5. SHIELDING EVALUATION

Shielding is essentially unneccessary for cylinders of UF_6 because the 1/2" thick cylinder walls provide more than adequate shielding for low enriched uranium. However, it is the responsibility of the shipper to assure compliance with 10CFR71.47 regarding radiation standards for each shipment.

6. CRITICALITY EVALUATION

The criticality safety evaluation for the DOT 21PF-1 package is the basis for the following evaluation of the NCI-21PF-1 package.

6.1 Comparison of NCI-21PF-1 and DOT-21PF-I Packages

The NCI Model NCI-21PF-1 package is a replacement for the DOT Specification 21PF-1B package and its predecessor, the DOT-21PF-1 package, which are used for the shipment of 30B UF_6 cylinders containing approximately 5000 lb. of UF_6 enriched up to 5% U-235. The DOT-21PF-1 package was evaluated and determined to be a Fissile Class II Package as reported in Part III, K-1686 (see Reference 6.5.1).

As reported in K-1686, the primary criticality control factor in the nuclear safety evaluation of the DOT-21PF-1 package was the moderation control afforded by the cylinder and by the neutron absorption afforded by the 1/2" thick steel cylinder walls. Since other factors are of secondary importance as compared with the moderation control effects on criticality in a 30" UF_6 cylinder, it is reasonable to apply the criticality evaluation presented in K-1686 to the NCI-21PF-1 package because of its similar size and identical contents.

6.2 Evaluation of Model NCI-21PF-1 Package As a Fissile Class II Shipping Package

As shown in K-1686, 63 undamaged packages would be subcritical in any arrangement when closely reflected by water. One-fifth that number, approximately 12, would be permitted for transport as a Fissile Class II shipment. Since damage from the hypothetical accident testing (see Section 2.7) would have almost no effect on spacing in an array, and since the analysis presented in K-1686 already assumed optimum interspersed water moderation, the number of packages which would be subcritical in any arrangement under Hypothetical Accident Conditions with optimum interspersed moderation and reflection on all sides by water would also be 63. One-half that number of packages would be allowed for transport as a Fissile Class II shipment. Therefore, the maximum number of packages to be transported together as permitted by 10CFR71.59 would be 12. The Transport Index to be assigned to each such Fissile Class II package is 5.0 as calculated per IOCFR71.59.

6.3 Summary of NCI-21PF-1 Evaluation As a Fissile Class II Package

NORMAL CONDITIONS:

No. of undamaged pkgs calculated to be subcritical.	380
When closely reflected by water.	63
Package size, cu. cm.	3,700,000

ACCIDENT CONDITIONS:

No. of damaged pkgs calculated to be subcritical.	380
With optimum interspersed hydrogenous moderation and full water reflection.	63
Package size, cu. cm.	3,700,000
Transport Index	5.0

6.4 Evaluation of Model NCI-21PF-1 Package As a Fissile Class I Shipping Package

The NCI-21PF-1 Protective Shipping Package has been approved per NRC Certificate of Compliance No. USA/9234/AF as a Fissile Class II package and continues to be treated as such herein. However, it should be noted that recent evaluations including ORNL/TM-11947 (reference 6.5.2 below) have established that 30" UF_6 cylinders which are limited to 5% U-235 enrichment and are packaged in 21PF-1 overpacks meet the 10CFR71 criteria for Fissile Class I packages. As shown throughout this safety analysis report, the NCI-21PF-1 package offers equivalent spacing and protection as the DOT-21PF-1 package and is, in fact, simply a modified and improved version of the 21PF-1 package. As such, the NCI-21PF-1 package must also meet the 10CFR71 criteria for Fissile Class I packages. Of course, a Transport Index may still be required depending on radiation levels from the package in any given circumstance.

6.5 References

6.5.1 A. J. Mallett and C. E. Newlon, "Protective Shipping Packages for 30-Inch Diameter UF_6 Cylinders", pp 21-27, Part III, K-1686, Oak Ridge Gaseous Diffusion Plant, Union Carbide Corporation, Nuclear Division, April 13, 1967.

6.5.2 B. L. Broadhead, "Criticality Safety Review of 2 1/2-, 10-, and 14-Ton UF_6 Cylinders", ORNL/TM-11947, Oak Ridge National Laboratory, Martin Marietta Energy Systems, Inc., October, 1991.

7. OPERATING PROCEDURES

The NCI-21PF-1 package is loaded and unloaded and the 30B UF_6 cylinder is filled, tested, and handled in accordance with standard, in-plant, operating procedures at the various enrichment plants and at the various nuclear fuel facilities. These procedures are in accordance with ORO-651 and ANSI Standard N14.1 and meet the requirements of 10CFR71, Subpart G. As a minimum, the specific procedures must include the following steps:

7.1 Procedure for Loading the Cylinder

7.1.1 Cylinder Inspection

Complete inspection report verifying that the cylinder meets the requirements of ORO-651 and ANSI N14.1; that it has been leak-tested as required below; and that the cylinder and cylinder components are free from damage and are in working order as follows:

(1) Cylinder is free from damage and is ASME "U" stamped, and has evidence that it has been cleaned and tested as required in ORO-651 and ANSI N14.1.

(2) Cylinder has required evidence of proper inspection and leak testing per Items 1 and 2, Section 2.5.1.

(3) Cylinder valve is free from damage and has required evidence of proper inspection and leak testing per Items 1 and 2, Section 2.5.1.

(4) Cylinder plug is free from damage and has required evidence of proper inspection and leak testing per Items 1 and 2, Section 2.5.1.

(5) If the cylinder is to be used for a Type B shipment, that it has been leak tested as required in 7.1.2 below.

7.1.2 Type B Requirements

If the cylinder is to be used for a Type B shipment of UF_6 which is probably derived from recycled uranium, the following items must be completed:

(1) The isotopic and radionuclide contents of each cylinder must be determined by approved written procedures; the UF_6 must meet the contents limits specified in Section 1.2.3.

(2) Based on (1) above, the A_2 value for the cylinder contents must be established in accordance with 10CFR71, Appendix A; the cylinder must not contain more that 1,150 A_2 values.

(3) The cylinder must have been helium leak tested per Item 3, Section 2.5.1, within past 12-month period or since valve or plug replacement, demonstrating no leakage greater than 4×10^{-8} atm cc/sec.

(4) After filling with UF_6, the cylinder shall have been leak tested per Item 4, Section 2.5.1, demonstrating no leak greater than 1×10^{-3} atm cc/sec.

(5) After filling with UF_6, the cylinder valve shall have been leak tested per Item 5, Section 2.5.1, demonstrating no leak greater than 1×10^{-3} atm cc/sec.

7.1.3 Final Cylinder Inspection

Complete inspection of UF_6 cylinder prior to insertion into package per ORO-651 and ANSI N14.1. Per ORO-651, the cylinder shall not be over filled; the UF_6 shall have properly cooled;

7.2 Procedure for Loading the Package

7.2.1 Complete inspection report verifying that the following package components are free from damage and are in working order:

(1) Inner and outer shells.

(2) Cylinder support pads.

(3) Gasket and gasket surfaces; verify that gaskets have been replaced within the past 3 years.

(4) Vent seals/plugs.

(5) Tie-down and lifting/stacking supports.

(6) Lifting U-bolts.

(7) Toggle closures and toggle handle ball-lock-pins.

(8) Security seal lugs.

7.2.2 Carefully load UF_6 cylinder into package with the cylinder valve positioned up (at 12:00 O'clock position). If the cylinder is being used for a Type B shipment, it is imperative that the temporary valve protector be removed.

7.2.3 Carefully replace lid on package.

7.2.4 Engage all toggle clamps, then close all toggle clamps alternating corner-to-corner and side-to-side; secure the handles with the ball-lock-pins.

7.2.5 Install security seals and record their numbers.

7.2.6 Complete inspection report.

7.2.7 Complete radiation survey and assign Transport Index if different from 5.

7.2.8 Remove old labels and re-label per applicable regulations.

7.3 Procedure for Unloading the Package

7.3.1 Complete receiving report.

7.3.2 Remove and record the package seal.

7.3.3 Remove the ball-lock-pins and open all toggles before disengaging from the upper brackets.

7.3.4 Carefully remove the lid of the package.

7.3.5 Carefully remove the cylinder from the package.

7.3.6 Clean package interior and close prior to storage.

7.4 Preparation of an Empty Package for Transport

Preparation of an empty package for shipment involves all of the same steps as listed in 7.2 and 7.3 above except that the labeling and marking are different for empty packages and there may or may not be an empty UF_6 cylinder being shipped in the package.

7.5 Routine User Maintenance

The user shall maintain and inspect these packages in accordance with written procedures prior to every outgoing shipment and upon receipt of every incoming shipment to assure the following:

7.5.1 Check that the package base and supports are sound with no broken welds or components, and they are bolted tightly to trailer; torque bolts per specifications.

7.5.2 Check that the package is intact with no broken welds and no holes, tears, or cracks greater than 1/2 inch.

7.5.3 Check that the inner liner is free of debris and standing water and is intact with no holes, tears, cracks, or broken welds; clean as necessary.

7.5.4 Check that the gaskets and cylinder support pads are in place and intact and are not in a deteriorated or damaged condition. Gaskets shall be replaced every 36 months or more often if found deteriorated or damaged.

7.5.5 Check that the wood cover plates and welds are sound and undamaged.

7.5.6 Check that the package halves fit together properly with no gaps.

7.5.7 Check that all closure clamps are properly adjusted for tight closure and the coupling/adjusting nuts are properly locked.

7.5.8 Check that all vent seals/plugs are securely in place; vent plugs shall be replaced whenever they are found missing.

7.5.9 Packages which are rejected during any of the above routine inspections shall be repaired and reinspected conforming to drawing requirements per QC Acceptance Tests (see Section 8 and to the requirements of ORO-651 and ANSI N14.1.

7.5.10 If recycled uranium is being shipped, determine A_1 value for each shipment and assure that it will not exceed 1,150 at any time during the shipment. Also, determine that radionuclide contents do not exceed limits specified in Section 1.2.3.

7.5.11 Make radiation survey and assure compliance with regulations including 10CFR71.47.

7.6 Annual User Maintenance

The user shall establish written procedures for annual maintenance and inspection of each Model NCI-21PF-1 package requiring the following items as a minimum:

7.6.1 Check that lifting/stacking frames, lifting U-bolts, closure clamps, and tie-down supports are sound and free from weld cracks, damage, and deterioration.

7.6.2 Check that closure clamps are properly adjusted and locked.

7.6.3 Check that all vents are properly sealed.

7.6.4 Check that gaskets are replaced at least every 36 months and are in place, intact, and not damaged or deteriorated.

NOTE: The initial requirement was for the gaskets to be replaced annually. This was primarily based on the poor performance of the expanded rubber gaskets specified on the old DOT-21PF-1 package. Experience with the silicone rubber sponge gaskets now specified has shown most gaskets to be in excellent condition after service of only one year. The shelf life of these gaskets in indefinite. Maintenance and inspection procedures are much better than in the past, and they require worn or damaged gaskets be replaced. Finally, criticality safety is not dependent on the absence of water around the UF_6 cylinder(s). For all of these reasons, the mandatory replacement period for the gaskets should be extended to 36 months.

7.6.5 Check that inner and outer shells are free of holes, cracks, tears, and broken welds, and the inner shells are free of debris and standing water.

7.6.6 Check that the wood cover plates are sound and undamaged, and gasket sealing surfaces meet drawing requirements.

7.6.7 Individually weigh each half (lid and bottom) of each packaging to verify that neither half has gained more than 25 pounds. Weight gain must be assumed to be water. If either half exhibits a gain of more that 25 pounds, the packaging must be removed from service and dried to within 10 pounds of its original nameplate weight. New weights of each packaging half must be established after any modifications, refurbishment, or repainting; such new weights must account for any existing weight gain prior to such maintenance. After drying each packaging must be inspected per 7.6.8 below.

7.6.8 Check that at least once every five years, the foam insulation in each packaging must be inspected by inserting a probe through each vent hole in both the lid and the bottom to confirm the presence and rigidity of the insulation. If a packaging has required drying (see Section 7.6.7 above), this inspection is mandatory.

7.6.9 Verify that the 30B UF_6 cylinder has been recertified within 5 years as having been cleaned, hydrostatic tested, and leak tested as required by ORO-651 and ANSI N14.1.

7.6.10 Verify that the 30B cylinder valve has been cleaned and installed as required by ORO-651 and ANSI N14.1.

8. QUALITY ASSURANCE

Every user of the NCI-21PF-1 Protective Shipping Package for the shipment of enriched UF_6 must have an approved Quality Assurance Program which meets the requirements of 10CFR71.37 and 10CFR71, Subpart H, and which addresses the following items as a minimum:

8.1 Design

8.1.1 NCI-21PF-1 Protective Shipping Package

The NCI-21PF-1 Protective Shipping Package was designed by Nuclear Containers, Inc. (NCI) and primarily involved the modification of the DOT-21PF-1B. Test models were manufactured and tested by NCI using written procedures under its NRC approved QA Program (NRC Approval No. 0179). Design and QC provisions were incorporated into Drawing No. DED-206-B (see Appendix 1.3.1). The package was tested for compliance with the requirements of 10CFR71 and IAEA Safety Series No. 6 by NCI using a half-scale model and by COGEMA, Pierrelatte, France, using a full scale, two year old production unit which was taken from regular service. All testing was performed and documented in accordance with written procedures meeting the requirements of the QA Programs of both companies. Much of the design and testing programs are included in this Safety Analysis Report.

8.1.2 Model 30B UF_6 Cylinder

The 30B UF_6 cylinder was designed over 20 years ago to meet the requirements of the American Society of Mechanical Engineers for unfired pressure vessels. This design was standardized by the American National Standards Institute in ANSI Standard N14.1.

8.2 Procurement

8.2.1 Procurement of NCI-21PF-1 Packages

The user of the NCI-21PF-1 Protective Shipping Package for the transportation of enriched UF_6 shall establish written procedures for procurement Model NCI-21PF-1 packages requiring conformance with all drawing requirements (see Appendix 1.3.1) as well as the requirements of this Safety Analysis Report. Upon procurement of these packages, the user shall require the supplier to also have an approved Quality Assurance Program meeting the appropriate requirements of 10CFR71, Subpart H, in addition to a specific Quality Assurance Plan for the manufacture of these packages. As a minimum, the specific Quality Assurance Plan shall include the following provisions:

8.2.1.1 Materials

All drawing requirements (see NCI Drawing No. DED-206-B, Sheets 1 through 11, Rev.4 -- Appendix 1.3.1) regarding material specifications shall be satisfied as follows:

(1) Type 304 stainless steel materials and components per drawing Notes 1(a), 1(b), 1(c), 1(e), 1(f), and 3.

(2) Type 17-4PH stainless steel material and components per drawing Notes 1(d) and 3.

(3) Fastener items per drawing Note 1(g).

(4) Wood per drawing Note 6.

(5) Gaskets and RTV caulking/adhesives per drawing requirements.

(6) Cast stainless steel components per drawing Note 3.

8.2.1.2 Welds

All weld requirements specified in drawing Note 4 shall be satisfied as follows:

(1) Welders and weld procedures shall be qualified per drawing Note 4(b).

(2) Weld rods and filler materials per drawing Note 4(b)

(3) Specified grinding and cleaning procedures and materials per drawing Note 4(d).

(4) Welds over wood and foam per drawing Note 4(c).

(5) Welds shall be inspected per drawing Notes 4(a) and 4(e).

8.2.1.3 Dimensional Tolerances

Adequate inspection shall be required to insure compliance with dimensional tolerances specified in drawing Note 5. A check-list shall be established for critical dimensions for which records must be maintained as follows:

(1) Inner cylinder cavity dimensions.

(2) Outer shell dimensions.

(3) Toggle clamp locations.

(4) Bolt center locations and hole diameters in tie-down supports and in lifting/stacking frames.

(5) Flatness of gasket surfaces.

8.2.1.4 Assembly Inspections

Mandatory hold points shall be established to insure the inspection of the following assembly operations:

(1) All weld inspections.

(2) Inspection and installation of wood per drawing Notes 6 and 7.

(3) Installation of fire retardant phenolic foam per drawing Note 8; record pre-foaming weights, post-foaming weights, and actual foam weights by difference for each package lid and bottom.

(4) Application of fire retardant intumescent paint to wood and to wood cover plates.

(5) Installation of wood cover plates.

(6) Installation of pads and gaskets.

(7) Installation of vent port seals and caulking.

8.2.1.5 Post Assembly Inspections

Each completed package shall be inspected to document compliance with the following drawing requirements:

(1) Final dimensions per 3.0 above.

(2) Installation of gaskets and cylinder support pads.

(3) Lid to body fit.

(4) Toggle clamp adjustments and locking of adjustment nuts.

(5) Installation of lifting eye-bolts and security seal pads.

(6) Actual tare weights of lid and bottom halves.

(7) Final assembled tare weight.

(8) Proper permanent marking and nameplates per 10CFR71.85(c), 49CFR178.121-5, and ANSI N14.1 (latest revision).

8.2.2 30B UF_6 Cylinders

The user of the NCI-21PF-1 Protective Shipping Package for the transportation of enriched UF_6 shall establish written procedures for procurement Model 30B UF_6 cylinders requiring conformance with all requirements of ANSI N14.1 as well as the requirements of this Safety Analysis Report. Upon procurement of the 30B cylinders for use in these packages, the user shall require the supplier to be approved by the ASME for the manufacture of unfired pressure vessels and for stamping each 30B cylinder with the ASME "U" stamp. Procurement documents must require that all cylinders and cylinder components meet the requirements of ANSI N14.1 and ORO-651. As a minimum, the specific Quality Assurance Plan shall include the following provisions:

8.2.2.1 Materials

All drawing and specification requirements (see ANSI N14.1) regarding material specifications shall be satisfied as follows:

(1) The pressure vessel steel must be ASTM A516, Grade 70, normalized and Charpy V-notch impact tested.

