71-3076

U.S. Department
of Transportation
**Pipeline and
Hazardous Materials
Safety Administration**

400 Seventh Street, S.W.
Washington, D.C. 20590

SEP 12 2005

Mr. Shawn Williams, Project Manager
Licensing Section, Spent Fuel Project Office
Office of Nuclear Material Safety
and Safeguards
U. S. Nuclear Regulatory Commission
Mail Stop O13D13
Washington, DC 20555-0001

Dear Mr. Williams:

Enclosed is the response from the applicant to your July 18, 2005 Request for Additional Information concerning our February 4, 2005 request for your assistance in evaluating the Model Nos. F-458/F-245, F-458/F-247, F-458/F-251, F-458/F-251 MK2, F-458/F-318 and F-458/F-448 transport packages, authorized by Canadian Certificate of Approval No. CDN/2078/B(U)-96. Two copies of the applicant's non-proprietary response are included, as well as two copies of their proprietary response, along with a signed affidavit presenting their justification for considering the designated material to be proprietary.

Please feel free to contact me or Fred Ferate if you need any additional information. We can both be reached at 202-366-4545.

Sincerely,

Fred Ferate,

for Richard W. Boyle, Chief
Radioactive Materials Branch
Office of Hazardous Materials
Technology

Enclosures

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MDS Nordion
Science Advancing Health

September 7, 2005

Dr. Fred Ferate
Hazardous Materials Technology
Research and Special Programs Administration
Office of Hazardous Materials Transportation
Radioactive Materials Branch
U.S. Department of Transport, Room 8430
400 7th Street, South West
Washington, D.C. 20590

Subject: **Application for Validation of the Canadian Nuclear Safety Commission Package Design Approval Certificate CDN/2078/B(U)-96 (Rev.0) for the F-458/F-245, F-458/F-247, F-458/F-251, F-458/F-251 MK2, F-458/F-318 and F-458/F-448 Transport Packages**

Dear Dr. Ferate,

This letter and the attachments form the response to the US Nuclear Regulatory Commission, Request for Additional Information enclosed in your email of July 20, 2005. The additional information is for Docket No. 71-3076, MDS Nordion model nos. F-458/F-245, F-458/F-247, F-458/F-251, F-458/F-251 MK2, F-458/F-318 and F-458/F-448, Canadian Package Design Certificate No. CDN/2078/B(U)-96.

Two proprietary copies of this response have been provided with two non-proprietary copies for the Public Document Room. Attached is an affidavit to support MDS Nordion's request to withhold the above-mentioned document from public disclosure. This document is specific to the design and fabrication of the F-458/F-245, F-458/F-247, F-458/F-251, F-458/F-251 MK2, F-458/F-318 and F-458/F-448 transport packages and would enable a third party to manufacture similar transport packages.

Thank you for your consideration of this matter. Should you have any questions or require further information, please do not hesitate to contact me by telephone at (613) 592-3400 ext. 2421 or by fax at (613) 592-2006 or by email at mcharette@mds.nordion.com.

Sincerely yours,

Marc-Andre Charette
International Transport & Nuclear Initiatives
Manager, Regulatory Affairs

Encl: IS/DS 1789 F458 (5), Affidavit

Copy to: Mike Krzaniak, Fred Taylor, Luc Desgagné

GENERAL INFORMATION

1. Describe the authorized contents of the F-458/F-251 MK2 configuration. Describe the difference between the F-251 and F-251 MK2 configurations.

   This information is needed to show compliance with IAEA No. TS-R-1, Section IV and paragraph 415.

   Response:
   The authorized contents for the F-458/F-251 MK2 configuration are the same as the F-251. Please see the note at the bottom of Table 2 in section 1.2.

   The F-251 uses a gasket seal and four bolts on the top, while the F-251 MK2 uses o-rings and six bolts. See drawing F-625101-002 in Appendix 2.1. Item 45 on this drawing is the F-251 MK2 and it has o-rings item 47 and 48. Item 40 on this drawing is the F-251 and it has gasket item 41. Item 43 are the bolts, 3/8-16UNC by 7/8 inch long, with the F-251 MK2 having a larger bolt circle diameter than the F-251.

STRUCTURAL

2. Clarify whether or not the lid was removed after the nine meter free drop reported in Appendix H of Appendix 4, or whether the lid was only removed after all four of the tests reported in Appendix H were completed. Describe this sequence of observations including what was actually visible after each test phase reported in Appendix H.

   Appendix H, F-458 Serial #5 Drop Test, of Appendix 4, F-458/F-251 Package Drop Test Report, in Section 3.2, pages H-2 and H-3, presents the photographs and text description of the nine meter free drop against the top of the specimen. The stated observations were as follows:

   "After the test, the F-458 stayed upside down as shown in Figure H-4. The damage to the top consisted of slight rolling and flattening of the top chime. The cover handles bent outside the OD of the flange. Several cover bolts touched the target. All bolts were intact."

   Section 3.4, pages H-5 through H-7, of the same Appendices, presents the photographs and text description of the one meter pin drop against the top of the specimen. The observations provided on page H-6 are as follows:

"The cavity flange weld cracked when the lid handles bent on impact during the nine meter drop against the top. The crack extends from bolt #5 to bolt #4 as marked in Figure H-10. No foam was exposed." Clarify why this observation of the cracked cavity flange weld was not included in Section 3.2, page H-3.
This information is needed to show compliance with IAEA No. TS-R-1, paragraph 716.

Response:
The lid was removed after all four of the tests reported in Appendix H were completed. Since the package was only opened after the final one-meter drop, any internal damage could not be observed until such time.

The observation "The cavity flange weld cracked ..... exposed" on page H-6 was to give the location of the crack with reference to the marked numbers on the bolts. The crack cannot be seen in this photo, but is shown in Figure H 10.

The damage to the cavity flange was attributed to the 9 meter drop because:

1) The design concept for the drop on the top of the package requires the [redacted] The lid is fabricated from [redacted] stainless steel and as it is deformed the attached flange is also bent.

2) The drop history for damage to the top of the package includes the two 1 meter drops and the 9 meter top drop. The two 1 meter drops resulted in minor damage to the lid of the package, but this damage was not near the lid handles.

3) The 9 meter top drop caused the lid handles to deform about [redacted] with some of the lid bolts touching the target at the end of the deformation. The crack in the cavity flange weld was located at the lid handle location where this flange had rotated.

It is concluded from these observations that the damage to the flange was caused by the 9-meter top drop.

3. Provide the observations that are associated with the testing of Specimen #7 for the nine meter free-side drop that is shown in Figure J-8 and apparently Figure J-9 (not labeled).

Appendix J, F-458 Serial #7 Drop Test, of Appendix 4, F-458/F-251 Package Drop Test Report, in Section 3.3, pages J-5 and J-6, provides no information on the post-drop observations while the associated figures show some deformation of the package.

This information is needed to show compliance with IAEA No. TS-R-1, paragraph 716.

Response:
There was a misprint in the document resulting in some image and text not printing. A reprinted page J-5 of the report IS/TR 1783 F458/F251 is attached in Appendix A.

THERMAL

4. Describe the special stowage provisions, given that the package heat load exceeds 15 watts/square meter (W/m2).

   Under the "Shipment" heading in the certificate, it is stated that supplementary arrangements must be made with the carrier to ensure adequate heat dissipation. Also, on page 19 of the Engineering Assessment, paragraph 565, it is mentioned that certain contents can cause the package to exceed the 15 W/m^2 limit. However, no description is provided to identify specifically what these arrangements must include.

   This information is needed to show compliance with IAEA No. TS-R-1, paragraph 565.

   Response:
   The preparation for shipment procedure for this package requires the following supplementary stowage arrangements to be added to the shipping documents when the heat flux exceeds 15 W/m^2

   "To allow for the safe dissipation of heat, do not cover with other materials. Allow for adequate air circulation around the package."

5. State the design restrictions on transport. For example, shipments of more than 25 watts of Ir-192 are prohibited for air transport because the surface temperature would exceed the 50 °C. (refer to Appendix 7, Section 7.8). State under what circumstances the heat shield would be utilized.

   This information is needed to show compliance with IAEA No. TS-R-1, paragraph 617.

   Response:
   The design restrictions on transport are:
   1. Supplemental heat screen to be used for shipments of Ir-192 in excess of 150 TBq
   2. See answer to question 4 for supplementary stowage arrangements required.

   As shown in Appendix 2.2, F458 Transport Package Spec sheet, Note 5:
   "Supplemental heat screen to be used for shipments of Ir-192 in excess of 150 TBq"

   These design restrictions are listed in section 6.2 in the MDS Nordion IS/DS 1789 F458 (5), "Design, Manufacturing and Operating Specification for the F-458 Family of Transport Package". A copy of this specification is attached in Appendix B.

