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DEPARTMENT OF ENERGY
NATIONAL NUCLEAR SECURITY ADMINISTRATION
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NR:RS:MAKuprenas Z#C19-03241
August 5, 2019

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John Lubinski
Director, Office of Nuclear Materials Safety and Safeguards
Nuclear Regulatory Commission
Washington, DC 20555

S5G REACTOR COMPARTMENT DISPOSAL PACKAGE - SAFETY ANALYSIS
REPORT FOR PACKAGING (DOCKET NO. 71-9788); REQUEST FOR NUCLEAR
REGULATORY COMMISSION REVIEW AND CONCURRENCE (U)

Background: Reactor Compartment Disposal Packages (RCDPs) are shipping containers for radioactive material, manufactured by modifying the reactor compartments of nuclear powered vessels. Naval Reactors has previously prepared Safety Analysis Reports (SARPs) for the RCDPs from defueled S5W and SSN 688 Class submarines and NR-1. These SARPs evaluate the RCDPs, which contain components that constitute a Type B quantity of radioactive, non-fissile material, for compliance with the normal and accident conditions specified in 10 CFR 71. NRC Certificate of Compliance (CoC) USA/9788/B(U)-96 documents NRC concurrence that reactor compartments from defueled submarines, modified to become RCDPs, met the requirements of 10 CFR 71 for Type B shipping containers.

Discussion: The S5G RCDP is the RCDP for the EX-USS NARWHAL (SSN 671). Only one ship of this class was built. The USS NARWHAL was shut down in November 1998. Like previous submarine RCDPs, the S5G RCDP consists of the deactivated and defueled submarine reactor compartment, separated from the remainder of the submarine, and prepared for shipment by sealing all openings and attaching handling fixtures. The NRC previously reviewed an earlier version of this SARP; however, the attached SARP represents a complete revision based on the extent of the changes in the structural analysis.

The RCDP does not contain any fissile material. The authorized contents include activated structural components associated with the reactor vessel complex, plant piping, ion exchanger resin, residual liquid, and other miscellaneous components and materials contaminated with radioactive corrosion products. The reactor plant is drained except for small inaccessible pockets of water, and absorbent material and hydrogen-oxygen recombining catalysts are added to the reactor vessel, as required by the burial site authority. The S5G SARP demonstrates that the submarine RCDP complies with all 10 CFR 71 requirements.

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Request for Action: This letter requests that the NRC review and concur with the S5G RCDP SARP as transmitted in Enclosure (1) to this letter. Enclosure (2) provided, for information, the proposed revised Department of Energy CoC. Naval Reactors requests concurrence by February 28, 2020, to support planned operations. If you have any questions regarding this submittal, please call me at (202) 781-6060.

The action taken by this letter is considered by the Government to be within the scope of existing contracts and therefore does not involve or authorize any delay in delivery or additional cost to the Government, either direct or indirect.



M. A. Kuprenas
Naval Reactors

- Enclosure: (1) S5G REACTOR COMPARTMENT DISPOSAL PACKAGE SAFETY ANALYSIS REPORT FOR PACKAGING
(2) DOE-NR CERTIFICATE OF COMPLIANCE FOR SUBMARINE REACTOR COMPARTMENT DISPOSAL PACKAGE, USA/9788/B(U)-96, REVISION 23 (PROPOSED)

Copy to (Prime Contractor):

KAPLADSARS

General Manager, NNL*

Manager, Reactor Servicing, NNL*

Manager, Reactor Servicing Systems, RS, NNL*

Manager, Shipping Containers, RSS, RS, NNL*

Manager, Shipping Design & Support, SC, RSS, RS, NNL*

G. P. Steiner, Shipping Container Analysis, SC, RSS, RS, NNL*

NRLFO*

(* = without Enclosure (1))

Copy to (All Others):

M. Layton, Director, Division of Spent Fuel Management, NMSS, NRC*

J. McKirgan, Chief Spent Fuel Licensing Branch, SFM, NMSS, NRC*

B. White, Special Project Manager, Licensing Branch, SFM, NMSS, NRC

(* = without Enclosure (1))

ENCLOSURE (1)

**S5G REACTOR COMPARTMENT DISPOSAL PACKAGE
SAFETY ANALYSIS REPORT FOR PACKAGING**

Enclosure (1) to
08Z#C19-03241

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ENCLOSURE (2)

**DOE-NR CERTIFICATE OF COMPLIANCE
FOR SUBMARINE REACTOR COMPARTMENT DISPOSAL PACKAGE,
USA/9788/B(U)-96, REVISION 23 (PROPOSED)**

The enclosed proposed Certificate of Compliance shows additions and deletions from the current version of the certificate. Minor formatting and editorial changes are not highlighted.