(2) Valve and plug couplings shall meet ANSI N14.1 specifications.

(3) Skirt steel must meet ANSI N14.1 specifications.

8.2.2.2 Welds

All weld requirements specified in drawing Note 4 shall be satisfied as follows:

(1) Welders and weld procedures shall be qualified per Section IX, ASME Boiler and Pressure Vessel Code.

(2) Weld rods and filler materials must meet ANSI N14.1 specifications.

(3) Specified grinding and cleaning procedures and materials must be in accordance with ANSI N14.1 specifications.

(4) Weld repair procedures must be in accordance with ASME and ANSI N14.1 specifications.

(5) Welds shall be inspected and radiographed per ANSI N14.1 specifications.

8.2.2.3 QC Inspections

Adequate inspection shall be required to insure compliance with ANSI N14.1 specifications specifically including:

(1) Dimensional tolerances.

(2) Weld inspections and radiography.

(3) Cylinder interior cleanliness.

(4) Hydrostatic testing at 400 psig water pressure.

(5) Leak testing at 100 psig air pressure.

8.2.2.4 ASME "U" Stamp

An ASME U1A file shall be established for each cylinder and each cylinder must be stamped with capacity data and the ASME "U" stamp as required by the ANSI N14.1 specifications.

8.2.2.5 Repairs and Modifications

All repairs and modifications to a Model 30B UF$_6$ cylinder must be performed in accordance with ASME and ANSI N14.1 specification requirements. The user shall require the supplier of such services to be approved by the ASME for the manufacture of unfired pressure vessels and for stamping each 30B cylinder with the ASME "U" stamp. Procurement documents for such services must require that all such services be performed under an approved QA Program and with approved written procedures which meet the requirements of ASME, ANSI N14.1, and ORO-651.

8.3 Routine Operating Procedures

The user of the NCI-21PF-1 Protective Shipping Package for the transportation of enriched UF_6 shall establish written procedures for routine operations involving the filling, loading, and preparation of the Model 30B UF_6 cylinders, the cylinder valves, and the NCI-21PF-1 PSP for shipment as outlined in Section 7. All such procedures must conform with all requirements of ANSI N14.1 and ORO-651, as well as with the requirements of this Safety Analysis Report and shall address the following as a minimum:

8.3.1 Preparing and Filling the 30B Cylinder

The user must establish written procedures for preparing and filling the 30B UF_6 cylinder and for inspecting these operations verifying conformance with the requirements of ORO-651 and ANSI N14.1. Prior to filling; the user must prepare and inspection report verifying that the cylinder and its valve and plug have been leak-tested as required below and that the cylinder and cylinder components are free from damage and are in working order as follows:

(1) Cylinder is free from damage and is ASME "U" stamped, and has evidence that it has been cleaned and tested as required in ORO-651 and ANSI N14.1.

(2) Cylinder has required evidence of proper inspection and leak testing per Items 1 and 2, Section 2.5.1.

(3) Cylinder valve is free from damage and has required evidence of proper inspection and leak testing per Items 1 and 2, Section 2.5.1.

(4) Cylinder plug is free from damage and has required evidence of proper inspection and leak testing per Items 1 and 2, Section 2.5.1.

(5) If the cylinder is to be used for a Type B shipment, that it has been leak tested as required in 7.1.2 below.

8.3.2 Additional Type B Requirements

For the use of the NCI-21PF-1 package for Type B shipments of UF_6 (which is probably derived from recycled uranium), the user must establish written procedures to ensure compliance with additional requirements for the 30B cylinder and NCI-21PF-1 packages (see Section 2.5.1) as follows:

(1) The isotopic and radionuclide contents of each cylinder must be determined by approved written procedures; the UF_6 must meet the contents limits specified in Section 1.2.3.

(2) Based on (1) above, the A_1 value for the cylinder contents must be established in accordance with 10CFR71, Appendix A; the cylinder must not contain more that 1,150 A_1 values.

(3) The cylinder must have been helium leak tested per Item 3, Section 2.5.1, within past 12-month period or since valve or plug replacement, demonstrating no leakage greater than 4×10^{-8} atm cc/sec.

(4) After filling with UF_6, the cylinder shall have been leak tested per Item 4, Section 2.5.1, demonstrating no leak greater than 1×10^{-3} atm cc/sec.

(5) After filling with UF_6, the cylinder valve shall have been leak tested per Item 5, Section 2.5.1, demonstrating no leak greater than 1×10^{-3} atm cc/sec.

8.3.3 Loading the NCI-21PF-1 PSP

The user of the NCI-21PF-1 Protective Shipping Package for the transportation of enriched UF_6 shall establish written procedures for inspection of the filled 30B cylinder, for loading the cylinder into the NCI-21PF-1 package, and for inspection of the package prior to shipment to conform with all requirements of ANSI N14.1 and ORO-651, as well as with the requirements of this Safety Analysis Report and shall address the following as a minimum:

8.3.3.1 Inspection of UF_6 cylinder prior to insertion into package per ORO-651 and ANSI N14.1, ie. the cylinder shall not be over filled; the UF_6 shall have properly cooled; and the absolute internal pressure in the cylinder shall not exceed 0.4 atm.

8.3.3.2 Verification that the following package components are free from damage and are in working order:

(1) Inner and outer shells.

(2) Cylinder support pads.

(3) Gasket and gasket surfaces; verify that gaskets have been replaced within the past 3 years.

(4) Vent seals/plugs.

(5) Tie-down and lifting/stacking supports.

(6) Lifting U-bolts.

(7) Toggle closures and toggle handle ball-lock-pins.

(8) Security seal lugs.

8.3.3.3 Loading of the 30B UF_6 cylinder into package (see Section 7.2) with the cylinder valve properly positioned and valve protector removed. (Valve should be up at 12:00 O'clock position. If the cylinder is being used for a Type B shipment, it is imperative that the valve protector not be used.) Provide instructions for and verification of the following operations as a minimum:

(1) Replacement of lid on package.

(2) Engagement and proper closure and securing of toggle clamps.

(3) Installation and documentation of security seals.

(4) Completion of inspection report.

(5) Completion and documentation of radiation survey and assignment of Transport Index.

(6) Labeling per applicable regulations (such as those by the USNRC, USDOT, IAEA, etc.).

8.3.4 Unloading the NCI-21PF-1 PSP

The user of the NCI-21PF-1 Protective Shipping Package for the transportation of enriched UF_6 shall establish written procedures for receiving and inspecting an loaded NCI-21PF-1 package and for unloading the cylinder out of the NCI-21PF-1 package to conform with all requirements of ANSI N14.1 and ORO-651, as well as with the requirements of this Safety Analysis Report and shall address the following as a minimum:

8.3.4.1 Completion of a receiving report.

8.3.4.2 Removal and recording the package seal.

8.3.4.3 Opening the package and removal of the cylinder (see Section 7.3).

8.3.5 Preparation of an Empty Package for Transport

The user of the NCI-21PF-1 Protective Shipping Package shall establish written procedures for preparing an empty package for shipment (see Section 7.4) to conform with all requirements of ANSI N14.1 and ORO-651, as well as with the requirements of this Safety Analysis Report and shall address the following as a minimum:

8.3.5.1 Proper closure of the package.

8.3.5.2 Radiation survey.

8.3.5.3 Proper labeling.

8.4 Routine User Maintenance

The user of the NCI-21PF-1 Protective Shipping Package for the transportation of enriched UF_6 shall establish written procedures for performing routine maintenance and inspections for the NCI-21PF-1 package and 30B cylinder to conform with all requirements of ANSI N14.1 and ORO-651, as well as with the requirements of this Safety Analysis Report. Such routine maintenance and inspection shall be performed prior to every outgoing shipment and upon receipt of every incoming shipment and shall address the following as a minimum:

8.4.1 Package Maintenance

Assure sound package per Section 7.5. requiring inspections to verify that:

8.4.1.1 Package base and supports are sound with no broken welds or components, and they are properly bolted to trailer (torqued per specifications).

8.4.1.2 Package is intact with no broken welds and no holes, tears, or cracks greater than 1/2 inch.

8.4.1.3 Inner liner is free of debris and standing water and is intact with no holes, tears, cracks, or broken welds.

8.4.1.4 Gaskets and cylinder support pads are in place and intact and are not in a deteriorated or damaged condition. Gaskets must be replaced every 36 months or more often if found deteriorated or damaged.

8.4.1.5 Wood cover plates and welds are sound and undamaged.

8.4.1.6 Package halves fit together properly with no gaps.

8.4.1.7 Closure clamps are properly adjusted for tight closure and the coupling/adjusting nuts are locked.

8.4.1.8 Vent seals/plugs are securely in place.

8.4.1.9 Packages which have been rejected during any of the above routine inspections must be repaired and reinspected conforming to drawing requirements to the requirements of ORO-651 and ANSI N14.1.

8.4.2 30B Cylinder Maintenance

The user must establish written procedures for the routine inspection and maintenance of the 30B UF_6 cylinders and their valves and plugs; as a minimum these procedures must address the following:

8.4.2.1 Routine inspection of cylinder and valve for damage.

8.4.2.2 Procedures for replacing valves and plugs.

8.4.2.5 Procedures for determining the internal pressure in the cylinder prior to shipment.

8.4.2.6 Procedures for filling with UF_6 per ORO-651 requirements.

8.4.2.7 Procedures for weighing 30B cylinders before and after filling with UF_6 per ORO-651 requirements and to determine that cylinders are not filled with more than 5,020 pounds of UF_6.

8.4.3 Type B Shipments

If the NCI-21PF-1 package is being used to make Type B shipments of recycled uranium, the user must establish additional written procedures per 8.3.2 above as follows:

(1) Determination that the isotopic and radionuclide contents of each cylinder meet the contents limits specified in Section 1.2.3.

(2) Determination of the A_1 value for the cylinder contents in accordance with 10CFR71, Appendix A; the cylinder must not contain more that 1,150 A_1 values.

(3) Helium leak test procedure per Item 3, Section 2.5.1, which must be done within past 12-month period prior to each shipment or after valve or plug replacement.

(4) For routine leak testing the cylinder after filling with recycled UF_6 per Section 2.5.1, Item 4.

(5) For routine leak testing the cylinder valve after filling with recycled UF_6 per Section 2.5.1, Item 5.

8.5 Annual User Maintenance

The user of the NCI-21PF-1 Protective Shipping Package for the transportation of enriched UF_6 shall establish written procedures for performing annual maintenance and inspections for the NCI-21PF-1 package and 30B cylinder to conform with all requirements of ANSI N14.1 and ORO-651, as well as with the requirements of this Safety Analysis Report; as a minimum, the following items must be addressed:

8.5.1 NCI-21PF-1 Package

The NCI-21PF-1 package must be inspected annually to determine that:

8.5.1.1 Lifting/stacking frames, lifting U-bolts, closure clamps, and tie-down supports are sound and free from weld cracks, damage, and deterioration.

8.5.1.2 Closures are properly adjusted and locked.

8.5.1.3 All vents are properly sealed.

8.5.1.4 Gaskets are replaced at least every 36 months and are in place, intact, and not damaged or deteriorated. (Justification for gasket replacement is provided in the note to Section 7.6.4).

8.5.1.5 Inner and outer shells are free of holes, cracks, tears, and broken welds, and the inner shells are free of debris and standing water.

8.5.1.6 Wood cover plates are sound and undamaged, and gasket sealing surfaces meet drawing requirements.

8.5.1.7 Weight of each half (lid and bottom) of each packaging must not have gained more than 25 pounds. Weight gain must be assumed to be water. If either half exhibits a gain of more that 25 pounds, the packaging must be removed from service and dried to within 10 pounds of its original nameplate weight. New weights of each packaging half must be established after any modifications, refurbishment, or repainting; such new weights must account for any existing weight gain prior to such maintenance. After drying each packaging must be inspected per 7.6.8.

8.5.1.8 At least once every five years, the foam insulation in each packaging must be inspected for soundness per Section 7.6.8.

8.5.2 30B UF_6 Cylinder

Each 30B UF_6 cylinder (with valve and plug) must be inspected annually to determine that:

8.5.2.1 The 30B UF_6 cylinder has been recertified within 5 years as having been cleaned, hydrostatic tested, and leak tested as required by ORO-651 and ANSI N14.1.

8.5.2.2 The 30B cylinder valve has been cleaned and installed as required by ORO-651 and ANSI N14.1.

8.5.2.3 If the 30B cylinder is being used or is to be used for the shipment of recycled uranium, it must be helium leak-tested per Section 8.3.2, Item (3). This testing must be done not more than 12 months prior to any Type B shipment or whenever the valve and/or plug is replaced if used for Type B shipments.

8.6 Records

As a minimum the user shall retain the following records for the life of each package and/or cylinder; the supplier(s) shall retain copies of records which pertain to them for a period of not less than 5 years:

8.6.1 Procurement orders and sub-contracts.

8.6.2 Material test reports and certifications.

8.6.3 Welder and weld procedure qualification records.

8.6.4 Critical dimension inspection reports.

8.6.5 Assembly and post assembly inspection reports.

8.6.6 Foam inspection and package tare weight reports.

8.6.7 Gasket inspection and replacement reports.

8.6.8 30B cylinder ASME U1A file including recertification reports as required by ORO-651 and ANSI N14.1.

8.6.9 30B cylinder leak test reports.

8.7 Sub-Contractors

The user of the NCI-21PF-1 Protective Shipping Package for the transportation of enriched UF_6 shall require, by sub-contract, purchase order, or other procurement document, that sub-contractors providing materials, components, or services related to the manufacture, repair, modification, inspection, or testing of NCI-21PF-1 packages or of 30B cylinders or cylinder components (including valve and plug) comply with all applicable requirements for a Quality Assurance Program and, as a minimum, comply with the applicable Quality Assurance Plan requirements stipulated above.

8.8 Audits

The user of the NCI-21PF-1 Protective Shipping Package for the transportation of enriched UF_6 shall include in its QA Program provisions for requiring routine, documented audits of its QA Program including its QA Plan(s), procurement procedures, operating procedures, inspection procedures, analytical procedures, and radiation survey procedures regarding the use of NCI-21PF-1 and 30B cylinders; provisions shall also be included requiring similar audits of applicable parts of the QA Programs of its suppliers and sub-contractors.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

NOV 19 1992

SGTB:NLO
71-9234

Nuclear Containers, Inc.
ATTN: Mr. William R. Housholder
PO Box 1080
Elizabethton, TN 37643

Dear Mr. Housholder:

Enclosed is Certificate of Compliance No. 9234, Revision No. 2, for the Model No. NCI-21PF-1 package. This certificate supersedes, in its entirety, Certificate of Compliance No. 9234, Revision No. 1, dated June 11, 1991. The Certificate of Compliance, as amended, specifies that a physical inspection of the insulation in these packages be performed. Changes made to the enclosed certificate are indicated by vertical lines in the margin.

Those on the attached list have been registered as users of this package under the general license provisions of 10 CFR §71.12 or 49 CFR §173.471.

The approval constitutes authority to use the package for shipment of radioactive material and for the package to be shipped in accordance with the provisions of 49 CFR §173.471.

Sincerely,

Ross Chappell

for Charles E. MacDonald, Chief
Transportation Branch
Division of Safeguards
and Transportation, NMSS

Enclosures:
1. Certificate of Compliance
No. 9234, Rev. 2
2. Approval Record

cc w/encl:
Mr. James K. O'Steen
Department of Transportation

Registered Users

NRC FORM 618
(8-85)
10 CFR 71

U.S. NUCLEAR REGULATORY COMMISSION

CERTIFICATE OF COMPLIANCE
FOR RADIOACTIVE MATERIALS PACKAGES

1.a. CERTIFICATE NUMBER	b. REVISION NUMBER	c. PACKAGE IDENTIFICATION NUMBER	d. PAGE NUMBER	e. TOTAL NUMBER PAGES
9234	2	USA/9234/AF	1	3

2. PREAMBLE

a. This certificate is issued to certify that the packaging and contents described in Item 5 below, meets the applicable safety standards set forth in Title 10, Code of Federal Regulations, Part 71, "Packaging and Transportation of Radioactive Material."

b. This certificate does not relieve the consignor from compliance with any requirement of the regulations of the U.S. Department of Transportation or other applicable regulatory agencies, including the government of any country through or into which the package will be transported.

3. THIS CERTIFICATE IS ISSUED ON THE BASIS OF A SAFETY ANALYSIS REPORT OF THE PACKAGE DESIGN OR APPLICATION

a. ISSUED TO *(Name and Address)*

Nuclear Containers, Inc.
P.O. Box 1080
Elizabethton, TN 37643

b. TITLE AND IDENTIFICATION OF REPORT OR APPLICATION:

Nuclear Containers, Inc. application dated September 1, 1988, as supplemented.

c. DOCKET NUMBER 71-9234

4. CONDITIONS

This certificate is conditional upon fulfilling the requirements of 10 CFR Part 71, as applicable, and the conditions specified below.

5.

(a) Packaging

(1) Model No.: NCI-21PF-1

(2) Description

Overpack for 30-inch enriched uranium hexafluoride (UF6) cylinders. The overpack is a right circular cylinder constructed of two stainless steel shells with the volume between the shells filled with fire resistant, phenolic-foam per USAEC Specification SP-9. The volume between the 1/4-inch thick end closure plates of the two shells is filled with oak wood blocks which are cross-laminations of 3 layers of boards glued and nailed together. A stepped and gasketed horizontal joint permits the top half of the overpack to be removed from the base. The package "halves" are secured with ten, 1-inch stainless steel toggle closures. The overpack is 43-5/8 inches O.D. by 92 inches long. Maximum gross weight of the package is 8,700 pounds.

