Second Request for Additional Information
for the
Model No. OPTIMUS-H Package
Docket No. 71-9392

By letter dated December 22, 2021 (Agencywide Documents Access and Management System [ADAMS] Accession No. ML21361A089), NAC International (NAC) submitted an application for approval of the Model No. OPTIMUS®-H radioactive material transport package (Optimal Modular Universal Shipping cask for High activity contents). On August 16, 2022, NAC submitted its responses to the U.S. Nuclear Regulatory Commission staff's request for supplemental information for the review of the Model No. OPTIMUS-H Package, dated April 28, 2022. On October 4, 2022, your application was accepted for a detailed technical review.

On May 5, 2023, NAC submitted its responses to the staff's request for additional information (RAI) letter dated March 6, 2023.

On August 14, 2023, NAC provided supplemental responses to the staff's first RAI pursuant to a clarification call held between NAC and the staff on July 12, 2023.

This second RAI identifies information needed by the staff in connection with its review of the Model No. OPTIMUS-H package.

CHAPTER 2 MATERIALS EVALUATION

2.1 Considering the maximum allowable fabrication flaw sizes based on the applicable nondestructive examination (NDE) acceptance criteria for the ductile cast iron (DCI) outer shield vessel (OSV) components, provide information that demonstrates adequate protection, at the lowest service temperature (LST), against OSV fracture that results in any of the following events:

(1) For the normal conditions of transport (NCT) impact test (2-ft free drop) and hypothetical accident conditions (HAC) impact tests (30-ft free drop and puncture drop), OSV fracture that results in any of the cask containment vessel (CCV) components exceeding their allowable stress limits in Table 2.1-3,

(2) For the NCT impact test (2-ft free drop), OSV fracture that results in a significant increase in external surface radiation levels, such that the package is not in compliance with Title 10 of the *Code of Federal Regulations* (10 CFR) Sections 71.43(f) and 71.51(a)(1),

(3) For the HAC impact tests (30-ft free drop and puncture drop), OSV fracture that results in an external radiation dose rate exceeding 10 mSv/hr (1 rem/hr) at 1 m (40 in) from the external surface of the package, such that the package is not in compliance with 10 CFR 71.51(a)(2).

Enclosure

The information should address the following, as needed to demonstrate adequate protection against unacceptable OSV fracture at the LST that results in any of the above three events.

a. Rapid-load fracture toughness (K_{IC-R}) test data for the subject American Society for Testing and Materials (ASTM) DCI material specification based on rapid-load fracture toughness testing at or below the LST,
b. Correlations between measurements of absorbed Charpy impact energy and rapid-load fracture toughness test data for the subject ASTM DCI material specification that are applicable in the ductile-to-brittle transition region for the DCI material,
c. Fracture mechanics analyses and/or other types of structural and radiation streaming analyses that are needed to demonstrate adequate protection against unacceptable OSV fracture at the LST.

This information should adequately demonstrate that, when the DCI components are subjected to the impact loads associated with the NCT and HAC free drop and puncture drop tests, a preexisting fabrication flaw of the maximum allowable size (based on NDE acceptance standards) in the most highly stressed locations of the components would not propagate through the DCI components and cause complete structural failure (e.g., a large through-wall rupture or break) of the OSV, or achieve a final flaw size at the end of the impact event that would result in any of the above three criteria being violated.

The staff noted that the application includes requirements for performing Charpy impacts tests on samples of the subject DCI material at the LST and associated acceptance criteria for the measurements of absorbed Charpy impact energy. The staff also noted that the application includes requirements for volumetric and surface NDE of the OSV castings using non-U.S. consensus standards for performance of NDE and associated fabrication flaw acceptance criteria. The staff's RAI on non-U.S. consensus standards for NDE and associated fabrication flaw acceptance criteria was covered in a separate RAI letter. Based on the review of the application-specified acceptance criteria for absorbed Charpy impact energy, the staff could not determine whether the subject DCI material would have sufficient fracture toughness at the LST to ensure adequate protection against OSV fracture that results in the occurrence of any of the events listed above.

The staff also noted that the application does not propose to use the subject DCI material for any containment function. As addressed in the application, the DCI OSV components are not designed to retain internal pressure or to prevent or mitigate leakage of radionuclides to the outside environment. However, the application indicates that the OSV functions as a secondary enclosure for the CCV during transport to provide radiation shielding and to protect the CCV from the direct effects of NCT and HAC impact loading and HAC fire test conditions. Therefore, for the NCT and HAC impact tests, the DCI material must have sufficient toughness at the LST to protect against fracture of the DCI OSV components that results in any of the events listed above.

The information is required to determine compliance with 10 CFR 71.43(f), 71.51(a)(1), and 71.51(a)(2).