6. Provide information and drawings regarding inserts/shielding F-368, F-336, F-389, F-174, F-286, F-382 that are mentioned in the tables of Section 1.2 of the Engineering Assessment. Also, clarify if the inserts used for Ir-192 (i.e. F-368, F336) with the higher heat loads (>6 watts), have O-rings.

   No information is provided in the Engineering Assessment regarding these aforementioned inserts or shields other than by reference to them.

   Response:
   See Appendix 2.1 Information Drawings:
   F-368 See drawing F-625101-002
   F-336 See drawing F-624501-002
   F-174, F-286, F-382 See drawing F-644801-002

   There are no O-rings for the inserts (F-368, F-336, F-174, F-286, F-382) used for Ir-192 shipments with heat loads greater than 6 Watts.

7. Justify the temperature limit of the O-ring in the leakproof insert as being 149 °C as stated in Appendix 11, Section 4.2.3. Considering the uncertainties in the calculation method, justify the conclusion that the O-ring is suitable for the Hypothetical Accident Condition fire.

The calculated maximum temperature of the O-ring is 133°C (refer to Section 7.2 of Addendum 11I). Appendix 2.1 drawings show the O-ring as neoprene. The 1992 edition of the Parker O-ring Handbook, page A3-35, shows the upper normal temperature range of a neoprene O-ring as 121 °C, with a short term temperature limit of 135 °C.

This information is needed to show compliance with IAEA No. TS-R-1, paragraph 638.

Response:
The temperature limit of 149°C for the O-ring in the leakproof insert is derived from Figure A3-6 in Appendix C. The O-ring seal is specified as a "Parker [redacted] or equivalent" [redacted] O-ring. Per the manufacturer's product handbook, the service temperature is -43°C to + 150°C (-45°F to + 300°F) per Table A3-13. From Figure A3-6, at 1000 hours, [redacted] has a temperature limit of 300°F that corresponds to the service temperature from Table A3-13 for Parker compound [redacted] The comment on "Time" in the manufacturer's product handbook, page A3-37 is: "The curves show the safe, cumulative time at a given temperature for specific elastomers used as static seals. For dynamic seal applications, temperatures as much as 25 °F (14 °C) below those indicated may be more realistic."

The O-ring application in the leak-proof insert is static sealing. This temperature range is applicable to the normal conditions of transport (NCOT).

For NCOT, the design package temperature range specified in paragraph 637 of TS-R-1 is –40°C to +70°C. In the application, paragraph 637 states that the packaging is capable of withstanding this temperature range with no damage to the packaging.

The manufacturer also notes that actual temperature limits will vary based on the application. Figure A3-6 of the Parker handbook, Appendix A, shows that the general seal life at temperature for neoprene is approximately 1 hour at 240°C. Transient temperature excursions outside the normal service temperature range may be sustained by the neoprene. This is applicable to the accident conditions of transport (ACOT), since the elevated temperatures are transient.

The F-256 leak-proof insert survived the fire test with no damage. Following the fire test, the insert was helium leak tested and was found to be leak-tight to better than 10^{-7} std.cc/s of air. The O-ring had remained pliable and greased after the fire test, with no signs of compression set. The observed temperature of [redacted] was less than the service temperature of 150 °C quoted by the manufacturer and substantially less than the 240 °C limit for one hour.

This provides practical evidence of the adequacy of the design and further supports the manufacturer's data.

The calculation method followed two steps. First a validation was done of the calculations using the actual fire test data. Once a robust model was developed, the IAEA boundary conditions were applied to this model, and the calculations were repeated.

For the fire test, the ambient temperature was [redacted], there was no heat generation and the duration of the fire was [redacted] minutes. The Fire Test temperature curve, Figure 11I-11 was used. Good agreement between the experimental measurements of the transport package fire transient temperatures and the ANSYS simulated results was obtained, see Table 11I-1.

The calculations were repeated to include the regulatory fire test conditions and to add internal heat generation of 6 watts. It is noted that this amount of heat generation is negligible in comparison to the heat input from the fire.

The calculations showed a maximum temperature of the O-ring as [redacted]. This temperature is five degrees less than Load Case 1, the fire test. It is concluded that the fire test provided more than the required amount of heat input.

8. Explain the how the fire test was performed in accordance with the requirements of IAEA TS-R-1, as stated in Appendix 11 Section 1, when the fire test did not consider any internal heat load and used a lower ambient temperature than the required 38 °C. Also, state how these omissions would impact the conclusions reached regarding the post fire condition of the lead and O-ring.

   This information is needed to show compliance with IAEA No. TS-R-1, paragraph 728.

   Response:
   The fire test did not consider any internal heat load and used a lower ambient temperature than the required 38 °C due to testing limitations. The FEA analysis took into account the internal heat load and an ambient temperature of 38 °C. The fire test and FEA analysis show that the F-458 is in accordance with the requirements of IAEA TS-R-1.

   See answer 7 above. It is concluded that the fire test provided more than the required amount of heat input.

AFFIDAVIT

I, E. S. Martell, in my capacity as Senior, Vice President, Quality & Regulatory Affairs, having been duly authorized to apply for withholding from disclosure of proprietary information by and on behalf of MDS Nordion, a division of MDS (Canada) Inc., ("MDS Nordion"), do depose and say:

1. I, E.S. Martell, am the Senior, Vice President, Quality & Regulatory Affairs, of MDS Nordion.

2. The information contained in the attached document to MDS Nordion's, letter to Dr. Fred Ferate dated September 7, 2005, are the property of MDS Nordion. This document contains proprietary information related to the design of the F-458/F-251, F-458/F-318, F-458/F-448, F-458/F-245 and F-458/F-247 transport packages.

3. MDS Nordion, has expended extensive funds and manpower in developing the aforementioned document and any release for disclosure of such information to third parties would enable and assist third parties to use the information to fabricate and register a similar transport package without incurring any development costs. This could compromise MDS Nordion's, ability to compete in the marketplace. Therefore, MDS Nordion, submits that parts of the response to question 2 and 7 of the attached document to MDS Nordion letter to Dr. Fred Ferate dated September 7, 2005, should be withheld from public disclosure.

4. The information has been held in confidence by MDS Nordion, and any disclosure thereof for developmental purposes, has been accompanied by a confidentiality agreement protecting the trade secrets contained herein.

5. The information has been transmitted to and received by the Department of Transportation in the United States in confidence.

6. This information is not available in public sources.

7. The information contained in this affidavit is to the best of my knowledge true and correct.

Sworn before me this 7th day of September 2005 in the City of Ottawa, Ontario, Canada.

Neil J. Gotfrit
Notary Public in and
for the Province of Ontario, Canada

per:

E. S. Martell
Senior, V.P., Quality and Regulatory Affairs
MDS Nordion, a division of MDS (Canada) Inc.

Appendix A

Reprinted Page J-5
IS/TR 1783 F458/F251 (2)

3.3 9 m free drop against the side of the specimen

The F-458 was dropped onto the side.

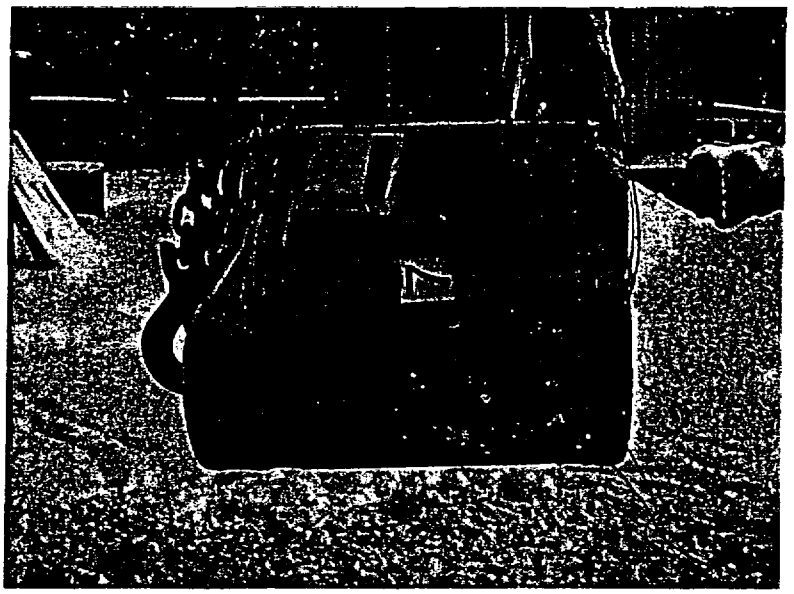

Figure J-8

Figure J-9

Observations:

The F-458 bounced and came to rest as shown in Figure J-9. There was no significant damage to the body or welds other than the flattening of a section of the body. The damage was a flattening of the body. The flat spot had a width of 21 cm at the top which tapered to 14 cm at the bottom.