Enclosure (2) to
08Z#C19-03241

U. S. DEPARTMENT OF ENERGY

DOE F 5822.1

(5-85)

(Formerly EV-618)

CERTIFICATE OF COMPLIANCE

For Radioactive Materials Packages

OMB Approval
No. 1910-2000

| | | | | |
|--|--|---|-------------------|--------------------------|
| 1a. Certificate Number USA/9788/B(U) (DOE-NR) | 1b. Revision No. 23 (Proposed) | 1c. Package Identification No. USA/9788/B(U)-96 (DOE-NR) | 1d. Page No. 1 | 1e. Total No. Pages 5 |
|--|--|---|-------------------|--------------------------|

2. PREAMBLE

2a. This certificate is issued under the authority of 49CFR Part 173.7(d).

2b. The packaging and contents described in item 5 below, meets the safety standards set forth in subpart E, "Package Approval Standards" and subpart F, "Package, Special Form, and LSA-III Tests" Title 10, Code of Federal Regulations, Part 71.

2c. 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

(1) Prepared by (Name and address):

Naval Nuclear Laboratory
P. O. Box 79
West Mifflin, PA 15122-0079

(2) Title and Identification of report or application:

Safety Analysis Report for Packaging for
Deactivated Submarine Reactor
Compartment

(3) Date

July 1981

4. CONDITIONS

This certificate is conditional upon the fulfilling of the applicable Operational and Quality Assurance requirements of 49CFR Parts 100-199 and 10CFR Part 71, and the conditions specified in item 5 below.

5. Description of Packaging and Authorized Contents, Model Number, Criticality Safety Index, Other Conditions, and References:

a. Description of Packaging

The package consists of a deactivated and defueled S5W class, SSN 688 Class, S5G, or NR-1 Reactor Compartment which has been separated from the remainder of the submarine hull and prepared for shipment by sealing all openings and attaching handling fixtures. For each package, the reactor compartment itself is either between two containment bulkheads, or one containment bulkhead and the hemispherical head end of the hull. The containment bulkheads are added to the package before shipping. The ship's hull and the containment bulkheads define the package containment boundaries. The containment bulkheads are either installed at the ends of the package or recessed such that the hull structure forms an overhang over the bulkheads. The strength of all package boundary closures is at least equivalent to the strength of the new bulkheads (300 foot submergence). The deactivated reactor plant remains in place within the reactor compartment during shipment. The plant is defueled and drained except for small inaccessible pockets of liquid, primarily water. Potentially radioactively contaminated components and piping from other locations in the ship may be placed within the package and secured.

The S5W Reactor Compartment package is between 35 and 45 feet long and approximately cylindrical with a maximum diameter of approximately 33 feet. New containment bulkheads are made of HS steel and the hull is constructed of HY-80 steel. The maximum weight of the S5W package is 2,160,000 pounds for the 598 and 585 classes and is 2,262,400 pounds for all other classes.

| | |
|--|--|
| 6a. Date of Issuance: Month XX, 2019 | 6b. Expiration Date: September 30, 2023 |
| FOR THE U.S. DEPARTMENT OF ENERGY | |
| 7a. Address (of DOE Issuing Office) Naval Reactors U. S. Department of Energy Washington, D. C. 20585 | 7b. Signature, Name and Title (of DOE Approving Official) S. J. Trautman Deputy Director, Naval Reactors |

The SSN 688 Class Reactor Compartment package is approximately 46 feet long and approximately cylindrical with a maximum diameter of approximately 33 feet. New containment bulkheads are made of HS steel and the hull is constructed of HY-80 steel. The maximum weight of the package is 3,360,000 pounds.

