

**CERTIFICATE OF COMPLIANCE
FOR RADIOACTIVE MATERIAL PACKAGES**

1.	a. CERTIFICATE NUMBER	b. REVISION NUMBER	c. DOCKET NUMBER	d. PACKAGE IDENTIFICATION NUMBER	PAGE	PAGES
	9405	0	71-9405	USA/9405/B(U)-96	1	OF 3

2. PREAMBLE

- a. This certificate is issued to certify that the package (packaging and contents) described in Item 5 below meets the applicable safety standards set forth in Title 10, Code of Federal Regulations, Part 71, "Packaging and Transportation of Radioactive Material."
- b. This certificate does not relieve the consignor from compliance with any requirement of the regulations of the U.S. Department of Transportation or other applicable regulatory agencies, including the government of any country through or into which the package will be transported.

3. THIS CERTIFICATE IS ISSUED ON THE BASIS OF A SAFETY ANALYSIS REPORT OF THE PACKAGE DESIGN OR APPLICATION

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| <p>a. ISSUED TO (<i>Name and Address</i>)</p> <p>QSA Global, Inc.
40 North Avenue
Burlington, MA 01803</p> | <p>b. TITLE AND IDENTIFICATION OF REPORT OR APPLICATION</p> <p>Safety Analysis Report for the Model No. 1100
Transport Packages, Revision No. 0, dated
October 2024.</p> |
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4. CONDITIONS

This certificate is conditional upon fulfilling the requirements of 10 CFR Part 71, as applicable, and the conditions specified below.

5.

(a) Packaging

- (1) Model No. 1100
- (2) Description

The Model No. 1100 package is designed for use as an industrial radiography exposure device and as a transport package for Type B quantities of radioactive material in special form. The 1100 has a maximum capacity of 150 Curies of Iridium-192 or 150 Curies of Selenium-75.

The 1100 package, without the jacket, is cylindrical in shape with a diameter of 5 inches (127 mm) and a length of 13 inches (330 mm). With the jacket, the shape of the package is an extruded triangle that is 8.5 inches (226 mm) tall, 6.5 inches (168 mm) wide, and 13 inches (330 mm) long.

The weight of the 1100 is 44 pounds (20 kg) without the jacket, and 48 pounds (22 kg) with the jacket.

The major components of the package consist of a welded stainless steel cylindrical body, a depleted uranium shield, a rear plate with locking assembly, a front plate assembly, a containment system (special form source), and optional jacket.

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5(a)(2) Description (continued)

The depleted uranium shield is suspended inside the welded body between the endplate by brackets that are welded to the inside of each endplate. A copper spacer fills the gap between the shield and the bracket. An S-shaped titanium source tube is cast into the center of the shield to provide a cavity for the source wire assembly and shipping plug assembly to travel through during use.

The rear plate with locking assembly is attached to the welded body with four tamperproof screws through rivnuts assembled into the endplate. The front plate assembly is attached to the welded body with three tamperproof screws through rivnuts assembled into the endplate. The rear plate assembly consists of a source wire locking mechanism fastened to the rear plate. The front plate assembly consists of a shielded port mechanism contained within the front plate.

An optional polyurethane jacket covers the package cylinder, provides a handle and a stable base, and is attached to the shell cylinder by posts and screws located outside the shield cavity area.

(3) Drawings

The packaging is constructed in accordance with the QSA Global, Inc., drawing R1100-USER, Rev. A, sheets 1-4.

(b) Contents

(1) Type and form of material

Iridium-192 as a sealed source which meets the requirements of special form radioactive material.

Selenium-75 as a sealed source which meets the requirements of special form radioactive material.

(2) Maximum quantity of material per package

Ir-192: 150 Curies (5.55 TBq) (output).

Se-75: 150 Curies (5.55 TBq).

Output curies for Ir-192 are determined by measuring the source output at 1 meter and expressing its activity in curies derived from the following: 0.48 R/(hr-Ci) (Ref: American National Standards Institute N432-1980, "Radiological Safety for the Design and Construction of Apparatus for Gamma Radiography").

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5.(b) Contents (continued)

- (3) Maximum weight: 18 grams.
- (4) Maximum decay heat: 2.1 Watts.

6. In addition to the requirements of Subpart G of 10 CFR Part 71:

- (a) The package shall be prepared for shipment and operated in accordance with the Operating Procedures in Chapter 7.0 of the application; and,
- (b) The package must meet the Acceptance Tests and Maintenance Program of Chapter 8.0 of the application.

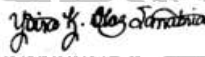
7. The package authorized by this certificate is hereby approved for use under the general license provisions of 10 CFR 71.17.

8. Expiration date: August 31, 2030.

REFERENCES

QSA Global, Inc., application "Model 1100 Type B(U) Transport Package", Revision No. 0, dated October 2024, as supplemented on February 11, 2025, and June 2, 2025.

FOR THE U.S. NUCLEAR REGULATORY COMMISSION



Signed by Diaz-Sanabria, Yoira
on 09/08/25

Yoira Diaz-Sanabria, Chief
Storage and Transportation Licensing Branch
Division of Fuel Management
Office of Nuclear Material Safety
and Safeguards

Date: September 8, 2025

SAFETY EVALUATION REPORT
Docket No. 71-9405
Model No. 1100
Certificate of Compliance No. 9405
Revision No. 0

SUMMARY

By letter dated October 3, 2024 (Agencywide Documents Access and Management System [ADAMS] Accession No. ML24284A277), as supplemented on February 11, 2025 (ML25050A245), and June 2, 2025 (ML25155A042) QSA Global (hereon referred to as QSA or the applicant) submitted an initial application for the Model 1100 transportation package (hereon referred to as Model 1100 or the package) design to the U.S. Nuclear Regulatory Commission (NRC) for review against the requirements of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 71.

NRC staff reviewed the application using the guidance in NUREG-2216, "Standard Review Plan for Transportation Packages for Spent Fuel and Radioactive Material" Based on the statements and representation in the application, as supplemented, and the conditions listed below, the staff agrees that the package meets the requirements of 10 CFR Part 71.

1.0 GENERAL INFORMATION

1.1 Package Description

The Model 1100 is designed for use as an industrial radiography exposure device and as a transport package for Type B quantities of radioactive material in special form. It has a maximum capacity of 150 Curies of Iridium-192 (Ir-192) or 150 Curies of Selenium-75 (Se-75).

The 1100 package, without the jacket, is cylindrical in shape with a diameter of 5 inches (127 mm) and a length of 13 inches (330 mm). With the jacket, the shape of the package is an extruded triangle that is 8.5 inches (226 mm) tall, 6.5 inches (168 mm) wide, and 13 inches (330 mm) long.

The weight of the Model 1100 is 20 kilograms (44 pounds) without the jacket, and 22 kilograms (48 pounds) with the jacket.

The major components of the package consist of a welded stainless steel cylindrical body, a depleted uranium shield, a rear plate with locking assembly, a front plate assembly, a containment system, and an optional jacket.

The depleted uranium (DU) shield is suspended inside the welded body between the endplates by brackets that are welded to the inside of each endplate. A copper spacer fills the gap between the shield and the bracket. An S-shaped titanium source tube is cast into the center of the shield to provide a cavity for the source wire assembly and shipping plug assembly to travel through during use.

The rear plate with locking assembly is attached to the welded body with four tamperproof screws through rivnuts assembled into the endplate. The front plate assembly is attached to the welded body with three tamperproof screws through rivnuts assembled into the endplate. The rear plate assembly consists of a source wire locking mechanism fastened to the rear plate. The front plate assembly consists of a shielded port mechanism contained within the front plate.

An optional polyurethane jacket covers the package cylinder, provides a handle and a stable base, and is attached to the shell cylinder by posts and screws located outside the shield cavity area.

1.2 Contents

The Model 1100 package is designed to transport special form capsules containing Ir-192 or Se-75. The maximum activity for both isotopes is 150 Ci (5.55 TBq).

1.3 Drawings

The packaging is constructed in accordance with the QSA Global, Inc., drawing R1100 Descriptive Drawing, Rev. B, sheets 1-6.

