GENERAL ELECTRIC

NUCLEAR ENERGY
DIVISION

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May 24, 1974

Mr. C. E. MacDonald
Chief, Transportation Branch
Directorate of Licensing
Office of Regulation
U. S. Atomic Energy Commission
Washington, D. C. 20545

Subject: Modification 23 to Appendix D
License SNM-54, Docket 70-1007

Dear Mr. MacDonald:

General Electric has been granted Amendment 71-21 and Amendment 71-22 (and Revision 1 thereto) to License SNM-54 authorizing delivery of special nuclear material, UO_2, to a carrier for transport in the packages designated as Models BU-4 and BU-5, respectively.

Safety analysis has been completed for a package designated as GE Model BU-6, constructed in a manner similar to BU-4 and 5 with identical contents but smaller in physical size and for lesser amounts per package. The inner and outer drums of the BU-6 are fabricated according to a military specification (copy enclosed for information) which is equivalent to DOT Specification 17H.

In addition, tests and safety analysis have been completed for a package designated as GE Model BU-7 which is constructed of materials identical to that of the BU-4 and BU-5, except for the insulating and gasket material.

The contents of the BU-7 consist of "dry" uranium oxide powder and pellets identical to those authorized for the BU-5 except that the enrichment is limited to 4%.

Accordingly, General Electric hereby requests amendment of License SNM-54 to authorize delivery of special nuclear material to a carrier

for transport in the GE Model BU-6 and the GE Model BU-7 as shown in the enclosed Modification 23 to Appendix D of the application for that license. Modification 23 consists of new Sections 1.7 and 1.8 on pages 1-71 through 1-83, dated May 24, 1974, which should be added to pages of Appendix D previously submitted.

We trust that this application is sufficient to permit issuance of the appropriate amendment and will be happy to furnish further information if necessary.

Very truly yours,

A. N. Tschaeche
Administrator-Licensing
M/C 273, Ext. 2235

hb
enc.

1.7 "MINI-BU" - GE MODEL BU-6

1.7.1 Package Description - Packaging

(a) General: Inner containment is a nominal one-half gallon steel drum closed by a gasketed-bolted lid, centered and supported within an outer nominal 10-gallon drum by solid insulating media, and containing one or more closed containers which contain uranium compounds (see Figure 1.7.1).

(b) Gross Weight: 125 pounds, maximum

(c) Uranium compound container: One or more closed rigid-form containers which do not decompose at temperatures up to 190° F.

(d) BU-6 inner containment: A nominal one-half gallon, Mil-Spec. 24347-21, drum, constructed of 26-gauge steel, modified by the welded attachment of a closure flange to accept a 1/8" thick steel lid which is gasketed for resistance to high temperatures as shown in Figure 1.7.1 and attached by six 1/4" steel bolts. The maximum inside dimensions of the inner containment drum are 5-1/8" diameter by 5-3/4" high.

(e) BU-6 outer container: A nominal 10-gallon, Mil-Spec. 27684-7, steel drum as shown in Figure 1.7.1 with nominal outer dimensions 14-1/2" diameter by 15-3/8" high.

(f) Insulating material: The inner containment drum is centrally held within the outer container by, and the space between the inner and outer containers is completely filled with solid

insulating media composed of vermiculite and plywood bonding material (V-Pak) as specified in Figure 1.7.1. Four 1/4" diameter holes near the top of the outer container, covered with weatherproof tape, would permit steam to escape in the event free moisture in the insulating material were exposed to the heat from an accidental fire during transport.

1.7.2 Package Description - Contents

(a) Type and form of material: Either uranium compounds enriched not more than 4% which together with any other associated materials do not decompose at temperatures up to 210° F and of bulk density not greater than 10.96 grams per cc at any H/U-235 ratio, or uranium oxides enriched not more than 5%, and of bulk density not greater than 10.96 grams per cc at H/U-235 ratios not exceeding 0.45, considering all sources of hydrogeneous material within the inner containment.

(b) Maximum quantity: 18 kilograms

1.7.3 Package Evaluation

Packages are constructed of materials and in a manner identical to those of the GE Model BU-5 package which the Commission has licensed for use, specifically:

a) The steel thickness of both of the outer containers is 18 gauge.

b) Both outer container closures are bolted rings of 12-gauge steel.

c) The insulating material is of the same composition and thickness.

d) The inner containment closure method, pressure test and gasket material are identical. Six bolts are used in the BU-6 inner closure instead of 12 bolts as are used in the BU-5. However, the distance between bolt centers is essentially the same, namely: 3 inches.