The NR-1 package is approximately 43 feet long and approximately cylindrical with a maximum diameter of approximately 12.5 feet. The NR-1 package has one containment bulkhead at the forward end of the package. The aft end of the package is the hemispherical head section of the hull. The new containment bulkhead is made of HS steel and the hull is constructed of HY-80 steel. A 20 feet long box keel section remains attached to the bottom of the package. Additional plating of HS steel on the hull surrounds the pressure vessel region of the Reactor Compartment, including the box keel. The maximum weight of the package is 406,500 pounds.

The S5G Reactor Compartment package is approximately 46 feet long and approximately cylindrical with a maximum diameter of approximately 33 feet. New containment bulkheads are made of HS steel and the hull is constructed of HY-80 steel. The maximum weight of the S5G package is 2,950,000 pounds.

b. Authorized Contents

The authorized contents consist of activated structural components associated with the S5W class, SSN 688 Class, S5G, or NR-1 reactor vessel complex, plant piping, ion exchanger resin, purification filter media (SSN 688 Class only), residual liquid, and other miscellaneous components and materials contaminated with radioactive corrosion products (crud).

c. Criticality Safety Index

None; the package does not contain fissile material.

d. Other Conditions (Restrictions)

- (1) For S5W packages, ion exchanger resin with up to 3.1 curies (1.1×10^{11} becquerels) of Co-60 may be shipped in the package.
- (2) For SSN 688 Class packages, the Co-60 activity of the ion exchanger resin (A_{IX}) and activity of the purification filter media (A_{PF}) must meet the following conditions:

(a) when only the PF is solidified,

for activity in curies:

$$[A_{PF} (27.2 \text{ mr/hr/Ci}) + A_{IX} (283.8 \text{ mr/hr/Ci})] \leq 995 \text{ mr/hr}$$

for activity in becquerels:

$$[A_{PF} (7.35 \times 10^{-10} \text{ mr/hr/Bq}) + A_{IX} (7.67 \times 10^{-09} \text{ mr/hr/Bq})] \leq 995 \text{ mr/hr}$$

(b) when only the IX is solidified,

for activity in curies:

$$[A_{IX} (53.9 \text{ mr/hr/Ci}) + A_{PF} (299.6 \text{ mr/hr/Ci})] \leq 995 \text{ mr/hr}$$

for activity in becquerels:

$$[A_{IX} (1.46 \times 10^{-09} \text{ mr/hr/Bq}) + A_{PF} (8.10 \times 10^{-09} \text{ mr/hr/Bq})] \leq 995 \text{ mr/hr}$$

- (c) when both the PF and IX are solidified,
for activity in curies:

$$[A_{IX} (53.9 \text{ mr/hr/Ci}) + A_{PF} (27.2 \text{ mr/hr/Ci})] \leq 995 \text{ mr/hr}$$

- for activity in becquerels:

$$[A_{IX} (1.46 \times 10^{-09} \text{ mr/hr/Bq}) + A_{PF} (7.35 \times 10^{-10} \text{ mr/hr/Bq})] \leq 995 \text{ mr/hr}$$

- (d) when neither the IX nor PF are solidified, the limit for A_{PF} is 3.3 curies of Co-60 (1.22×10^{11} becquerels), the limit for A_{IX} is 3.5 curies of Co-60 (1.30×10^{11} becquerels), and the total of A_{IX} and A_{PF} cannot exceed 4.5 curies of Co-60 (1.67×10^{11} becquerels), unless additional shielding is added, See (6) and (7).

These activity limits are based on limiting total radiation levels to 995 mrem/hr under hypothetical accident conditions. If contaminated filters are shipped with the package, the sum of the radiation levels from each filter at one meter, shielded by the hull, must be subtracted from this 995 mrem/hr, and the A_{IX} and A_{PF} activity limits must be reduced accordingly for SSN 688 Class Packages.

- (3) Shipment of S5W packages must not occur before 180 days after final reactor shutdown, and shipment of SSN 688 Class packages shall not occur before 365 days after final reactor shutdown.
- (4) For S5W packages with recessed containment bulkheads, the aft containment bulkheads, stiffeners, horizontal girder and any structure between the pressure hull and the outer non-pressure hull must be recessed at least 7 inches from the aft end of the package. The forward containment bulkhead, stiffeners, and horizontal girder must be recessed at least 15 inches from the forward end of the package.