1.4 Evaluation Findings

The staff reviewed the general design information. Based on its review, the staff concludes that the information presented in this section of the application provides an adequate basis for the evaluation of the Model 1100 package against the requirements in 10 CFR Part 71 for each technical discipline.

2.0 STRUCTURAL EVALUATION

The objective of the NRC structural evaluation is to verify that the applicant has adequately analyzed the structural performance of the package so that it meets the performance requirements in the regulations of 10 CFR 71, "Packaging and Transportation of Radioactive Material."

The NRC staff performed the review in accordance with the applicable chapters in NUREG-2216 "Standard Review Plan for Transportation Packages for Spent Fuel and Radioactive Material: Final Report" (ML20234A651).

2.1 Description of Structural Design

2.1.1 Overview

The Model 1100 is comprised of a welded cylindrical body, a DU shield, a rear plate with a locking assembly, a front plate assembly, an optional jacket, and a source assembly. The welded cylindrical body consists of a stainless-steel tube with endplates welded at both ends.

The DU shield is suspended inside the welded cylindrical body through two brackets on two ends. Each bracket is welded to the inside surface of the endplate. Polyurethane foam is used to fill the space between the DU shield and the welded cylindrical body.

An S-shaped titanium source tube is cast into the center of the DU shield. The source assembly is secured in the center of the source tube during transportation.

The source assembly is in the form of a flexible steel wire and consists of a special form source capsule and a connector. The capsule is the main containment component housing the radioactive material to be shipped in the package.

The rear and front plate assemblies provide the locking function and are attached to the rear and front endplate respectively. The rear plate assembly is protected by a lock cover during transportation.

The optional jacket provides additional features for the attachments used for securing the package during transportation.

2.1.2 Design Criteria and Acceptance Criteria

The Model 1100 is designed to meet the criteria specified in 10 CFR 71.45 "Lifting and tie-down standards", 10 CFR 71.47 "External radiation standards for all packages", and 10 CFR 71.51 "Additional requirements for Type B packages."

The NRC staff reviewed the applicant's drop tests performed on the Model 1100 packages under both Normal Conditions of Transport (NCT) and Hypothetical Accident Conditions (HAC). The radiation levels after the drop tests were compared with the criteria specified in the 10 CFR 71.47 and were acceptable. Therefore, the NRC staff determines that the QSA Model 1100 package design criteria provide assurance that the structural performance of the cask system will meet the desired regulatory safety objectives.

2.1.3 Weights and Centers of Gravity

The nominal weights and centers of gravity are provided in Section 2.1.3 of the safety analysis report (SAR). The NRC staff reviewed the weights and centers of gravity information and found that the information provided in the SAR supplies sufficient details to satisfy the package description requirement listed in 10 CFR 71.33. Therefore, the NRC staff concludes that the package complies with the 10 CFR 71.33 requirement.

2.1.4 Codes and Standards

The American Welding Society (AWS) weld codes and American Society for Test and Materials (ASTM) material codes used for the design of the Model 1100 are indicated in the drawings in SAR Section 1.3. The NRC staff reviewed the drawings attached to the SAR and found that the codes chosen by the applicant are adequate to provide details for fabrication as required by 10 CFR 71.31(c). Therefore, the NRC staff concluded that the package meets the requirements of 10 CFR 71.31(c).

2.2. Materials

2.3. Fabrication and Examination

The NRC-approved Quality Assurance Program Number 0040 and International Standardization Organization (ISO) 9001:2015 are used to ensure the quality of the fabrication. The quality assurance (QA) program is based on NUREG 6407, "Classification of Transportation Packing and Dry Spent Fuel Storage System Components According to Importance to Safety." The

licensee's examination is provided in Section 8.0 of the SAR. As the quality assurance program was previously approved and was not changed by the applicant, the staff did not perform additional reviews of the Model 1100 QA program.

2.4. General Requirements for All Packages

2.4.1 Minimum Package Size

The smallest overall dimension of the package is 5 inches as described in the SAR. The NRC staff found that this dimension exceeds the specified requirement of 4 inches in 10 CFR 71.43(a). Therefore, the NRC staff concluded that the package meets the requirements of 10 CFR 71.43(a) for minimum size.

2.4.2 Tamper Indicating Feature

The SAR described various methods for application of a tamper indicating feature on this package. This includes the addition of a seal wire around the knob of the front plate to serve as evidence of possible unauthorized access to the contents. Alternate means of tamper indicating seals (e.g., seal labels, etc.) can be used on the front or rear plate assemblies so long as their breakage would serve as evidence of possible unauthorized access to the contents. The NRC staff reviewed this tamper indicating feature and found it provides the feature required by 10 CFR 71.43(b). Therefore, the NRC staff concludes that the package design meets the requirements of 10 CFR 71.43(b).

2.4.3 Positive Closure

The applicant stated in the SAR that the rear plate assembly is used to secure the position of the source assembly, and the sleeve, lock slide, and a source wire cover plate are used to maintain the source assembly locked in the secured position and prevent access to the package during transportation. The NRC staff reviewed the closure system and found that the package maintains positive closure using the closure system described in the SAR. Therefore, the NRC staff concludes that the requirements of 10 CFR 71.43(c) are satisfied.

2.5 Lifting and Tie-down Standards for All Packages

2.5.1 Lifting Devices

The application included a "Test Plan Report 240" to demonstrate that the grip plastic jacket and the cutout feature on the shell can be used to lift the heaviest package and still meet the requirement of a factor of safety (FS) of three against material yielding.

The NRC staff reviewed the "Test Plan Report 240" and found that the lifting device is able to maintain the FS of three against material yielding as required by 10 CFR 71.45(a). Therefore, the NRC staff concludes that the requirements of 10 CFR 71.45(a) are satisfied.

2.5.2 Tie-Down Devices

The application provided "Test Plan Report 240" and "Test Plan Report 413" to demonstrate that the grip plastic jacket and the cutout feature on the shell can be used as tie-down devices. The NRC staff reviewed the Test Plan Reports and found that the tie-down device is able to maintain the material stress below yielding for multiple acceleration conditions applied to the center of gravity as required by 10 CFR 71.45(b)(1). Therefore, the NRC staff concludes that the requirements of 10 CFR 71.45(b)(1) are satisfied.

2.6. Normal Conditions of Transport

2.6.1 Heat

2.6.1.1 Pressures and Temperatures

Since this package is vented to the environment, no pressure differential exists for the package body. The temperature impact in 38 °C (100 °F) in still air with and without insolation conditions are evaluated in Section 3.4, "Thermal Evaluation Under NCT," of the SAR.

2.6.1.2 Differential Thermal Expansion

Differential thermal expansion was calculated by hand and demonstrated that the small expansion is very close to the manufacturing tolerance and would generate a very small stress due to differential expansion.

The NRC staff reviewed the SAR Section 2.6.1 and found the heat and associated thermal expansion and pressure will not impact the package performance. Therefore, the NRC staff concludes that the requirements of 10 CFR 71.71(c)(1) are satisfied.

2.6.2 Cold

The materials used for safety related components include stainless steel, titanium, tungsten, copper and DU which retain their mechanical properties at -40 °C (-40 °F). Since these materials of construction are not susceptible to brittle fracture, no further analyses of the components were needed. The staff reviewed SAR Section 2.6.2 and determined that differential thermal contraction would not adversely affect this package. Therefore, the staff concludes that the requirement of 10 CFR 71.71(c)(2) is satisfied.

2.6.3 Reduced External Pressure and Increased External Pressure

Because the package is vented to the environment, the requirements of 10 CFR 71.71(c)(3) and (c)(4) are not applicable.

2.6.5 Vibration

The applicant performed a vibration-resistance test according to ISO 3999:2004(E) Sections 6.4.5 on the Model 1100. The test process and results are provided in Section 5.7 of the "Test Plan Report 239" in the SAR. The NRC staff reviewed the result and found that the natural frequencies are identified, and the components were shown to function properly under test conditions. Therefore, the NRC staff concludes that the requirement of 10 CFR 71.71(c)(5) is satisfied.

2.6.6 Water Spray

Due to the materials of construction, including water-resistant seals, the NRC staff determined that water spray will not reduce the package effectiveness and concludes that the requirement of 10 CFR 71.71(c)(6) is satisfied.

