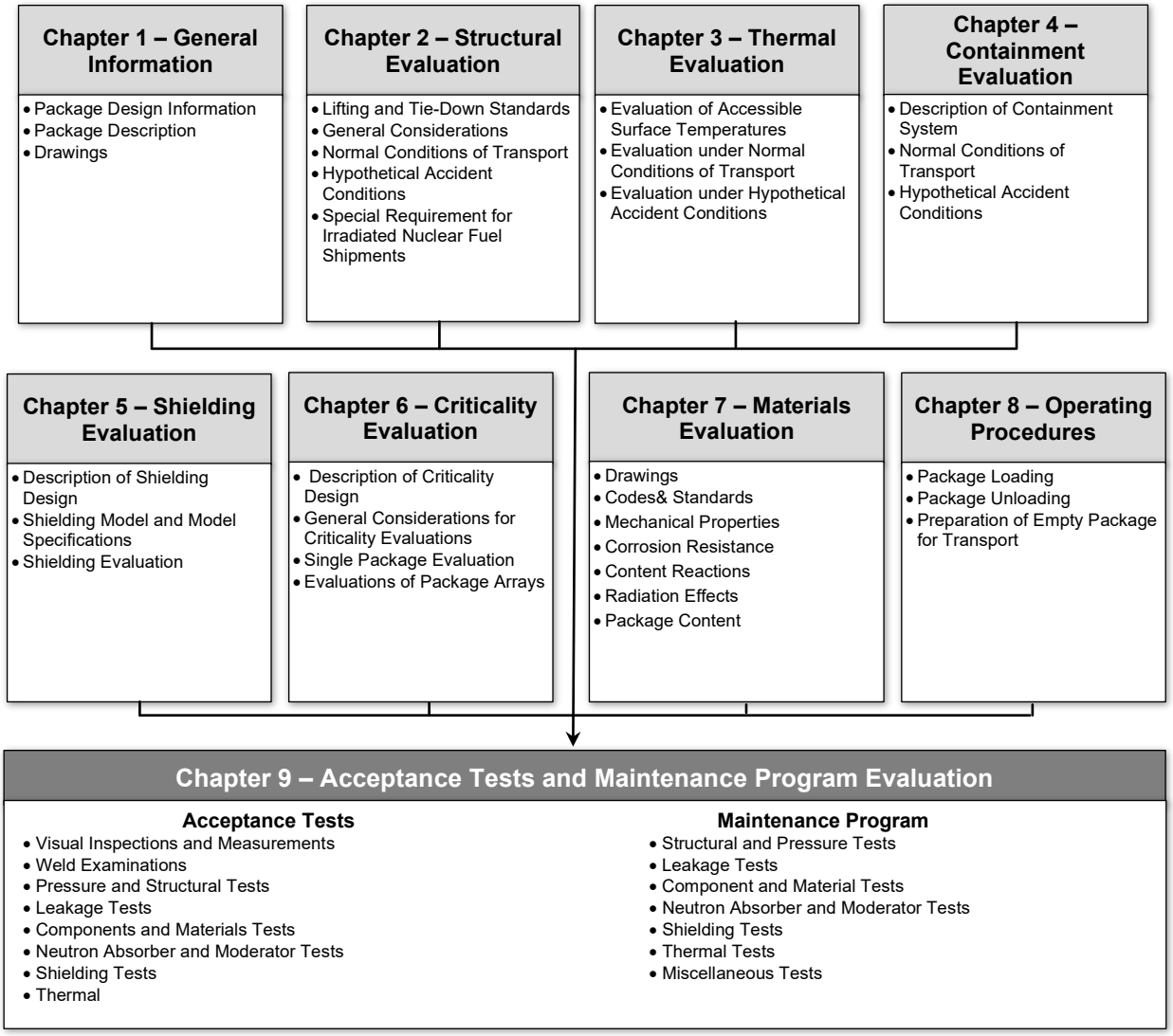

Figure 9-1 Information Flow for the Acceptance Tests and Maintenance Program Evaluation

confirmed by taking measurements. Verify other specifications for welds, examinations, and acceptance are confirmed as appropriate.

Additional guidance on welding criteria is provided in NUREG/CR-3019, "Welding Criteria for Use in the Fabrication of Radioactive Material Shipping Containers," issued March 1984.

9.4.1.3 Structural and pressure tests

Verify that the application identifies and describes the structural or pressure tests. Such tests shall comply with 10 CFR 71.85(b) and applicable codes or standards specified in the application. Confirm that the application indicates that structural testing of lifting trunnions shall be conducted in accordance with NUREG-0612, ANSI N14.6, or other appropriate specification.

9.4.1.4 Leakage tests

Verify that the containment system of the packaging is subjected to fabrication and leakage tests of the containment boundary. These tests should be performed during the fabrication process such that subsequent fabrication procedures do not adversely affect the integrity of the containment boundary. Verify that all closures, including drains and vents, are leak-tested. Ensure that the acceptable leakage criterion is consistent with that identified in the Containment Evaluation section of the application. The NRC, through Regulatory Guide 7.4, "Leakage Tests on Packages for Shipment of Radioactive Materials," endorses the methods and procedures of leakage rate testing described in ANSI N14.5.