Appendix B

MDS Nordion IS/DS 1789 F458 (5)
Design, Manufacturing and Operating Specification for the F-458 Family of Transport Package

MDS Nordion

Package Engineering

IS/DS 1789 F458 (5)

Effective Date: 05 09 06
DC: 19810

Design, Manufacturing and Operating Specification for the F-458 Family of Transport Packages

Signatures

Prepared by: F. Taylor, Package Engineering Date: 05/09/01 yy/mm/dd

Reviewed by: M.A. Charette, Regulatory Affairs Date: 05/09/01 yy/mm/dd

Reviewed by: K. Sibbert, Manager of Compliance Date: 05/09/02 yy/mm/dd

Approved by: for M. Krzaniak, Manager Package Engineering Date: 05/09/02 yy/mm/dd

Document History

Effective Date	Version	Comments	Prepared by	Reviewed by	Approved by
01-10-31	1	DCN A1205-D-10B	V. Eichler	F. Taylor M.A. Charette K. Sibbert	M. Krzaniak
02-07-04	2	DCN A2228-D-03A	F. Taylor	M.A. Charette K. Sibbert	M. Krzaniak
03-02-26	3	DCN A1205-D-04C	V. Eichler	M.A. Charette K. Sibbert	M. Krzaniak
04-02-10	4	DCN A1205-D-08C	F. Taylor	M.A. Charette K. Sibbert	M. Krzaniak

NOTE: A vertical line in the margin (tracking bar), denotes change. For complete rewrites, tracking bars are not used.

TABLE OF CONTENTS

1. SCOPE

This specification establishes the essential technical requirements for technical specifications, drawings, procedures and other documents that are used in the design, fabrication, maintenance, inspection and the preparation for shipment of the F-458 Family of Transport Packages.

Section 4, which pertains to manufacturing, shall not apply for the F-318 shielding vessels, as only the F-251 design is manufactured.

The requirements defined herein ensure compliance with the terms and conditions of the Safety Analysis Report [1], the package Design Approval Certificate for the F-458/F-245, F-458/F-247, F-458/F-251*, F-458/F-318 and F-458/F-448 [2] and the Regulations [3, 4].

***NOTE**: The term "F-251" includes the model F-251 Mk II.

2. PACKAGE DESCRIPTION

2.1 Introduction

The F-458/F-245, F-458/F-247, F-458/F-251, F-458/F-318 and F-458/F-448 transport packagings have been designed to transport a variety of isotopes in solid or liquid form. The F-458/F245 packaging is shown in MDS Nordion drawing F624501-002 [5]. The F-458/F-247 packaging is shown in MDS Nordion drawing F624701-002 [6]. The F-458/F251 packaging is shown in MDS Nordion drawing F625101-002 [7]. The F-458/F-318 packaging is shown in MDS Nordion drawing F631801-002 [8]. The F-458/F-448 packaging is shown in MDS Nordion drawing F644801-002 [9]. Shielding is provided by the F-245, F-247, F-251 or F-318 shielding vessels, which are depleted uranium encased in stainless steel fabrications or the F-448 shielding vessel, which is lead encased in stainless steel fabrication. Containment is provided by either a welded stainless steel sealed sources, which may meet the requirements for Special Form radioactive material, or a model F-242, F-248, F-250, F-256 or F-320 leakproof insert. Fire and impact protection is provided by the F-458 overpack** which is a double skinned stainless steel container with a bolted on closure lid. The space between skins of the stainless steel container is filled with closed cell polyurethane foam.

Only package configurations specified on the Design Approval Certificate [2] shall be shipped.

The nominal weights of the individual packages areas follows:

F-458/F-245	152.6 kg
F-458/F-247	124.5 kg
F-458/F-251	167.0 kg
F-458/F-318	164.0 kg
F-458/F-448	137.2 kg

The above referenced drawings form an integral part of this specification.

****NOTE**: The F-458 is an integral part of the packaging and is therefore not considered an overpack according to IAEA regulation. The term in this particular case is used as a matter of convenience.

2.2 F-458 Overpack

The F-458 overpack provides impact and fire protection for the F-245, F-247, F-251, F-318 and/or F-448 shielding vessels and their contents during accident conditions of transport. They are illustrated in MDS Nordion drawings F625101-001 [5], F631801-001 [6], F625101-002 [7], F631801-002 [8] and F644801-002 [9]. The F-458 overpack consists of the following features:

- double skinned type 304L stainless steel container, 40 cm diameter by 49 cm high
- the container is equipped with two lifting apertures in the top chime
- a closure lid is bolted to the container body and may be fitted with a tamperproof seal
- one identification plate bearing the CNSC certification number and a trefoil is affixed to the side of the container
- one radiation warning plate is affixed to the side of the container
- the space between the double skins of the stainless steel container is filled with closed cell polyurethane foam
- the vent holes for the polyurethane foam, located on the bottom of the container and lid, are plugged with plastic pipe thread plugs, that are designed to melt in the hypothetical fire
- nominal weight of the empty F-458 container is 62 kg (136 lbs.).

2.3 F-245 Shielding Vessel

The F-245 is a depleted uranium-filled cylindrical vessel. It is illustrated in MDS Nordion drawing F624501-001 [5], and includes the following features:

- Type 304L stainless steel encased depleted uranium
- nominal depleted uranium thickness is 51 mm (2.0 in.)
- minimum thickness of the stainless steel shell of 2.54 mm (0.100 in.)
- nominal cavity size of 63 mm (2.47 in.) in diameter by 116 mm (4.56 in.) high
- shielding vessel plug retained with 4 screws, 3/8-16 UNC x 7 / 8 in. long SAE J429 Grade 5 (or equivalent)
- plug is sealed with a 1/8 in. thick Neoprene gasket
- auxiliary tungsten shielding insert may be used for additional shielding
- nominal weight of the F-245 shielding vessel is 87 kg (192 lbs.)

2.4 F-247 Shielding Vessel

The F-247 is a depleted uranium-filled cylindrical vessel. It is illustrated in MDS Nordion drawing F624701-001 [5], and includes the following features:

- Type 304L stainless steel encased depleted uranium
- nominal depleted uranium thickness is 46 mm (1.8 in.)
- minimum thickness of the stainless steel shell of 2.54 mm (0.100 in.)
- nominal cavity size of 52 mm (2.06 in.) in diameter by 96 mm (3.78 in.) high
- shielding vessel plug retained with 4 screws, 3/8-16 UNC x 7 / 8 in. long SAE J429 Grade 5 (or equivalent)
- plug is sealed with a 1/8 in. thick Neoprene gasket
- auxiliary tungsten shielding insert may be used for additional shielding
- nominal weight of the F-247 shielding vessel is 62 kg (137 lbs.)

2.5 F-251 Shielding Vessel

The F-251 is a depleted uranium-filled cylindrical vessel. It is illustrated in MDS Nordion drawing F625101-001 [5], and includes the following features:

- Type 304L stainless steel encased depleted uranium
- nominal weight of depleted uranium is 83 kg (183 lbs.)
- nominal depleted uranium thickness is 44 mm (1.75 in.)
- minimum thickness of the stainless steel shell of 2.5 mm (0.10 in.)
- nominal cavity size of 75 mm (3 in.) in diameter by 150 mm (5.9 in.) high
- shielding vessel plug retained with 4 screws, or 6 screws (model F-251 Mk II), 3/8-16 UNC x 1.0 in. long SAE J429 Grade 5 (or equivalent)
- plug is sealed with a 1/8 in. thick Neoprene gasket, or two neoprene O-rings (model F-251 Mk II)
- auxiliary tungsten shielding insert may be used for additional shielding
- nominal weight of the F-251 shielding vessel is 100 kg (220 lbs.)

2.6 F-318 Shielding Vessel

The F-318 is a depleted uranium-filled cylindrical vessel. It is illustrated in MDS Nordion drawing F631801-001 [6], and includes the following features:

- Type 304L stainless steel encased depleted uranium
- nominal weight of depleted uranium is 75 kg (165 lbs.)
- nominal depleted uranium thickness is 46 mm (1.8 in.)
- minimum thickness of the stainless steel shell of 2.5 mm (0.10 in.)
- nominal cavity size of 72 mm (2.85 in.) in diameter by 155 mm (6.12 in.) high
- shielding vessel plug retained with 6 screws, 3/8-16 UNC x 1.0 in. long SAE J429 Grade 5 (or equivalent)
- plug is sealed with a 1/8 in. thick Neoprene gasket
- auxiliary tungsten shielding insert may be used for additional shielding
- nominal weight of the F-318 shielding vessel is 95 kg (210 lbs.).

