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396-55

Department of Energy
Chicago Operations Office
9800 South Cass Avenue
Argonne, Illinois 60439

OCT 5 1982

Mr. Charles E. MacDonald, Chief
Transportation Certification Branch
Division of Fuel Cycle and Material Safety, NMSS
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. MacDonald:

SUBJECT: REVISIONS TO U. S. NUCLEAR REGULATORY COMMISSION (NRC) CERTIFICATE OF COMPLIANCE - USA/6400/B( )F AND USA/6272/B( )

Argonne National Laboratory (ANL) will conduct, over the next several years, a chemical analysis program for irradiated fuel elements from the Shippingport Reactor Light Water Breeder Reactor Project. This proof-of-breeding project will generate liquid analytical residue which is to be disposed of as radioactive waste material.

ANL has developed a process which will immobilize and solidify the liquid waste with cement. This waste form is packaged in a multicontainer shielded configuration which meets the requirements of the U. S. Department of Energy's (DOE's) Rockwell-Hanford Operations Waste Storage Site.

Transportation of the waste material is proposed utilizing the Super Tiger or Polypanther shipping containers. This would require revision of the subject Certificates of Compliance, which have been issued for the Super Tiger and Polypanther containers, respectively. ANL has prepared a report, "Application for Immobilization with Portland Cement of Liquid Analytical Residues from the Light Water Breeder Reactor Proof-of-Breeding (LWBR-POB) Project." This report describes the waste material, immobilization process, packaging configuration, provides technical data to support the process, and proposes wording changes to the respective Certificates of Compliance. Reference is made in the ANL report to technical information developed by the General Electric Company for a revision application for NRC Docket No. 71-9044.

Enclosed are 12 copies of the ANL report, to support the revision applications for NRC Docket Nos. 71-6400 and 71-6272. If necessary, we can provide you with copies of the General Electric Company application report referenced by ANL.

FEE EXEMPT

21334

Questions on this matter should be directed to Robert I. Elder on FTS 972-2269.

Sincerely,

R. M. Moser, Director
Operational and Environmental
Safety Division

Enclosure:
Application for Immobilization with Portland Cement
of Liquid Analytical Residues From the Light Water
Breeder Reactor Proof-of-Breeding (LWBR-POB) Project, 12 cys.

cc: T. Dunckel, HQ, w/1 encl.

APPLICATION FOR IMMOBILIZATION WITH PORTLAND CEMENT OF LIQUID ANALYTICAL RESIDUES FROM THE LIGHT WATER BREEDER REACTOR PROOF-OF-BREEDING (LWBR-POB) PROJECT

SUMMARY

Argonne National Laboratory (ANL) proposes to use Portland cement to immobilize radioactive liquid analytical residue from the dissolution of LWBR fuel element segments, using a steel can as a primary storage container. The primary can, a secondary steel can, lead shielding, and an approved 55-gal drum comprise the basic package. These basic packages will be packed into steel bins and then into either the SuperTiger Overpak (Option I) or PolyPanther Overpak (Option II) for transport to Rockwell-Hanford Operations (RHO) at Richland, Washington for interim storage.

DESCRIPTION OF WASTE MATERIALS

The dissolver solutions are generated in the course of dissolving segments of irradiated LWBR fuel rods. The approximate amounts of the major components in the residual analytical solutions produced during the total LWBR-POB analytical campaign are summarized as follows:

Total Volume	700 L
HNO_3	490 Kg
H_2O	350 Kg
Th	32.2 Kg
^{233}U	0.6 Kg
Zr	3.5 Kg
Al	3.5 Kg
^{3}H	25 Ci
Fission Products	~25,000 Ci
Heat Generation	50 watts

The concept of immobilizing the solution in cement grout has, in principle, been approved and has undergone extensive testing. The addition of extra lime works to neutralize the HNO_3, which, in turn, enhances the nature of the final cement product, e.g., fewer cracks form. Individual batches will be mixed and packaged as per either Option I or Option II.

OPTION I
UTILIZATION OF SUPERTIGER SHIPPING CONTAINER

SINGLE BATCH WASTE CHARACTERISTICS

Individual batches of waste will consist of 3.5 L of dissolver solution mixed with a cement-water slurry in a 2-gal steel can. The mix will cure for 72 hr and be dehydrated by heating at 125°C for ~200 hr. The end product is an 8000-g monolithic waste block within the 2-gal steel can. The can is closed with a press fit friction-type lid. The compressive strength of the waste block is ~2000 psi. The final product has a cracked crust after drying which consists of $<1.0\%$ of the total mass of the block. The materials used for a 2-gal batch of cemented waste and selected batch properties are listed below:

Dissolver Solution	3500 mL
Portland Cement	4550 g
Slaked Lime	2590 g
Water	4550 g
Final Total Weight (after dehydration)	8000 g
Heat Generation (based on an average value)	0.25 watts
^{233}U Content	5.2 g
Fission Product Content	~195 Ci

PACKAGING CONFIGURATION

One sealed 2-gal can of cemented waste will be placed in a secondary steel containment can which will then be sealed with a double-friction lid. This secondary containment package will be placed inside a protective radiation shield.