2.6.7 Free Drop

The applicant performed free drop testing on the Model 1100. The test process and results are provided in Section 2.12 of the SAR as part of Test Plan 237 and Test Plan Report 237.

The NRC staff reviewed the results in the “Test Plan 237” in the SAR and found that the test units and test configurations demonstrated the most vulnerable test conditions and showed that the free drop test results satisfy the acceptance requirements described in Section 2.1.1. Therefore, the NRC staff determines that the requirements of 10 CFR 71.71(c)(7) are satisfied.

2.6.8 Corner Drop

Because the package is not designed for shipping fissile material and is made up using metal material, the corner drop is not applicable to this package design. The requirements of 10 CFR 71.71(c)(8) are not applicable.

2.6.9 Compression

The compression drop test was performed on representative specimens. The package exhibited no damage to external dimensions after the test; therefore, the staff finds that the requirements of 10 CFR 71.71(c)(9) are satisfied.

2.6.10 Penetration

The penetration drop tests were performed on representative specimens. The package exhibited no damage to external dimensions after testing under Test Plan 237 as documented in Test Plan Report 237.

The NRC staff reviewed the results of the penetration testing in the SAR and found that the test units and test configurations demonstrated the most vulnerable damaged conditions were tested and showed that the penetration drop test results satisfy the requirements of the acceptance criteria described in Section 2.1.2. Therefore, the NRC staff determines that the requirements of 10 CFR 71.71(c)(10) are satisfied.

2.7 Hypothetical Accident Conditions

2.7.1 Nine-meter Free Drop

The applicant performed free drop testing on the Model 12100. The test process and results are provided in Section 2.12 of the SAR as part of Test Plan 237 and Test Plan Report 237. The NRC staff reviewed the details in the “Test Plan 237” in the SAR and found that the test results documented in the “Test Plan Report 237” demonstrated that the most vulnerable damage pattern are the same as the NCT drop tests. The testing showed that the HAC free drop tests results satisfy the requirements of the acceptance criteria described in Section 2.1.2 of this safety evaluation report (SER). Therefore, the NRC staff determines that the requirements of 10 CFR 71.73(c)(1) are satisfied.

2.7.2 Crush

This evaluation is not applicable due to the package content being a special form of radioactive material. Therefore, the requirements of 10 CFR 71.73(c)(2) are not applicable.

2.7.3 Puncture

The applicant performed puncture drop testing on the Model 1100. The test process and results are provided in Section 2.12 of the SAR as part of Test Plan 237 and Test Plan Report 237. The NRC staff reviewed the test details in the “Test Plan 237” in the SAR and found that the test results documented in “Test Plan Report 237” demonstrated the most vulnerable damaged

conditions were tested, and showed that the puncture drop test results satisfy the requirements of the acceptance criteria of 10 CFR 71.51(a)(2). Therefore, the NRC staff concludes that the package performance meets the acceptance criteria of 10 CFR 71.51(a)(2).

2.7.4 Thermal

Given the package materials of construction and the performance of the package in the tests preceding the thermal test, the applicant determined that a thermal test was not required. Based on calculation for the amount of differential expansion in steel and DU and the package being open to environment, the NRC staff concludes that the thermal test would not impact the structural integrity of the package and therefore, the staff finds that the requirements of 10 CFR 71.73(c)(4) are satisfied.

2.7.5 Immersion - Fissile

The applicant states that the package is not intended to transport fissile material, therefore, the requirements of 10 CFR 71.73(c)(5) are not applicable.

2.7.6 Immersion - All Packages

Since the package contents are special form sources and the requirements for special form sources exceed the equivalent pressure of 150 kPa due to immersion, this requirement is bounded by the test requirements of special form source qualification. Therefore, the NRC staff concludes that the requirements of 10 CFR 71.73(c)(6) are satisfied.

2.7.7 Deep Immersion

The contents have less than $10^5 A_2$, therefore this test of 10 CFR 71.61 is not applicable.

2.8. Special Form

The applicant stated in SAR Section 2.10 that the special form met the American National Standards Institute (ANSI)/Health Physics Society (HPS) N43.6 and ISO 2919 Class 3 requirements. The NRC staff reviewed the description and found that the special form achieved the performance goal described in 10 CFR 71.75(d). Therefore, the NRC staff determines that the special form radioactive material meets 10 CFR 71.75 requirements.

2.9. Evaluation Findings

Based on review of the statements and representations in the application, the NRC staff concludes that the structural design has been adequately described and evaluated and that the package has adequate structural integrity to meet the requirements of 10 CFR Part 71.

3.0 THERMAL REVIEW

The objective of this review was to verify that the thermal performance of the Model 1100 package has been adequately evaluated for the tests specified under both NCT and HAC and that the package design satisfies the thermal requirements of 10 CFR Part 71. Regulations applicable to the thermal review include 10 CFR 71.31, 71.33, 71.35, 71.43, 71.51, 71.71, 71.73, 71.75.

3.1 Description of Thermal Design

According to sections 1.1 and 1.2.1 of the application, the Model 1100 is an industrial radiography exposure device and transport package for Type B quantities of special form radioactive material. The packaging consists of a welded stainless steel cylindrical body with endplates, DU shield, rear plate with locking assembly, front plate assembly, and optional outer jacket constructed of polyurethane. The weight of the outer jacket is approximately 4 lbs. according to table 1.2.A of the application. The package dimensions and weight without the optional polyurethane outer jacket are approximately 13 inches in length, 5 inches in diameter, and 44 lbs. Sections 3.4.3 and 3.5.3 of the application noted that the welded cylindrical body has slight gaps which prevent the body from being pressurized. Section 1.2.1.1 indicated the polyurethane foam that is filled inside the cylindrical body and surrounds the DU shield acts as an impact limiter under drop conditions and prevents contamination migration from the shield.

Sections 1.2.1.6, 1.2.2, 2.12.10, and 2.12.11 of the application described the containment system and content. As noted in table 1.2.B of the application, the content permitted in the Model 1100 package includes Ir-192 with activity of 150 Ci and Se-75 with activity of 150 Ci. Section 1.2.2 presented the calculation for determining the maximum decay heat of the two radionuclides and noted that a correction factor was used to correct the difference between output Curies and content Curies for Ir-192. Section 3.1.2 of the application indicated that the Ir-192 content resulted in the bounding decay heat of 2.1 W.

The radionuclide material is placed within a double encapsulated welded source capsule assembly. The inner source capsule and outer source capsule are tested and approved as special form source capsules. As noted in Section 1.2.1.6 of the application, the source capsule assembly with its two special form source encapsulations are the primary containment for the radionuclides. The source capsule assembly and the source assembly connector are swaged to the flexible steel wire (forming the source assembly) that is placed within the titanium source tube surrounded by the DU shield.

Section 2.10 of the application provided typical U.S. Department of Transportation (DOT) Special Form Certificates applicable to typical special form capsules that can be transported within the Model 1100. Additionally, the application states that the Model 1100 package will meet the requirements of ANSI/HPS N43.6-2007 (R2013) and ISO 2919:2012(E) standards (or later editions with equivalent classification requirements) with Classification of 3 for pressure testing and Classification of 6 for temperature testing, which exposes the source capsule to higher thermal inputs than the special form thermal test described in 10 CFR 71.75. Table 2.10.A of the application provided the typical special form capsule designations, radionuclides, source assembly identification, and the corresponding special form reference.

3.2 Material Properties and Component Specifications

Section 2.3.1 of the application noted that package components are procured, manufactured, and inspected per the NRC-approved QA program for QSA Global, Inc. Section 3.2.2 of the application indicated that specifications of components are provided in the Appendix 1.3 drawings and Section 2.1.2 stated that the Model 1100 package is designed to meet the performance requirements for industrial radiography exposure devices as specified in 10 CFR 34, Subpart C - Equipment.

Section 3.2.1, table 3.2.A, and table 3.2.B of the application discussed the materials and properties (e.g., thermal conductivity, maximum temperatures) and corresponding references

(e.g., ASTM) associated with the important-to-safety package components. Except for the aluminum lock mount and cover, which are not the primary means to confine the source assembly within the package, the package's metal materials had melting point temperatures greater than 800°C. For example, table 3.2.B noted that DU (i.e., shielding) and stainless steel (i.e., body of packaging) had 1130°C and 1400°C melting point temperatures, respectively.