2.2 State whether the welded carbon steel shield insert assembly (SIA) material is required to be Charpy impact tested in accordance with the requirements of Subarticle NF-2300 of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (BPVC), Section III, Subsection NF. If so, revise section 2.1.2.5.4 of the application to specify this requirement. If not, considering the maximum allowable fabrication flaw sizes based on the applicable NDE acceptance criteria for the welded carbon steel SIA components, provide information that demonstrates adequate protection at the LST against SIA fracture that results in any of the following events:

(1) For the NCT impact test (2-ft free drop), SIA fracture that results in a significant increase in external surface radiation levels, such that the package is not in compliance with 10 CFR 71.43(f) and 71.51(a)(1),

(2) For the HAC impact tests (30-ft free drop and puncture drop), SIA fracture that results in an external radiation dose rate exceeding 10 mSv/hr (1 rem/hr) at 1 m (40 in) from the external surface of the package, such that the package is not in compliance with 10 CFR 71.51(a)(2).

The information should address the following, as needed to demonstrate adequate protection against unacceptable SIA fracture at the LST that results in any of the above events.

a. Rapid-load fracture toughness (K_{IC-R}) test data for the subject ASTM carbon steel material specification based on rapid-load fracture toughness testing at or below the LST,

b. Fracture mechanics analyses and/or other types of structural and radiation streaming analyses that are needed to demonstrate adequate protection against unacceptable SIA fracture at the LST.

This information should adequately demonstrate that, when the carbon steel SIA components are subjected to the impact loads associated with the NCT and HAC free drop and puncture drop tests, a preexisting fabrication flaw of the maximum allowable size (based on NDE acceptance standards) in the most highly stressed locations of the components would not propagate through the carbon steel SIA components and cause complete structural failure of the SIA (e.g., a large through-wall rupture or break), or achieve a final flaw size at the end of the impact event that would result in any of the above criteria being violated.

The staff noted that the application does not include any requirements for performing Charpy impacts tests on samples of the SIA carbon steel material at the LST, although such impact test are specified in Subsection NF of the ASME BPVC, Section III. The staff also noted that section 2.1.2.5.4 of the application states that the SIA is designed in accordance with the Category III fracture toughness criteria of NUREG/CR-1815. However, the staff noted that Regulatory Guide 7.11 does not endorse the use of NUREG/CR-1815 Category III fracture toughness criteria for radiation shielding components. Rather, Subsection NF, Subarticle NF-2300 fracture toughness requirements for materials are endorsed in NUREG/CR-3854. Thus, the staff could not determine whether the subject SIA material would have sufficient fracture toughness at the LST to ensure adequate protection against SIA fracture that results in the occurrence of any of the above events.

The staff also noted that the application does not propose to use the subject SIA material for any containment function or structural support function. As addressed in the application, the carbon steel SIA components are not designed to retain internal pressure or to prevent or mitigate leakage of radionuclides to the outside environment, and they are not credited in the structural analyses of the CCV or OSV. However, the application indicates that the SIA functions as an internal enclosure for the radioactive contents inside CCV to provide radiation shielding. Therefore, for the NCT and HAC impact tests, the SIA material must have sufficient toughness at the LST to protect against fracture of the SIA components that results in any of the events listed above.

The information is required to determine compliance with 10 CFR 71.43(f), 71.51(a)(1), and 71.51(a)(2).

CHAPTER 4 CONTAINMENT EVALUATION

4.1 Differentiate the various TRU waste content types described in the application, along with their corresponding heat load limits, and clarify which contents will requiring inerting of the OPTIMUS-H package prior to shipment. Further, in chapter 7 of the SAR, clarify whether TRU Contents 1-1, 1-2A, 1-2B and 1-2C may be shipped together in the same package and, if so, address how criteria related to flammable gases concentration limits and inerting will be applied for mixtures of these contents.

The applicant has provided different criteria for TRU waste shipments with Contents 1-1, 1-2A, 1-2B, and 1-2C. For Contents 1-1 and 1-2A, the secondary container and cask containment vessel must be inerted to limit oxygen concentration to 5 vol% or less, while for Content 1-2C, the gaseous content of the lecture bottle is either unknown or known to be a flammable gas, thus limiting the fuel concentration to below the lower flammability limit of 5 vol%. On the other hand, for content 1-2B, hydrogen and other flammable gases comprise less than 5 vol% of the total gas inventory within any confined volume.

The applicant needs to clarify the TRU waste content types (e.g., Contents 1-1, 1-2A, 1-2B and 1-2C) and their corresponding heat load limits, specifying which contents will requiring inerting. Further, the applicant has not explained whether TRU Contents 1-1, 1-2A, 1-2B and 1-2C may be transported together in a single package and, if so, what the criteria for limiting the generation of flammable gases and the corresponding inerting requirement should be.

This information is required to determine compliance with 10 CFR 71.43(d).