SAFETY EVALUATION REPORT

Docket No. 71-9157
Model No. IR-100
Certificate of Compliance No. 9157
Revision No. 15

SUMMARY

By letter dated July 8, 2015, as supplemented August 6, 2015, Industrial Nuclear Company submitted an amendment request to revise the certificate of compliance (CoC) for the Model No. IR-100 package. The applicant revised the shielding and thermal sections of the safety analysis report (SAR) to allow the use of Selenium-75 (Se-75) as a radiation source. In addition, the applicant reformatted the SAR in accordance with Regulatory Guide 7.9, Revision 2. NRC staff reviewed the application using the guidance in NUREG-1609, "Standard Review Plan for Transportation Packages for Radioactive Material." Based on the statements and representations in the application, as supplemented, the staff agrees that these changes do not affect the ability of the package to meet the requirements of 10 CFR Part 71.

1.0 GENERAL INFORMATION

1.1 Content Description

The applicant revised the content description in the SAR to allow the use of Se-75 in a special form capsule. The SAR identified the maximum amount of Se-75 to be loaded into the package as 120 Curies (Ci). Staff finds this change acceptable since it adequately identifies the maximum amount of radioactive material allowed in the package as well as the form of the material.

1.2 Evaluation Findings

Based on a review of the statements and representations in the application, the staff concludes that the package has been adequately described to meet the requirements of 10 CFR Part 71.

2.0 THERMAL

The applicant sought authorization to ship Se-75 in a special form capsule in the IR-100 package. The objective of this review is to verify that the package design satisfies the thermal requirements of 10 CFR Part 71 under normal conditions of transport (NCT) and hypothetical accident conditions (HAC).

2.1 Decay Heat

The IR-100 was previously approved for up to 120 Ci of Iridium-192 (Ir-192) in a special form capsule and the applicant sought approval for 120 Ci of Se-75 in a special form capsule as well. The applicant stated that the radiolytic decay heats of Ir-192 and Se-75 are 7.03×10^{-3} W/Ci and

$2.41x10^{-3}$ W/Ci, respectively. The staff confirmed the Ir-192 heat load bounds the heat load of Se-75. Therefore, the maximum heat load for the IR-100 remains 0.84 watts. The staff reviewed the package description and evaluation relative to the changes associated with this request and concluded that they satisfy the thermal requirements of 10 CFR Part 71.

2.2 Material Properties and Component Specifications

The applicant described the IR-100 components and their material properties in SAR Section 3.2. The IR-100 package is constructed with a stainless steel outer skin surrounding polyurethane foam and a depleted uranium (DU) gamma shield. The thermal limits for the DU and stainless steel are their melting temperatures. The melting temperatures are 2,071°F for DU and 2,800°F for stainless steel.

The staff reviewed the material properties and component specifications provided in the SAR. Staff confirmed that the thermal properties and component specifications for the IR-100 package are unchanged when loaded with Se-75. Therefore, the staff concluded that the material properties and component specification were sufficiently described to evaluate the IR-100 against the thermal requirements of 10 CFR Part 71.

2.3 Thermal Evaluation Under NCT

The applicant stated in SAR Section 3.3 that the calculated surface temperature is 189.9°F with a heat load of 0.84 watts, an ambient temperature of 100°F and maximum insolation under NCT. The applicant also stated in SAR Section 3.3 that the maximum IR-100 surface temperature in shade with an ambient temperature of 100°F is 100°F. Similarly, the applicant stated that the IR-100 surface temperature will be equal to ambient under the lower temperature conditions of -20°F and -40°F at which the DU and stainless steel have been tested. In addition, the applicant asserted that, with a heat load less than 1 watt, the peak internal temperatures will closely match the package surface temperatures.

The applicant stated in SAR Section 3.4.3 that the containment of the IR-100 is provided by the special form capsule, and that gas can freely flow from the internal cavity to the environment. Therefore, there is neither a pressure boundary, nor a maximum normal operating pressure for the IR-100 package.

The staff reviewed the changes in the SAR and confirmed that the thermal design and features of the IR-100 package are unchanged by the proposed amendment. The staff also confirmed that the maximum allowable service temperatures of all components remain unchanged and the minimum allowable service temperature of all components is still -40°F in compliance with 10 CFR 71.71.

The staff reviewed the SAR changes and determined that the thermal configuration for the IR-100 package is unchanged. The staff also determined that the IR-100 package has neither a pressure boundary nor a maximum normal operating pressure. The staff reviewed the package design and submitted evaluations. Staff determined that the package temperatures will not exceed the allowable thermal limits (melting points) for the package materials and components during NCT for shipment with Se-75 and are consistent with the tests specified in 10 CFR 71.71.

2.4 Thermal Evaluation Under HAC

The applicant performed the HAC 30-minute thermal test in an oven, as described in SAR Section 3.4, with a minimum temperature of 1475°F at the package surface. During heat up, burning of the polyurethane foam was observed. Following the 30-minute fire test, the package was removed from the oven and cooled in air in compliance with 10 CFR 71.73. After completion of the test, the applicant examined the package and found the polyurethane was completely consumed by the fire, adding its combustion energy to the package. However, the DU and the outer skin of the package were neither compromised nor appreciably oxidized. The peak test temperatures were still well below the melting temperatures of stainless steel (2,800°F) and uranium shielding (2,071°F).