2.7 F-448 Shielding Vessel

The F-448 is a lead-filled cylindrical vessel. It is illustrated in MDS Nordion drawing F644801-002 and includes the following features:

- Type 304L stainless steel encased lead
- nominal lead thickness is 48 mm (1.88 in.)
- minimum thickness of the stainless steel shell of 2.54 mm (0.100 in.)
- nominal cavity size of 75 mm (3 in.) in diameter by 106 mm (4.2 in.) high
- shielding vessel plug retained with 6 screws, 3/8-16 UNC x 7 / 8 in. long SAE J429 Grade 5 (or equivalent)
- a leak test port is fitted between two O-rings
- auxiliary lead, steel or tungsten shielding insert may be used for additional shielding
- maximum weight of the F-448 shielding vessel including its contents is 79 kg (175 lbs.)

2.8 Containment System

Either a Special Form sealed source, or a C133 welded stainless steel sealed source, or an F-242, F-248, F-250, F-256 or F-320 leakproof insert provides containment. The leakproof inserts include the following features:

- cylindrical body, material stainless steel Type 304
- threaded cap, material stainless steel Type 416
- neoprene O-ring (or an equivalent O-ring material with an equal or better service temperature range)
- minimum internal volume of 103 ml for F-242, 390 ml for F-250 and F-320, 194 ml for F-248 and 252 ml for F-256
- minimum wall thickness of 0.25 cm (0.10 in.)
- the design shall be demonstrated to withstand a gauge pressure of 4.9MPa (711psi) at 138°C without leakage.

2.9 Shielding Inserts

The Iridium-192 sources shall be contained within the insert as follows:

The F-336 insert shall used with the F-245 shielding vessel and will include the following features:

- it shall fit directly into the F-245 shielding vessel cavities
- nominal tungsten thickness of 15 mm (0.6 in.)
- nominal weight of the F-336 insert is 4.65 Kg (10.25 lbs.).

The F-368 insert shall used with the F-251 and F-318 shielding vessels and will include the following features:

- it shall fit directly into the F-251 and F-318 shielding vessel cavities
- nominal tungsten thickness of 20 mm (0.8 in.)
- nominal weight of 9 Kg (20 lbs.).

The F-174, F-286, F-382 or F-389 inserts may be used with the F-448 shielding vessels and will include the following features:

- The F-174, F-286 and F-382 must fit directly into the F-448 shielding vessel cavity
- The F-389 must fit within the F-256 leakproof insert

2.10 Contents

The permissible activity and form of the radioisotopes shall be as listed in the tables below.

Table 1
Package Configurations and Authorized Radioactive Contents
F-458/F-245 and F-458/F-247

Isotope	Package Configuration			Chemical and Physical Form
	F245 with F248 insert	F247 with F242 insert	F245 with with F336 insert	
I-131	7500 GBq (202 Ci)	3300 GBq (89 Ci)	--	Solid or Aqueous NaOH solution or Aqueous NaOH with up to 0.2 M Na_2SO_4
Ir-192		37 TBq (1000 Ci)	--	Solid Pellets
Ir-192	--	--	300 TBq (8100 Ci)	Solid Pellets within a C133 sealed source
Ir-192	--	110 TBq (2970 Ci)		Special Form Capsule
Mo-99/ Tc-99m	37 TBq (1000 Ci)	25 TBq (676 Ci)	--	Solid or aqueous NaOH solution or aqueous NaOH with up to 1 M NH_4NO_3 and up to 0.4% NaOCl
Co-60		--	275 GBq (7.4 Ci)	Solid

Table 2
Package Configurations and Authorized Radioactive Contents
F-458/F-251 and F-458/F-318

Isotope	Package Configuration			Chemical and Physical Form
	F-251, or F-318 with F248 insert	F-251, or F-318 with F320 insert or F251 with F250 insert	F-251, or F-318 with F368 insert	
I-131	37 TBq (1000 Ci)	37 TBq (1000 Ci)	37 TBq (1000 Ci)	Solid
I-131	7.4 TBq (200 Ci)	13 TBq (350 Ci)	–	Aqueous NaOH solution or aqueous NaOH with up to 0.02 M Na_2SO_4
Ir-192	–	–	300 TBq (8100 Ci)	Special Form capsule
Mo-99/ Tc-99m	37 TBq (1000 Ci)	55.5 TBq (1500 Ci)	–	Solid or aqueous NaOH solution or aqueous NaOH with up to 1 M NH_4NO_3 or up to 0.4% NaOCl
Sr-90/Y-90	6.4 TBq (173 Ci) each	11.1 TBq (300 Ci) each	–	Liquid in up to 1 N HCl
Y-90	6.4 TBq (173 Ci)	11.1 TBq (300 Ci)	–	Liquid in 0.04 N HCl
Sr-90/Y-90	18.5 TBq (500 Ci) each	18.5 TBq (500 Ci) each	–	Solid
Y-90	18.5 TBq (500 Ci)	18.5 TBq (500 Ci)	–	Solid

Table 3
Authorized Radioactive Contents for Isotope Shipped in F-448/F-256 Leak Proof Inserts

Isotope	Package Configuration		Chemical and Physical Form
	F448/F256	F448/F256/F389	
I-125	7,400 GBq (200 Ci)	7,400 GBq (200 Ci)	Solid or Aqueous NaOH solution
I-131	5,180 GBq (140 Ci)	10,000 GBq (270 Ci)	Solid or Aqueous NaOH solution or aqueous NaOH with 0.02 M Na_2SO_4
Mo-99/Tc-99m	555 GBq (15 Ci)	1,110 GBq (30 Ci)	Solid or aqueous NaOH solution or aqueous NaOH with 1 M NH_4NO_3 or up to 0.4% NaOCl
Y-90	16,000 GBq (432 Ci)	–	Solid or Liquid in 0.04 N HCl
Sr-90/Y-90	16,000 GBq (432 Ci)	–	Solid or Liquid in up to 1 N HCl

Table 4
Package Configuration and Authorized Radioactive Contents for Isotopes in Special Form Sources F-458/F-448

Isotope	Package Configuration			
	F448	F448/F174	F448/F286	F448/F382
Co-60	4.0 GBq (0.1 Ci)	15.0 GBq (0.4 Ci)	4.0 GBq (0.11 Ci)	15.0 GBq (0.4 Ci)
Ir-192	2,405 GBq (65 Ci)	9,250 GBq (250 Ci)	4,800 GBq (130 Ci)	33,300 GBq (900 Ci)
Sb-124	7.4 GBq (0.2 Ci)	11.1 GBq (0.3 Ci)	7.4 GBq (0.2 Ci)	44.4 GBq (1.2 Ci)
Y-90	18,000 GBq (461 Ci)	18,000 GBq (461 Ci)	18,000 GBq (461 Ci)	18,000 GBq (461 Ci)
Sr-90/Y-90	18,000 GBq (486 Ci)	18,000 GBq (486 Ci)	18,000 GBq (486 Ci)	18,000 GBq (486 Ci)

3. QUALITY ASSURANCE

MDS Nordion has established, and maintains, a Quality Assurance Program. Within this program, the Radioactive Material Transport Package Quality Plan [10] and the Sealed Source Quality Plan [11] ensure that the specified requirements for the transport packaging for radioactive material (including sealed sources) comply with the regulations [3, 4].

These plans define the standard operating practices at MDS Nordion that prescribe the measures used to control the activities affecting radioactive material transport package quality. They define responsibilities and establish a documented system of management controls that provide confidence in the quality of all associated work activities, including design, manufacture, testing, documentation, use, maintenance and inspection.

3.1 Design Control

The design of the F-458/F-245, F-458/F-247, F-458/F-251, F-458/F-318 and F-458/F-448 packages is controlled in accordance with the Radioactive Material Transport Package and Sealed Source Quality Plans [10, 11].

3.2 Manufacturing Requirements

3.2.1 F-458 container

Manufacture of the F-458 container will be completed in accordance with the technical specification and the controlled engineering drawings specified in the drawing and document list (refer to Appendix A). The F-458 container shall be inspected by the supplier for conformance with the current engineering drawings. The supplier's quality program must be certified to ISO 9002 or an approved equivalent.

3.2.2 F-245 Shielding Vessel

Manufacture of the F-245 shielding vessel shall be completed in accordance with the technical specification and the controlled engineering drawings specified in the drawing and document list (refer to Appendix A). The supplier's quality program must be certified to ISO 9002 or an approved equivalent.

The following inspections shall be completed prior to first use:

1. Dimensional inspections for conformance with the engineering drawings.
2. Leak Test as per section 4.4.2 below.
3. Radiation survey as per section 4.4.3 below.

3.2.3 F-247 Shielding Vessel

Manufacture of the F-247 shielding vessel shall be completed in accordance with the technical specification and the controlled engineering drawings specified in the drawing and document list (refer to Appendix A). The supplier's quality program must be certified to ISO 9002 or an approved equivalent.