For SSN 688 Class packages with recessed containment bulkheads, both the aft and forward bulkheads, stiffeners, and horizontal girders must be recessed at least 15 inches from the end of the package.

- (5) The Lowest Service Temperature (LST) must be determined for each package. The package must not be shipped unless its LST is less than or equal to the daily minimum temperature expected during shipment of the package as determined on the basis of weather forecasts.
- (6) Prior to shipment, radiation surveys of the exterior of the unshielded package must be taken. Additional shielding must be provided on the exterior of a SSN 688 Class package by securely welding steel plates to the package surface if either of the following conditions exist:
- (a) Radiation levels on the exterior of the package obtained via surveys exceed 200 mrem/hr on-contact or 10 mrem/hr at 2 meters.
 - (b) When the PF and IX are not solidified, A_{PF} exceeds 3.3 curies of Co-60, A_{IX} exceeds 3.5 curies of Co-60, or the total of A_{IX} and A_{PF} exceeds 4.5 curies of Co-60.

Radiation surveys must be re-performed after adding supplemental shielding. Final radiation levels must not exceed 200 mrem/hr on-contact or 10 mrem/hr at 2 meters.

- (7) When condition 6(a) exists, 0.5-inch thick steel plates must extend from one inch above the bottom of the shielded tunnel on the starboard side to 87° beyond the keel on the port side and

extend 110 inches forward and aft of the centerline of the Pressure Vessel. Additional steel plates of a 1.25-inch thickness must extend 22° beyond the keel on the port and starboard side and 77 inches forward and aft of the centerline of the Pressure Vessel.

When condition 6(b) exists, 1-inch thick steel plates must either:

- (a) Extend from 1-inch above the bottom of the shielded tunnel on the starboard side to 64° beyond the keel on the port side and extend from frame 73 to frame 76. In this case, A_{PF} cannot exceed 7.8 curies of Co-60 (2.89×10^{11} becquerels), A_{IX} cannot exceed 8.2 curies of Co-60 (3.03×10^{11} becquerels), and the total of A_{PF} and A_{IX} cannot exceed 8.5 curies of Co-60 for D1G-2 cores or 9.0 curies of Co-60 for D2W cores (3.14×10^{11} and 3.33×10^{11} becquerels, respectively); or
- (b) Extend from 1-inch above the bottom of the shielded tunnel on the starboard side to 37° beyond the keel on the port side and extend from frame 73 to frame 76. In this case, A_{PF} cannot exceed 7.8 curies of Co-60 (2.89×10^{11} becquerels), A_{IX} cannot exceed 3.5 curies of Co-60 (1.30×10^{11} becquerels), and the total of A_{PF} and A_{IX} cannot exceed 8.5 curies of Co-60 for D1G-2 cores or 9.0 curies of Co-60 for D2W cores (3.14×10^{11} and 3.33×10^{11} becquerels, respectively).

When both conditions 6(a) and 6(b) exist, 1-inch thick steel plates must extend from 1 inch above the bottom of the shielded tunnel on the starboard side to 87° beyond the keel on the port side and extend 110 inches forward and 172 inches aft of the centerline of the Pressure Vessel. Additional steel plates of a 0.75-inch thickness must extend 22° beyond the keel on the port and starboard side and extend 77 inches forward and aft of the centerline of the Pressure Vessel. In this case, A_{PF} cannot exceed 7.8 curies of Co-60 (2.89×10^{11} becquerels), A_{IX} cannot exceed 8.2 curies of Co-60 (3.03×10^{11} becquerels) and the total of A_{PF} and A_{IX} cannot exceed 8.5 curies of Co-60 for D1G-2 or 9.0 curies of Co-60 for D2W cores (3.14×10^{11} and 3.33×10^{11} becquerels, respectively).