The staff reviewed the HAC thermal evaluation in SAR Section 3.4 and inquired of the applicant if the HAC test procedures had been changed. The applicant responded that both the fire test procedures and conditions had not changed (Agencywide Documents Access and Management System accession number ML15226A339). Therefore, staff accepts the test procedures and conditions for shipment of Se-75 in the IR-100 package. The staff reviewed the thermal features of the IR-100 package and confirmed that both the stainless steel and the DU have melting points of 2,800°F and 2,071°F, respectively. Since these temperatures are greater than the fire temperature of 1,475°F, the staff determined that neither the stainless steel nor the DU will significantly degrade in a HAC fire. The staff also confirmed that the thermal features and test conditions of the IR-100 package with Se-75 payload remain unchanged from the previously approved conditions.

The staff reviewed the package design and evaluation. Staff concluded that the package material and component temperatures will not degrade in the HAC fire test because the melting points of stainless steel and DU are much higher than the 1475°F fire temperature. The staff also confirmed that the thermal evaluation and the fire test, described in SAR 3.4 for the IR-100 package with Se-75 payload, meet the thermal requirements specified in 10 CFR 71.73.

2.5 Evaluation Findings

Based on review of statements and representations in this proposed amendment, the staff determined that the thermal design and features of the IR-100 package remain unchanged from the conditions previously approved by staff and meet the thermal requirements of 10 CFR Part 71 for shipment of Se-75 in a special form capsule.

3.0 SHIELDING EVALUATION

The objective of this evaluation is to verify that the IR-100 package with 120 Ci of Se-75 in special form capsule meets the regulatory requirements of 10 CFR Part 71 for external dose rate limits for packages under NCT and HAC.

3.1 Shielding Design Description

The IR-100 is a transportation packaging system previously approved for transporting 120 Ci of Ir-192 in a special form capsule. This amendment requested the addition of 120 Ci of Se-75 in a special form capsule as allowable content.

The IR-100 packaging consists of a DU shield and a polyurethane impact absorbing layer encased in a 12 gauge 304 type stainless steel shell. The source is secured in the center of the

DU shield by a pigtail assembly along with a lock box and lockball. The minimal thickness of the DU is 1.78 inches as shown in licensing drawing number IR 100-1B. The DU provides the primary radiation shield. The package is designed for non-exclusive use and the Transport Index, which is determined by pre-shipment measurement, shall not exceed 10.

3.2 Radiation Source Specification

The amendment requested authorization of 120 Ci of Se-75 in special form as allowable content. The new content radioactivity is the same as the previously approved Ir-192 source.

3.3 Shielding Model

For original issuance of the certificate of compliance with an Ir-192 source, neither computational models nor analysis were used to demonstrate compliance with the regulations. Instead, the applicant performed the tests described in 10 CFR 71.71 and 10 CFR 71.73 and measured the subsequent package dose rate. With an Ir-192 source, the measured dose rate on the package surface under NCT was 106 mrem/hr, and 0.9 mrem/hr one meter from the package surface. Therefore, the Transport Index for this package was determined to be 0.9. Under HAC, the dose rate one meter from the package surface was also determined to be 0.9 mrem/hr.

To show compliance with the regulations for this amendment, the applicant compared the gamma constants, i.e., the dose rate from a given amount of radionuclide at a specific distance, for Ir-192 and Se-75. The gamma constants used by the applicant for Ir-192 and Se-75 were 0.460 and 0.203 rem per hour per curie of activity, respectively. Staff reviewed the gamma constants used by the applicant to data in the latest publications [Refs. 1, 2]. Staff determined the applicant used conservative values, and that this comparison demonstrated that the Ir-192 source bounds the Se-75 source for the same radioactivity.

3.4 Evaluation Findings

The staff reviewed the description of the package shielding design and the source terms. The staff also reviewed the design method and the maximum dose rates of the package under NCT and HAC. Based on its review, staff determined that the applicant's design approach, i.e., demonstration of compliance with the regulation by testing, acceptable. The staff also finds that the radiation intensity of Se-75 is much lower than that of Ir-192 with the same radioactivity, i.e., 120 Ci, based on the decay scheme, energy spectrum, and the number of photons emitted per Ci of activity. Therefore, the source strength of 120 Ci of Ir-192 in a special form capsule bounds that of 120 Ci of Se-75 in special form.

Based on its review of the statements and representations provided in the application, the staff has reasonable assurance that the shielding design of the IR-100 package with the proposed contents meets the regulatory requirements of 10 CFR 71.47 and 71.51. The staff followed the guidance of NUREG-1609, "Standard Review Plan for Transportation Packages for Radioactive Material" in its review.

References:

1. M. M. Ninkovic, et. al., "Air Kerma Rate Constants for Gamma Emitters," Radiation Protection Dosimetry (2005), Vol. 115, No. 1–4, pp. 247–250.
2. P. Hayward, et., al., "Radiography of Welds Using Selenium 75, Ir-192, and X-ray," 12th A-PCNDT 2006 – Asia-Pacific Conference on NDT, 5th – 10th Nov. 2006, Auckland, New Zealand.

CONDITIONS

The CoC includes the following condition(s) of approval:

Condition 5(a)(2) was revised to incorporate Se-75 into the package description.

Condition 5(b)(1) was revised to incorporate Se-75 as allowable contents.

Condition 10 was added to allow the use of Revision 14 of this certificate until September 30, 2016.

The references section has been updated to include this request.

Minor editorial corrections were made.

CONCLUSIONS

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 No. IR-100 package meets the requirements of 10 CFR Part 71.

Issued with Certificate of Compliance No. 9157, Revision No. 15
on September 22, 2015.