Section 2.12.10 of the application provided DOT Special Form Certificate USA/0335/S-96 Rev 14, which included the source description and QSA drawing of the capsule construction including capsule materials and weld details. For example, the outer capsule is made of Type 304L stainless steel and constructed with tungsten inert gas or laser welding. The inner capsule is made of stainless steel or titanium and constructed with tungsten inert gas or laser welding. Similarly, Section 2.12.11 provided DOT Special Form Certificate USA/0502/S-96 Rev 13, which included the source description and QSA drawing of the capsule construction. The certificate stated that the outer capsule is made of titanium or stainless steel, and the inner encapsulation is made of titanium, stainless steel, or aluminum and constructed with tungsten inert gas or laser welding.

3.3 General Considerations

Section 2.2.2 of the application indicated that package material components would not result in galvanic reactions because of their similar galvanic activity and the use of intermediate materials (e.g., copper separators) to prevent formation of eutectics. In addition, it was noted that chemicals used in the package (e.g., lubricants, sealants) would not contain halides (e.g., chlorides) that could cause corrosion.

Section 2.10 of the application provided the DOT Special Form Certificate for each special form capsule that can be transported within the Model 1100 package. As noted in Section 3.4.1.4, a special form certificate indicates that the integrity of the special form source was maintained (i.e., tested for leak tightness) after undergoing the tests described in 10 CFR 71.75 (e.g., exposed to 800°C [1,472°F] for 10 minutes).

In addition, Sections 3.4.1.4, 2.7, 2.12.13, 2.12.4, and 2.12.15 of the application stated that the source capsules successfully passed the ANSI/HPS N43.6 Class 6 thermal test and Class 3 pressure test. The response to the thermal reactor siting index (RSI) (submitted February 2025 [ML25050A245]) discussed the details of the Classification 3 pressure testing and Classification 6 temperature testing. For example, Classification 6 temperature testing consists of the source capsule being exposed to a temperature of -40°C (-40°F) for 20 minutes, then exposed to 800°C (1,472°F) for 1 hour and the corresponding high internal pressure (i.e., ideal gas law), then subjected to a thermal shock from 800°C (1,472°F) to 20°C (68°F) within 15 seconds, followed by a leakage test to confirm source capsule integrity. Staff notes that a source capsule directly exposed to a 800°C (1,472°F) environment for 60 minutes would bound the thermal condition of a source capsule within the insulative (i.e., unexposed) confines of the surrounding 15.4 kilograms (34 lbs). (per table 7.1.A) DU shield (and initial presence of foam) that experience the thermal effects from the 30-minute exposure of a 800°C (1,472°F) fire on the package's stainless steel cylindrical body exterior.

3.4 Thermal Evaluation under Normal Conditions of Transport

3.4.1 Model Description

Section 3.4.1 of the application described the analyses for determining package and surface temperatures at hot conditions with insolation and without insolation. These analyses were based on energy balances between thermal inputs (e.g., decay heat, insolation, package surface dimensions, heat transfer coefficients) and thermal outputs (e.g., convection heat transfer and radiant heat transfer from the package's outer surfaces). Section 3.4.1.1 provided the calculation's input parameters, including maximum decay heat of 2.1 W, package dimensions and resulting exposed surface area. A similar energy-balance calculation was performed for the NCT case that addressed 10 CFR 71.43(g) in which a steady-state analysis assumed 38°C (100.4°F) ambient temperature without insolation.

Staff notes that, although the focus of the above-mentioned thermal analyses was the package's outer surface, it is possible that higher than ambient temperatures also would be found in the interior of the package at, and adjacent to, the special form source capsule with a 2.1 W decay heat. However, the temperatures at these locations would decrease as conduction heat transfer diffuses outward through the adjacent DU metal shield and foam to the package surface. Interior temperatures would not reach high values because the decay heat is relatively low, the thick DU shield has relatively high thermal conductivity, and the amount of foam surrounding the uranium shield is relatively thin for a large portion of the package interior, according to drawing "R1100 Descriptive Drawing sheet 2 of 6, Rev B." Therefore, temperatures within the package would be below the allowable temperatures reported in table 3.2.B of the application.

Finally, Section 3.4.1.3 of the application discussed a "cold" NCT condition that assumed an ambient temperature of -40°C (-40°F) with no insolation and no decay heat. Sections 2.6.2, 3.1.1, and 3.4.1.3 indicated that package materials are not adversely affected by a -40°C (-40°F) temperature and are not susceptible to brittle fracture. In addition, Classification 6 temperature testing of the special form source consists of the source capsule being exposed to -40°C (-40°F).

The staff reviewed the assumptions, boundary conditions, and parameters used in the thermal analysis as well as the temperature margins of package components with allowable values and finds that the applicant's thermal evaluation under NCT is acceptable and meets the requirements of 10 CFR 71.71.

3.4.2 Temperature Results

Section 3.4.1.1 of the application indicated that the maximum wall temperature of the package during the hot NCT condition and similarly, Section 3.4.1.2 indicated that the maximum outer surface temperature of the package during a 38°C ambient temperature without insolation meets the regulatory requirements of 10 CFR 71.43(g).

3.4.3 Maximum Normal Operating Pressure

Section 3.4.3 of the application noted that the package design includes small openings and design clearances that allow venting to the atmosphere, thereby preventing the package from being pressurized during NCT such that there is no internal package pressure. In addition, Section 3.4.1.4 of the application noted that the special form source capsules are leak tested after being exposed to an 800°C (1,472°F) temperature and corresponding pressure (i.e., ideal gas law) for 1 hour and are subsequently demonstrated to retain their integrity.

3.4.4 Maximum Thermal Stress

Based on the above temperature and pressure discussion, Sections 2.6.1.2, 2.6.1.3., 2.6.1.4, and 3.4.2 of the application indicated that the package retains its structural integrity and shielding effectiveness under normal transport thermal stress conditions.

3.5 Thermal Evaluation under Hypothetical Accident Conditions

3.5.1 Evaluation Methodology

Section 3.5.1 of the application discussed the thermal evaluation for the hypothetical fire accident condition and noted the damage to the Model 1100 test package was minimal after the 1.2 m (NCT) drop test, the 9 m (HAC) drop test, and the HAC puncture test, consisting of insignificant deformation of the package shell, lock mounting block, and dust cover. Therefore, the application indicated the package's design features described earlier in the SER would remain during the fire HAC such that high internal pressures and high-temperature reactions of internal important-to-safety package components would not occur. Section 3.5.2 of the application stated that fire test thermal analyses did not show excessive stress on the package structure (e.g., less than 5% strain) and structural material yielding from the package's self-weight would be minimal due to the melting points of the package metals. In addition, the response to RAI 3-1 (ML25155A042) indicated that temperatures of package components that retain the source within the shield remain below their allowable values. Finally, the special form source was individually exposed and tested to 800°C for one hour and demonstrated to retain its integrity by subsequent leak testing. Therefore, as noted in sections 2.7.4 and 2.7.4.5 of the application, the Model 1100 package would retain its shielding and containment integrity during the 30-minute HAC thermal test.

Section 3.5.1 of the application mentioned the potential for the small amount of polyurethane foam within the stainless-steel housing to react during a HAC fire and the response to RAI 3-2 (ML25155A042) indicated the outer polyurethane jacket may combust during the fire. These two reactions are additional thermal contributions to the package during the HAC fire, although sections 2.7.4 and 3.5.1 indicated the potential reaction of the small amount of polyurethane foam within the stainless-steel housing would be pyrolysis, which has reduced thermal input compared to full combustion. Drawing "R1100 Descriptive Drawing (sheet 5 of 6)" showed that the special form source is in the center region of the depleted uranium shield. Staff found that a simplified thermal calculation that modeled the temperature within the center of a spherical DU mass of approximately 34 lbs (the weight of the depleted uranium shield, per table 1.2.A of the application) surrounded by a thin layer of polyurethane foam and outer stainless-steel housing with an external ambient temperature slightly higher than 1000°C (i.e., polyurethane jacket flame temperature noted in the RAI 3-2 response (ML25155A042) showed interior shield temperatures would reach less than 800°C during a 30 minute period.