The activity limits for the ion exchanger and purification filter are based on limiting total radiation levels to 995 mrem/hr under hypothetical accident conditions. If contaminated filters are shipped with the package, the sum of the radiation levels from each filter at one meter, shielded by the hull, must be subtracted from this 995 mrem/hr, and the A_{IX} and A_{PF} activity limits must be reduced accordingly.

- (8) Liquids within plant systems must be removed to the maximum extent practical in accordance with established procedures, methods, and controls. Not more than 660 gallons may remain in an S5W package, not more than 1200 gallons may remain in the S5G or SSN 688 Class packages, and not more than 90 gallons may remain in the NR-1 package.
- (9) For SSN 688 Class packages, there are two submarines (SSN 701 and SSN 711) that are not authorized for shipment under this Certificate of Compliance.

e. References

None.

f. Additional Information

Division of Fuel Cycle and Material Safety, NRC memorandum FCTC:CRC 71-9781 dated May 6, 1983 concurred that the SARP for S5W reactor compartment disposal packages complies with the requirements of 10CFR71. Transportation Branch NRC memorandum SGTB:HWL 71-9788 dated July 25, 1990 concurred with adding containment bulkheads to the package, determining an LST for individual packages based on procedures in NUREG/CR-1815, and allowing low curie content ion exchanger resin to be retained in package. Transportation Branch NRC memorandum SGTB:HWL 71-9788 dated September 7, 1990 concurred with allowing as much as 230 gallons of contaminated liquid, primarily water, to be retained in the package. Transportation Branch NRC memorandum SGTB:CJW 71-9788 dated September 30, 1992 concurred with increasing the package weight to a maximum of 2,262,400 pounds and basing the shipping hold time solely on the curie content of the ion exchanger resin. Spent Fuel Project Office NRC memorandum Docket No. 71-9788 dated April 15, 1996 concurred with increasing the residual liquid limit to 660 gallons for S5W packages. Spent Fuel Project Office NRC memorandum Docket No. 71-9788 dated June 4, 1997 concurred that the SARP for the SSN 688 Class reactor compartment disposal package complies with the requirements of 10CFR71. In addition, this NRC memorandum concurred that the installation of containment bulkheads at the ends of a submarine reactor compartment disposal package complies with the requirements of 10CFR71. Spent Fuel Project Office NRC memorandum Docket No. 71-9788 dated September 25, 1998 concurred with reducing the allowable curie content of SSN 688 Class purification media and designating submarine reactor compartment disposal packages as Type B(U)-85 packages. Spent Fuel Project Office NRC memorandum Docket No. 71-9788 dated February 28, 2003 issued Revision No. 13 to the NRC CoC for the Model No. S5W and SSN 688 Class Reactor Compartment Disposal Packages. In this revision, the following were added for SSN 688 Class RCDPs: 1) flat plate containment bulkhead design; 2) the option to solidify IX and PF resin to meet 10 CFR 71.51 (a)(2) requirements for post-accident releases and external radiation dose rate requirements, and associated curie content limits if this option is exercised; 3) the requirements for external shielding, if added to meet 10 CFR 71.51 (a)(2) requirements for post-accident external radiation dose requirements, and associated curie content limits if this option is exercised. Spent Fuel Project Office NRC memorandum Docket No. 71-9788 dated September 16, 2008, issued the NRC Safety Evaluation Report agreeing that the SSN 688 Class and S5W RCDP's meet the 2004 Revision to 10CFR71, and issued the renewed NRC CoC for these RCDPs as Revision 14 with the RCDPs designated as Type B(U)-96 packages. NRC memorandum dated December 19, 2011, agreed that SSN 688 Class reactor compartments from submarines operated with a D2W core meet the requirements of 10CFR71. Spent Fuel Project Office NRC memorandum Docket No. 71-9788 dated February 16, 2019 concurred that the SARP for the NR-1 reactor compartment disposal package complies with the requirements of 10CFR71. Spent Fuel Project Office NRC memorandum Docket No. 71-9788 dated XXX X, XXXX concurred that the SARP for the S5G reactor compartment disposal package complies with the requirements of 10CFR71.

S2C, S2Wa, S3W, S4G, and S4W reactor compartment disposal packages were previously authorized for shipment under this Certificate of Compliance. The shipment of these packages has been completed, and the packages have been removed from the CoC.