9.4.1.5 Component and material tests

Confirm that the application specifies the appropriate tests and acceptance criteria for components that affect package performance. Examples of such components include seals, gaskets, valves, fluid transport systems, and rupture disks or other pressure-relief devices. Verify that the application states that the components shall be tested to meet the performance specifications shown on the engineering drawings of the package. Ensure that the application describes applicable QA procedures to follow when a test adversely affects the continued performance of a component. Such procedures should provide justification that the tested component is equivalent to the component that will be used in the packaging.

Also, for spent nuclear fuel packages that rely on moderator exclusion to demonstrate compliance with 10 CFR 71.55(e), ensure that the application includes tests that will adequately demonstrate that packaging components relied on as barriers to water in-leakage will perform as credited in the analysis (i.e., to criteria consistent with the evaluation to keep water out).

Verify that the SAR specifies the appropriate tests and acceptance criteria for packaging materials. Tests for insulating materials (e.g., foams, fiberboard) should assure that minimum specifications for density and isotopic content are achieved. Verify that the SAR states that the materials are tested to meet the performance specifications shown on the engineering drawings. See Section 7.4.4 of this SRP for additional information on mechanical properties.

9.4.1.6 Neutron-absorber and moderator tests

Confirm that the application specifies appropriate tests and acceptance criteria for any neutron absorbers and any moderators that are packaging components. The tests for the absorbers should verify the amount and distribution of neutron-absorber nuclides in the absorber materials. Appropriate tests depend upon the amount of credit for the absorber nuclides in the criticality analysis. The tests and acceptance criteria should be sufficient to confirm that the absorbers meet the materials specifications in the drawings referenced in the CoC for the credit given to the absorber nuclides in the criticality evaluation. The tests for moderators should be adequate to verify that the moderator material specifications meet the properties (e.g., density, isotopic content such as hydrogen content) credited in the criticality evaluation and specified in the drawings referenced in the CoC. Coordinate this review with the materials and criticality reviewers. Section 7.4.7 of this SRP includes detailed guidance regarding qualification and acceptance tests for neutron absorbers.

9.4.1.7 Shielding tests

Ensure that the application specifies appropriate shielding tests for gamma and neutron radiation. Confirm that the tests and acceptance criteria are sufficient to verify that the as-fabricated packaging shielding meets the minimum shielding effectiveness specified in the drawings referenced in the CoC and used in the shielding evaluation. This includes ensuring no voids or streaming paths exist in the shielding and that the shielding meets the specified dimensional and material specifications (e.g., minimum density, boron content, and hydrogen content of neutron shields). Coordinate with the shielding and materials reviewers to ensure the adequacy of the shielding tests. Chapter 5, "Shielding Evaluation," of this SRP includes guidance regarding acceptance tests for shielding components (e.g., Sections 5.4.1.1 and 5.4.3.2).

9.4.1.8 Thermal tests

Verify that the SAR specifies the appropriate tests to demonstrate the heat-transfer capability of the packaging. Verify that these tests confirm the heat-transfer characteristics and the performance predicted in the Thermal Evaluation section of the SAR.

9.4.2 Maintenance Program

The maintenance program review is based in part on the descriptions and evaluations presented in the General Information, Structural Evaluation, Thermal Evaluation, Containment Evaluation, Shielding Evaluation, Criticality Evaluation, Materials Evaluation, and Operating Procedures sections of the application and follows the sequence established to evaluate the packaging against applicable 10 CFR Part 71 requirements. Examples of application information flow into and within the maintenance program review are shown in Figure 9-1.

The maintenance program should be adequate to assure that packaging effectiveness is maintained throughout its time in service. The specificity of the information should be consistent with the importance of the maintenance in assuring this continued performance. Verify that maintenance tests and inspections, including those that follow below, are described with schedules and criteria for each test or minor refurbishment and replacement of parts, as applicable. Confirm that the established codes, standards, and specific provisions of the QA program used in all aspects of the maintenance of the packaging are identified.

9.4.2.1 Structural and pressure tests

Verify that the SAR identifies and describes any periodic structural or pressure tests. Such tests would generally be conducted according to codes, standards, or other procedures specified in the SAR. Confirm that the SAR specifies that structural testing of lifting trunnions shall be conducted in accordance with NUREG-0612, ANSI N14.6, or other appropriate specification.

9.4.2.2 Leakage tests

Verify that the containment system of the packaging is subjected to maintenance and periodic leakage tests. The NRC, through Regulatory Guide 7.4, endorses the methods and procedures of leakage rate testing described in ANSI N14.5. Ensure that the acceptable leakage criterion is consistent with that identified in the Containment Evaluation chapter of the SAR. Elastomeric seals should be replaced and leak tested within the 12-month period preceding shipment, and metal seals should be replaced after each use.