The above-mentioned calculation included a number of conservative assumptions. For example, the time period of the additional transitory thermal inputs would tend to be less than 30 minutes and the modeled layer of internal polyurethane foam had a reduced thickness compared to actual fabrication, and therefore, was conservatively less insulative. Staff notes that a less than 800°C depleted uranium shield temperature surrounding the special form capsule has a lower thermal impact than the special form capsule being directly exposed to the 800°C temperature for 60-minute condition of the ANSI/HPS N43.6 Class 6 thermal test. Based on the above discussion, there is reasonable assurance that the effect of additional thermal input of reactions from polyurethane foam and polyurethane jacket would not result in appreciable impacts on the package's shielding capacity or the integrity of the special form source centrally located within the depleted uranium shield.

The staff reviewed the assumptions, boundary conditions, and parameters used for the HAC thermal evaluation and finds the package would meet the requirements of 10 CFR 71.51 for the thermal hypothetical accident condition.

3.5.2 Maximum Temperatures

Table 3.2.B and sections 3.2 and 3.5.3 of the application indicated that the package's structural and shielding components have melting temperatures well above the 800°C flame temperature during a HAC fire. In addition, the source capsule has been shown by leak testing to retain its integrity after being exposed to 800°C (1,472°F) for up to one hour. Therefore, Section 3.5.4 noted that the Model 1100 transport package would maintain its structural integrity and source shielding effectiveness under the HAC.

3.5.3 Maximum Pressure

Section 3.5.3 of the application noted that the package is vented to the atmosphere through the front and rear vents and, therefore, the package is not pressurized during the HAC fire, such as by the potential of pyrolysis gases from the foam within the package. In addition, the special form source capsule has been demonstrated to retain its integrity by leak testing after being exposed to 800°C (1,472°F) and its corresponding pressure (i.e., ideal gas law) for 1 hour.

3.5.4 Maximum Thermal Stresses

Section 3.5.4 of the application discussed the potential effects of package thermal stresses during the fire HAC and found that the worst case temperature differential of 840°C (1,544°F) could cause a minimal, physical increase in length of the source wire, which could cause the source assembly to slightly flex but not alter the position of the source capsule in a manner that would increase external radiation dose rate.

3.6 Evaluation Findings

The staff reviewed the package description, material properties, component specifications, and the methods used in the thermal evaluation and has reasonable assurance that they are sufficient to provide a basis for evaluation of the package against the thermal requirements of 10 CFR Part 71. The staff reviewed the accessible surface temperatures of the Model 1100 as it will be prepared for shipment and has reasonable assurance that the temperatures satisfy 10 CFR 71.43(g). The staff reviewed the package design, construction, and package preparations for shipment and has reasonable assurance that the package material and component temperatures will not extend beyond the specified allowable limits during NCT, consistent with the tests specified in 10 CFR 71.71. The staff also has reasonable assurance that the package

material and component temperatures will not exceed the specified allowable short-time limits during HAC, consistent with the tests specified in 10 CFR Part 71.73.

Based on review of the statements and representations in the application, the staff concludes that the thermal design has been adequately described and evaluated, and that the thermal performance of the Model 1100 meets the thermal requirements of 10 CFR Part 71.

4.0 CONTAINMENT EVALUATION

The objective of this review was to verify that the containment associated with the Model 1100 (designated as a Type (B) package) transporting a specified special form source would meet regulations under NCT and HAC. Regulations applicable to the containment review include 10 CFR 71.31, 71.33, 71.35, 71.43, and 71.51.

4.1 Description of Containment Boundary and Content

As noted in drawing number R1100 Descriptive Drawing, figure 1.2.C, and Section 1.2.1 of the application, the Model 1100 is a hand-held radiography package in which a small special form source is surrounded by a thick DU shield and outer polyurethane foam within a welded stainless steel housing. The special form source is held within an S-shaped titanium source tube by a source wire. The two ends of the shield source channel within the DU shield are blocked by a metal front plate assembly and by a metal rear plate assembly. Sections 1.2.4 and 2.4.3 of the application noted that the source assembly is held securely within the center of the source tube by the sleeve, selector ring retainer, and rear plate assembly, including a lock slide, lock plunger, and cover during transport; additional details are provided in Section 7 of the application.

Section 1.2.1.6 and figure 1.2.D of the application indicated that the containment design of the special form content is a double encapsulation that is swaged to the source assembly and that the inner source capsule and outer source capsule (i.e., double encapsulation) are tested and approved as special form source capsules. Table 1.2.B of the application stated that the package can transport either an Ir-192 special form source with an activity of 150 Ci or a Se-75 special form source with an activity of 150 Ci.

Section 2.12.10 of the application provided DOT Special Form Certificate USA/0335/S-96 Rev 14, which included the source description and QSA drawing of the capsule construction including capsule materials and weld details. For example, the outer capsule is made of Type 304L stainless steel and constructed with tungsten inert gas or laser welding. The inner capsule is made of stainless steel or titanium and constructed with tungsten inert gas or laser welding. Similarly, Section 2.12.11 provided DOT Special Form Certificate USA/0502/S-96 Rev 13, which included the source description and QSA drawing of the capsule construction. The certificate stated that the outer capsule is made of titanium or stainless steel and the inner encapsulation is made of titanium, stainless steel, or aluminum and constructed with tungsten inert gas or laser welding.

4.2 General Considerations

Section 2.2.2 of the application indicated that material selection and package design result in there being no significant chemical or galvanic reaction between package components during

NCT and HAC. For example, copper separators are placed between steel and uranium interfaces to prevent possible formation of a eutectic alloy.

4.3 Containment Evaluation under Normal Conditions of Transport

Sections 2.6, 2.6.10.3, and 4.2 of the application discussed the NCT physical structural tests and indicated that the source containment boundary integrity would be maintained and the damage to the package's shell was minimal such that the source would remain confined within the package. Similarly, Section 3.4 noted that package temperatures during NCT cold and hot conditions would be within their allowable values.

A summary of the ISO 2919:2012(E) and ANSI/NPS N43.6 (2007) tests (or later editions with equivalent classification requirements per Section 2.10 of the application) and results on the radioactive sources were provided in sections 2.12.13, 2.12.14, and 2.12.15 of the application in the form of a certificate of radioactive source integrity. The tests included temperature, pressure, impact, vibration, and puncture. Specifically, Section 2.10 stated that the sources transported in the Model 1100 satisfied the test requirements of ANSI/ISO Pressure Classification of 3 and an ANSI/ISO Temperature Classification of 6. As noted in Section 2.7 of the application, these test conditions are more severe than the special form test requirements provided in 10 CFR 71.75. Finally, Section 4.4 of the application stated that the source capsules are also leak tested once every 6 months prior to transport in accordance with ISO 9978:2020(E) (or more recent editions) to ensure that contamination release from the package does not exceed regulatory limits.

4.4 Containment Evaluation under Hypothetical Accident Conditions

Sections 2.7, 2.7.4.5 and 3.5 of the application indicated that results showed there was no damage to the source encapsulations within the package after the structural HAC transport tests or thermal input from the HAC fire. In particular, the source encapsulations, which undergo the above-mentioned ANSI/NPS N43.6 thermal test, experienced a minimum environment temperature of 800°C and the corresponding pressure (i.e., ideal gas law) for 1 hour (which is longer than the 30-minute HAC fire period described in 10 CFR 71.73) without loss of containment.

4.5 Evaluation Findings

The staff reviewed the applicant's description and evaluation of the containment system and concludes that the application identifies established codes and standards for the containment system and the Model 1100 includes a containment system securely closed by a positive fastening device that cannot be opened unintentionally or by a pressure that may arise within the package. The staff reviewed the applicant's evaluation of the containment system under NCT and concludes that the package is designed, constructed, and prepared for shipment so that under the tests specified in 10 CFR 71.71, "Normal Conditions of Transport," the package satisfies the containment requirements of 10 CFR 71.43(f) and 10 CFR 71.51(a)(1) for NCT with no dependence on filters or a mechanical cooling system. The staff has reviewed the applicant's evaluation of the containment system under HAC and concludes that the package satisfies the containment requirements of 10 CFR 71.51(a)(2) for HAC, with no dependence on filters or a mechanical cooling system.