(3) Drawing

The Model No. NCI-21PF-1 packaging is fabricated in accordance with Nuclear Containers, Inc. Drawing No. DED-206-B, Sheets 1 through 10, Rev. 2.

5. (b) Contents

(1) Type and form of material

Uranium hexafluoride enriched in the U-235 isotope.

(2) Maximum quantity of material per package.

(i) Model No. 30A cylinder: 4,950 pounds UF_6 enriched to not more than 5 w/o in the U-235 isotope.

(ii) Model No. 30B cylinder: 5,020 pounds UF_6 enriched to not more than 5 w/o in the U-235 isotope.

(c) Fissile Class II

Minimum transport index 5.0

6. The 30-inch diameter UF_6 cylinders must be fabricated, inspected, tested, and maintained in accordance with American National Standard N14.1 (1990 edition). Cylinders shipped after December 31, 1992 must be fabricated in accordance with Section VIII, Division I, of the ASME (American Society of Mechanical Engineers) Boiler and Pressure Vessel Code and be ASME code stamped.

7. At least once every five years, each packaging must be inspected to verify the presence and condition of the insulation. The inspection shall consist of inserting a probe through each vent hole in both the lid and base to confirm the presence and rigidity of the insulation. For packagings which require drying, the inspection must be performed after drying.

8. In addition to the requirements of Subpart G of 10 CFR Part 71:

(a) Prior to each shipment, the overpack gaskets must be inspected. These gaskets must be replaced if inspection shows any defects or every 12 months, whichever occurs first.

(b) Each packaging must meet the Acceptance Tests and Maintenance Program of supplement dated October 18, 1988.

(c) The package shall be prepared for shipment and operated in accordance with the Operating Procedures of supplement dated October 18, 1988.

9. The package authorized by this certificate is hereby approved for use under the general license provisions of 10 CFR §71.12.

10. Expiration date: December 31, 1993.

REFERENCES

Nuclear Containers, Inc. application dated September 1, 1988.
Supplements dated: October 18 and November 28, 1988; and April 2, 1991.

FOR THE U.S. NUCLEAR REGULATORY COMMISSION

Ross Chappell

for Charles E. MacDonald, Chief
Transportation Branch
Division of Safeguards
and Transportation, NMSS

Date: NOV 19 1992

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

APPROVAL RECORD
Model No. NCI-21PF-1 Package
Certificate of Compliance No. 9234
Revision No. 2

By letter dated June 5, 1992, Westinghouse Electric Corporation provided a report under the provisions of 10 CFR §71.95. The report concerned partial loss of insulation from several Model No. W-21PF-1 packagings, Certificate of Compliance No. 4909. The Model No. W-21PF-1 package is a foam-filled overpack for 30-inch diameter UF_6 cylinders. The Model No. W-21PF-1 design is similar to the Nuclear Containers, Inc. Model No. NCI-21PF-1 design, Certificate of Compliance No. 9234.

Based on the information regarding the possible loss of insulation, Certificate of Compliance No. 9234 has been conditioned to specify that each packaging must be inspected to verify the presence and condition of the insulating material. The inspection consists of inserting a probe through each vent hole in both the lid and base to confirm the presence and rigidity of the insulating material. The inspection must be performed at least once every five years. For packagings which require drying, the inspection must be performed after drying.

This change does not affect the ability of the package to meet the requirements of 10 CFR Part 71.

Ross Chappell
for Charles E. MacDonald, Chief
Transportation Branch
Division of Safeguards and
Transportation, NMSS

Date NOV 19 1992

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

JUN 11 1991

SGTB:EPE
71-9234

Nuclear Containers, Inc.
ATTN: Mr. William R. Housholder
Route 9, Box 2237
Elizabethton, TN 37643

Dear Mr. Housholder:

As requested by your application dated April 2, 1991, enclosed is Certificate of Compliance No. 9234, Revision No. 1 for the Model No. NCI-21PF-1 shipping package. This certificate supersedes, in its entirety, Certificate of Compliance No. 9234, Revision No. 0 dated December 27, 1988.

Changes made to the enclosed certificate are indicated by vertical lines in the margin.

Those on the attached list have been registered as users of this package under the general license provisions of 10 CFR §71.12 or 49 CFR §173.471.

This approval constitutes authority to use this package for shipment of radioactive material and for the package to be shipped in accordance with the provisions of 49 CFR §173.471.

Sincerely,

Charles E. MacDonald, Chief
Transportation Branch
Division of Safeguards
and Transportation, NMSS

Enclosures:
1. Certificate of Compliance
No. 9234, Rev. 1
2. Approval Record

cc w/encl:
Mr. James K. O'Steen
Department of Transportation

Registered Users

NRC FORM 618
(8-86)
10 CFR 71

U.S. NUCLEAR REGULATORY COMMISSION

CERTIFICATE OF COMPLIANCE
FOR RADIOACTIVE MATERIALS PACKAGES

1.a. CERTIFICATE NUMBER	b. REVISION NUMBER	c. PACKAGE IDENTIFICATION NUMBER	d. PAGE NUMBER	e. TOTAL NUMBER PAGES
9234	1	USA/9234/AF	1	3

2. PREAMBLE

a. This certificate is issued to certify that the packaging and contents described in Item 5 below, meets the applicable safety standards set forth in Title 10, Code of Federal Regulations, Part 71, "Packaging and Transportation of Radioactive Material."

b. This certificate does not relieve the consignor from compliance with any requirement of the regulations of the U.S. Department of Transportation or other applicable regulatory agencies, including the government of any country through or into which the package will be transported.

3. THIS CERTIFICATE IS ISSUED ON THE BASIS OF A SAFETY ANALYSIS REPORT OF THE PACKAGE DESIGN OR APPLICATION

a. ISSUED TO *(Name and Address)*

Nuclear Containers, Inc.
P.O. Box 1080
Elizabethton, TN 37643

b. TITLE AND IDENTIFICATION OF REPORT OR APPLICATION:

Nuclear Containers, Inc. application dated September 1, 1988, as supplemented.

c. DOCKET NUMBER 71-9234

4. CONDITIONS

This certificate is conditional upon fulfilling the requirements of 10 CFR Part 71, as applicable, and the conditions specified below.

5.

(a) Packaging

(1) Model No.: NCI-21PF-1

(2) Description

Overpack for 30-inch enriched uranium hexafluoride (UF_6) cylinders. The overpack is a right circular cylinder constructed of two stainless steel shells with the volume between the shells filled with fire resistant, phenolic-foam per USAEC Specification SP-9. The volume between the 1/4-inch thick end closure plates of the two shells is filled with oak wood blocks which are cross-laminations of 3 layers of boards glued and nailed together. A stepped and gasketed horizontal joint permits the top half of the overpack to be removed from the base. The package "halves" are secured with ten, 1-inch stainless steel toggle closures. The overpack is 43-5/8 inches O.D. by 92 inches long. Maximum gross weight of the package is 8,700 pounds.

(3)) Drawing

The Model No. NCI-21PF-1 packaging is fabricated in accordance with Nuclear Containers, Inc. Drawing No. DED-206-B, Sheets 1 through 10, Rev. 2.

5. (b) Contents

(1) Type and form of material

Uranium hexaflouride enriched in U-235 isotope.

(2) Maximum quantity of material per package and fissile class

(i) Model No. 30A cylinder: 4,950 pounds UF_6 enriched to not more than 5 w/o in the U-235 isotope.

(ii) Model No. 30B cylinder: 5,020 pounds UF_6 enriched to not more than 5 w/O in the U-235 isotope.

(c) Fissile Class — II

Minimum transport index — 5.0

6. The 30-inch diameter UF_6 cylinders must be fabricated, inspected, tested, and maintained in accordance with American National Standard N14.1 (1990 edition). Cylinders shipped after December 31, 1992 must be fabricated in accordance with Section VIII, Division I, of the ASME (American Society of Mechanical Engineers) Boiler and Pressure Vessel Code and be ASME code stamped.

7. In addition to the requirements of Subpart G of 10 CFR Part 71:

(a) Prior to each shipment, the overpack gaskets must be inspected. These gaskets must be replaced if inspection shows any defects or every 12 months, whichever occurs first.

(b) Each packaging must meet the Acceptance Tests and Maintenance Program of supplement dated October 18, 1988.

(c) The package shall be prepared for shipment and operated in accordance with the Operating Procedures of supplement dated October 18, 1988.

8. The package authorized by this certificate is hereby approved for use under the general license provisions of 10 CFR §71.12.

9. Expiration date: December 31, 1993.

REFERENCES

Nuclear Containers, Inc. application dated September 1, 1988.
Supplements dated: October 18 and November 28, 1988; and April 2, 1991.

FOR THE U.S. NUCLEAR REGULATORY COMMISSION

Charles E. MacDonald, Chief
Transportation Branch
Division of Safeguards
and Transportation, NMSS

Date: JUN 11 1991

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

APPROVAL RECORD
Model No. NCI-21PF-1
Certificate of Compliance No. 9234
Revision 1

By application dated April 2, 1991, Nuclear Containers, Inc. (NCI) requested an amendment to Certificate of Compliance No. 9234 to authorize shipment of Model 30A cylinders in the Model No. NCI-21PF-1 overpack. The Model No. NCI-21PF-1 overpack is currently authorized (in Revision 0) to ship only Model 30B cylinders. NCI had not previously requested approval to ship Model 30A cylinders, because the Department of Energy (DOE), the cylinder's major user, was in the process of phasing out their use. DOE has indicated that it will not fill Model 30A cylinders after December 31, 1992.

Certificate of Compliance No. 9234 has been revised to clarify weight limits for UF_6 shipped in Model 30A and 30B cylinders, and to update requirements for the fabrication, inspection, maintenance and testing of UF_6 cylinders shipped in the Model No. NCI-21PF-1 overpack.

The certificate has been conditioned to require specific limits on the maximum weight of enriched UF_6 that can be shipped in Model 30A and 30B cylinders. The maximum weight of UF_6 that can be shipped in a Model 30A cylinder is 4,950 pounds, whereas the maximum weight of UF_6 that can be shipped in a Model 30B cylinder is 5,020 pounds. These weight limits are consistent with the 1971, 1982, 1987 and 1990 versions of American National Standard N14.1 (ANSI N14.1), Uranium Hexaflouride - Packaging for Transport. The maximum U-235 enrichment is limited to 5 w/o.

The certificate has also been conditioned to include revised fabrication requirements for UF_6 cylinders to assure consistency, reliability and accountability during the fabrication process. These revised fabrication requirements are needed because subcriticality of the cylinders during shipment is based on moderation control, i.e., structural integrity of the package. The certificate as amended requires that 30-inch diameter UF_6 cylinders shipped in the Model No. NCI-21PF-1 overpack be fabricated, inspected, tested and maintained in accordance with the 1990 version of ANSI N14.1. The 1990 version of ANSI N14.1 incorporates specific material specifications and ASME code requirements for fabrication of UF_6 cylinders. In addition, cylinders shipped after December 31, 1992 must be fabricated in accordance with Section VIII, Division I, of the ASME Boiler and Pressure Vessel Code (ASME Code) and be ASME Code stamped.

Charles E. MacDonald, Chief
Transportation Branch
Division of Safeguards
and Transportation, NMSS

Date: JUN 11 1991

LIST OF USERS FOR CERTIFICATE - 9234

FOR MODEL - NCI-21PF-1

ADVANCED NUCLEAR FUELS CORP.
ATTN: MR. L. D. GERRALD
P. O. BOX 130
RICHLAND WA 99352

DEPARTMENT OF ENERGY
ATTN: MR. JACQUES READ
EH-321
WASHINGTON DC 20545

NUCLEAR CONTAINERS, INC.
ATTN: MR. WILLIAM HOUSEHOLDER
P.O.BOX 1080,WATAUGA R.IND.PK.
ELIZABETHTON TN 37643

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

DEC 27 1988

SGTB:CEW
71-9234

Nuclear Containers, Inc.
ATTN: Mr. William R. Householder
P.O. Box 1080, Watauga River Industrial Park
Elizabethton, TN 37643

Gentlemen:

As requested by your application dated September 1, 1988, as supplemented, enclosed is Certificate of Compliance No. 9234, Revision No. 0, for the Model No. NCI-21PF-1 package.

Nuclear Containers, Inc. has been registered as an owner of this package design.

This approval constitutes authority to use this package for shipment of radioactive material and for the package to be shipped in accordance with the provisions of 49 CFR §173.471.

Sincerely,

Charles E. MacDonald, Chief
Transportation Branch
Division of Safeguards
and Transportation, NMSS

Enclosures:
1. Certificate of Compliance No. 9234, Rev. 0
2. Approval Record

cc w/encls:
Mr. Michael E. Wangler
Department of Transportation

U.S. NUCLEAR REGULATORY COMMISSION

NRC FORM 618
(8-85)
10 CFR 71

CERTIFICATE OF COMPLIANCE
FOR RADIOACTIVE MATERIALS PACKAGES

1.a. CERTIFICATE NUMBER	b. REVISION NUMBER	c. PACKAGE IDENTIFICATION NUMBER	d. PAGE NUMBER	e. TOTAL NUMBER PAGES
9234	0	USA/9234/AF	1	3

2. PREAMBLE

a. This certificate is issued to certify that the packaging and contents described in Item 5 below, meets the applicable safety standards set forth in Title 10, Code of Federal Regulations, Part 71, "Packaging and Transportation of Radioactive Material."

b. This certificate does not relieve the consignor from compliance with any requirement of the regulations of the U.S. Department of Transportation or other applicable regulatory agencies, including the government of any country through or into which the package will be transported.

3. THIS CERTIFICATE IS ISSUED ON THE BASIS OF A SAFETY ANALYSIS REPORT OF THE PACKAGE DESIGN OR APPLICATION

a. ISSUED TO (Name and Address)

Nuclear Containers, Inc.
P.O. Box 1080
Elizabethton, TN 37643

b. TITLE AND IDENTIFICATION OF REPORT OR APPLICATION:

Nuclear Containers, Inc. application dated September 1, 1988, as supplemented.

c. DOCKET NUMBER 71-9234

4. CONDITIONS

This certificate is conditional upon fulfilling the requirements of 10 CFR Part 71, as applicable, and the conditions specified below.

5.

(a) Packaging

(1) Model No.: NCI-21PF-1

(2) Description

Overpack for 30-inch enriched uranium hexafluoride (UF_6) cylinders. The overpack is a right circular cylinder constructed of two stainless steel shells with the volume between the shells filled with fire resistant, phenolic-foam per USAEC Specification SP-9. The volume between the 1/4-inch thick end closure plates of the two shells is filled with oak wood blocks which are cross-laminations of 3 layers of boards glued and nailed together. A stepped and gasketed horizontal joint permits the top half of the overpack to be removed from the base. The package "halves" are secured with ten, 1-inch stainless steel toggle closures. The overpack is 43-5/8 inches O.D. by 92 inches long. Maximum gross weight of the package is 8,700 pounds.

5. (a) (Continued)

(3)) Drawing

The Model No. NCI-2PF-1 packaging is fabricated in accordance with Nuclear Containers, Inc. Drawing No. DED-206-B, Sheets 1 through 10, Rev. 2.

(b) Contents

(1) Type and form of material

Uranium haxaflouride enriched in U-235 isotope.

(2) Maximum quantity of material per package and fissile class

5,020 pounds UF_6 enriched to not more than 5 w/o in the U-235 isotope.

(c) Fissile Class II

Minimum transport index 5.0

6. The 30-inch UF_6 cylinders, Model 30B, must be fabricated, inspected, tested, maintained in accordance with Atomic Energy Commission Report ORO-651, Revision 3 (August 1972).

7. In addition to the requirements of Subpart G of 10 CFR Part 71:

(a) Prior to each shipment, the overpack gaskets must be inspected. These gaskets must be replaced if inspection shows any defects or every 12 months, whichever occurs first.

(b) Each packaging must meet the Acceptance Tests and Maintenance Program of supplement dated October 18, 1988.

(c) The package shall be prepared for shipment and operated in accordance with the Operating Procedures of supplement dated October 18, 1988.

8. The package authorized by this certificate is hereby approved for use under the general license provisions of 10 CFR §71.12.

9. Expiration date: December 31, 1993.

REFERENCES

Nuclear Containers, Inc. application dated September 1, 1988.
Supplements dated: October 18 and November 28, 1988.

FOR THE U.S. NUCLEAR REGULATORY COMMISSION

Charles E. MacDonald, Chief
Transportation Branch
Division of Safeguards
and Transportation, NMSS

te: DEC 27 1988

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

Transportation Branch
Approval Record
Model No. NCI-21PF-1 Package
Docket No. 71-9234
Revision 0

By application dated September 1, 1988, as supplemented October 18 and November 28, 1988, Nuclear Containers, Inc. requested an amendment to Certificate of Compliance No. 4909 to permit the use of Model No. NCI-21PF-1 packaging for the transportation of 30 inch UF_6 cylinders. In support of the amendment request the applicant submitted packaging drawings, acceptance tests and maintenance programs, operating procedures and a report on a half-scale model test program carried out by the applicant. To accommodate this request, Certificate of Compliance No. 9234 is issued for Model No. NCI-21F-1 packaging.