In addition, the BU-6 is approximately three times lighter than the BU-5. Accordingly, the BU-6 package design is evaluated to be as effective or better than that of the BU-5 in retaining the contents and preventing water inleakage during normal transport and accident conditions, as evidenced by the test results described in paragraphs 1.5.3, 1.5.3.1, 1.5.3.2 and 1.6.7 in this Appendix D. A single package is critically safe because the inner containment diameter (5-1/8") is a critically safe diameter for 5% enriched uranium in any form with optimum moderation and full water reflection.

1.7.3.1 Array

Evaluations set forth in paragraph 1.6.7.1 for the BU-5 demonstrate that an infinite number of packages are critically safe under both normal and accident conditions of transport (e.g. $k_\infty < 1.00$). The k_∞ of the BU-6 package under both of these same transport conditions is

less than the K_∞ for the BU-5 because the ratio of the volume of the insulating material to that of the fuel (RVIF) is larger for the BU-6 than for the BU-5; that is, RVIF for BU-6 is approximately 19 whereas for BU-5 it is less than 3. All other nuclear characteristics of the packages which could affect criticality safety are the same. The effect of RVIF on K_∞ is illustrated as follows:

(a) The K_∞ for any package is inversely proportional to three ratios:

(1) RVIF

(2) That of the macroscopic absorption cross section of the insulation to that of the fuel, and

(3) That of the average neutron flux in the insulation to that of the fuel. This ratio is directly proportional to RVIF.

K_∞ is also proportional to fundamental nuclear parameters, the magnitudes of which are identical for both the BU-5 and BU-6.

(b) The two parameters described in (a)(1) and (3) above are larger for the BU-6 than those for the BU-5 because:

(1) RVIF is larger for the BU-6 than for the BU-5,

(2) The chemical and physical characteristics of the fuel are the same for both package models, and

(3) The physical and chemical properties of the V-Pac are the same for both package models.

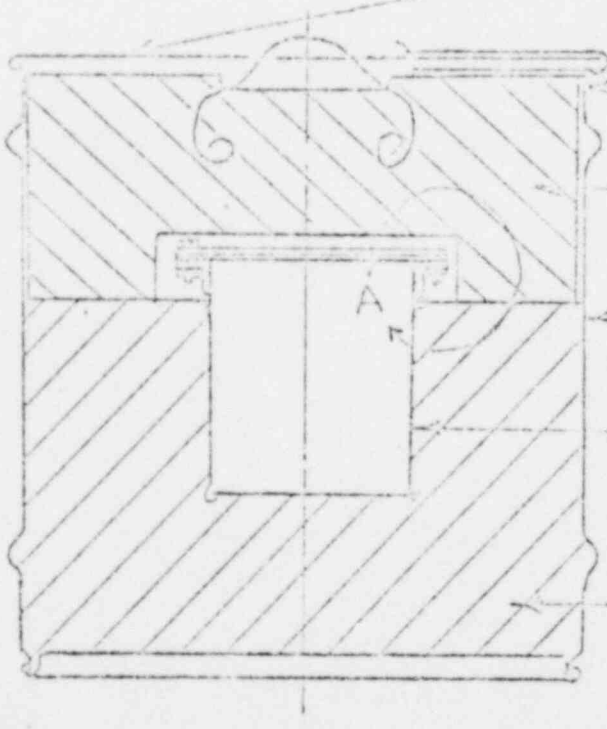
(c) The ratio described in (a)(2) above is the same for both the BU-6 and BU-5 because the macroscopic absorption cross section of both the fuel and the insulation is the same in both the BU-6 and BU-5.

Therefore, because the numerical value of each of the three ratios for the BU-6 is either greater than or equal to the corresponding ratio for the BU-5, the k_∞ of the BU-6 package is less than the k_∞ of the BU-5 package. Accordingly, the BU-6 may be transported as Fissile Class I, authorization for which is therefore requested.

1.7.4 Procedural Controls

New and used containers will be inspected, loaded and closed, as described in paragraph 1.5.4 of this Appendix D.