The following inspections shall be completed prior to first use:

1. Dimensional inspections for conformance with the engineering drawings.
2. Leak Test as per section 4.4.2 below.
3. Radiation survey as per section 4.4.3 below.

3.2.4 F-251 or F-251 Mk II Shielding Vessel

Manufacture of the F-251 or F-251 Mk II shielding vessel shall be completed in accordance with the technical specification and the controlled engineering drawings specified in the drawing and document list (refer to Appendix A). The supplier's quality program must be certified to
ISO 9002 or an approved equivalent.

The following inspections shall be completed prior to first use:

1. Dimensional inspections for conformance with the engineering drawings.
2. Leak Test as per section 4.4.2 below.
3. Radiation survey as per section 4.4.3 below.

3.2.5 F-448 Shielding Vessel

Manufacture of the F-448 shielding vessel shall be completed in accordance with the technical specification and the controlled engineering drawings specified in the drawing and document list (refer to Appendix A). The supplier's quality program must be certified to ISO 9002 or an approved equivalent.

The following inspections shall be completed prior to first use:

1. Dimensional inspections for conformance with the engineering drawings.
2. Leak Test as per section 4.4.2 below.
3. Radiation survey as per section 4.4.3 below.

3.2.6 F-318 Shielding Vessel

The design of the F-251 shielding vessel prevails and no new F-318 shielding vessels will be manufactured.

3.2.7 Leakproof Inserts

Manufacture of leakproof inserts will be completed in accordance with the technical specification and the controlled engineering drawings specified in the drawing and document list (refer to Appendix A). The supplier's quality program must be certified to ISO 9002 or an approved equivalent.

The following inspections shall be completed prior to first use:

1. Dimensional inspection for conformance with the engineering drawings.
2. Hydrostatic pressure test per section 4.4.1 below.
3. Leak testing per section 4.4.2 below.

3.2.8 Shielding Inserts

Manufacture of the shielding inserts will be completed in accordance with the technical specification and the controlled engineering drawings specified in the drawing and document list (refer to Appendix A). The shielding inserts shall be inspected by the supplier for conformance with the engineering drawings.

The following inspections shall be completed prior to first use:

1. Dimensional inspections for conformance with the engineering drawings.
2. Radiation survey per section 4.4.3 below.

3.2.9 Sealed Sources

Manufacture of sealed sources will be completed in accordance with a technical specification and controlled engineering drawings. The supplier's quality program must be certified to ISO 9002 or an approved equivalent. Sealed source welding shall be in accordance with section 4.3.2.2 below.

The following inspections shall be completed prior to first use:

1. Dimensional inspection of components for conformance with the engineering drawings. This inspection will be completed prior to welding
2. Periodic examination of test welds for conformance with an 80% minimum penetration requirement.
3. Leakage testing by hot-liquid bubble test per ISO 9978 paragraph 6.2.2 or a test of equivalent or better sensitivity.
4. Dry wipe contamination testing per ISO 9978 paragraph 5.3.2 or a test of equivalent or better sensitivity.

3.3 Controls in Use

The package shall be inspected and prepared for shipment as described in Sections 5 and 6 below.

4. MANUFACTURING

4.1 Quality Levels

The F-458/F-245, F-458/F-247, F-458/F-251 and F-458/F-448 package components shall be manufactured according to the Quality Assurance requirements defined in Section 3 above.

4.2 Storage and Handling

Storage and handling of all materials and sub-assemblies shall be carried out in a manner that ensures their positive identification during manufacture and assembly. Components shall be stored in a dry, clean area. All components shall be protected and covered to prevent damage, corrosion, and the ingress of foreign materials. Materials and assemblies shall be packaged in such a manner that they will not be damaged during transit.

Handling of stainless steel components and assemblies is considered a Special Process and shall be in accordance with section 4.3.3 below.

4.3 Special Processes

4.3.1 Processing and Cleaning

After fabrication and assembly, all dirt, salt, oil, grease, chemical deposits or other surface contaminants shall be removed.

Cleaning of stainless steel components shall be in accordance with ASTM A380. All stainless steel parts shall be cleaned such that when submitted to the ASTM A380 Water Wetting and Drying Test, surfaces will show no evidence of rust stains or corrosion.

4.3.2 Welding

4.3.2.1 Shielding Vessel and F-458 Container Welding

Welding shall be in accordance with ASME Boiler and Pressure Vessel Code Section IX, or CSA Standard W59, or other approved equivalent standards. Welders shall be qualified to the applicable standard.

Welded surfaces shall be smooth and shall merge smoothly into the parent metal. All scale, oxide, weld spatter, oil, chips, and other foreign material shall be completely removed.

Completed welds shall be inspected in accordance with ASTM E165 "Standard Methods for Liquid Penetrant Inspection". The acceptance criteria shall be as follows:

- No more than five (5) linear indications
- Maximum size of a linear indication shall be 2 mm (0.08 in) long
- Adjacent linear indications shall be 25 mm (1.0 in) apart
- The sum of the diameters of visible porosities shall not exceed 20 mm (0.8 in) in any 300 mm (12 in.) length of weld

The inspector shall be certified to CGSB Standard 48-GP-9 or equivalent.

4.3.2.2 Sealed Source Welding

Sealed sources shall be designed, manufactured and tested in accordance with the Sealed Source Quality Plan [11].

Welding shall be in accordance with formal procedures. Only trained personnel shall perform welding.

Welded surfaces shall be smooth and shall merge smoothly into the parent metal. All scale, oxide, weld spatter, oil, chips, and other foreign material shall be completely removed. Weld penetration shall be 80% minimum.

Sealed sources shall be leakage tested according to ISO 9978.

4.3.3 Handling Stainless Steel Components

Stainless steel parts shall be processed and handled in such a way as to minimize contamination by iron, grit, lead, halogens, and sulfur. Only clean stainless steel brushes and iron-free grinding wheels shall be used on stainless steel surfaces.

4.4 Manufacturing Testing

4.4.1 Pressure Test

The leakproof insert body shall be subjected to a hydrostatic pressure test at a minimum gauge pressure of 1,070 kPa (155 psi) for at least 5 minutes at room temperature (20°C). As a result of the test the insert shall not deform permanently, leak, or crack.

4.4.2 Leak Testing

Each F-248, F-250, F-256 and F-320 leakproof insert shall be leak tested using a method sensitive to 10^{-8} std cc/s according to a procedure prepared in accordance with ISO 12807. The leak test shall be performed after the pressure test.

The leak rate shall be less than 10^{-7} std cc/s.

The stainless steel shell surrounding the depleted uranium in the F-245, F-247 and F-251 shielding vessels shall be leak tested using a test sensitive to 10^{-8} std cc/s. The leak rate shall be less than 10^{-7} std cc/s.

In addition, the F-245, F-247 and F-251 cavities shall be leak tested using a test sensitive to 10^{-4} std cc/s. The leakage rate from assembled units shall be less than $1x10^{-3}$ std.cc/s.

4.4.3 Radiation Survey

The shielding vessel shall be subjected to a radiation survey using I-131, Ir-192 or Mo-99. The activity of isotope used for the test shall be sufficient to produce radiation fields of at least 500 µSv/h (50 mR/h) on the surface of the shielding vessel.

An additional radiation survey shall be completed with the shielding vessel installed in the F-458 overpack. Maximum radiation levels on contact shall be determined for the side, top, and bottom of the package. Similarly, maximum TI readings shall be recorded.

When extrapolated to the activity limit specified in the Design Approval Certificate, the radiation fields shall be no greater than 2 mSv/h (200 mR/h) on the surface and 100 µSv/h (10 mR/h) at 1 m from the surface of the package.

4.5 Documentation

For all package components manufactured to a quality program, manufacturing records shall include the following:

- Inspection and Test Plan
- Inspection records
- List of drawings and specifications used in the manufacture
- List of approved Special Process Procedures
- List of serial numbers of the units manufactured
- Certification of materials used in the manufacture in the form of Certified Material Test Reports (CMTR's), Mill Certificates, or alternatively Certificates of Compliance
- Certified NDE reports, leak test reports, personnel qualifications and radiation survey reports
- Records of any approved deviations, repair or rework.

5. REQUIREMENTS FOR MAINTENANCE AND INSPECTION PROCEDURES

5.1 General

1. The F-458/F-245, F-458/F-247, F-458/F-251, F-458/F-318 and the F-458/F-448 packaging shall be subjected to a Routine Inspection prior to each shipment and a Detailed Inspection once a year, or more frequently if a Routine Inspection identifies a defect. The requirements for the Routine Inspection and the Detailed Inspection procedure are specified in sections 5.2 and 5.3 below.
2. Formal procedures shall be prepared for the inspection and maintenance of the transport packaging components. The results of the inspections shall be documented and the inspection history of packaging components shall be recorded.
3. Only trained personnel shall perform packaging inspections.
4. Package components shall be quarantined until they have passed inspection.
5. Repairs to damaged packaging components shall be in accordance with the standards for manufacturing identified in section 4 above. Repairs shall be documented and reinspected.
6. All inspections are to be performed on empty packagings.