The major structural changes from the existing 21PF-1 overpacks are:

1. Eliminates all end stiffeners but thickens the inner and outer end plates from 14 gage (2.1mm) to 1/4 inch (6.4mm).

2. Replaces the 14, 3/4" diameter carbon steel closure bolts with 10, 1 inch stainless steel toggle closures.

3. Adds inverted tie-down basses to the overpack top to facilitate stacking of overpacks.

4. The maximum gross weight of the package is increased by 100 pounds to 8,700 pounds. The weight of the half-scale model represented a package gross weight of 8,800 pounds.

To demonstrate the Model No. NCI-21PF-1 overpack will provide adequate protection to the UF_6 cylinder and cylinder valve, a half-scale model of the package was subjected to three 30 foot drops (end, bottom and side) and two puncture tests (end and side on the toggle closure). The damages to the overpack are similar to, but in no case greater than, the damage which occured to the existing 21PF-1 overpack design.

The packaging drawings adequately show the construction details, materials of construction, dimensional information and fabrication requirements for the overpack. The certificate of compliance has been conditioned to require the packaging to be acceptance tested, maintained and operated in accordance with the procedures given in Nuclear Containers, Inc. supplement dated October 18, 1988.

The above changes will not effect the ability of the package to meet the requirements of 10 CFR Part 71.

Charles E. MacDonald, Chief
Transportation Branch
Division of Safeguards
and Transportation, NMSS

Date: DEC 27 1988

U.S. Department of Transportation
Research and Special Programs Administration

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

COMPETENT AUTHORITY CERTIFICATION FOR A FISSILE RADIOACTIVE MATERIALS PACKAGE DESIGN CERTIFICATE USA/9234/AF, REVISION 0

This certifies that the radioactive materials package design described below has been certified by the competent authority of the United States as meeting the regulatory requirements for a Type AF packaging for fissile radioactive materials as prescribed in the International Atomic Energy Agency[1] and USA regulations.[2]

1. Package Identification - Nuclear Containers, Inc. Model No. NCI-21PF-1

2. Packaging Description and Authorized Radioactive Contents - as described in Nuclear Regulatory Commission Certificate of Compliance No. 9234, Revision 0 (attached).

   Shipment is authorized as Fissile Class II with a minimum transport index of 5.0 per package.

3. GENERAL CONDITIONS -

   a. Each user of this certificate must have in his possession a copy of this certificate and all documents necessary to properly prepare the package for transportation.

   b. Each user of this certificate, other than the original petitioner, shall register his identity in writing to the Office of Hazardous Materials Transportation, Research and Special Programs Administration, U.S. Department of Transportation, Washington D.C. 20590.

   c. This certificate does not relieve any consignor or carrier from compliance with any requirement of the Government of any country through or into which the package is to be transported.

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1 "Safety Series No. 6, Regulations for the Safe Transport of Radioactive Materials, 1973 Revised Edition" published by the International Atomic Energy Agency (IAEA), Vienna, Austria.

2 Title 49, Code of Federal Regulations, Parts 100 - 199, USA.

d. This certificate is issued only to authorize transport from point of entry to final destination within the United States and from point of origin in the United States to point of exit.

4. Marking and Labeling - The package shall bear the marking USA/9234/AF in addition to other required markings and labeling.

5. Expiration Date - This certificate expires on December 31, 1993.

This certificate is issued in accordance with paragraph 814 of the IAEA Regulations and Section 173.471 of Title 49 of the Code of Federal Regulations, and in response to the January 11, 1989 petition by Transnuclear,Inc., Hawthorne, NY, and in consideration of the associated information therein.

Certified by:

Michael E. Wangler

Michael E. Wangler
Chief, Radioactive Materials Branch
Office of Hazardous Materials Transportation

MAR 8 1989
(DATE)

NUCLEAR CONTAINERS, INC.

Chemical & Nuclear - Engineering and Equipment Fabrication

P.O. Box 1080, Watauga River Industrial Park, Elizabethton, Tennessee 37643
Telephone 615/543-4211

September 1, 1988

United States Nuclear Regulatory Commission
Washington, DC 20555

Attention: Mr. Charles E. MacDonald, Chief
Transportation Certification Branch
Division of Fuel Cycle and Material Safety, NMSS

Reference: Certificate of Compliance No. 4909, Rev. No. 6

Gentlemen:

This is to request amendment to Certificate of Compliance No. 4909, Rev. 6, to approve the use of Model NCI-21PF-1 Protective Shipping Package for the transportation of UF_6 enriched up to 5% U-235 contained in 30-inch UF_6 cylinders. The stainless steel NCI-21PF-1 PSP is essentially a refinement of previously approved versions of DOT Specification Package 21PF-1 (per 49CFR178.121) including the W-21PF-1, the GE-21PF-1, and the newly designated 21PF-1B which was described and evaluated in DOE SARP No. K/D-5400, Rev. 3. The NCI-21PF-1 package is manufactured in accordance with the 21PF-1B drawings (Union Carbide Corporation--Nuclear Division Drawing No. E-S-31536 J, Rev. P) as modified by Nuclear Containers, Inc. Drawing No. DED-206-B, Sheets 1 through 8, Rev. 1.

The NCI-21PF-1 Package was developed in order to meet a growing demand for a UF_6 cylinder overpack that is stackable, that employs quick opening closures, and that provides better protection for the cylinder valve. The NCI-21PF-1 design not only eliminates loose closure bolts and nuts; it also replaces the lifting shackles with lifting eyes on top of the package where they are less likely to be improperly used for tie down. Stackability and quick opening closures are conveniences that can reduce operating costs, but the need for better valve protection was indicated by the results of the Italian tests reported at the UF_6Conference held May 24--26, 1988, in Oak Ridge, TN (Conference Proceedings CONF-880558, pages 147 through 155).

In order to evaluate the design changes in the NCI-21PF-1 package, a one-half scale model was fabricated and subjected to a 9-meter drop test and a 1-meter puncture test; both tests involved impact on the valve end of the package with the center-of-gravity in vertical alignment over the valve. The package suffered expected deformation to the impacted region, but the cylinder and cylinder valve were undamaged as reported in the attached report.

The stacking frames of the NCI-21PF-1 package are simply mirror images of the tie-down bases which have not changed from the original 21PF-1 design as shown in Drawing No. DED-206-B. We request the approval of alternate tie-down bases (and stacking frames) as employed on the W-21PF-1 and GE-21PF-1 packages per Westinghouse Electric Corporation Drawing No. 360F05E001, Sheet Nos. 1, 2, and 3, Rev. 8, and General Electric Company Drawing No. 769E237, Sheet Nos. 1 and 2, Rev. 3. As provided by C-O-C No. 4909, Rev. 6, the tie-down support bases may be any length from 43" to 55".

Enclosed is NCI Check No. 11565 for $150.00 to cover the initial application fee. Your earliest attention to this request will be greatly appreciated because we would very much like to provide these new packages in response to orders from the French, Japanese, and Koreans.

Very truly yours,

William R. Housholder
President

Encl.

SAFETY ANALYSIS REPORT
FOR THE
MODEL NCI-21PF-1 PROTECTIVE SHIPPING PACKAGE

Submitted by:

NUCLEAR CONTAINERS, INC.
Elizabethton, Tennessee, USA

September 1, 1988

Introduction

The newly designated 21PF-1B Protective Shipping Package is the end result of recent modifications to the 21PF-1 Protective Shipping Package for 30-inch UF6 Cylinders. Many long standing design deficiencies of the 21PF-1 Package were corrected, but the following concerns remained unresolved:

1. Questionable protection of the cylinder valve if the package is subjected to the 1-meter puncture test with the center-of-gravity over and in vertical alignment with the valve and target piston.

2. The lack of a convenient closure system which would eliminate the loose nuts, bolts, and washers now used.

3. The lack of a means to stack these packages for storage or for shipment with an empty cylinder.

Nuclear Containers, Inc. has modified the current 21PF-1B design to address these concerns, and has designated the modified package the NCI-21PF-1 Protective Shipping Package.

NCI-21PF-1 Design

The NCI-21PF-1 PSP design is described in the attached NCI Drawing No. DED-206-B, Sheets 1 through 8, Rev.1, which delineates changes to the 21PF-1B drawing requirements given in Martin-Marietta Drawing Numbers E-S-31536-J, Rev. P, and SIE-31536-J2, Rev. B. The major changes are as follows:

1. The inner and outer ends have been changed from 14 Gage (2.1mm) sheetmetal to 1/4" (6.4mm) plate.

2. The fourteen 3/4" (19.0mm) carbon steel closure bolts have been replaced by ten 1" (25.4mm) stainless steel toggle closures which are quick-opening and have no loose parts.

3. All stiffeners have been eliminated from the ends reducing the overall length from 96" (243.8cm) to 92" (233.7cm).

4. The center angle stiffener ring has been changed to a band made of 1/4" x 3" (6.4mm x 7.6cm) Flat Bar.

5. The other angle stiffener rings, which were 3-1/2" x 3-1/2" x 3/8" (8.9cm x 8.9cm x 9.5mm) on the bottom and 3" x 2" x 1/4" (7.6cm x 5.1cm x 6.4mm) on the top, have been changed to 3" x 3" x 3/8" (7.6cm x 7.6cm x 9.5mm) top and bottom.

6. A set of inverted tie-down bases have been added to the top to facilitate stacking.

7. The four lifting shackles have been eliminated and replaced with four 3/4" (19.0mm) eye-bolts in the inverted stacking frame; when packages are stacked, these eye-bolts are used to bolt the packages together. The four lifting shackles were often improperly used for tie-down; the location of the new lifting eyes makes their use for tie-down very unlikely.

8. All attachments to the outer shell of the package are now joined by continuous welds thus eliminating pockets where water and corrosive materials might gather.

9. Material specifications have been changed to allow the use of straight grade Type 304 stainless steel in place of Type 304L stainless steel, which is much more difficult to obtain and which is unnecessary for this application.

10. Wood specifications have been changed to allow the use of red or white oak and to allow the use of No. 1 Common Grade lumber in the wooden laminations. At the same time, the wood specifications have been tightened to disallow specific defects and to eliminate end splicing; also the use of essentially clear lumber is specified for the wooden rails and cap boards and these must be single boards with no splicing or lamination allowed. The corner blocks and plywood end rings have been eliminated as unnecessary.

11. Quality Assurance requirements for the NCI-21PF-1 are the same as for the GE-21PF-1, the W-21PF-1, and the new 21PF-1B packages. Specific Quality Control requirements regarding material specifications including the requirements for test reports and certifications, tolerances, weld specifications, heat treating specifications, and inspections are specified in NCI Drawing No DED-206-B, Sheets 6 through 8, Rev.1.

Safety Evaluation

The NCI-21PF-1 PSP is structurally very similar to the original 21PF-1 package and even more similar to the stainless steel versions including the GE-21PF-1, the W-21PF-1, and the new 21PF-1B package. The thermal insulation is phenolic foam per AEC Specification SP-9 which is identical to that used in the other 21PF-1 packages. Assuming the package stays together when subjected to hypothetical accident conditions of transport, then its containment and nuclear safety capabilities should also be equivalent to those of the other 21PF-1 packages. Since the original 21PF-1 and all the stainless steel versions of the 21PF-1 package have been thoroughly tested and evaluated, it is therefore reasonable to limit the safety evaluation of the NCI-21PF-1 PSP to the following considerations:

1. To evaluate the new lifting and stacking design.

2. To evaluate the design modifications for the effects of vibration incident to normal conditions of transportation.

3. To test the ability of the package to protect the cylinder and cylinder valve when subjected to 9-meter drop test and 1-meter puncture test, both conducted with the center-of-gravity in vertical alignment over the valve and, in the puncture test, over the target piston.

4. To test the ability of the closure devices to withstand the above drop tests without failure of the closures and without developing larger openings between the closures than previously experienced in similar tests of 21PF-1 packages.

Lifting and Stacking Capabilities

The stacking frames on the NCI-21PF-1 PSP are identical to its tie-down bases which are identical to the tie-down bases on either the original 21PF-1, the GE-21PF-1, or the W-21PF-1 package. These are capable of handling loads equal to at least five loaded packages. The stacking frames are <u>not</u> to be used for stacking loaded packages during transport.

The lifting eye-bolts are rated for 5,200-pound working loads which is comparable to the shackles used on the other 21PF-1 packages. The lifting eyes are bolted into the 1/2" thick base plates which are comparably stronger than the 3/8" thick angle to which the shackles are attached on the other 21PF-1 packages.

Vibration Analysis

Among package components which might be adversely affected by vibration, the lifting eye-bolts and the closure devices on the NCI-21PF-1 package are the only components which are different from those on all the other 21PF-1 packages. The lifting eye bolts are tightened down on lock washers to prevent them from vibrating loose. The toggle closures are protected from adverse effects of vibration as follows:

1. The adjusting collars are locked by three self-locking set screws in each collar so that neither the collars nor the set screws can vibrate loose.

2. The toggle pivots (shoulder bolts) are tack welded after installation to prevent them from vibrating loose.

3. The toggle mechanisms are under tension when closed, and the handles are locked down by self-locking ball-lock pins which cannot vibrate loose.

No other parts of the NCI-21PF-1 package or of its closure devices are subject to loosening or other damage by vibration.

Half-Scale Model

The ability of the NCI-21PF-1 design to protect the cylinder and cylinder valve when subjected to hypothetical accident conditions was tested by subjecting a half-scale model to the drop tests proposed above. The model was fabricated in accordance with NCI Drawing No. DED-206-B, Sheets 1 through 8, Rev. 1, except that all dimensions, including thicknesses and tolerances, were reduced by one-half. Wood and foam thicknesses were easily reduced to one-half, but metal thicknesses are dependent on standard items available from the steel mills. The half-scale model was built using metal thicknesses which were equal to or less than one-half their full-scale counterparts as shown below:

FULL-SCALE (thickness, mm)	HALF-SCALE (thickness, mm)
16 Gage Sheet (1.524)	22 Gage Sheet (0.762)
14 Gage Sheet (1.905)	20 Gage Sheet (0.914)
1/4" Plate (6.35)	11 Gage Sheet (3.05)
1/4" x 3" Bar (6.35)	11 Gage x 1.5" Strip (3.05)
1/2" x 6" Bar (12.70)	1/4" x 3" Bar (6.35)
2" x 2" x 1/4" Angle (6.35)	1" x 1" x 1/8" Angle (3.18)
3" x 3" x 1/4" Angle (6.35)	1.5" x 1.5" x 1/8" Angle (3.18)
3" x 3" x 3/8" Angle (9.53)	1.5" x 1.5" x 3/16" Angle (4.76)

All parts of the closure toggles, except for the brackets, were cast and were exactly one-half the size of their full-scale counterparts. Threaded parts, including those in the closure toggles, were National Coarse threads which do not scale exactly. However, as can be seen below, the minor thread diameters of the half-scale threads are equal to or less than one-half that of the full-scale threads such that the scaling was conservative:

MINOR THREAD DIAMETERS (mm)

Full-Scale Threads	Half-Scale Threads
1/4"-20NC (4.79)	No. 5-40NC (2.395)
3/4"-10NC (15.93)	3/8"-16NC (7.58)
1"-8NC (21.50)	1/2"-13NC (10.30)
1-1/4"-7NC (27.30)	5/8"-11NC (13.04)

There were some minor differences in the half-scale model. Since it was not being subjected to thermal testing the vent holes were sealed with silicone RTV caulking only, and the gasket was made of sponge rubber. Also, the toggle lock-down pins were simple 1/4" diameter pins instead of 1/4" ball-lock pins, and the seal lugs were omitted. None of these differences would affect the outcome of the drop and puncture tests.

All Quality Assurance requirements for the manufacture of NCI-21PF-1 PSP's as specified in Drawing No. DED-206-B, Sheets 1 through 8, Rev. 1, were applied to the manufacture of the half-scale model. Due to the thinness of the metal only the GTAW welding process was employed, and the stiffener rings were not continuously welded. Otherwise, requirements for materials and material test reports, welding, tolerances, heat treating, and inspections were strictly followed.

With its inverted stacking frame, the NCI-21PF-1 PSP should weigh approximately 2250 pounds (1023 kg); this is about 15% heavier than the 21PF-1B PSP but is about the same as the GE-21PF-1, the W-21PF-1, and the UX-30 packages. At 1/8 the weight of the full size package, the half-scale model NCI-21PF-1 should have weighed about 281 pounds (128 kg); it actually weighed 302 pounds (137 kg), but this extra weight was attributed to 20 pounds of extra foam which was needed to fill the insulation cavity. This was not surprising because smaller pours do not foam as well as those used in full size packages and result in somewhat higher density foam in small packages. The drop tests being performed did not involve the foamed portions of the package such that this higher density foam was of little significance except that it made the package weigh heavy.

A half-scale dummy cylinder was fabricated with its shell made of 1/4" (6.35mm) thick steel plate and with flat end plates made of 1/2" thick steel plate instead of dished ends of 1/4" (6.35mm) thick steel. The dummy cylinder was loaded with a mixture of steel slugs and sand to give a gross weight of 809 pounds (367 kg), simulating a full scale UF6 cylinder weighting 6472 pounds (2936 kg), somewhat heavier than the nominal gross weight of 6420 pounds (2912 kg) given in ORO-651 for a 30B cylinder. A capped brass pipe nipple was installed in the end of the half-scale cylinder in the correct position and angle to simulate the 30B cylinder valve.

Test Facilities

Drop and puncture testing of the half-scale model NCI-21PF-1 PSP took place at Nuclear Containers, Inc., Elizabethton, TN. The drop test target was an 8' x 8' x 1" thick steel plate lying on a 12' x 12' x 18" thick concrete pad which was poured on a 6" thick crushed stone base and reinforced with four layers of #4 steel rebar wired in 4" grids. This pad weighs apporoximately 32,000 pounds (29 times the weight of the loaded half-scale test model) and has been used several times during the past ten years for 9-meter drop tests of packages weighing up to 2000 pounds without any cracking or other visible damage. The puncture test piston was a 3" diameter x 12" long solid steel rod welded to a 1/2" thick steel base; the penetrating edge has a machined 1/8" corner radius. Therefore, the piston was exactly a half-scale model of the piston specified in 10CFR71.73.