DETAIL A



Cover per MS 27684-23 except material is 18-gauge steel

Lock ring per MS 27684-32

Four 1/4" dia. holes equally spaced around circumference

Top plug solid insulation-cushioning material 3" thick min. except for cover clearance (1)

Outer container per MS 27684-7 except material is 18-gauge steel

Modified one-half gallon inner containment per MS 24347-21 test at 7 psig for water-tightness after fabrication

Solid insulation-cushioning material 4-1/2" thick minimum (1)

(1) Insulation poured in place as wet mix consisting of Vermiculite, 37 w/o - "Piyamine" #21-015 (with catalyst) 63 w/o. Piyamine is a trade name of Reichold Chemicals, Inc. Dry insulation density is 6.88 - 7.70 gm/in^3.

GE MODEL BU-4 CONTAINER

License No. SNM-5	Docket No. 71-1007	Sect. No. Fig. 1.7.1 Appendix D	Page
Model No. Model 423	Date May 24, 1974	Amends/Supplements New	1-76

1.8 PAIL(S) IN STANDARD DRUM - GE MODEL BU-7

1.8.1 Package Description - Packaging

(a) General: Inner containment is a nominal 16-gallon drum closed by a gasketed-bolted lid, centered and supported within an outer 55-gallon drum by solid insulating media, and containing two or more steel pails which contain UO_2 (see Figure 1.8.1).

(b) Gross Weight: 347 pounds, maximum

(c) Uranium oxide powder container: One or more closed containers, 11.25" inside diameter fabricated of minimum 24-gauge steel, vertically stacked in each BU-7 unit.

(d) BU-7 inner containment: A nominal 16-gallon, DOT Specification 17H drum constructed of 18-gauge steel, modified by the welded attachment of a closure flange to accept a 3/16" thick steel lid which is gasketed for resistance to high temperature as shown in Figure 1.8.1 and attached by twelve 5/16" minimum steel bolts. The inside dimensions of the inner containment drum are 13.75" diameter by 27" high. The maximum hydrogen to uranium atomic ratio within the inner containment is 0.45.

(e) BU-7 outer container: A nominal 55-gallon, DOT Specification 17H, 18-gauge steel drum with nominal outer dimensions 22.82" diameter by 36.5" high.

(f) Insulating material: The inner containment drum is centrally held within the outer container by, and the space between the inner

and the outer containers is completely filled with a solid insulating media composed of fire-retardant phenolic foam as specified in Figure 1.8.1. Four 1/4" diameter holes near the top of the outer container, covered with waterproof tape, would permit steam to escape in the event free moisture in the insulating material were exposed to the heat from an accidental fire during transport.

1.8.2 Package Description - Contents

(a) Type and form of material: Uranium oxides enriched not more than 4% and of bulk density not greater than 10.96 grams per cc.

(b) Maximum quantity: 89 kilograms per package except that enrichments above 3.00% shall be limited to twice the safe batch sizes given in paragraph 7.3.3, Appendix A to the application for License SNM-1097, Docket 70-1113. For mixtures of powder and pellets, the pellet batch size shall be used with such limitation beginning at 2.7% and the maximum quantity shall be 90 kilograms per package.

1.8.3 Package Evaluation

There are no components of the packaging or its contents which are subject to chemical or galvanic reaction during normal transportation.

The package cannot be opened inadvertently, uses no coolant and has no lifting or tiedown attachments.

1.8.3.1 Single Package - Normal Transport Conditions

(a) Thermal: Packaging components, i.e., metal drums and pails, phenolic foam and gasket material are unaffected by temperature extremes in excess of 130°F as demonstrated by the fire test described later. There are no plastic components, therefore no loss of structural integrity at very low temperatures. Since uranium oxide is generated at operating temperatures far in excess of 130°F, there can be no further effect at this temperature.

(b) Pressure: The outer container is pierced by four 1/4" diameter pressure relief holes so that no differential pressure will exist at 0.5 atmospheres. The inner containment is pressure tested to 7 psi after fabrication including flange installation.

(c) Vibration: The metal-insulating media construction of the BU-7 precludes damage by vibration, and voids cannot be created in the insulation during normal transport.

(d) Water spray and free drop: Metal drums are unaffected by water. A 4-foot free drop produces no damage of consequence to the shipment of dry, low-enriched material.