5.2 Requirements for Routine Inspection Procedure

5.2.1 F-458 Overpack

1. The external surface of the cylinder shall be checked for contamination, and decontaminated if necessary.
2. The outer surface of the cylinder shall be inspected for damage such as rust, severe dents and perforation.
3. The condition of the lifting perforations shall be inspected.
4. All permanent labels (e.g. MDS Nordion Identification and Radiation Caution Plate, This Side Up Label, etc.) shall be examined for legibility and proper attachment to the drum.
5. The lid and bolts shall be removed and inspected. If they are not significantly damaged, these components may be reused.
6. The F-245, F-247, F-251, F-251 Mk II, F-318 or the F-448 shielding vessel shall be removed from the overpack and checked for contamination. It shall be decontaminated if necessary. If the outside surface of the shielding vessel is contaminated, the interior of the F-458 overpack shall be checked for contamination.

5.2.2 F-245, F-247, F-251, F-251 Mk II, F-318 or the F-448 Shielding Vessel

1. The shielding vessel shall be inspected for significant damage, such as cracks, dents or other such deformation.
2. The top plug shall be removed and checked for contamination. It shall be decontaminated if necessary.
3. The screws securing the plug shall be inspected to verify that they are clean and in good condition. The threads shall be inspected and there shall be no cracks or gouges in the screws. Damaged screws shall be replaced as necessary.
4. The leakproof insert shall be removed and checked externally for contamination. It shall be decontaminated if necessary and inspected in accordance with section 5.2.3 below.
5. The shielding vessel cavity shall be checked for contamination and decontaminated if necessary.
6. The neoprene gasket shall be inspected and replaced if necessary. (all models except F-448 and F-251 Mk II)
7. The two neoprene O-rings shall be removed and replaced with the new ones (models F-448 and F-251 Mk II only)
8. The O-rings groves ahall be inspected for damage and cleaned prior installation of new O-rings (models F-448 and F-251 Mk II only)
9. The condition of the internal threads shall be inspected. They shall be clean and the screws shall turn freely in the screw holes.
10. The top face of the shielding vessel shall be inspected for gouges, corrosion, or any damage that may affect the gasket seal.
11. The sealing face of the top plug shall be inspected for gouges, corrosion, or any damage that may affect the gasket seal.

5.2.3 F-242, F-248, F-250, F-256 or F-320 Leakproof Inserts

1. The leakproof insert shall be decontaminated inside and out.
2. The lifting handle on the insert shall be in working order and shall lie flat when it is in the down position.
3. The leakproof insert shall be checked for dents, deformation, or other damage.
4. The lid and the body shall have matching serial numbers.
5. The lid shall thread freely onto the body without an O-ring. The sealing surfaces shall be smooth and free of defects.
6. A new O-ring shall be placed in the cavity of the insert for installation prior to the next product loading.
7. If routine inspection identifies a defect, the leakproof insert shall be quarantined.

5.2.4 F-368 Shielding Insert

1. The shielding insert shall be decontaminated inside and out.
2. The shielding insert shall be checked for dents, deformation, or other damage.
3. If routine inspection identifies a defect, the shielding insert shall be quarantined.

5.3 Requirements for Detailed Inspection Procedure

In addition to Routine Inspection, the following inspection shall be performed.

5.3.1 F-458 Overpack

1. The external surface of the container shall be examined for rust, severe dents, perforation, or other damage. If significant damage is observed, the container shall be repaired or replaced. The new container shall have the same serial number as the original.
2. The shielding vessel shall be removed from the overpack. The F-458 cavity shall be checked for cracks or other damage. If significant damage is observed the container shall be repaired or replaced.

5.3.2 F-245, F-247, F-251, F-251 Mk II, F-318 and the F-448 Shielding Vessel

1. The top plug shall be removed from the shielding vessel. The sealing faces of the body and plug shall be free of gouges, deformation or any other damage that may affect the integrity of the seal.
2. The gasket or O-ring shall be inspected and replaced if necessary.
3. The plug screws shall be examined for cleanliness, damaged threads, cracks, or other such damage. The screws shall be replaced if necessary.
4. The condition of the internal threads in the shielding vessel shall be checked. The threads shall be clean and the screws shall turn freely.
5. The condition of the cavity walls shall be checked for cracks, holes, or other damage.
6. Check the internal and external surfaces of the shielding vessel for alpha contamination.

5.3.3 F-242, F-248, F-250, F-256 or F320 Leakproof Insert

1. A hydrostatic pressure test shall be performed on the leakproof insert body at a minimum gauge pressure of 1,070 kPa (155 psi) for at least 5 minutes at room temperature (22°C). There shall be no permanent deformation, leaking, or cracking.
2. A Vacuum Liquid Bubble Test shall be performed on the leakproof insert. There shall be no visible sign of leakage. Alternative leakage tests in accordance with ISO 12807 may be used provided that they have equal or better sensitivity. The leak test shall be performed after the pressure test.

6. REQUIREMENTS FOR PREPARATION FOR SHIPMENT PROCEDURE

6.1 General

1. The F-458/F-245, F-458/F-247, F-458/F-251, F-458/F-318 and F-458/F-448 packages shall be prepared for shipment according to the requirements specified in sections 6.2 through 6.5 below.
2. Formal procedures shall be prepared for preparing the package for shipment.
3. Only trained personnel shall prepare the package for shipment. The training shall be documented.
4. All package components shall be subjected to a routine inspection prior to shipment. On an annual basis, the package components shall be subjected to a detailed inspection.
5. The package shall contain only isotopes in quantities and form specified on the Design Approval Certificate.
6. Only package configurations with sources, leakproof inserts, and shielding inserts listed on the Design Approval Certificate shall be used.
7. Either a sealed source or a leakproof insert shall provide containment of the radioisotope.
8. The package shall be lifted using two opposing lifting handles on the package.

6.2 Packaging the Product

1. If the product is to be contained in a leakproof insert, the O-ring shall be lightly greased and installed on the cap of the leakproof insert.
2. The product shall be dispensed into its bottle or source and sealed. The radioactive contents shall not exceed the authorized limit specified on the Design Approval Certificate. Receptacles with isotopes in liquid form shall not be filled beyond 80% of their volume capacity.
3. If the product is in a bottle, it shall be placed into the leakproof insert and the cap of the LPI shall be installed. The cap shall be seated and there shall be no visible gap between the body and the lid.
4. If the product is in a sealed source, the F-368 tungsten shielding insert shall be installed in the shielding vessel.
5. Inside the hot cell, the product shall be placed into the shielding vessel body and it shall be properly seated. If applicable, the lifting handle on the leakproof insert shall be in the down position.
6. The shielding vessel top plug shall be installed.
7. All external surfaces of the shielding vessel shall be decontaminated. The level of non-fixed radioactive contamination shall be determined by wiping an area of 300 cm^2 of the external surface by hand with a dry filter paper, or a wad of dry cotton wool, or any other material of this nature. The maximum permissible level of contamination is 3.7 Bq/cm^2 (10^{-4} $\mu Ci/cm^2$).
8. The top plug screws shall be installed and torqued evenly to 14-20 N·m (10-15 ft lb.).
9. The shielding vessel shall be placed inside the F-458 overpack.
10. The container cover shall be installed in place and fastened down with six hex. head cap screws.
11. The screws shall be torqued to 14 -20 N-m (10-15 ft lb.).
12. A tamper-evident seal shall be installed.
13. When 150TBq (4000 Ci) or more of Iridium-192 is to be transported the supplemental heat shield F145801-003 is to be installed, and the following instruction shall be added in the Shipper's Declaration for Dangerous Goods document, under the Additional Handling Information:

    "To allow for the safe dissipation of heat, do not cover with other materials. Allow for adequate air circulation around the package."

6.3 Contamination Check and Radiation Survey

1. The exterior surfaces of the overpack shall be tested for removable contamination. The level of non-fixed radioactive contamination shall be determined by wiping an area of 300 cm^2 of the external surface by hand with a dry filter paper, or a wad of dry cotton wool, or any other material of this nature. The maximum permissible level of contamination is 3.7 Bq/cm^2 (10^{-4} $\mu Ci/cm^2$).
2. A radiation survey shall be performed on the assembled package. Radiation levels shall not exceed 2 mSv/h (200 mrem/h) on the external surface of the package or 0.1 mSv/h (10 mrem/h) at any point one meter from the surface of the package.