Each drop was effected by means of a fuseable link which was used to attach the package to the lifting hook of the crane hoist; the fuseable link was connected to a 400 amp weld machine. A premeasured plumb line taped to the bottom edge of the package was used to determine that the package was hoisted to the correct height for each drop and to determine exact alignment with the puncture piston for the puncture test. When the package was at the correct height and properly aligned, the plumb line was pulled loose, and the package was released by applying current to the fuseable link causing it to part. This simple mechanism effects a clean drop without imparting any turning or twisting motion to the package such that it impacts in exactly the same angle as it is suspended.

The testing and test results were documented by still 35mm photography. Impact deformations were measured and recorded after each drop, and the package was opened between drops to assess damage to the cylinder and to the dummy cylinder valve.

Test Sequence

1. The dummy cylinder was installed inside the half-scale model PSP (see Figure 1), and the package was closed and secured with the toggle lock-down pins (see Figure 2).

2. The package was attached to the fuseable link from which it was suspended from the crane hook in such an attitude that it would impact the drop pad on the valve end of the package with the package center-of-gravity over and in alignment with the dummy cylinder valve (see Figure 3). The package was hoisted until a 9-meter plumb line taped to the bottom-most portion of the package swung free.

3. The plumb line was pulled free, and the package was dropped by applying current to the fuseable link (see Figure 4).

4. Damage to the package consisted of crushing the impacted area of the package to a depth of 7 cm (see Figures 5 and 6); there were no tears or rips in the outer skin of the package and there were no broken welds. The toggle closures on the deformed end of the package were bent, but all toggle closures were still tight and proved to be operable even though the lock-down pins were severly bent on the inpacted end of the package. A small gap of about 0.5 cm had developed between the upper and lower portions of tne package on the impacted end only.

5. Upon opening the package, the end of the inner liner was deformed into the end of the cylinder skirt and bulged inward toward the cylinder valve leaving a gap between the end of the valve and the deformed end plate of about 0.6 cm. The dummy valve was undamaged. Later assessment, after all testing was complete and the cylinder was removed from the package, showed that the cylinder skirt had suffered some deformation but still offered adequate protection to the valve.

6. The package was reclosed as before with no correction of damaged conditions such as re-adjusting the toggle closures except that the bent lock-down pins were straightened.

7. The package was attached to a new fuseable link suspended from the crane hook in such an attitude that it would impact the puncture piston on the valve end of the package with the package center-of-gravity over and in vertical alignment with the dummy cylinder valve and the piston. A 1-meter plumb line was taped to the bottom-most portion of the package and was used to determine the height of the package and the position of the target piston (see Figure 7).

8. The plumb line was pulled free, and the package was dropped by applying current to the fuseable link (see Figure 8).

9. Damage to the package consisted of a shallow 3-inch diameter dent about 0.7 cm deep in the area of impact with the piston (see Figure 9). The end plate was not penetrated, and there were no broken welds or tears in the outer skin. One of the tie-down bases was bent when the package fell off the puncture piston. The toggle closures were all still tight and were not damaged at all by the puncture drop test; the gap at the closure plane on the impacted end of the package was actually reduced about 1 mm.

10. Upon opening the package, the gap between the cylinder valve and the inner end was slightly reduced to about 0.5 cm (see Figure 10), but no further damage was found. In order to remove the cylinder from the package, it was necessary to pry the deformed inner end plate away from the dummy valve and disengage it from the cylinder skirt. After the cylinder was removed, the cylinder skirt was found to be slightly deformed, but it still provided a space of about 1.8 cm between the end of the dummy valve and the plane at the end of the skirt (see Figure 11). The inner liner was deformed in the area of impact, primarily from the 9-meter drop (see Figure 12), but there was no evidence of broken welds or tears in the inner skin. Some very small, tight cracks had developed in the miter joints of the wood cover plates, but these were considered insignificant compared to the tears that occurred during earlier 21PF-1 testing.

NOTE: Figures 3, 7, and 8 show evidence of previous damage to the test package; this damage resulted from earlier similar testing which employed a lighter walled dummy cylinder. The lighter cylinder end skirt had collapsed on impact allowing the valve to impact with the bulging inner end plate.

Those earlier tests resulted in damage to the end or the package cover. Some internal straightening was necessary in order to load the cylinder for the later tests . The cylinder was loaded with the valve down, and impacts were on the bottom end of the package opposite the previously damaged end. This difference in loading is considered inconsequential since the top and bottom halves of the NCI-21PF-1 package are nearly identical including the tie-down (stacking) bases.

The significance of the earlier testing is that the damage to the package bottom in the tests described above was virtually identical to the earlier damage to the cover. Also, the same toggle closures were used in both tests; no repairs were made to the toggle closures between the two test series.

Conclusions

Based on the above test results, it is concluded that a full size NCI-21PF-1 Protective Shipping Package, if subjected to a 9-meter drop test and a subsequent 1-meter puncture test as described above, would suffer the following consequences:

1. As a result of the 9-meter drop the impacted end of the package would be crushed to a depth of about 13 cm, and a 12-mm gap would develop at the closure plane on the impacted end of the package. Such a gap at the closure plane is much better than the 2 to 3-cm gaps which developed at the closure plane during previous testing of the original 21PF-1 package.

2. As a result of the 1-meter puncture test, the impacted area on the end of the package would receive a 6" diameter dent about 1.4 cm deep but would experience no penetration of the end plate.

3. The toggle closures on the impacted end of the package would be deformed, but all of the toggle closures would still be tight and operable and would maintain the closure of the package.

4. The inner end plate would be deformed inward toward the cylinder valve leaving a gap of about 1 cm between the deformed end plate and the valve cap. The cylinder skirt would be slightly deformed, but the valve would be undamaged.

5. The package would suffer other incidental damage such as bent tie-down bases or stacking frames and bent and inoperable lock down pins, but would not suffer any significant tears or rips in the outer skin or other broken components.

6. Based on the results of tests on the original 21PF-1 package, the NCI-21PF-1 package in such damaged condition as described above would afford adequate protection to the cylinder and cylinder valve if subjected to other hypothetical accident conditions including thermal testing and immersion testing as specified in 10CFR71.73 and, therefore, it meets the standards specified in 10CFR71, Subpart E.

References

1. NRC Certificate of Compliance No. 4909, Rev. 6.

2. Safety Analysis Report for Modified UF_6 Cylinder Shipping Package, DOT Specification 21PF-1, DOE Document No. K/D-5400, Rev. 3, dated December, 1986.

3. Uranium Hexafluoride--Safe Handling, Processing, and Transporting, DOE Conference Proceedings CONF-880558 dated May 24-26, 1988.