9.4.2.3 Component and materials tests

Verify that the SAR describes the periodic tests and replacement schedules for components, as appropriate. Such components include valves, rupture disks, and seals.

Also, for spent nuclear fuel packages that rely on moderator exclusion to demonstrate compliance with 10 CFR 71.55(e), ensure that the application includes tests that will adequately demonstrate that packaging components relied on as barriers to water in-leakage will perform as credited in the analysis (i.e., to criteria consistent with the evaluation to keep water out).

Confirm that the SAR identifies any process that could result in the deterioration of packaging materials such as reduction in hydrogen content of neutron shields and density changes of insulating materials. Verify that the SAR specifies appropriate tests and their acceptance criteria to ensure packaging effectiveness for each shipment.

9.4.2.4 Neutron-absorber and moderator tests

Verify that the application identifies any process that could result in the deterioration of neutron-absorbing material and any moderators that are packaging components and specifies the appropriate tests to ensure continued effectiveness of the absorbers and moderators in the package. Coordinate with the materials and criticality reviewers to determine the acceptability of the tests in the application.

9.4.2.5 Shielding tests

Verify that the application identifies any processes that could result in degradation of the shielding components and specifies appropriate periodic tests and acceptance criteria to ensure continued effectiveness of the shielding components. Coordinate with the shielding and materials reviewers to determine the acceptability of the tests in the application. Consideration should be given to materials changes that shielding components may undergo with time and use. Such changes include density changes and reduction of important material constituents (e.g., hydrogen) and physical changes (e.g., cracking) in polymer-based neutron shields. Chapter 5 of this SRP includes guidance regarding acceptance tests for shielding components (e.g., Sections 5.4.1.1 and 5.4.3.2) that is also useful for evaluating periodic maintenance tests for package shielding.

9.4.2.6 Thermal tests

Verify that the SAR specifies and describes the appropriate periodic tests to demonstrate the heat-transfer capability of the packaging during its time in service. Tests similar to the acceptance tests may be applicable. The typical interval for periodic thermal tests is 5 years.

9.4.2.7 Miscellaneous tests

Confirm that the SAR describes any additional tests that should be performed periodically on the package or its components.

9.5 Evaluation Findings

Prepare evaluation findings on satisfaction of the regulatory requirements in Section 9.3. If the documentation submitted with the application fully supports positive findings for each of the regulatory requirements, the statements of findings should be similar to the following:

F9-1 The staff has reviewed the identification of the codes, standards, and provisions of the QA program applicable to the package design and finds that they meet the requirements specified in 10 CFR 71.31(c) and 10 CFR 71.37(b).

F9-2 The staff has reviewed the description of the preliminary determinations for the package before first use and finds that it meets the requirements of 10 CFR 71.85 and 10 CFR 71.87(g).

F9-3 The staff has reviewed the identification of the codes, standards, and provisions of the QA program applicable to maintenance of the packaging and finds that it meets the requirements specified in 10 CFR 71.31(c) and 10 CFR 71.37(b).

F9-4 The staff has reviewed the description of the routine determinations for package use preceding transport and finds that they meet the requirements of 10 CFR 71.87(b) and 10 CFR 71.87(g).

The reviewer should provide a summary statement similar to the following:

> Based on review of the statements and representations in the application, the NRC staff finds that the acceptance tests and maintenance program have been adequately described and meet the requirements of 10 CFR Part 71.

9.6 References

10 CFR Part 71, “Packaging and Transportation of Radioactive Material.”

American Society of Mechanical Engineers (ASME) Boiler and Pressure (B&PV) Code, 2017. Section III, “Rules for Construction of Nuclear Facility Components.” Division 3, “Containments for Transportation & Storage of Spent Nuclear Fuel and High Level Radioactive Material & Waste”

American National Standards Institute, ANSI N14.5–2014, *Institute for Nuclear Materials Management*, “Radioactive Materials—Leakage Tests On Packages for Shipment,” New York, NY.

ANSI N14.6–1993, *Institute for Nuclear Materials Management*, “Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (45000 kg) or More for Nuclear Materials,” New York, NY.

NUREG-0612, U.S. Nuclear Regulatory Commission, “Control of Heavy Loads at Nuclear Power Plants,” July 1980, Agencywide Documents Access and Management System (ADAMS) Accession No. ML070250180.

NUREG/CR-3019, U.S. Nuclear Regulatory Commission, “Recommended Welding Criteria for Use in the Fabrication of Shipping Containers for Radioactive Materials,” UCR-L53044, Lawrence Livermore National Laboratory, Livermore, CA, March 1984.

NUREG/CR-3854, U.S. Nuclear Regulatory Commission, “Fabrication Criteria for Shipping Containers,” UCRL-53544, Lawrence Livermore National Laboratory, Livermore, CA, March 1985.

Regulatory Guide 7.4, U.S. Nuclear Regulatory Commission, “Leakage Tests on Packages for Shipment of Radioactive Materials,” ADAMS Accession No. ML112520023.