6.4 Labeling

1. Two appropriate category labels shall be affixed to opposite sides of the drum. The required information regarding the contents shall be completed (e.g. radionuclide, activity, transport index, etc.).
2. One appropriate UN number label shall be affixed next to each of the category labels, on opposite sides of the drum, for a total of two UN number labels per package.
3. The "ship to" label and the appropriate shipping documents shall be affixed to the drum.
4. The Shipper's Declaration, the Emergency Response Form, and the Waybill, shall be completed.
5. The Design Approval Certificate shall be included with the shipping documents.

6.5 Shipping Empty Packages

1. When the package is shipped empty, it shall be prepared for shipment in accordance with a formal procedure that complies with the pertinent requirements of the regulations [3, 4].

7. APPLICABLE STANDARDS

The current editions of the following standard and codes shall apply unless a specific edition of the standard or code is referenced. In addition to the IAEA regulations, the F-458 family transport packages comply with the relevant transport regulations for dangerous goods and the regulations of the cognizant transport organizations.

1. ASTM A380, Standard Practice for Cleaning and Descaling Stainless Steel Parts, Equipment and Systems.
2. ASTM E165, Standard Methods for Liquid Penetrant Inspection.
3. ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.
4. CAN/CGSB Standard 48.9712, Qualification and Certification of Nondestructive Testing Personnel .
5. CSA Standard W59, Welded Steel Construction (Metal Arc Welding).
6. ISO 9978, Radiation Protection – Sealed Radioactive Sources – Leakage Test Methods, 1992.
7. ISO 12807, Safe Transport of Radioactive Materials – Leakage Testing on Packages, 1996.

8. REFERENCED DOCUMENTATION

1. MDS Nordion Report No. IS/TR 1791 F458, "Engineering Assessment of the Ability of the F-458/F-251 and the F-458/F-318, F-458/F-448, F-458/F-245 and F-458/F-247 to Meet the Requirements of IAEA TS-R-1, 1996 Edition (Revised).
2. Radioactive Material Type B(U) Package Design Approval Certificate No. TBD
3. Packaging and Transport of Nuclear Substances Regulations, Nuclear Safety and Control Act, SOR//DORS/2000-208, 31 May, 2000.
4. Regulations for the Safe Transportation or Radioactive Materials, 1996 Edition (Revised), IAEA Regulations No. TS-R-1 (ST-1, Revised).
5. MDS Nordion drawing F624501-002, "F-458/F-245 Transport Package Information Drawing".
6. MDS Nordion drawing F624701-002, "F-458/F-247 Transport Package Information Drawing".
7. MDS Nordion drawing F625101-002, "F-458/F-251 Transport Package Information Drawing".
8. MDS Nordion drawing F631801-002, "F-458/F-318 Transport Package Information Drawing".
9. MDS Nordion drawing F644801-002, "F-458/F-448 Transport Package Information Drawing".
10. MDS Nordion Specification No. IN/QA 0224 Z000, "Radioactive Material Transport Package Quality Plan".
11. MDS Nordion Specification No. IN/QA 0562 A000, "Sealed Source Quality Plan".

Appendix A
Drawing and Document List for the F-458 Family of Transport Packages

Document	Component	Description
IS/DS 1789 F458	All	Design, manufacturing and Operating Specification for the F-458 Family of Transport Packages
F624501-002	F-458/F-245	Specification Drawing for the F-458/F-245 Transport Package
F624701-002	F-458/F-247	Specification Drawing for the F-458/F-247 Transport Package
IS/IM 1767 F458	All	Inspection and Maintenance Procedure for the F-458 Family of Transport Packaging
IS/PP 1693 F458	All	Preparation for Shipment Procedure for the F-458 Family of Transport Packaging
IS/TS 1680 F458	F-458	Technical Specification for the F-458 Overpack
IS/TS 1686 F458	F-458	Technical Specification for Rigid Polyurethane Foam
IS/OP 1685 F458	F-458	Procedure for the Foam Filling of the F-458 Overpack
F145801-001	F-458	F-458 Cylinder, Shipping Assembly
F545801-001		F-458 Cylinder Specification
F545801-002		Name and Radiation Caution Plate
F545801-003		Gasket
F545801-004		Locating Pin
F145801-002		Bottom Spacer Disk
S/TS 0058 F245	F-245	Technical Specification for the F-245 Shielding Vessel
F124501-001	F-245	F-245 Shipping Container Assembly (4 oz)
F124501-003		Container Cavity Welding
F124501-005		Container Top Plate
F124501-019		Plug Bottom Plate
F124501-020		Outer Tube
F124501-021		Uranium Top Plug
F124501-022		Top Plate Plug
F124501-023		Handle
F124501-010		Uranium Casting
F124501-033		Uranium Casting Assembly
F124501-034		Bottom Plate
F124501-035		Outer Casing
F124501-036		Gasket
A15676		Radioactivity Caution Plate

(Cont.) Drawing and Document List for the F-458 Family of Transport Packages

Document	Component	Description
IS/TS 0059 F247	F-247	Technical Specification for the F-247 Shielding Vessel
F124701-001	F-247	F-247 Shipping Container Assembly
F124701-003		Container Top Plug Welding And Machining
F124701-019		Plug Top Plate
F124701-020		Outer Tube
F124701-021		Top Plug
F124701-022		Plug Bottom Plate
F124701-023		Handle
F124701-004		Container Cavity Welding And Machining
F124701-005		Uranium Outer Casting Assembly
F124701-017		Bottom Plate
F124701-018		Uranium Outer Tube
F124701-006		Gasket
F124701-016		Uranium Casting
A15676		Radioactivity Caution Plate
IN/TS 0100 F000	F-248, F-242	Technical Specification for Leakproof Inserts
IS/IM 0015 F000	F-248, F-242	Inspection and Maintenance Procedure for Leakproof Inserts
F124501-004	F-248	F-248 Leakproof Insert, 4 oz
F124501-029		Outer Body
F124501-030		Top Cap
F124501-031		Bottle Flask Handle
F124701-026	F-242	F-242 Leakproof Insert
F124701-009		Top Cap
F124701-010		Handle
F124701-028		Outer Body
IS/TS 1273 F000	F-336	Technical Specification for Shielding Inserts used in Transport Packages
F133601-001	F-336	F-336 Tungsten Insert Assembly, Ir-192
F133601-002		Bottom Cap
F133601-003		Spacer
F133601-004		Body
F133601-005		Top Cap
F133601-006		Washer Assembly
F133601-007		Washer

(Cont.) Drawing and Document List for the F-458 Family of Transport Packages

Document	Component	Description
IS/DS 1789 F458	All	Design, manufacturing and Operating Specification for the F-458 Family of Transport Packages
F625101-002	F-458/F-251	F-458/F-251 Transport Package Information Drawing
F631801-002	F-458/F-318	F-458/F-318 Transport Package Information Drawing
IS/IM 1767 F458	All	Inspection and Maintenance Procedure for the F-458 Family of Transport Packaging
IS/PP 1693 F458	All	Preparation for Shipment Procedure for the F-458 Family of Transport Packaging
IS/TS 1680 F458	F-458	Technical Specification for the F-458 Overpack
IS/TS 1686 F458	F-458	Technical Specification for Rigid Polyurethane Foam
IS/OP 1685 F458	F-458	Procedure for the Foam Filling of the F-458 Overpack
F145801-001	F-458	F-458 Cylinder, Shipping Assembly
F545801-001		F-458 Cylinder Specification
F545801-002		Name and Radiation Caution Plate
F545801-003		Gasket
F545801-004		Locating Pin
IS/TS 0049 F251	F-251	Technical Specification for the F-251 Shielding Vessel
F125101-001	F-251	F-251 Shipping Container Assembly (8 oz)
F125101-002		Outer Casing Assembly
F125101-008		Bottom Plate
F125101-009		Outer Casing
F125101-005		Plug Welding And Machining Assembly
F125101-010		Plug Bottom Plate
F125101-011		Outer Tube
F125101-012		Uranium Top Plug
F125101-013		Plug Top Plate
F125101-014		Handle
F125101-006		Uranium Casting
F125101-007		Gasket
F125101-024		Adapter For 4 oz Bottle
F125101-030		Cavity
A15676		Radioactivity Caution Plate
F125101-032	F-251 Mk II	F-251 MK II Shipping Container Assembly (8 oz)
F125101-035		Plug Welding And Machining Assembly
F125101-010		Plug Bottom Plate
F125101-041		Outer Tube
F125101-012		Uranium Top Plug
F125101-037		Plug Top Plate
F125101-014		Handle
F144802-009		Boss (Plug)
F125101-039		Container Bottom Assembly