Submitted By: Nuclear Containers, Inc.
Elizabethton, TN 37643

William R. Householder, President
September 1, 1988

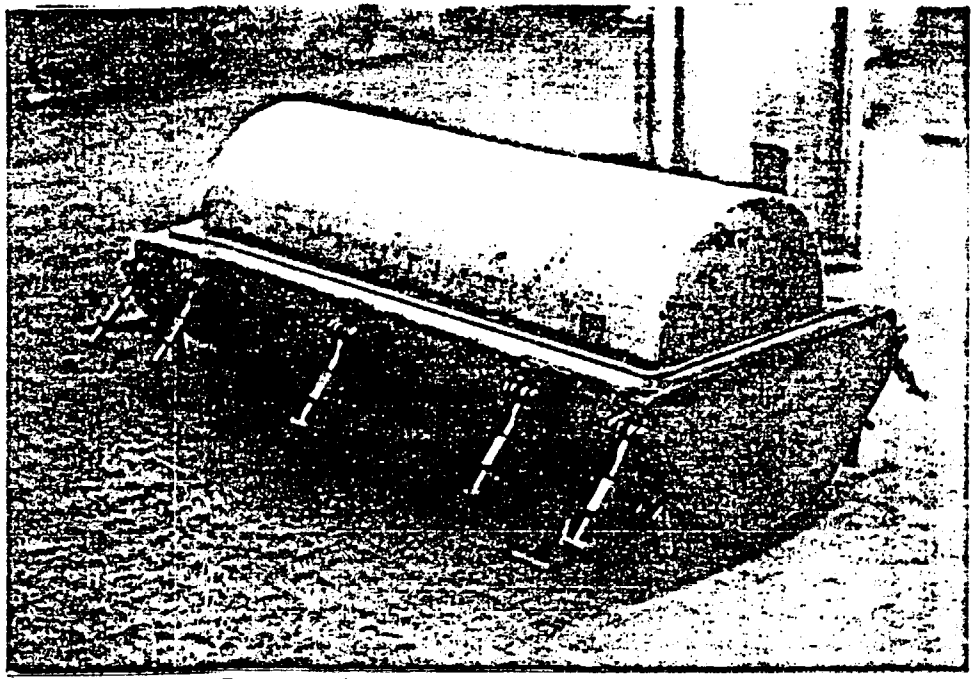

FIGURE 1. Dummy Cylinder in Half Scale NCI-21PF-1

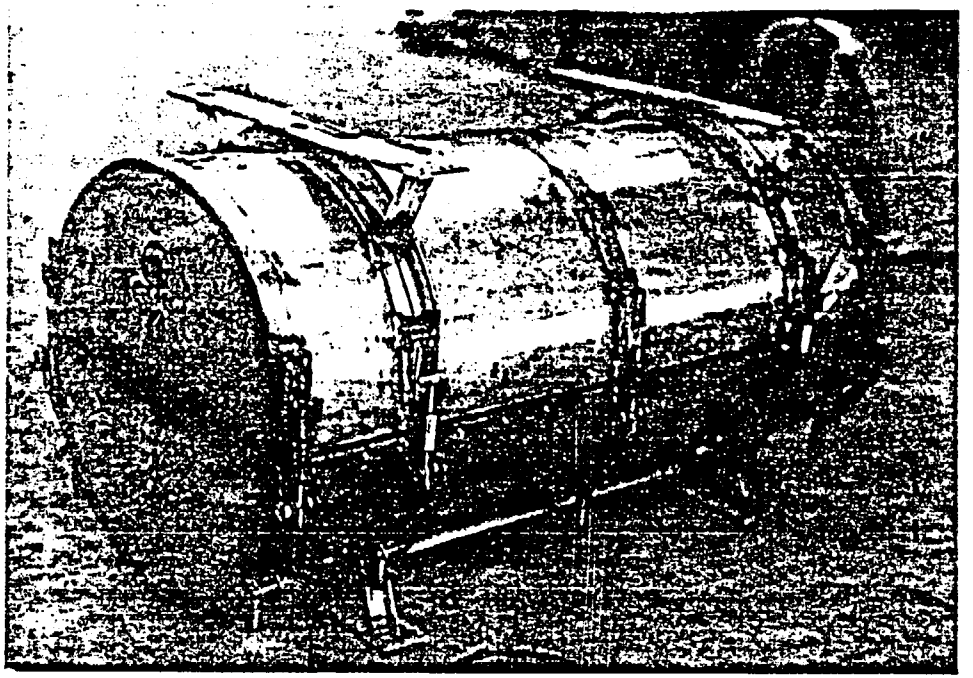

FIGURE 2. NCI-21PF-1 Model Ready for Drop Tests

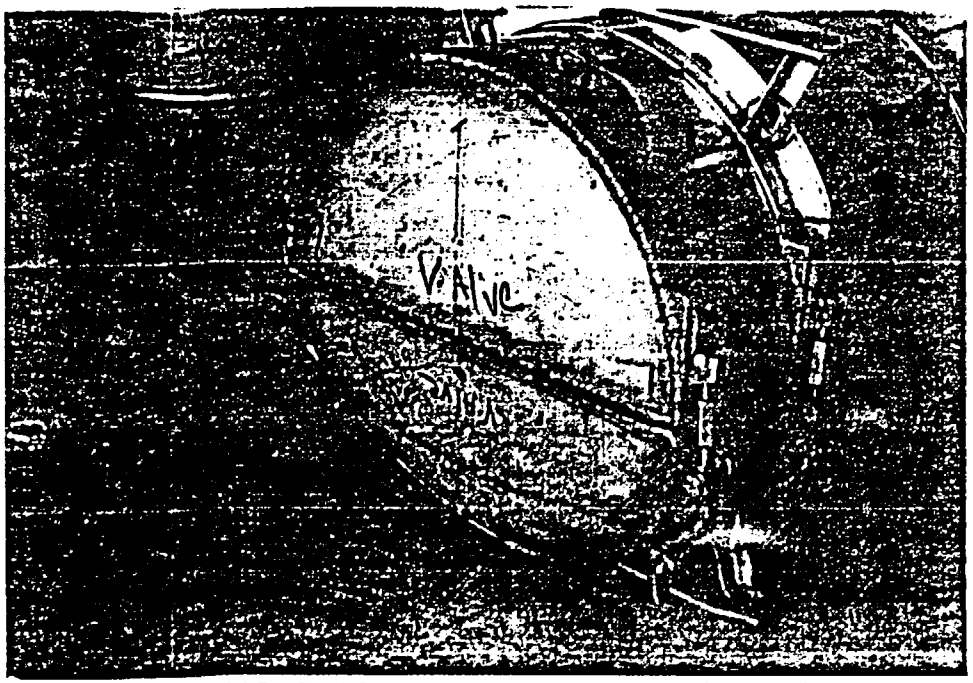

FIGURE 5. NCI-21PF-1 After 9-Meter Drop Test

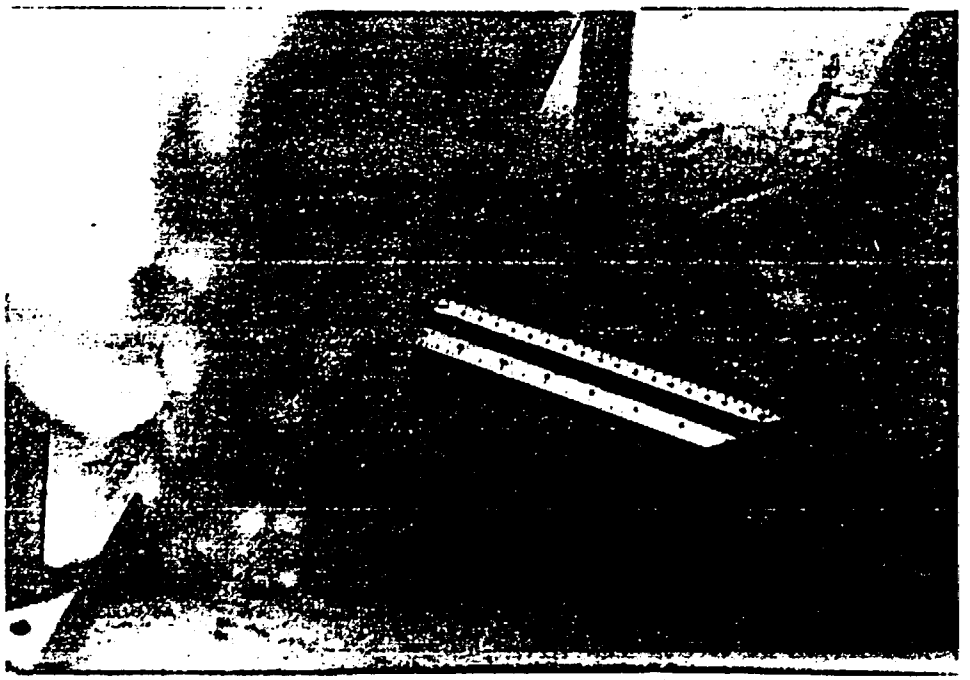

FIGURE 6. 7-cm Deformation After 9-Meter Drop

FIGURE 3. Prep for 9-Meter Drop

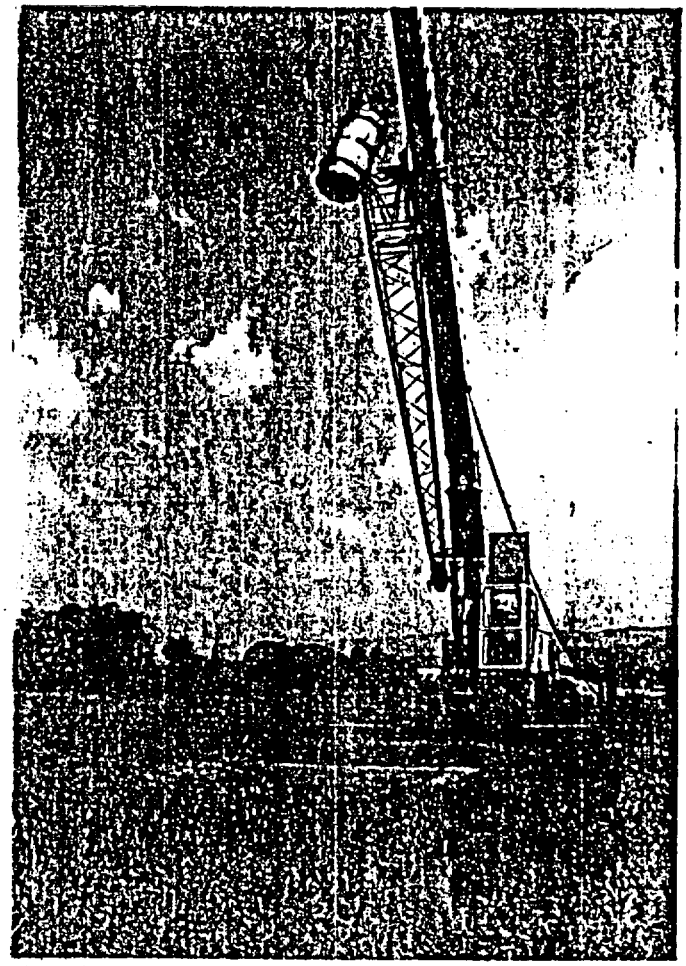

FIGURE 4. 9-Meter Drop Test

FIGURE 7. Prep for Puncture Test

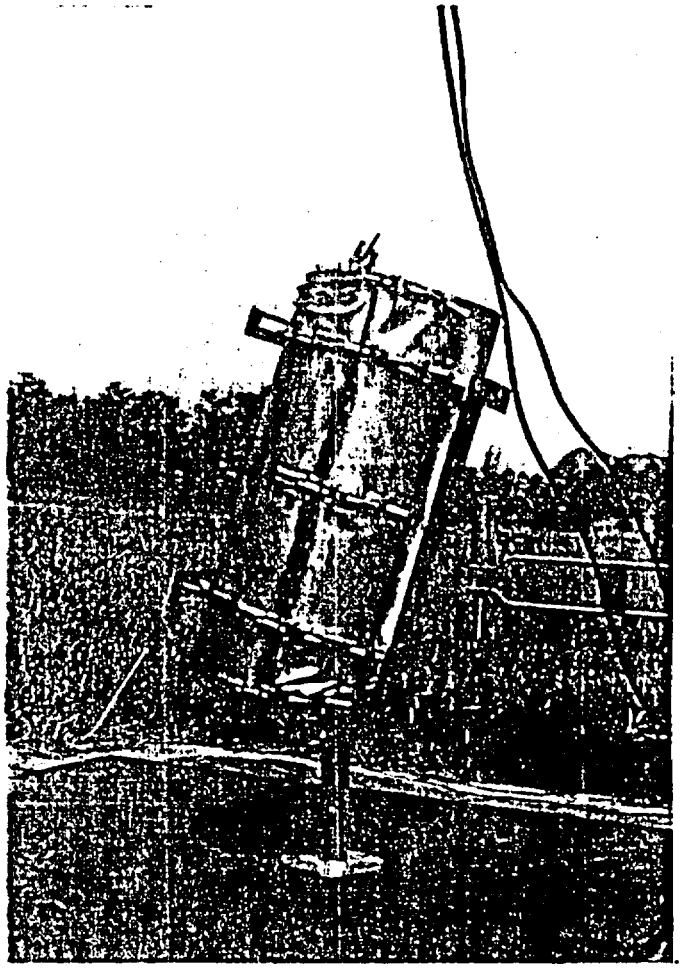

FIGURE 8. 1-Meter Puncture Test

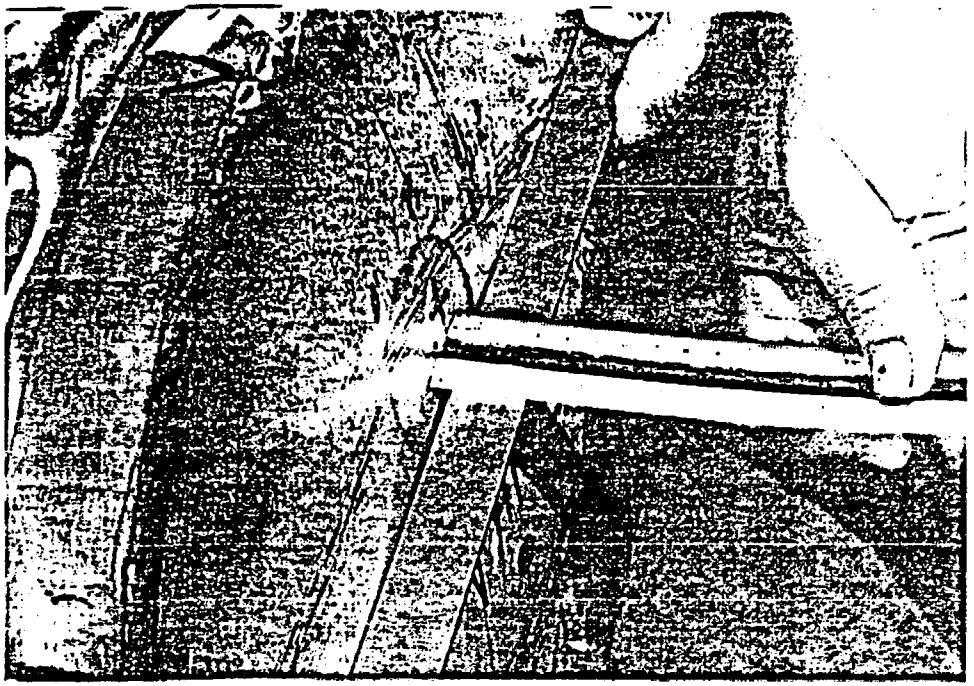

FIGURE 9. 0.7-cm Dent After 1-Meter Puncture Test

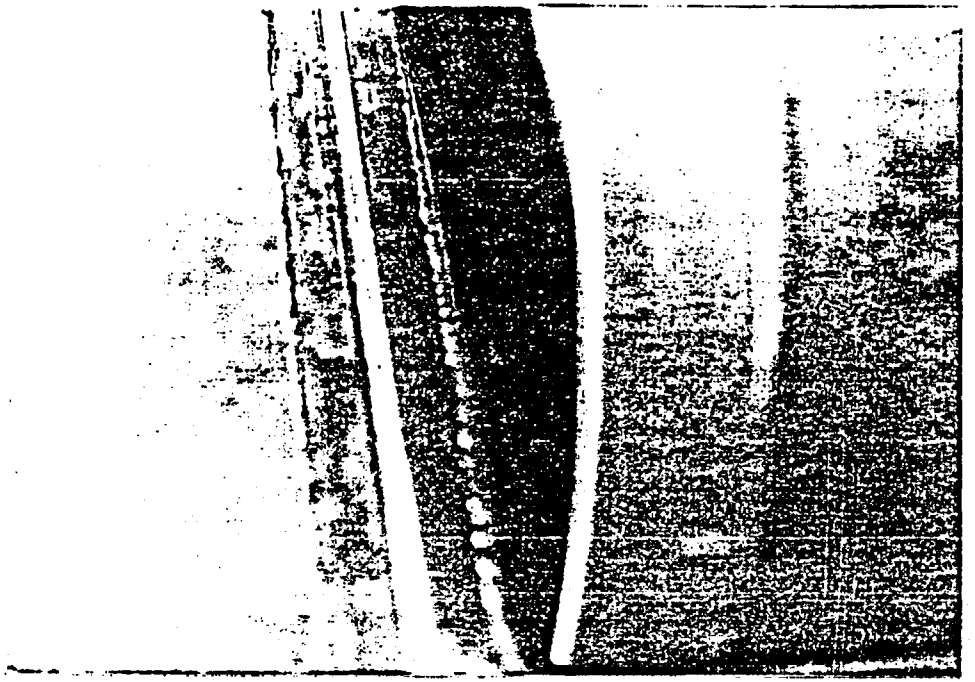

FIGURE 10. 0.5-cm Valve Clearance After Testing

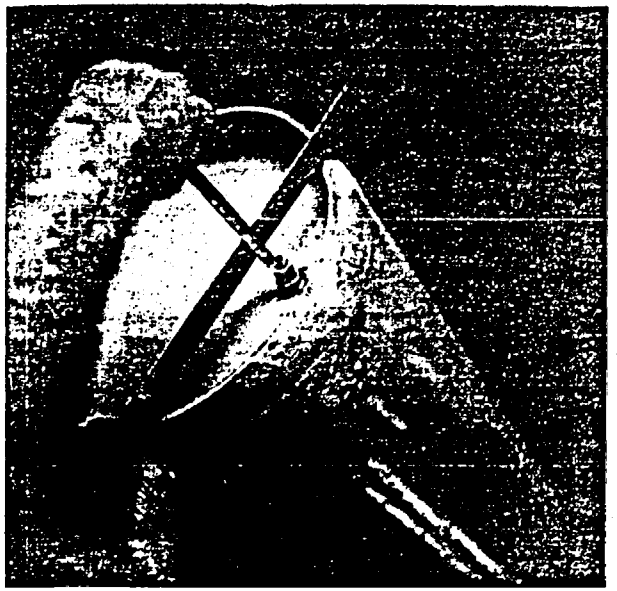

FIGURE 11. Condition of Dummy Valve After Tests

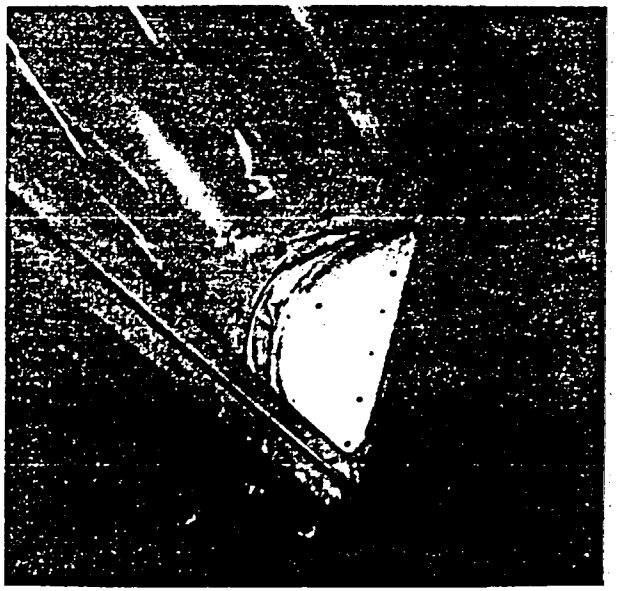

FIGURE 12. Condition of Inner Liner After Tests

FIGURE WITHHELD UNDER 10 CFR 2.390

TOLERANCES	REVISIONS			NUCLEAR CONTAINERS, INC. ELIZABETHTOWN, TENN.		
DECIMAL ±	NO.	DATE	BY	MODEL NC1-21PF-1 PACKAGE		
	1	7/1/88	WRA			
FRACTIONAL ± NOTE 6	2			DRAWN BY WRA	SCALE 1/2 = 12	MATERIAL 304 SS
ANGULAR ±	3			CHK'D WRA	DATE 6-1-88	DRAWING NO. DED-206-B
	4			TRACED	APP'D WRA	SHEET 1 OF 8
	5					

FIGURE WITHHELD UNDER 10 CFR 2.390

TOLERANCES	REVISIONS			NUCLEAR CONTAINERS, INC. ELIZABETHTOWN, TENN.		
DECIMAL ±	NO.	DATE	BY	TYPICAL WELD DETAILS MODEL NCI-21PF-1 PACKAGE		
	1	7/1/88	WRH			
FRACTIONAL ± NOTE 6	2			DRAWN BY WRH	SCALE HALF	MATERIAL 304 SS
	3			CHK'D WRH	DATE 6-1-88	DRAWING NO. DED-206-B
ANGULAR ±	4			TRACED	APP'D WRH	SHEET 2 OF 8
	5					

FIGURE WITHHELD UNDER 10 CFR 2.390

TOLERANCES (UNLESS OTHERWISE NOTED)	REVISIONS			NUCLEAR CONTAINERS, INC. ELIZABETHTOWN, TENN.		
DECIMAL ± 0.002	NO.	DATE	BY	TOGGLE BRACKETS MODEL NCI-21PF-1 PACKAGE		
FRACTIONAL ±NOTE 6	1	7/1/88	WRH	DRAWN BY WRH	SCALE 1/2	MATERIAL 304 SS
ANGULAR ±	2			CHK'D WRH	DATE 6-1-88	DRAWING NO. DED-206-B
	3			TRACED	APP'D WRH	SHEET 3 OF 8
	4					
	5					

FIGURE WITHHELD UNDER 10 CFR 2.390

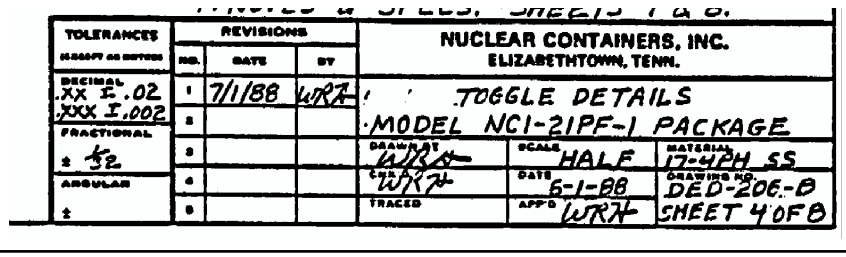

FIGURE WITHHELD UNDER 10 CFR 2.390

TOLERANCES	REVISIONS			NUCLEAR CONTAINERS, INC. ELIZABETHTOWN, TENN.		
DECIMAL ± 0.02	NO.	DATE	BY	TOGGLE CLOSURE DETAILS MODEL NCI-21PF-1 PACKAGE		
FRACTIONAL ± NOTE 6	1	7/1/88	WRH	DRAWN BY WRH	SCALE HALF	MATERIAL 304 SS
ANGULAR ±	2			CHK'D WRH	DATE 6-1-88	DRAWING NO. DED-206-B
	3			TRACED	APP'D WRH	SHEET 5 OF 8
	4					
	5					

AP 124698

BILL OF MATERIALS

Quantities for one Model NCI-2:PF-1 Protective Shipping Package; see Note 2 (Sheet 7) for material specifications. Items specified hereon by trade name provide minimum requirements only; equivalent or better items may be substituted.

ITEM	DESCRIPTION (QUANTITY REQUIRED)
Outer Shell	Sheet, 14 Ga x 72" x 91-3/4" (2 ea).
Outer Ends	Plate, 1/4" x 22" x 44" (4 ea).
Inner Shell	Sheet, 16 Ga x 60" x 82-5/8" (2 ea).
Inner Ends	Plate, 1/4" x 16" x 32" (4 ea).
Inner Angles	Angle, 2" x 2" x 1/4" by 91-1/2" length (2 ea).
Support Block Angles	Formed Angle, 1-1/2" x 1-1/2" x 16 Ga Sheet by 7" lengths (16 ea).
Wood Covers (Sides)	Sheet, 14 Ga x 7" x 92" (4 ea).
Wood Covers (Ends)	Sheet, 14 Ga x 5" x 43" (4 ea).
Closure Bands	Flat Bar, 1/4" x 3" by 72" length (6 ea).
Stiffener Rings	Angle, 3" x 3" x 3/8" by 80" length (4 ea).
Bottom Lift Angles	Angle, 3" x 3" x 1/4" by 56" length (2 ea).
Base Plates	Flat Bar, 1/2" x 6" by 43" length (4 ea).
Base Angle Legs	Angle, 2" x 2" x 1/4" by 12" length (8 ea).
Base Gussets	Plate, 1/2" x 2-1/8" x 3-1/8" (2 ea).
Lifting Eyes	Eye Bolt, 3/4"-10NC-2A x 2" long, with shoulder, galvanized carbon steel, 5200 lb. working load rating, McMaster Carr No. 3014T53 (4 ea).
Lifting Eye Nuts	Nuts, 3/4"-10NC-2B, ASTM A-194, Grade 8A Stainless Steel, ANSI B18.2.2.SF, Heavy Hex, with proper marking and material certification (4 ea).
Lifting Eye Washers	Lock Washer, 3/4" US Standard (4 ea).
Toggle Assemblies:	See Shts 3, 4, & 5 and Notes 2a, 4, & 14 (10 ea).
Upper Base	Plate, 1/4" x 7" x 10" (10 ea).
Upper Bracket	Flat Bar, 1/2" x 2-1/2" by 6" length (20 ea).
Lower Base	Plate, 1/4" x 7" x 9" (10 ea).
Lower Bracket	Flat Bar, 1/2" x 2-1/2" by 5-1/4" lgth (20 ea).
Arm Handle	Pipe, 1-1/4" Sch. 80 x 14" length (10 ea).
Arm Base	Flat Bar, 1/2" x 2" by 2-3/32" length (10 ea).
Arm Bracket	Flat Bar, 1/2" x 2" by 4" length (20 ea).
Upper T-Bolt	Casting, 1"-8NC-2A (10 ea).
Lower Swing-bolt	Casting, 1"-8NC-2A (10 ea).
Swing-bolt Pin	Rod, 1" dia. x 2" long (10 ea).
Pivot Bolts	Casting, 1-1/4"-7NC Hex Shoulder Bolt (20 ea).
Coupling Nut	Casting, 1-1/2" Hex x 1"-8NC (10 ea).
Set Screws	Hex Socket Set Screw, 1/4"-20NC-2A x 1/4", Self-Locking Stainless Steel, McMaster Carr No. 90251A533 (30 ea).
Lock-down Pin	Ball Lock Pin, 1/2" dia. x 2-1/2" long, Stainless Steel with attaching cable, Carr-Lane No. CL-8-BLP-T-2.5S (10 ea).
Lock-down Bracket Attaching Screw	Flat Bar, 1/4" x 1-1/2" by 3-1/4" lgth (20 ea). 1/4" Hex Head, Self Tapping SS Screw (10 ea).
Seal Lug	Pad Eye, 3/4", Stainless Steel, McMaster Carr No. 6892T12 (4 ea).