Based on review of the statements and representations in the application, the staff concludes that the Model 1100 has been adequately described and evaluated to demonstrate that it satisfies the containment requirements of 10 CFR Part 71.

5.0 SHIELDING EVALUATION

The objective of this evaluation is to verify that the design of the QSA Global, Model 1100, Type B(U) transport package meets the external radiation requirements of 10 CFR Part 71, "Packaging and Transportation of Radioactive Materials." NRC staff reviewed this application using the guidance in NUREG-2216, "Standard Review Plan for Transportation Packages for Spent Fuel and Radioactive Material," and NUREG-1886, "Joint Canada-United States Guide for Approval of Type B(U) and Fissile Material Transportation Packages."

5.1.1 Design Features

The principal shielding in the Model 1100 is the DU shield assembly. The shielding is cast as one piece and essentially enclosed by stainless steel. The applicant presented the dimensional information for the shield in the drawing section in 1.3.1 of the SAR. The major components of the package consist of welded cylindrical body, DU shield, rear plate with locking assembly, front plate assembly, optional jacket, and a containment system (part of source assembly).

5.1.2 Summary Table of Maximum Radiation Levels

The applicant presented the worst case radiation profile in table 5.1.A of the application, "Summary Table of External Radiation Levels Extrapolated to Capacity of 150 Ci Ir-192 (Non-Exclusive Use)" and Hypothetical Accident Transport Condition Testing, and table 5.1.B of the application, "Summary Table of External Radiation Levels Extrapolated to Capacity of 150 Ci Ir-192 (Exclusive Use)". The applicant used the profile data obtained from the Model 1100 packages to test the NCT and HAC under Test Plan 237. Table 5.1.C of the application, "Summary of External Radiation Levels Extrapolated to Capacity of Se-75 (Non-Exclusive Use)." The applicant stated that the Model 1100 meets the NCT and HAC transport regulatory limits specified in 10 CFR 71.47 and 71.51 in all cases. Based on the dose rates calculated for this application, the staff finds it acceptable and the package meets the NCT and HAC transport regulatory limits specified in 10 CFR 71.47 and 71.51 in all cases.

The staff reviewed tables 5.1.A, 5.1.B, and 5.1.C and found that the radiation levels are under the regulatory limits for gamma emissions. Neutron emissions are not applicable for this application since this package does not allow any neutron-emitter materials.

5.2 Source Specification

5.2.1 Gamma Source

The applicant presented the gamma sources allowed for transport in the Model 1100 in Sections 1.2.2 and 2.10 of the application.

From Section 1.2.2, the applicant designed the Model 1100 to transport special form capsules containing the isotopes listed in table 1.2.A of the application. The applicant also adjusted the data in table 1.2.B of the application to include the maximum decay heat for Ir-192 adjusted to account for the source's content activity and the weight of the source assembly holding the radioactive contents. Actual content to output activity varies based on the capsule configuration and variations in isotope self-absorption. The applicant used a correction factor for Ir-192 to convert output activity to content activity. The staff find this approach acceptable because this factor reflects the worst case (highest activity content) for Ir-192 sources transported in this package. The source capsules are loaded into the Model 1100 device and secured according to the procedure described in Section 7 of the application.

5.2.2 Neutron Source

No neutron sources are applicable for this package.

5.3 Shielding Model

5.3.1 Configuration of Source and Shielding

The applicant specified that the shielding model was not used as the primary justification for these packages. Shielding justification was based on direct measurement and a comparison of relative photon energy output per Ci between Ir-192 and Se-75 sources.

The staff finds this approach acceptable since they consider the direct measurement of gamma attenuation to be the most reliable method of measuring the expected gamma-absorbing behavior of the shielding materials.

5.3.2 Material Properties

The applicant stated that the primary shielding for the Model 1100 is DU contained within a welded enclosure. Based on temperature extremes in this package, DU will not experience any degradation in effectiveness or radiation exposure. The applicant used MicroShield® computer code to justify Se-75 by comparing relative photon shielding effectiveness between Ir-192 and Se-75.

The staff found the use of MicroShield® acceptable since this computer code is a comprehensive photon/gamma-ray shielding and dose assessment program widely used for designing shields, estimating source strength from radiation measurements, minimizing exposure to people, and teaching shielding principles.

5.4 Shielding Evaluation

The applicant adjusted the maximum activity for the radiation measurements using the package's capacity and also adjusted the surface measurements to correct the offset of the survey meter probe from the actual surface of the package. Radiation measurements at the surface of the container are also adjusted to compensate for the offset of the survey meter probe from the actual surface of the package.

For this application, the applicant referred to the QSA Global Model 880 regarding testing. The applicant used testing to justify that no side drop orientation was used for testing Model 1100 test specimens. Based on physical testing performed on the Model 880 design, it is assessed that the side drop orientation resulted in less damage to the package than was observed during the oblique (slap-down) drop orientation. According to the applicant, based on the similarity of construction between the Model 1100 and the Model 880 tested units, it is assessed that testing in the side drop orientation was unnecessary. The side drop orientation will not result in a Model 1100 package failure, and the Model 1100 testing under the oblique (slap-down) orientation will result in damage that would otherwise bound a side drop test on this package design.

The maximum extrapolated dose rates to capacity of 150 Ci of Ir-192 (non-exclusive use and exclusive use) for the Model 1100 during NCT were 168 mrem/hr at the surface and 1.1 mrem/hr at one meter. The maximum extrapolated dose rates to capacity of 150 Ci of Se-192 (non-exclusive use) for the Model 1100 during NCT were 73 mrem/hr at the surface and 0.2 mrem/hr at one meter. These values comply with the requirements of 10 CFR 71.47(a) and the

requirements of paras. 530 and 531 of TS-R-1.

Under HAC, the maximum extrapolated dose rates to capacity of 150 Ci of Ir-192 and Se-75 (non-exclusive use and exclusive use) for the Model No. 1100 were less than the maximum 10 mrem/hr allowable limit of 10 CFR 71.51(a)(2) and para. 656(b)(ii)(I) of TS-R-1.

The applicant demonstrated that the radiation profile data showed no increase in radiation dose after testing beyond normal measurement variations. All test specimens met the regulatory requirements.

The staff reviewed the package description and evaluation and found reasonable assurance that they satisfy the shielding requirements of 10 CFR Part 71. The staff reviewed the radiation source and found that they are sufficient to provide a basis for evaluation of the package against the shielding requirements of 10 CFR Part 71. The staff reviewed the methods used in the shielding evaluation and found reasonable assurance that they are described in sufficient detail to permit an independent review, with confirmatory calculations, of the package shielding design. The staff reviewed the external radiation levels under NCT and HAC and found reasonable assurance that they satisfy 10 CFR 71.43(f) and 71.51(a)(1).

5.5 Evaluation Findings

Based on the review of the statements and representations in the amendment, the staff concludes that the design of the Model 1100 has been adequately described and evaluated and that the package meets the shielding requirements of 10 CFR Part 71.

6.0 CRITICALITY EVALUATION

A criticality evaluation is not applicable to this package, as there is no fissile material.

7.0 MATERIALS EVALUATION

The staff evaluated the material characteristics of the Model 1100 design for an industrial radiography exposure device and transport package for Type B quantities of special form radioactive material. The staff used the guidance in NUREG-2216, "Standard Review Plan for Transportation Packages for Spent Fuel and Radioactive Material," issued August 2020 and other guidance documents as identified in this section to conduct the materials evaluation. The applicant demonstrated the performance of the package design to NCT and HAC for drop, vibration, and compression tests by physical testing of the assembled package, rather than relying on analysis.