(Cont.) Drawing and Document List for the F-458 Family of Transport Packages

Document	Component	Description
F125101-006		Uranium Casting
F125101-033		Cavity
F125101-034		Uranium Outer Casing Assembly
F125101-008		Bottom Plate
F125101-036		Outer Casing
F125101-040		Pin
F131801-001	F-318	F-318 Transport Packaging
F131801-002		Gasket
F131801-005		Body, F-318 Transport Packaging
F131801-006		Plug, Lid, F-318 Transport Packaging
F131801-007		Body, F-318 Transport Packaging
A15676		Radioactivity Caution Plate
IN/TS 0100 F000	F-248, F-250, F-320	Technical Specification for Leakproof Inserts
IS/IM 0015 F000	F-248, F-250, F-320	Inspection and Maintenance Procedure for Leakproof Inserts
F124501-004	F-248	F-248 Leakproof Insert, 4 oz
F124501-029		Outer Body
F124501-030		Top Cap
F124501-031		Bottle Flask Handle
F125101-025	F-250	F-250 Leakproof Insert, 8 oz
F125101-022		Top Cap
F125101-023		Handle
F125101-026		Outer Tube
F125101-027		Bottom Plate
F132001-001	F-320	F-320 Leakproof Insert, 8 oz
F132001-002		Top Cap
F132001-003		Body
F132001-004		Handle
IS/TS 1273 F000	F-368	Technical Specification for Shielding Inserts used in Transport Packages
F136801-001	F-368	F-368 Tungsten Insert Assembly
F136801-002		Body, F-368 Tungsten Insert Assembly
F136801-003		Cap, F-368 Tungsten Insert Assembly
F136801-006		Washer Assembly
F145801-003	F458/F251 and F458/F318	Heat Shield

(Cont.) Drawing and Document List for the F-458 Family of Transport Packages

Document	Component	Description
IS/DS 1789 F458	All	Design, manufacturing and Operating Specification for the F-458 Family of Transport Packages
F644801-002	All	F-458/F-448 Transport Package Information Drawing
IS/PP 1693 F458	All	Preparation for Shipment Procedure for the F-458 Family of Transport Packaging
IS/IM 1767 F458	All	Inspection and Maintenance Procedure for the F-458 Family of Transport Packagings
IS/TS 1680 F458	F-458	Technical Specification for the F-458 Overpack
IS/TS 1686 F458	F-458	Technical Specification for Rigid Polyurethane Foam
IS/OP 1685 F458	F-458	Procedure for the Foam Filling of the F-458 Overpack
F145801-001	F-458	F-458 Cylinder, Shipping Assembly
F545801-001		F-458 Cylinder Specification
F545801-002		Name and Radiation Caution Plate
F545801-003		Gasket
F545801-004		Locating Pin
F145801-002		Bottom Spacer Disk
IS/TS 1457 F448	F-448	Technical Specification for the F-448 Shielding Vessel Assembly
F144802-001	F-448	F-448 Shipping Container Assembly
F144802-002		Plug Machining Assembly
F144802-003		Plug Welding Assembly
F144802-006		Bottom Plate (Plug)
F144802-008		Top Plate (Plug)
F144802-009		Boss (Plug)
F144802-010		Handle (Plug)
F144802-004		Container Body Machining Assembly
F144802-005		Container Body Welding Assembly
F144802-011		Cylinder Body
F144802-012		Bottom Plate (Body)
F144802-013		Cavity
IN/TS 0100 F000	F-256	Technical Specification for Leakproof Inserts
IS/IM 0015 F000	F-256	Inspection and Maintenance Procedure for Leakproof Inserts
F125601-001	F-256	F-256 Insert Assembly
F125601-003		Body
F125601-004		Top Cap
F125101-023		Bottle Flask – Handle

(Cont.) Drawing and Document List for the F-458 Family of Transport Packages

Document	Component	Description
IS/TS 1273 F000	F-382, F-389, F-174, F-286	Technical Specification for Shielding Inserts Used in Transport Packages
F138901-001	F-389	F-389 Tungsten Insert
F138201-001	F-382	F-382 Insert Assembly
F138201-002		F-382 Top Insert
F138201-003		F-382 Bottom Insert
F138201-004		F-382 Handle
F128601-001	F-286	F-286 Source Holder for C-182 Capsules
CP36-B-671	F-174	Insert Assembly for SC-18 F-174
CP36-B-682		Top Insert Machining
CP36-B-672		Top Insert Welding Assembly
CP36-B-680		Plate
CP36-B-677		Inner Tube
CP36-B-675		Outer Tube
CP36-B-679		Inner Plate
CP36-B-681		Plate
CP36-B-683		Bottom Insert Machining
CP36-B-673		Bottom Insert Welding
CP36-B-680		Plate
CP36-B-678		Inner Tube
CP36-B-679		Inner Plate
CP36-B-676		Outer Tube
CP36-B-674		Bottom Plate

Appendix C

Manufacturer's O-ring seal life at Temperature

Parker chart of O-ring seal life at temperature

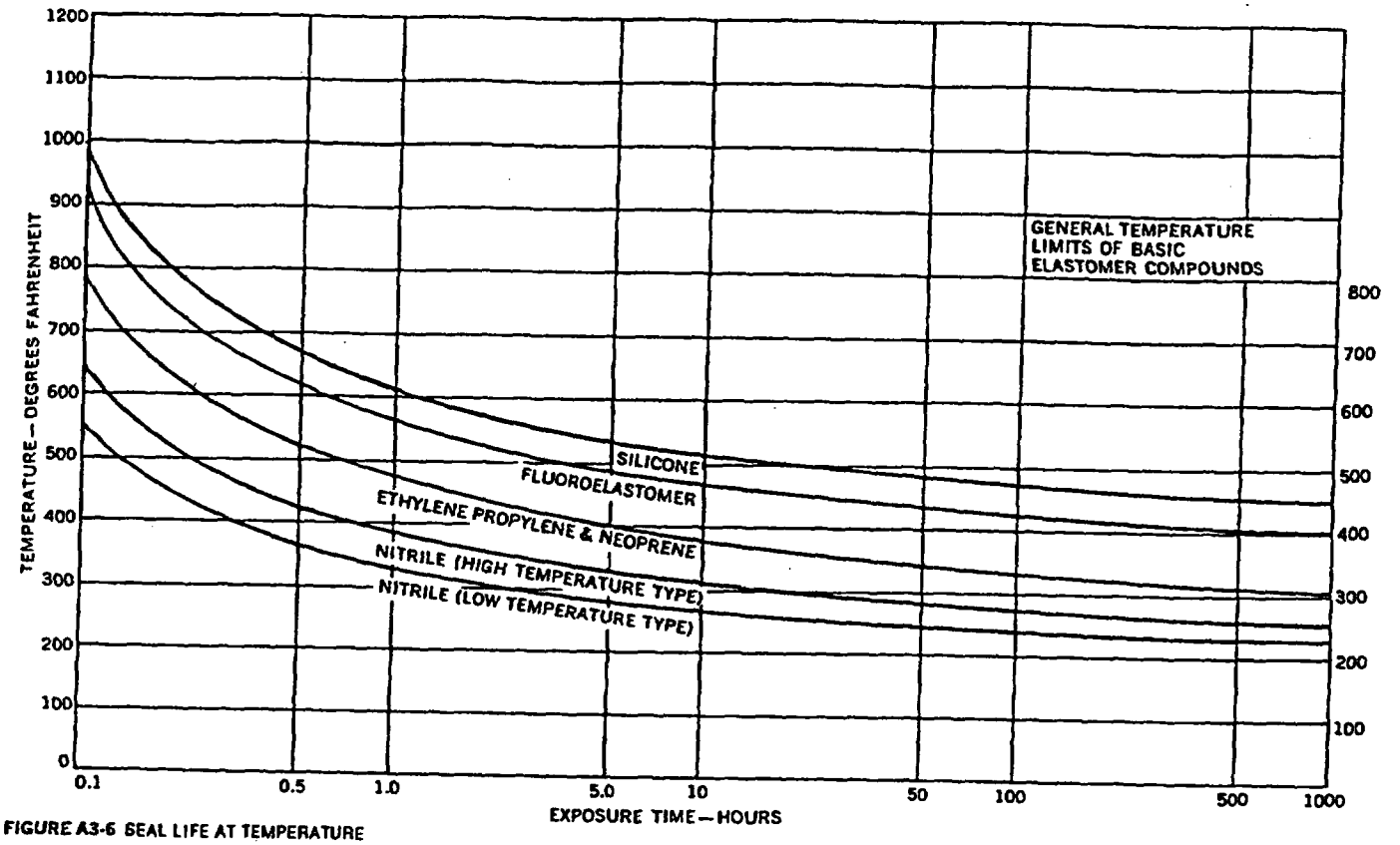

FIGURE A3-6 SEAL LIFE AT TEMPERATURE

Parker O-ring Handbook, 1992, page A3-36