ITEM	DESCRIPTION (QUANTITY REQUIRED)
Lag Screws	1/4" x 2" Hex Head (140 ea).
Boat Nails	Plain Flat Head, #10 x 2-1/2" (100 ea).
Wooden Components:	Oak, moisture content less than 15%. Rails and Cap Boards--Select Grade; laminated components--No. 1 Common or better, see Notes 1 & 7.
End Block	Cross-lamination 4-3/16" thick using 1-3/8" thick boards (4 ea, 150 board-feet).
End Rail	Board, 1-1/2" tk x 4-1/2" x 43" (4 ea, 16 brd-ft).
Upper End Cap	Board, 1" tk x 2-1/2" x 43" (2 ea, 4 board-feet).
Lower End Cap	Board, 5/8" tk x 2-1/2" x 43" (2 ea, 3 board-feet).
Side Rail	Board, 1-1/2" tk x 6-1/2" x 92" (4 ea, 45 brd-ft).
Upper Side Cap	Board, 1" tk x 3-1/2" x 92" (2 ea, 12 board-feet).
Lower Side Cap	Board, 5/8" tk x 3-1/2" x 92" (2 ea, 8 board-feet).
Support Block	Lamination, 6" thick x 5-1/2" x 9" made of 5 boards 1-3/8" thick boards, (8 ea, 25 board-feet).
Dowel Rod	Hardwood, 3/4" x 6" long (16 ea).
Wood Glue	Weldwood Waterproof Plastic Resin Adhesive (10 lb).
Concrete Nails	No. 10 x 2" and No. 10 x 3" (about 10 lb).
Phenolic Foam	Raw Materials for Fire Resistant Phenolic Foam Insulation per AEC Material and Equipment Specification No. SP-9, Rev. 1 and Supplement K/TL-729, see Notes 9 & 10 (about 260 lb total).
Upper Pad	Neoprene Sponge, 1/2" thick x 6" x 9", medium density, closed cell (4 ea).
Lower Pad	Neoprene, 3/16" thick x 6" x 9", 50 to 60 Durometer A (4 ea).
Rubber Adhesive	Rubber to Metal Cement, 3M No. 051135-08004 (2 oz) or Silicone Adhesive/Caulking described below.
Gasket	Silicone Sponge, 1/2" thick x 1-1/2" wide, medium density, closed cell, rated for continuous use at 400°F (21 feet).
Gasket Primer	Metal Primer, Clear, Albi 487S (1 pint).
Silicone Caulking	Silicone RTV Adhesive/Caulking, rated for continuous use at 400°F, Dow Silastic 732 (about 2 ea 10-oz tubes).
Paint, Fire	Fire Retardant Paint, White, Intumescent, Albi 107A (1 quart).
Vent Seals	Plastic Plugs for 1/4" holes, Caplug No. BPF-1/4 Polyethylene by Protective Closures Co., Buffalo, NY (40 ea).

TOLERANCES (UNLESS AS NOTED)	REVISIONS NO.	DATE	BY	NUCLEAR CONTAINERS, INC. ELIZABETHTOWN, TENN.		
DECIMAL ±	1	7/1/88	WKH	BILL OF MATERIALS MODEL NCI-2:PF-1 PACKAGE		
FRACTIONAL ± NOTE 6	2			DRAWN BY WKH	SCALE	MATERIAL NOTE 2
ANGULAR ±	3			CHK'D WKH	DATE 6-1-88	DRAWING NO. DED-206-B
	4			TRACED	APP'D WKH	SHEET 6 OF 8

NORTHSIDE BLUEPRINT & SUPPLY CO.

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NOTES

1. Work this drawing with UCC-ND Drawing Numbers E-S-31536-J, Rev. P and S1E-31536-J2, Rev. B for the following details:

   (a) Location of vent holes, boat nails, and lag screws.

   (b) Location of gaskets and rubber pads.

   (c) Fabrication and installation of wooden components and cover plates at the wooden step joints, except note that corner blocks and plywood end rings have been deleted.

2. Unless otherwise specified, all metal items shall be as follows:

   (a) Sheet--ASTM A-240, Type 304 or 304L Stainless Steel, #2B Finish.

   (b) Plate--ASTM A-240, Type 304 or 304L Stainless Steel, #1 Finish.

   (c) Angle & Flat Bar--ASTM A276, Type 304 or 304L Stainless Steel, Hot Rolled, Annealed, and Pickled. It is acceptable for flat bar to be fabricated from sheet or plate meeting above specifications.

   (d) Toggle Castings and Swing Pins--Type 17-4PH Stainless Steel, solution heat treated at 1900 ± 25°F for 30 minutes in vacuum and nitrogen cooled to put material in Condition A; then hardened to Condition H1100 by heat treating at 1100°F for 4 hours and air cooling. Machining operations may be done in either Condition A or H1100.

   (e) Pipe--ASTM A-312, Type 304 or 304L Stainless Steel, seamless or welded, cold drawn, annealed, and pickled. Fittings shall be ASTM A-403, Type 304 or 304L Stainless Steel.

   (f) Boat Nails, Lag Screws, Set Screws, Pad Eyes, & Washers--300 Series, 18-8, or 17-4PH Stainless Steel.

3. Certifications and Test Reports:

   (a) Mill test reports must be obtained and maintained on file for all stainless steel raw materials including sheet, plate, angles, flat bar, pipe and pipe fittings, and casting metal for cast toggle components.

   (b) Manufacturer's certifications must be obtained and maintained on file for gasket materials and for lifting eye-bolts and nuts.

   (c) All other commercially available items may be purchased without certification, but copies of written purchase orders which stipulate the appropriate specifications must be maintained on file for each such item.

4. All cast toggle components shall be Investment Castings of Type 17-4PH Stainless Steel in the H1100 Condition as specified in Note 2(a) above; these castings shall meet the requirements of Section VIII, Articles UG-24(a)(1) & (5) and UG-24(b) & (c), ASME Boiler and Pressure Vessel Code. After heat treating, all castings shall be examined per ASME Code, Section VIII, Appendix VII, Articles UA-80; UA-81(b) & (c); UA-82(a)(1), (2), (4), & (5); UA-83; and UA-84. All items must be re-examined after any repairs and/or reheat treating required by UA-83.

5. Welds:

   (a) Unless otherwise specified, all welds shall be continuous and shall develop the full strength of the weakest member being joined; butt welds shall be full penetration welds. All welds shall be free from cracks, excessive undercutting, pits, or spatter, and shall not be oxidized beyond normal discoloration which can easily be removed by wire brushing.

   (b) Welds shall only be by GTAW or GMAW processes using welders and welding procedures qualified on P8 materials in accordance with Section IX, ASME Boiler and Pressure Vessel Code. Use only Type 308L weld rod and filler materials for welding.

   (c) Do not weld over foam materials; weld over wood only when it has been coated with fire retardant intumescent paint and then use appropriate means to reduce heat to a minimum to protect the wood.

   (d) All stainless steel wire brushes, grinding wheels, and cutting discs which are used for stainless steel shall be used for stainless steel only and shall be so marked. Carbon steel wire brushes shall not be used on stainless steel.

   (e) Welds shall be inspected in accordance with Section V, Article 9 of the ASME Code; the inner liner, outer shell, and wood cover seams shall be inspected visually--linear defects over 1/16" shall be ground out and repaired, other welds shall meet the minimum requirements indicated.

TOLERANCES	REVISIONS			NUCLEAR CONTAINERS, INC. ELIZABETHTOWN, TENN.	
DECIMAL ±	NO.	DATE	BY	NOTES & SPECIFICATIONS MODEL NCI-21PF-1 PACKAGE	
FRACTIONAL ±NOTE 6	1	7/1/88	WRH	DRAWN BY WRH	SCALE — MATERIAL NOTE 2
ANGULAR ±	2			CHK'D WRH	DATE 6-1-88 — DRAWING NO. DED-206-B
	3			TRACED	APP'D WRH — SHEET 7 OF 8
	4				
	5				

AP 124698

NOTES--continued:

6. Tolerances; unless otherwise specified:

   (a) Dimensions up to 24" shall be ± 1/16".

   (b) Dimensions greater than 24" shall be ± 1/8".

   (c) Gasket sealing surfaces shall be flat ± 1/16" per 3 feet.

   (d) Overall diagonal lengths shall be within 1/8" of each other.

7. All wood shall be inspected to ensure that it is free of rot, end splitting, loose knots, etc. prior to use; Select Grade lumber for rails and cap boards shall essentially be clear lumber with no knots greater than 1/2". Unacceptable portions may be cut off and discarded, but all boards shall be full length and shall not be spliced lengthwise; each rail or cap board must be a single board. All wood assemblies shall be glued with waterproof plastic resin glue and nailed with No. 10 concrete nails spaced no more than 6" apart.

8. Paint all wood with two coats of fire retardant intumescent paint prior to installation. Seal all screw and nail penetrations through the inner liner or outer shell with silicone RTV caulking when inserting the screw or nail; wipe off excess RTV caulking.

9. Insulation shall be Fire Retardant Phenolic Foam fabricated in accordance with US AEC Material and Equipment Specification SP-9, Rev. 1 and Supplement K/TL-729. Foam each package in place using 2 or 3 equal pours each for the cover half and the bottom half; weight of finished insulation shall be a minimum of 100 pounds in each half. Install and secure the wooden end block in each half immediately after the last pour has been made. After foaming is complete, inspect all vent holes to ensure that the foam has completely filled all void space; if any voids are found, the end blocks must be removed and foam must be added as needed to fill all voids.

10. After foam has cured, drill out all vent holes to a depth of 1/4" to 1/2" and seal each with a plastic cap-plug set in silicone RTV caulking; wipe away excess caulking and allow to cure.

11. Prior to installation of gaskets or rubber pads, use acetone or MEK solvent to thoroughly clean and degrease the metal in the areas to which the rubber is to adhere. Then apply one coat of clear metal primer to the cleaned area and allow to air dry for one hour at room temperature. Install the silicone sponge gaskets by applying a uniform layer (15 to 30 mils) of silicone RTV caulking to the metal surface and applying the gasket using only enough pressure to displace the air but not the adhesive. Seal all joints in the gasket using silicone RTV caulking; wipe away excess caulking and allow to cure. Install the rubber pads using rubber to metal cement per the manufacturer's instructions or use silicone RTV caulking as described above.

12. Items specified hereon by trade name provide minimum requirements only; equivalent or better items may be substituted.

13. Obtain weights of cover, of bottom, and of assembled package without a cylinder; these weights (in pounds and kilograms) must be recorded and included in package labeling and in marking package identification plates.

14. After assembly of finished package, adjust all toggle closures to securely close the package giving a metal-to-metal seat without requiring excessive closing force; then tighten all set screws in each toggle coupling nut. Lock down each toggle handle using a ball-lock pin.

15. Attach the cable of each ball-lock pin to the lower toggle bracket just above it using a 1/4" self-tapping screw set in silicone caulking.

TOLERANCES (UNLESS OTHERWISE SPECIFIED)	REVISIONS			NUCLEAR CONTAINERS, INC. ELIZABETHTOWN, TENN.		
	NO.	DATE	BY	NOTES & SPECIFICATIONS MODEL NCI-21PF-1 PACKAGE		
DECIMAL ±	1	7/1/88	WRH			
FRACTIONAL ±NOTE 6	2			DRAWN BY WRH	SCALE	MATERIAL NOTE 2
ANGULAR ±	3			CHK'D WRH	DATE 6-1-88	DRAWING NO. DED-206-B
	4			TRACED	APP'D WRH	SHEET 8 OF 8
	5					

NUCLEAR CONTAINERS, INC.

Chemical & Nuclear - Engineering and Equipment Fabrication

P.O. Box 1080, Watauga River Industrial Park, Elizabethton, Tennessee 37643
Telephone 615/543-4211

October 18, 1988

United States Nuclear Regulatory Commission
Washington, DC 20555

Attention: Mr. Charles E. MacDonald, Chief
Transportation Certification Branch
Division of Fuel Cycle and Material Safety, NMSS

Reference: Docket 71-4909, NCI Application Dated 6/1/88

Gentlemen:

The enclosed addendum to our application dated 6/1/88, requesting amendment to Certificate of Compliance No. 4909, is a description of contents, operating procedures, quality control acceptance tests, and maintenance programs for the NCI-21PF-1 Protective Shipping Package for the transportation of 30-inch UF_6 cylinders.

The contents section requests that all 21PF-1 packages be redesignated Type B(U)F Packages to allow for future shipments of reprocessed UF_6 whose content of fission products and daughter products may cause it to exceed Type A quantity limits.

If you have any questions, please contact me.

Very truly yours,

William R. Householder
President

Encl.

ADDENDUM DATED OCTOBER 18, 1988
TO
SAFETY ANALYSIS REPORT DATED SEPTEMBER 1, 1988
FOR THE
MODEL NCI-21PF-1 PROTECTIVE SHIPPING PACKAGE

Submitted by:

NUCLEAR CONTAINERS, INC.
Elizabethton, Tennessee, USA

Contents

The NCI-21PF-1 Protective Shipping Package is used to ship 30-inch UF_6 Cylinders containing uranium enriched up to 5% U-235 with fill limits per 49CFR173.417 and/or ORO-651, Table 9. For uranium enriched from natural uranium, these fill limits do not exceed Type A quantities of radioactive materials. However, these packages may be used in the future for the shipment of reprocessed UF_6 which may contain fission products and daughter products up to the limits specified in ASTM C-787. As a result, such UF_6 may exceed Type A quantities and require Type B packaging for shipment. Since the entire family of 21PF-1 packages meet the requirements for Type B()F packages, we request that Certificate of Compliance No. USA/4909/AF be redesignated No. USA/4909/B()F.

Operating Procedures

The NCI-21PF-1 Overpack is loaded and unloaded in accordance with standard, in-plant, operating procedures at the various enrichment plants and at the various nuclear fuel facilities. These procedures are in accordance with such handling guides as ORO-651 and meet the requirements of 10CFR71, Subpart G. As a minimum, the specific procedures should include the following steps:

1. Procedure for Loading the Package

(a) Complete inspection report verifying that the following package components are free from damage and are in working order:

(1) Inner and outer shells.

(2) Cylinder support pads.

(3) Gasket and gasket surfaces.

(4) Vent seals/plugs.

(5) Tie-down and lifting/stacking supports.

(6) Lifting Eye-bolts.

(7) Toggle closures and toggle handle ball-lock-pins.

(8) Security seal lugs.

(b) Complete inspection of UF_6 cylinder prior to insertion into overpack per ORO-651 and ANSI N14.1, latest revisions.

(c) Carefully load UF_6 cylinder into overpack with the cylinder valve positioned up.

(d) Carefully replace lid on overpack.

(e) Engage all toggle clamps, then close all toggle clamps alternating corner-to-corner and side-to-side; secure the handles with the ball-lock-pins.

(f) Install security seals and record their numbers.

(g) Complete inspection report.

2. Procedure for Unloading the Package

(a) Complete receiving report.

(b) Remove the package seal.

(c) Remove the ball-lock-pins and open all toggles before disengaging from the upper brackets.

(d) Carefully remove the lid of the overpack.

(e) Carefully remove the cylinder from the overpack.

(f) Clean package interior and close prior to storage.

3. Preparation of an Empty Package For Transport

Preparation of an empty package for shipment involves all of the same steps as listed in 7.1 above except that the labeling and marking are different for empty packages; there may or may not be an empty UF_6 cylinder being shipped in the overpack.

Quality Control Acceptance Tests

Every user of the NCI-21PF-1 Overpacks for the shipment of UF_6 must have an NRC approved Quality Assurance Program in accordance with 10CFR71.37 and 10CFR71, Subpart H. Upon procurement of these overpacks, the user shall require the supplier to also have an NRC approved Quality Assurance Program meeting the appropriate requirements of 10CFR71, Subpart H, in addition to a specific Quality Assurance Plan for the manufacture of these overpacks. As a minimum, the specific Quality Assurance Plan shall include the following provisions:

1. Materials

All drawing requirements (see NCI Drawing No. DED-206-B, Sheets 1 through 3, Rev.1) regarding material specifications shall be satisfied as follows:

(a) Type 304 stainless steel materials and components per drawing Notes 2(a), 2(b), 2(c), and 2(e).

(b) Type 17-4PH stainless steel material and components per drawing Notes 2(d) and 4.

(c) Fastener items per drawing Note 2(f).

(d) Wood per drawing Note 7.

(e) Gaskets and RTV caulking adhesives per drawing requirements.

(f) Other stainless steel components per drawing Note 4.

2. Welds

All weld requirements specified in drawing Note 5 shall be satisfied as follows:

(a) Welders and weld procedures shall be qualified per drawing Note 5(b).

(b) Weld rods and filler materials per drawing Note 5(b)

(c) Specified grinding and cleaning procedures and materials per drawing Note 5(d).

(e) Welds over wood and foam per drawing Note 5(c).

(f) Welds shall be inspected per drawing Notes 5(a) and 5(e).

4. Dimensional Tolerances

Adequate inspection shall be required to insure compliance with dimensional tolerances specified in drawing Note 6. A check-list shall be established for critical dimensions for which records must be maintained as follows:

(a) Inner cylinder cavity dimensions.

(b) Outer shell dimensions.

(c) Toggle clamp locations.

(d) Bolt center locations and hole diameters in tie-down supports and in lifting/stacking frames.

(e) Flatness of gasket surfaces.

5. Assembly Inspections

Mandatory hold points shall be established to insure the inspection of the following assembly operations:

(a) Lid weld inspections.

(b) Inspection and installation of wood per drawing Notes 1(c) and 7.

(c) Installation of fire retardant phenolic foam per drawing Note 9; record pre-foaming weights, post-foaming weights, and actual foam weights by difference for each package lid and bottom.

(d) Application of fire retardant intumescent paint to wood and to wood cover plates.

(e) Installation of wood cover plates.

(f) Installation of pads and gaskets.

(g) Installation of vent port seals and caulking.

5. Post Assembly Inspections

Each completed package shall be inspected to document compliance with the following drawing requirements:

(a) Final dimensions per 3.0 above.