The shield consists of a thick lead sleeve formed and encased within a 1/4-in. thick steel support structure. The opening on the top of the structure is closed with a plug-type lid consisting of lead, cast within a 1/4-in. thick steel form. This lid is securely bolted to the lower steel structure. The shield assembly is placed inside a DOT 17-C 55-gal galvanized steel drum. The steel structure serves to center the shield both axially and radially within the drum. An additional 1/4-in. thick steel plate placed on top of the shield restrains the shield from moving within the drum. The drums are sealed with a gasket made of styrene-butadiene rubber meeting ASTM Standard D1418. The closure ring bolt will be sealed with a type "E" tamper indicator seal. The shield will be of a thickness that reduces the radiation dose rate, at the surface of the drum,

below the acceptable 200 mR/hr criteria. Approximately 2-1/2-in. of lead is used on the sides and 3-1/4-in. of lead is used on the top and bottom. The maximum weight of each drum will be 1150 lb.

Eight of these sealed drums will be packed into the steel corrugated box specified in the Rockwell Hanford Operations drawing No. H-2-9188, Sheet 1, Rev. O. The box will be closed and sealed. Two of these boxes will be loaded into the SuperTiger shipping container for transport to the Rockwell-Hanford Waste Storage Facility. Dunnage will be used as needed. At R-H, the steel boxes will be removed from the SuperTiger and buried intact.

OPTION II
UTILIZATION OF POLYPANTHER SHIPPING CONTAINER

SINGLE BATCH WASTE CHARACTERISTICS

Individual batches of waste will consist of 2.6 L of dissolver solution mixed with a cement-water slurry in a 1-1/2-gal steel can. The mix will cure for 72 hr and be dehydrated by heating at 125°C for ~200 hr. The end product is a 6000-g monolithic waste block within the 1-1/2-gal can. The can is closed with a press fit friction-type lid. The compressive strength of the waste block is ~2000 psi. The final product has a cracked crust after drying which consists of <1.0% of the total mass of the block. The materials used for a 1-1/2-gal batch of cemented waste and selected batch properties are listed below:

Dissolver Solution	2600 mL
Portland Cement	3380 g
Slaked Lime	1924 g
Water	3380 g
Final Total Weight (after dehydration)	8000 g
Heat Generation (based on an average value)	0.19 watts
^{233}U Content	3.8 g
Fission Product Content	~145 Ci

PACKAGING CONFIGURATION

One sealed 1-1/2-gal can of cemented waste will be placed in a secondary steel containment can which then will be sealed with a double friction lid. This secondary containment package will be placed inside a protective radiation shield.

The shield consists of a thick lead sleeve formed and encased within a 1/4-in. thick steel support structure. The opening on the top of the structure is closed with a plug-type lid consisting of lead, cast within a 1/4-in. thick steel form. This lid is securely bolted to the lower steel structure. The shield assembly is placed inside a DOT 17-C 55-gal galvanized steel drum. The steel structure serves to center the shield both axially and radially within the drum. An additional 1/4-in. thick steel plate placed on top of the shield restrains the shield from moving within the drum. The drums are sealed with a gasket made of styrene-butadiene rubber meeting ASTM Standard D1418. The lid closure ring bolt will be sealed with a type "E" tamper indicator seal.

The shield will be of a thickness that reduces the radiation dose rate, at the surface of the drum, below the acceptable 200 mR/hr criteria. Approximately 2 in. of lead is used on the sides and 3-1/4-in. of lead is used on the top and bottom.

Two of these sealed drums will be packed into a M-3 Steel Bin, ANL Drawing No. CS-2273. Dunnage will hold the drums securely within the bin. The bin will be sealed and packed into the PolyPanther shipping container. The maximum weight of the two drums, the dunnage, and the M-3 bin, will be 3000 lb. Six of the PolyPanther packages will be transported with each shipment to RHO at Richland, Washington. The M-3 Bins will be removed from the PolyPanther, and the individual drums will be removed for interim storage. The M-3 bin will be reused.

APPLICABLE TEST RESULTS FOR THE CEMENT GROUT

Reference 1: General Electric Company Model 1600 Package; Application for Immobilization of Waste Materials Using Hydraulic Cement, December 1, 1981.

The solidified LWBR-POB waste in cement grout has been described above. Information on cement grout, contained in Ref. 1, is relevant to the POB waste, as tabulated in Table 1; appropriate sections of the GE report are referenced. The conclusion has been made that there is sufficient comparability in the cement compositions to reference specific GE test data. Namely, the break-up fraction of the cement, F_2, (see Ref. 1), the dispersal size fraction, F_3, and the drum thermal dispersal fraction, F_4, are considered suitable representations of the ANL waste. Although different shipping containers are to be used and it is felt a larger amount of the radioactive material released from the primary container will be retained within the interior packaging of the drum and the shipping container, a factor of 10% is still used for the container release factor, F_5.