7.1 Drawings

The drawings for the Model 1100 components are provided in SAR Chapter 1, Section 1.3.1. The drawings include a Bill of Materials that provides the material specification of each component. Material alternatives, fabrication instructions, and additional material property requirements are provided in the drawing details and notes. The staff reviewed the drawings using the guidance in NUREG-2216, NUREG/CR-5502, "Engineering Drawings for 10 CFR Part 71 Package Approvals," issued May 1999, and Regulatory Guide 7.9, "Standard Format and Content of Part 71 Applications for Approval of Packages for Radioactive Material," for the

recommended content of engineering drawings. The staff verified that the drawings included design features considered in the package evaluation, including:

- the containment system
- closure device
- internal supporting or positioning structures
- gamma shielding
- outer packaging

The staff verified that the drawings include the information described in NUREG-2216 and the referenced NRC guidance documents above on the (1) materials of construction, (2) dimensions and tolerances, (3) codes, standards, or other specifications for materials, fabrication, examination, and testing (4) welding specifications, including location and nondestructive examination (NDE), (5) coating specifications and other special material treatments that perform a safety function and (6) specifications and requirements for alternative materials.

The staff determined that the drawings for the package provide the necessary information identified in the NRC guidance documents and the engineering drawings provided by the applicant are consistent with the design and description of the package, in accordance with 10 CFR 71.33, "Package Description." Therefore, the staff determined that the drawings provided by the applicant were acceptable.

7.2 Codes and Standards

The materials codes and standards are described in SAR Section 2.2.1. The Model 1100 is designed and constructed to 10 CFR 71, 49 CFR 173, IAEA Regulations for the Safe Transport of Radioactive Material No. TS-R-1 (2009 Edition) and SSR-6 Editions 2012 and 2018, and Canadian Nuclear Safety Commission (CNSC) PTNS Regulations SOR/2015-145.

Specific codes or standards related to the finished assemblies for this transport package are specified in the drawings. All component fabrication (including assembly) is controlled under the QSA Global, Inc. Quality Assurance Plan approved by the USNRC and ISO. The components of this package that do not comprise the containment boundary are constructed of materials that the ASTM has certified. The components of this package that are not important-to-safety are identified by generic names and their material properties are specified. This is consistent with the guidance in 10 CFR 71.31(c). The performance of all materials is demonstrated by testing production samples.

The staff determined that the description of the codes and standards applicable to the Model 1100 provided by the applicant was acceptable in accordance with 10 CFR 71.31(c).

7.3 Weld Design and Inspection

The Model 1100 welded joints are designed and implemented in accordance with AWS standards AWS D1.3: Structural Welding – Sheet Metal, and AWS D1.6: Structural Welding Code – Stainless Steel. Weldments are inspected by personnel qualified to American Society for Nondestructive Testing (ASNT) Recommended Practice SNT-TC-1A, Personnel Qualification and Certification in Nondestructive Testing. The staff notes this is consistent with the guidance in NUREG-2216, Section 7.4.3, which states that welds that are not part of the containment boundary may be governed by AWS Codes.

The staff reviewed the weld specifications and finds they are in accordance with applicable AWS and ASNT standards. Additionally, the sufficiency of the welds is demonstrated through testing in accordance with ISO 3999:2004(E), Radiation Protection – Apparatus for Industrial Gamma Radiography – Specifications for Performance, Design, and Tests; and ANSI N431 (1980), Radiological Safety for the Design and Construction of Apparatus for Gamma Radiography. Therefore, the staff finds the specification of welds to be acceptable in accordance with 10 CFR 71.31(c).

7.4 Mechanical Properties

The applicant provided a description of the mechanical properties of the packaging materials in SAR Section 2.2.1 and on the drawing R1100, in Section 1.3.1. The applicant lists the mechanical properties of structural materials in table 2.2.A. The applicant included material properties including yield strength, ultimate strength, elongation, and controlling specification. The references for the material properties include ASTM standards and

- American Society for Metals, Metals Handbook Ninth Edition, Volume 2 Properties and Selections: Nonferrous Alloys and Pure Metals, 1979;
- American Society for Metals, Metals Handbook Ninth Edition, Volume 3 Properties and Selections: Stainless Steels, Tool Materials and Special-Purpose Metals, 1980.

This is consistent with the guidance in NUREG-2216, Section 7.4.4.1 which states that components not designed to American Society of Mechanical Engineers (ASME) code may use material properties from other references such as ASTM standards.

The staff reviewed the material properties provided by the applicant and verified that the applicant provided the appropriate mechanical properties. The staff determined that the temperature ranges for the mechanical properties provided by the applicant bound the range of the packaging component temperatures provided in Section 3 of the SAR for NCT and HAC. Therefore, the staff determined that the mechanical properties of the materials for the Model 1100 provided by the applicant were acceptable and meet the requirements of 10 CFR 71.33, 71.35(a), 71.43(c), 71.43(d), 71.43(f), 71.51(a)(1), 71.71, 71.73, 71.85(a), 71.87(a), 71.87(b), 71.87(c), and 71.87(f).

7.5 Thermal Properties

The applicant provided thermal properties of the materials in table 3.2.B, including melting temperature, maximum service temperature, specific heat, thermal conductivity, thermal expansion, and density. The applicant provided values of the thermal properties obtained from several references:

- Materials Handbook Ninth Edition Volume 2 Properties and Selections: Nonferrous Alloys and Pure Metals, ASM Handbook Committee, 1979
- ASM Specialty Handbook Stainless Steels, ed. J.R. Davis, 1994
- ASM Metals Handbook Desk Edition, ed. Howard E Boyer, Timothy L. Gall, 1985
- Mi-Tech Metals Inc Data Sheet for HD17 with reference to ASTM-B777 Class 1
- Eugene A. Avallone and Theodore Baumeister III, Marks' Standard Handbook for Mechanical Engineers, Tenth Edition, New York, McGraw-Hill, 1996
- ASTM-B777 Class 1

- ASTM-B338 Grade 9
- Materials Handbook 2nd Edition, Francois Cardarelli, Springer-Verlag, London, 2008.

The staff reviewed the thermal properties provided by the applicant and determined that the thermal properties provided by the applicant were acceptable because they are in accordance with stated sources and therefore meet the requirements of 10 CFR 71.33(a)(5), 71.71, and 71.73.

7.6 Radiation Shielding

The staff reviewed information provided by the applicant regarding radiation shielding materials for the Model 1100. As described in Section 5 of the SAR, the package contents emit only gamma radiation. The applicant stated that gamma shielding is provided by the DU shield that surrounds the source, with its weight and dimension described in table 1.2.A and Section 1.3.1. A copper spacer separates the DU shield from the stainless-steel structure, preventing formation of a eutectic alloy between the steel and uranium. The shield is surrounded by polyurethane foam which prevents oxidation of the DU in NCT and HAC by limiting oxygen contact. In SAR Section 5.3.2, the applicant states that the shielding evaluation of Section 5 shows compliance with the limits of 10 CFR 71.47 and 71.51 through direct measurement, rather than relying on a shielding model. Therefore, the applicant does not provide shielding material properties. The staff reviewed the applicant's description of the compositions and geometries and finds it acceptable and consistent with the guidance in Section 7.4.6 of NUREG-2216.

As described in Section 2.7.4 of the SAR, damage to the outer shell from HAC is not sufficient to allow oxygen ingress into the package. The applicant therefore determined that oxidation of the DU is not possible. The staff reviewed the package design and the results of the NCT and HAC and determined that a loss of shielding function would not occur due to oxidation of DU.

Per the above discussion, the staff finds the applicant's radiation shielding materials acceptable to meet the requirements in 10 CFR 71.43(f) and 10 CFR 71.51(a).

7.7 Criticality Control

The applicant stated that the QSA Global Model 1100 authorized contents are limited to non-fissile radioactive materials. The staff determined that the Model 1100 meets the requirements in 10 CFR 71.15 because the package authorized contents as described in SER Section 7.12 are limited to non-fissile materials.