(e) Penetration: A 13-pound, 1-1/4" diameter bar was dropped four

feet onto the midpoint of the side wall of the drum. The resulting indentation (about 1/8" deep) is of no effect on containment or overall spacing.

(f) Compression: The loaded container is capable of withstanding five times its weight with no change in spacing.

(g) Summary and conclusions: The tests or assessments set forth above provide assurance that the powder or pellet contents are contained in the pails during normal transport and there is no reduction in effectiveness of the package system. Since the maximum quantity of fissile material in the pails is controlled to not more than 90% of the minimum critical mass by administrative control of loading, it is concluded that single package would be subcritical assuming water inleakage resulting in optimum moderation of contents with full reflection. It has been demonstrated, moreover, that there would be no water inleakage to the product during normal transport conditions.

1.8.3.2 Single Package - Accident Evaluation

(a) Free drop: One Model BU-7 test unit loaded with two 5-gallon pails, each containing 100 pounds of iron chips, was dropped from a height of 30 feet, the top head striking a solid concrete pad at an angle. This is believed to be the most damaging attitude from the standpoint of retaining the two pails within the drum.

The drum, inner containment and pail lids remained intact and in place, and there was no loss of contents from product pails. Three 2.5-gallon pails occupy essentially the same volume as two 5-gallon pails and, with the maximum uranium oxide loading produce the same test results within the limits of reproducibility.

(b) Puncture: A 40" drop onto a 6" diameter mandrel resulted in no reduction of effective spacing nor was the drum penetrated.

(c) Thermal: Following the free drop and puncture tests, the package was subjected to a thermal test in an electric furnace at 1475°F for 30 minutes. There was no damage to the container of consequence to nuclear safety and the gasket of the inner containment remained far below the 400°F service temperature. The temperature measurement method for the test unit is described in paragraph 1.6.7 on pages 1-54.0, 1-54.1, 1-54.2 and 1-55 of this Appendix D. The test includes measurements on the outer and inner surfaces of the 3/16" thick lid which demonstrate that the maximum temperature of the gasket in contact with the lid and flange is 200°F.

(d) Water immersion: The package which passed sequentially through the three tests above was immersed under at least three feet of water for not less than 24 hours. No water leaked into the inner containment.

(e) Summary and conclusions: The accident tests or assessments described above demonstrate that the package is adequate to retain the product contents and that it would remain subcritical assuming the contents changed from a cylindrical to a spherical form at the most reactive degree of moderation and closely reflected by water on all sides.

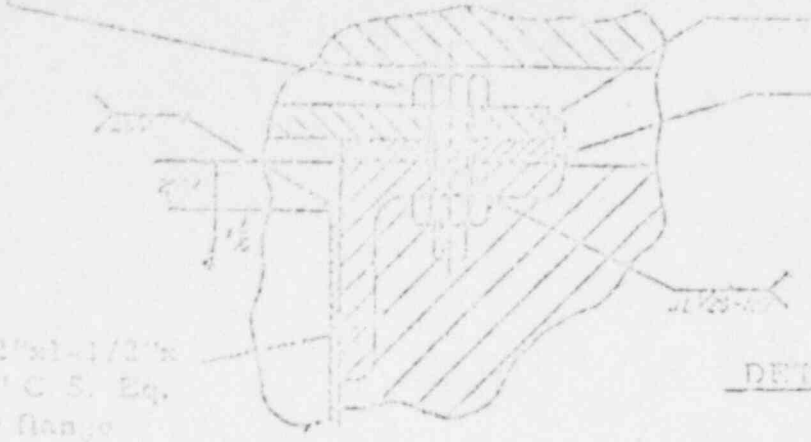
1.8.3.3. Array

The criticality safety of the BU-7 package is demonstrated in GE Document No. NEDO-11277, "The General Electric Model BU-7 Uranium Shipping Container - Criticality Safety Analysis," which is attached to this application. The analysis results indicate that the BU-7 may be transported as Fissile Class I, authorization for which is therefore requested.