Table 1.
CHARACTERISTICS OF CEMENT GROUT FOR LWBR-POB WASTE

Compressive Strength	2000 psi
Resistance to Heat	See results of Ref. 1, p. 10
Grout Drop Test	See results of Ref. 1, pp. 15-16
Applicable Dispersal Fractions or Containment Factors	See Ref. 1, pp. 16-20
Breakup Fraction, F_2	0.0175
Dispersal Size Fraction, F_3	0.25
Drum Thermal Dispersal Fraction, F_4	0.02
Container Release Fraction, F_5	0.10

APPLICATIONS OF CONTAINMENT FACTORS

The total inventory of fissile material, ^{233}U, and fission products are 600 g ^{233}U and 25,000 curies, respectively. The total heat generation is 50 watts. These values are for the entire 700 L. Inventories per drum and per shipping container are tabulated in Table 2.

The inventory data in Table 2 is used to determine the quantity of radioactive material which might be released to the environment. The containment factors are applied to this data and an estimated release of radioactivity is determined as per Ref. 1, p. 20. It is estimated about 1.7 mCi of fission products would be released for the individual drums with the SuperTiger option, and 0.82 mCi for the PolyPanther option.

Table 2.
DATA FOR THERMAL AND RADIOACTIVE MATERIAL DISPERSAL

A. Inventories

	Fission Products (Ci)	^{233}U (g)	Heat Source (Watts)
Total Inventory	25,000	600	50
SuperTiger Option			
Drum	195	5.2	0.25
Steel Box	1560	41.6	2.00
Shipment	3120	83.2	4.00
PolyPanther Option			
Drum	145	3.8	0.19
M-3 Bin	290	7.6	0.38
Shipment	1740	45.6	2.28

(Cont'd)

Table 2.(Cont'd)

B. Calculated Dispersal of Fission Product Radioactivity from Individual Drums

(F values from Ref. 1.)

	SuperTiger	
C_f[a]	= 195 Ci	
$C_f \times F_2$	= 195 x 0.0175	= 3.41 Ci
$C_f \times F_2 \times F_3$	= 3.41 x 0.25	= 0.85 Ci
$C_f \times F_2 \times F_3 \times F_4$	= 0.85 x 0.02	= 0.017 Ci
$C_f \times F_2 \times F_3 \times F_4 \times F_5$	=0.017 x 0.1	= 0.0017 Ci

	Poly-Panther	
C_f[a]	= 145 Ci	
$C_f \times F_2$	= 145 x 0.0175	= 2.54 Ci
$C_f \times F_2 \times F_3$	= 2.54 x 0.25	= 0.64 Ci
$C_f \times F_2 \times F_3 \times F_4$	= 0.64 x 0.02	= 0.013 Ci
$C_f \times F_2 \times F_3 \times F_4 \times F_5$	= 0.013 x 0.10	= 0.0013 Ci

CONCLUSION

It is concluded that cement grout is a good medium for immobilizing the LWBR-POB waste for transport and interim storage. The composite packaging arrangement will provide suitable containment, and the proposed shipping containers, used in the manner discussed, will be in full compliance with all Federal regulations pertaining to the shipment of radioactive material.

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[a] C_f = fission product level in a given 55-gal drum.

PROPOSED CHANGE IN CERTIFICATE OF COMPLIANCE USA/6400/B( )F

5 (b) Contents

"addition of a sixth category."

(6) Liquid analytical residues from the dissolution of spent reactor fuel rods, solidified in cement. The cement is contained in 2-gal steel cans closed with a friction-type lid. The primary can is packed in a secondary steel can sealed with a double friction lid. The secondary containment package and contents are placed within a radiation shield centered in a DOT Specification 17-C 55-gal steel drum. The drums are sealed with a styrene-butadiene rubber gasket contained with a standard drum closer. Total weight of the drum will be 1150 lb, and each drum will not exceed a fissile quantity of 60 g.

Sealed drums will be enclosed in a tight-fitting 3/16-in. thick corrugated steel box constructed in accordance with Rockwell-Hanford Operations' Drawing H-2-91888, Sheet 1, Rev. 0 (modified or unmodified). The space between the drums and the box, as well as void spaces between drums, must be filled with dunnage material.

PROPOSED CHANGE IN CERTIFICATE OF COMPLIANCE USA/6272/B( )

5 (b) Contents

(I) General Waste

(i) Type and form of material. Dry, solid radioactive material within the waste storage bin.

(ii) Maximum quantity of material per package not to exceed Type B quantities of radioactivity. The maximum weight of the contents shall not exceed 3,000 lb.

"addition of category II."

(II) Solidified liquid waste.

(i) Type and form of material. Liquid analytical residues from the dissolution of spent reactor fuel rods, solidified in cement. The cement is contained in a 1-1/2-gal steel can closed with a friction-type lid. The primary can is packed in a secondary steel can sealed with a double friction lid. The secondary containment package is placed within a radiation shield centered in a DOT Specification 17-C 55-gal steel drum. The drum is sealed with a styrene-butadiene rubber gasket contained with a standard drum closer. Two drums will be secured within the waste storage bin.

(ii) Maximum quantity of material per package. The quantity of radioactivity will be < 435 curies of mixed fission products. Maximum weight of the contents and dunnage shall not exceed 3,000 lb.