7.8 Corrosion Resistance

The applicant stated that all exposed external surfaces of the Model 1100 are made of stainless steel, except for the lock mount and lock cover, which are aluminum, and the key plunger lock, which is brass. The applicant notes that all the metals are close in galvanic potential, except for the DU. This close proximity indicates that galvanic reactions among them will be negligible. The DU is surrounded by polyurethane foam, except for the copper spacer at each end, which will prevent an electrolyte or other corrosive from contacting the uranium-copper interface. Additionally, lubricants, sealants, and other chemical ingredients used in the Model 1100 are reviewed to ensure they do not contain halides (typically chlorides) which could cause corrosion within the package under NCT and HAC. The materials that are exposed to the external environment include stainless steel (types 302, 304, 316, CF3, CF8), aluminum 6061, and tungsten. The other materials are inside the package and isolated from contact with air, water,

and other corrosive environments. Per NUREG-2214, "Managing Aging Processes in Storage (MAPS) Report," dated July 2019, stainless steels are susceptible to crevice corrosion, galvanic corrosion at the interface with the aluminum front and rear plate assemblies, and stress corrosion cracking at the welded joints; and that aluminum may be susceptible to pitting or galvanic corrosion. NUREG-2214 does not identify aging issues with tungsten. The applicant's operating procedures specify inspection to verify the package is free from corrosion or cracks prior to each shipment. This is consistent with the guidance in NUREG-2214 and therefore, 10 CFR 71.43(d) and 71.87(b).

The staff reviewed the information provided by the applicant regarding the design and operational mitigation of corrosion. The staff found that the applicant has accurately described and addressed corrosion from the environments for the Model 1100 transportation package through material selection and inspection procedures and is, therefore, in accordance with 10 CFR 71.43(d) and 71.87(b).

7.9 Content Reactions

The applicant evaluated the potential for chemical reactions between the contents and packaging materials, and corrosion reactions. The applicant provided an evaluation to show that chemical and corrosion reactions will not occur based on the chemical compatibility of the contents and the packaging materials. All components are vented to the ambient atmosphere so no pressure will build up in NCT or HAC.

As described in Section 7.8 of this SER, the staff have determined that the contents of the Model 1100 would not result in adverse reactions. Therefore, the staff finds that the Model 1100 meets the requirements of 10 CFR 71.33(b) for adverse reactions, and 10 CFR 71.43(d).

7.10 Radiation Effects

The applicant stated that the materials used in the Model 1100 have been used in other QSA transport packaging for decades without degradation of the package performance over time due to irradiation from the package contents.

The staff's review determined that since the only radiation is the gamma source, the package will not be susceptible to radiation-induced degradation. This is consistent with the guidance in NUREG-2216, Section 7.4.11, which states that metals and alloys are generally not susceptible to gamma radiation embrittlement. Therefore, the staff determined that the Model 1100 will meet the requirements of 10 CFR 71.35(a) and 10 CFR 71.43(d) for radiation effects on susceptible materials.

7.11 Package Contents

The Model 1100 contents are discussed in SAR Section 1.2. and could comprise up to 0.04 lbs of Ir-192 or Se-75 configured as Special Form Sources. All contents are non-fissile or fissile exempt (i.e., meeting at least one of the requirements of 10 CFR 71.15(a) through (f)).

The staff determined that the applicant provided an acceptable description of the contents of the Model 1100. The staff determined that the applicant provided information that was consistent with the guidance in NUREG-2216, Section 7.4.12 and therefore, in accordance with 10 CFR 71.33(b).

7.12 Bolting Material

The staff reviewed SAR Section 1.3.1 which describes the bolting material used. The drawing in Section 1.3.1 shows the only bolted connections are to affix the rear plate and front plate assemblies to the welded body. These connections use stainless steel screws threaded into threaded inserts. The assemblies and the welded body are also of stainless steel, so the thermal expansion will be similar, and no galvanic reaction will occur. The screws are tamperproof to ensure security of the source. The screws affixing the front and rear plate assemblies to the front and rear plates are specified to conform to recognized, material conformance standards.

The applicant stated that all fasteners are inspected prior to each operation to verify they are fit for use. In addition, the screws are removed and threads examined annually, as described in SAR Section 7.

The staff reviewed the material properties for the bolting materials specified in the SAR, describing the strength of the material and thermal expansion coefficients. The staff determined that the body, screws, and plate materials are compositionally similar and will not result in galvanic corrosion to these components. The staff confirmed that the applicant identified the materials to be used in bolted connections in accordance with 10 CFR 71.33(a)(5). The staff reviewed SAR Section 7 and verified that visual inspections of the screws were part of the periodic maintenance, which would allow for identification of damage or degradation and allow for replacement prior to use. The performance of the screws is demonstrated by direct testing.

The staff verified that the Model 1100 meets the requirements of 10 CFR 71.43(d), 71.71, and 71.73, and that there are expected to be no significant chemical, galvanic, or other reactions among the bolting materials.

Based on the NRC staff's review of the statements and representations in the SAR, the NRC staff concludes that the materials used in the Model 1100 design have been adequately described and evaluated and that the package meets the requirements of 10 CFR Part 71.

8.0 OPERATING PROCEDURES EVALUATION

Operating procedures for the package are specified in Chapter 7 of the application. The chapter includes sections on package loading, unloading, and preparation of an empty package for transport.

The applicant summarized the Model 1100 loading and unloading procedures to show a general approach to operational activities. The applicant explained that an operation manual will describe the operational steps in greater detail and then will be used for specific procedures that will address particular operational considerations related to the Model 1100. Deviations to the provided procedures are acceptable if justified by the applicable Licensee or Certificate Holder in their quality assurance program to maintain equal or better package effectiveness and continued compliance with the applicable 10 CFR Part 71 requirements.

The staff has reviewed the description of the operating procedures and finds that the package will be prepared, loaded, transported, received, and unloaded in a manner consistent with its design and evaluation for approval.

The staff has reviewed the description of the special instructions needed to safely open a package and concludes that the procedures for providing the special instruction to the consignee are in accordance with the requirements of 10 CFR 71.89.

8.1 Evaluation Findings

Based on the statements and representations in the application, the staff has adequate assurance that the operating procedures meet the requirements of 10 CFR Part 71 and that these procedures are acceptable to ensure the package will be operated in a manner consistent with its evaluation for approval.

9.0 ACCEPTANCE TESTS AND MAINTENANCE PROGRAM EVALUATION

Acceptance tests and the maintenance program for the package are specified in Chapter 8 of the application. The acceptance tests from Section 8.1 of the application include: visual inspection, weld examination, structural and pressure tests, leak tests, component and materials tests, and shielding tests.

Section 8.2 of the application provides the maintenance program for the package. This program includes structural and pressure tests, leak tests, components and materials tests, and ageing mechanism considerations tests.

The applicant summarized the Model 1100 acceptance tests and maintenance program to show the general approach to tests and maintenance activities. The acceptance tests from section 8.1 included visual inspection and measurements, weld examinations, structural and pressure tests, leakage tests, component and material tests, shielding tests, and thermal tests.

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).

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).

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).

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).

9.1 Evaluation Findings

Based on the statements and representations in the application, the staff has adequate assurance that the acceptance tests for the packaging meet the requirements of 10 CFR Part 71 and that the maintenance program is adequate to ensure packaging performance during its service life.

10.0 QUALITY ASSURANCE EVALUATION

The quality assurance program for the package is specified in Chapter 9 of the application. The chapter refers to the NRC approved QSA Global, Inc. QA program.

Based on the statements and representation in the application, the staff has adequate assurance that the QA program meets the requirements of 10 CFR Part 71 and that the program is acceptable to assure the package will be fabricated in a manner consistent with its evaluation for approval.

CONDITIONS

In addition to the package description, drawings and contents, the following conditions were included in the Certificate of Compliance:

Condition 6 states that in addition to the requirements of Subpart G of 10 CFR Part 71, the Model 1100 package shall:

- (a) Be prepared for shipment and operated in accordance with the operating procedures in Chapter 7 of the application, and
- (b) Meet the Acceptance Tests and Maintenance Program of Chapter 8 of the application.

Condition 7 states that the package is approved for use under the general license provision of 10 CFR 71.17.

Condition 8 states that the expiration date for the package will be August 31, 2030.

CONCLUSION

Based on the statements and representations contained in the application, as supplemented, and the conditions listed above, the staff concludes that the design has been adequately described and evaluated, and the Model 1100 package meets the requirements of 10 CFR Part 71.

Issued with Certificate of Compliance No. 9405, Revision No. 0.