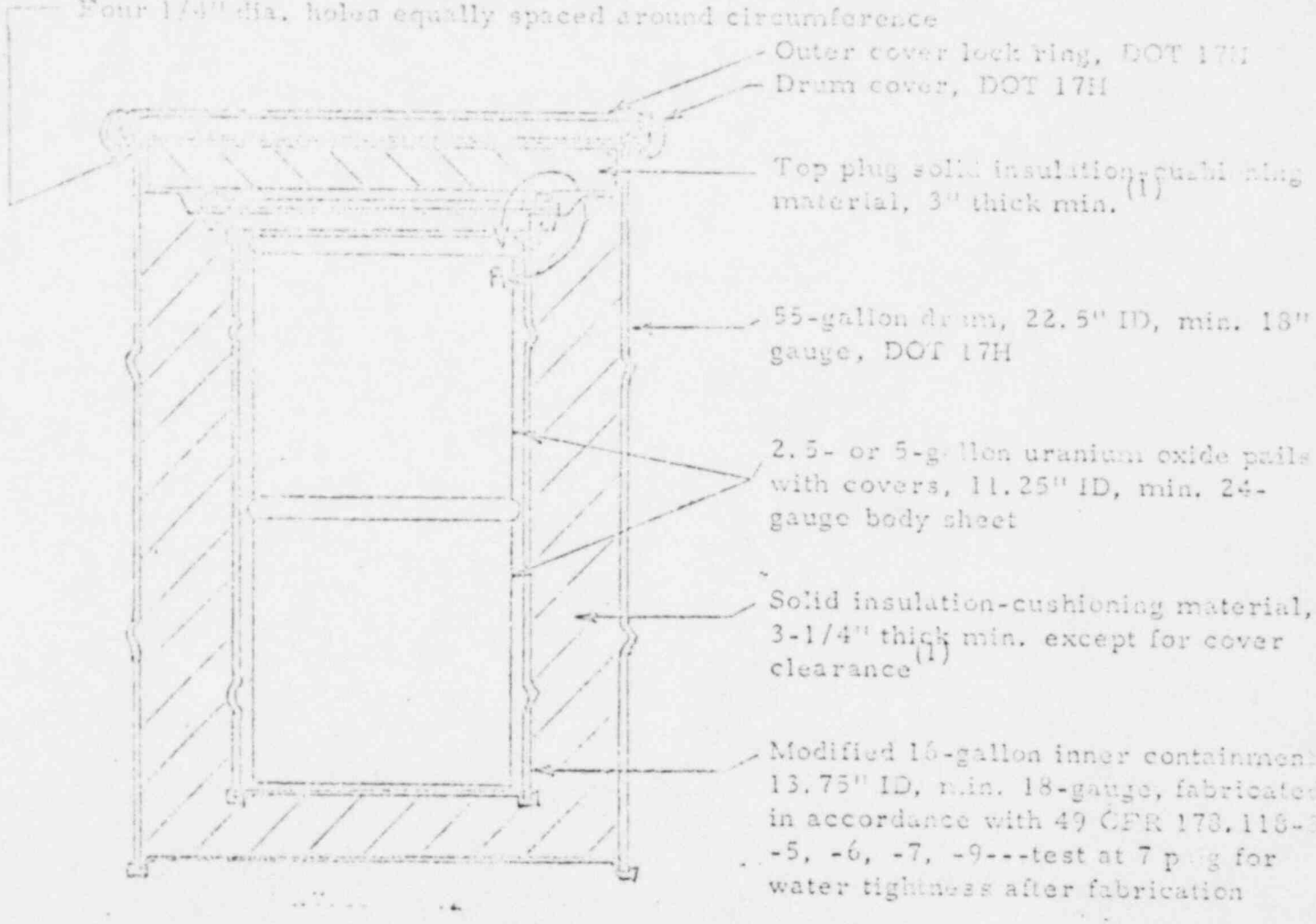
1.8.4 Procedural Controls

Inspections, loading and closure will be as described in paragraph 1.5.4 of this Appendix D.

5/16" min. C.S. Cad. plated cover bolts - 12 each



DETAIL A



(1) Insulation, poured in place consisting of phenolic foam per USAEC Spec. SP-9; minimum density 8 lbs/cu.ft. except top plug min. density 20 lbs/cu.ft.

GE MODEL BU-7 CONTAINER

Director, CTMSO
May 15, 1980

ATTACHMENT 3

ORIGINAL CRITICALITY SAFETY ANALYSIS

FOR BU-7 PACKAGE

A. L. Kaplan
:bcw