(b) Installation of gaskets and cylinder support pads.

(c) Lid to body fit.

(d) Toggle clamp adjustments and locking of adjustment nuts.

(e) Installation of lifting eye-bolts and security seal pads.

(f) Actual tare weights of lid and bottom halves.

(g) Final assembled tare weight.

(h) Proper permanent marking and nameplates per 10CFR71.85(c), 49CFR178.121-5, and ANSI N14.1 (latest revision).

6. Records

As a minimum the supplier shall retain the following records for a period of not less than 5 years; the user shall retain copies of items (b) through (f) for the life of each overpack:

(a) Procurement orders and sub-contracts.

(b) Material test reports and certifications.

(c) Welder and weld procedure qualification records.

(d) Critical dimension inspection reports.

(e) Assembly inspection reports.

(f) Post assembly inspection reports.

7. Sub-Contractors

Sub-contractors shall be required by the sub-contract, purchase order, or other procurement document to comply with all applicable requirements for a Quality Assurance Program and shall be required, as a minimum, to comply with the applicable Quality Assurance Plan requirements stipulated above.

8. Routine User Inspections

The user shall inspect these overpacks in accordance with written procedures prior to every outgoing shipment and upon receipt of every incoming shipment to assure the following:

(a) Overpack base and supports are sound with no broken welds or components, and they are bolted tightly to trailer.

(b) Overpack is intact with no broken welds and no holes, tears, or cracks greater than 1/2 inch.

(c) Inner liner is free of debris and standing water and is intact with no holes, tears, cracks, or broken welds.

(d) Gaskets and cylinder support pads are in place and intact and are not in a deteriorated or damaged condition.

(e) Wood cover plates and welds are sound and undamaged.

(f) Overpack halves fit together properly with no gaps.

(g) Closure clamps are properly adjusted for tight closure and the coupling/adjusting nuts are properly locked.

(h) All vent seals/plugs are securely in place.

Maintenance Program

1. Overpack Repairs

Overpacks which are rejected during any of the above routine inspections shall be repaired and reinspected conforming to drawing requirements per the above QC Acceptance Tests and to the requirements of QPO-651 and ANSI N14.1 (latest revisions).

2. Routine Maintenance

Gaskets shall be replaced every 12 months or more often if found deteriorated or damaged. Vent plugs shall be replaced whenever they are found missing.

3. Annual User Inspections

The user shall establish written procedures for annual inspection of each Model NCI-21PF-1 Overpack requiring inspections to verify the following items as a minimum:

(a) Lifting straps, lifting frames, lifting eye-bolts, closure clamps, and tie-down supports are sound and free from weld cracks, damage, and deterioration.

(b) Closure clamps are properly adjusted and locked.

(c) Air vents are properly sealed.

(d) Gaskets are replaced every 12 months and are in place, intact, and not damaged or deteriorated.

(e) Inner and outer shells are free of holes, cracks, tears, and broken welds, and the inner shells are free of debris and standing water.

(f) Wood cover plates are sound and undamaged, and gasket seating surfaces meet drawing requirements.

NUCLEAR CONTAINERS, INC.

Chemical & Nuclear - Engineering and Equipment Fabrication

P.O. Box 1080, Watauga River Industrial Park, Elizabethton, Tennessee 37643
Telephone 615/543-4211

November 28, 1988

United States Nuclear Regulatory Commission
Washington, DC 20555

Attention: Mr. Charles E. MacDonald, Chief
Transportation Certification Branch
Division of Fuel Cycle and Material Safety, NMSS

Reference: Docket 71-4909, NCI Application dated 9/1/88

Gentlemen:

Enclosed is a second addendum to our application dated 9/1/88, requesting Certificate of Compliance for the NCI-21PF-1 Protective Shipping Package for the transportation of 30-inch UF_6 cylinders. This addendum deletes our earlier request for Type B( )F approval and verifies the request for a Type AF Certificate of Compliance; it also includes revised drawings and presents further structural evaluation which involved additional 9-meter drop and 1-meter puncture testing.

I appreciate your efforts to expedite review and approval of this application. If you have any questions, please contact me.

Very truly yours,

William R. Householder
President

Enclosure

ADDENDUM DATED NOVEMBER 28, 1988
TO
SAFETY ANALYSIS REPORT DATED SEPTEMBER 1, 1988
FOR THE
MODEL NCI-21PF-1 PROTECTIVE SHIPPING PACKAGE

Submitted by:

NUCLEAR CONTAINERS, INC.
Elizabethton, Tennessee, USA

Contents

Please delete the request under "Contents" in the first addendum to the above titled SARP; that request was to designate as Type B( )F packages the NCI-21PF-1 PSP and all 21PF-1 PSP's included in Certificate of Compliance No. USA/4909/AF. This may be a future requirement, but it will be addressed at a later date. We renew our request for Type AF Certificate of Compliance for the NCI-21PF-1 Protective Shipping Package, which is used to ship 30-inch UF_6 Cylinders containing uranium enriched up to 5% U-235 with fill limits per 49CFR173.417 and/or ORO-651, Table 9.

Revised Drawings

NCI Drawing No. DED-206-B, Sheets 1 through 8, Rev. 1 have been revised to stand alone without reference to the DOT-21PF-1B drawings; the revised drawing is now designated DED-206-B, Sheets 1 through 10, Rev. 2. This revision does not contain any design changes, but describes the NCI-21PF-1 in complete detail. NCI Drawing No. DED-207-A has been added to provide nameplate details. These drawings are included in the appendix to this addendum.

Additional Structural Evaluation

NRC concern about the new toggle closures on the NCI-21PF-1 PSP has resulted in further structural evaluation by way of additional drop and puncture testing. These tests were accomplished using the same half-scale model, half-scale dummy cylinder, and test procedures as reported in the orginal SARP dated 9/1/88. The tests were conducted as follows:

1. The dummy cylinder was re-installed inside the half-scale model PSP, and the package was closed and secured with the toggle lock-down pins just as described in the 9/1/88 SARP. No repairs had been made to either the dummy cylinder or the test package since the drop and puncture tests described in the 9/1/88 SARP.

2. The package was attached to the fuseable link from which it was suspended from the crane hook in such an attitude that it would impact the drop pad flat on its bottom. The package was hoisted until a 9-meter plumb line taped to the bottom-most portion of the package swung free (see Figure 13).

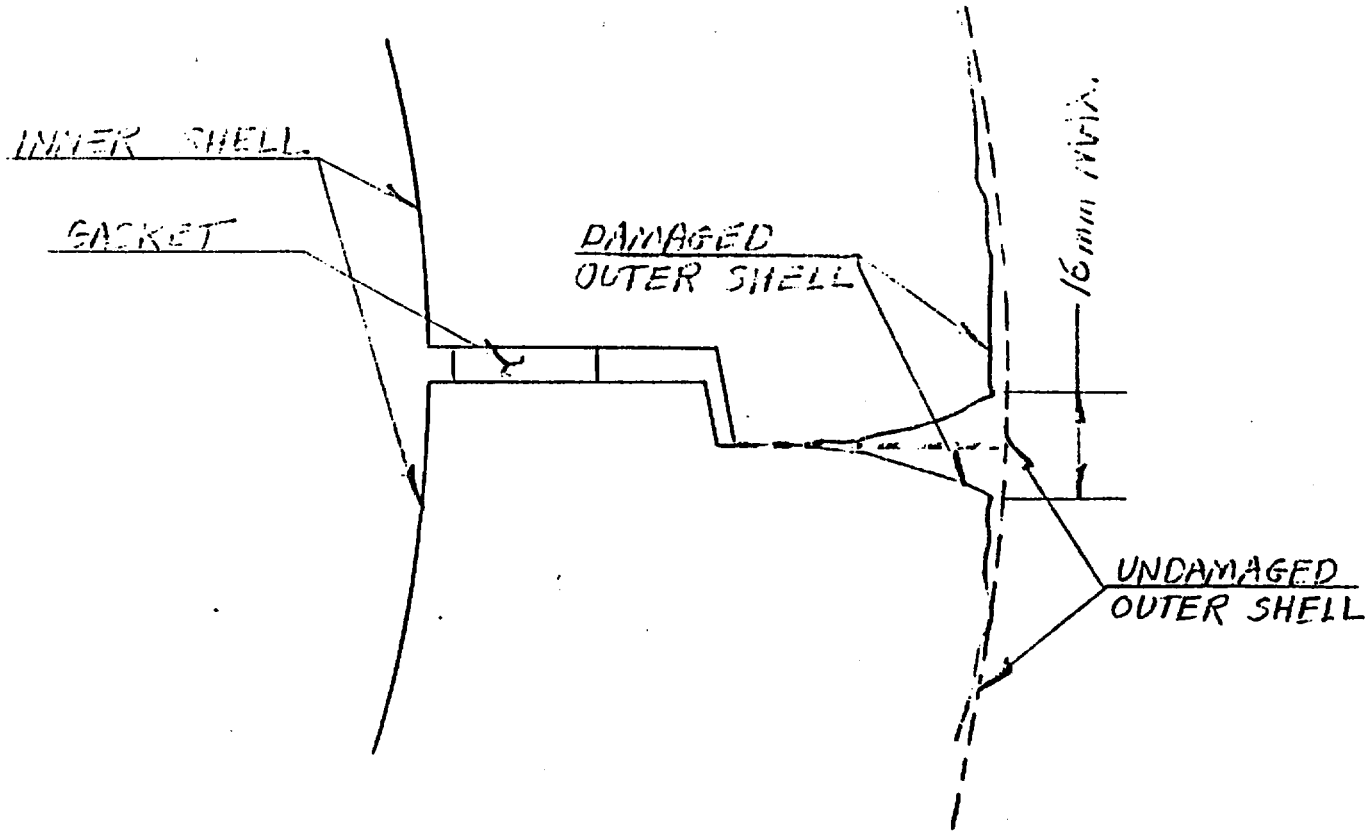
3. The plumb line was pulled free, and the package was dropped by applying current to the fuseable link (see Figure 14).

4. Damage to the package consisted of deforming the tie-down bases and slightly flattening the bottom of the package (see Figure 17). A narrow rip developed in the outer skin near the bottom valve end of the package in the area of severe deformation from previous 9-meter drop testing (see Figure 18); this rip was about 4.5 cm long with a maximum opening less than 1 cm wide. There were no broken welds. The toggle closures were all intact and still held the package tightly closed; no gaps developed between the cover and bottom portions of the package.

5. The package was attached to a new fuseable link and suspended from the crane hook in such an attitude that it would impact the drop pad flat on its side. A 9-meter plumb line was taped to the bottom-most portion of the package and was used to determine the height of the package (see Figure 15).

6. The plumb line was pulled free, and the package was dropped by applying current to the fuseable link (see Figure 16).

7. Damage to the package consisted of slight additional deformation of the toggle closures on the impacted side of the package as well as slight flattening to that side of the package (see Figure 19). The toggle closures remained intact and continued to hold the package tightly closed; however gaps between the cover and bottom portions of the package developed at the closure plane on the impacted side (see Figure 20). These gaps opened to a maximum width of about 1.5 cm at the surface and closed to nearly nothing at the step joint (see sketch). The tie-down bases and stacking frames were all somewhat deformed by this time, but there were no further rips or tears in the outer skin, and there were no broken welds.



8. The package was attached to a new fuseable link and suspended from the crane hook in such an attitude that it would impact the puncture piston flat on the coupling nut of the center toggle closure on the undamaged side of the package. A 1-meter plumb line was suspended from the coupling nut and was used to determine the height of the package and the position of the target piston (see Figure 21).

9. The plumb line was pulled free, and the package was dropped by applying current to the fuseable link (see Figure 22).

10. Damage to the package consisted of driving the toggle closure coupling nut and swing bolts into the side of the package (see Figure 23); there was no other damage from this drop.

Results

1. After the drop tests described in the 9/1/88 SARP and the two 9-meter drop tests and 1-meter puncture test described above, the toggle closures were all still intact and still held the package tightly closed. None of the toggle lock-down pins had failed. Even though two 1.5-cm wide gaps had developed at the external closure plane of the package, these gaps did not penetrate far into the package but tapered to nothing at the closure plane step joint such that the inboard gasket was not exposed. Except for the 4.5-cm rip in the previously deformed outer skin described above, there were no openings or penetrations in the outer skin, and there were no broken welds on the exterior of the package.

2. Several of the impacted toggle closures were badly deformed and jammed such that they had to be destroyed in order to open the package for inspection. The upper T-bolt of the toggle closure which had impacted on the puncture piston was easily broken indicating it had been cracked during the test; the other four closures on that side were in sound condition. The five toggle closures which had been impacted in the second 9-meter drop test were all sound and yielded only after an hours hard labor by three men working with pry bars, chisels and sledge hammers. Upon opening the package, the dummy cylinder was undamaged (see Figure 24). The inner liners in the cover and bottom portions of the package were badly damaged with long breaks near the welds joining the end plates with the inner shells (see Figure 25). The wood cover plate in one end of the cover had broken along most of its length near the weld joining it with the inner end plate (see Figure 26). A few small cracks had also developed in the miter joints of the wood cover plates (see Figure 27). However, none of the cracks and tears in the inner liners and wood cover plates would expose wood or foam to damage during any subsequent thermal test.

Conclusions

Based on the above test results, it is concluded that a full size NCI-21PF-1 Protective Shipping Package, if subjected to the four 9-meter drop tests and three 1-meter puncture tests as described in the 9/1/88 SARP and this addendum, would satisfactorily withstand the testing while suffering the following consequences:

1. As a result of the 9-meter drop tests the impacted ends of the package would be crushed to a depth of about 13 cm; the tie-down base would be deformed into the bottom of the package; the toggle closures on the impacted side of the package would be deformed into the side of the package; a 1.2-cm gap would develop at the external closure plane on each of the impacted ends of the package; a 9-cm long rip would open to a maximum width of 2 cm in the outer skin; and 3-cm gaps would develop at the external closure plane on the impacted side of the package. Such gaps at the closure plane are comparable to those developed in the original 21PF-1 PSP as reported in K-1686; however, these gaps did not penetrate far into the package and were nearly closed at the step-joint of the closure plane.

2. As a result of the 1-meter puncture tests, the impacted areas on the ends of the package would receive 6" diameter dents about 1.4 cm deep but would experience no penetration of the end plate.

3. Impacted toggle closures would be deformed, but all of the toggle closures would still be intact and would continue to hold the package tightly closed; none of the toggle lock-down pins would fall; and the unimpacted toggle closures would still be operable.

4. The inner end plate would be deformed inward toward the cylinder valve leaving a gap of about 1 cm between the deformed end plate and the valve cap. The cylinder skirt would be slightly deformed, but the valve would be undamaged.

5. The inner liners of the cover and bottom portions of the package would have several long tears near the welds joining the end plates with either the inner shells or the wood cover plates. None of this interior damage would result is exposure of the wood or foam to damage in subsequent thermal testing.

6. The package would suffer other incidental damage such as bent tie-down bases or stacking frames and bent toggle lock-down pins, but would not suffer any significant tears or rips in the outer skin or other broken conponents.

7. The basic envelop or space occupied by the damaged package is essentially unchanged from that occupied by the undamaged package.

8. Similar testing of the original 21PF-1 package as reported in K-1686, resulted in similar, but generally more severe, damage, ie. the gaps at the closure plane exposed unprotected wood, there were numerous broken exterior welds, and the puncture testing resulted in tears in the outer shell up to 12 cm in length. The damaged 21PF-1 prototype was subjected to a 1-hr diesel oil fire and 24-hr water immersion test with satisfactory results.

9. Except for its toggle closures, thicker end plates, stacking frames, and wood cover plates, the NCI-21PF-1 PSP is almost identical to the original 21PF-1 PSP. When compared to the original 21PF-1 PSP, there is no question that the NCI-21PF-1 (a) affords better puncture resistance in the ends of the package, (b) that its wooden structure is better protected, (c) that its toggle closures keep the package tightly closed even during hypothetical accident testing, (d) that its stacking frames do not compromise its capabilities as a protective shipping package, (e) that its gasket provides better thermal protection, (f) that it provides equal or better protection to its UF_6 cylinder, and (g) that it, consequently, provides equal or better containment and criticality safety.

10. Based on the above comparison with the original 21PF-1 PSP, it is fair to conclude that the NCI-21PF-1 package in such damaged condition as described above would afford adequate protection to the cylinder and cylinder valve if subjected to hypothetical accident conditions as specified in 10CFR71.73 including thermal testing and immersion testing and, therefore, it meets the standards specified in 10CFR71, Subpart E.

Appendices

1. Figures 13 through 27: Drop Testing Photographs.

2. NCI Drawing No. DED-206-B, Sheets 1 through 10, Rev. 2.

3. NCI Drawing No. DED-207-A, Rev. 0.

References

1. NRC Certificate of Compliance No. 4909, latest revision.

2. Uranium Hexafluoride--Safe Handling, Processing, and Transporting, DOE Conference Proceedings CONF-880558 dated May 24-26, 1988.

3. K-1686, Protective Shipping Packages for 30-inch Diameter UF_6 Cylinders, dated April 13, 1967

4. K/SS-471, Proposal for Modifications to US Department of Transportation Specification 21PF-1 Fire and Shock Resistant Phenolic Foam-Insulated Metal Overpack, dated November, 1986, and includes the following documents:

   a. Quality Assurance/Control in the Fabrication, Modification, Use, and Maintenance of the DOE 21PF-1 Shipping Package, dated November, 1986.

   b. K/D-5400, Rev. 3, Safety Analysis Report for Modified UF_6 Cylinder Shipping Package, DOT Specification 21PF-1, dated December, 1986.

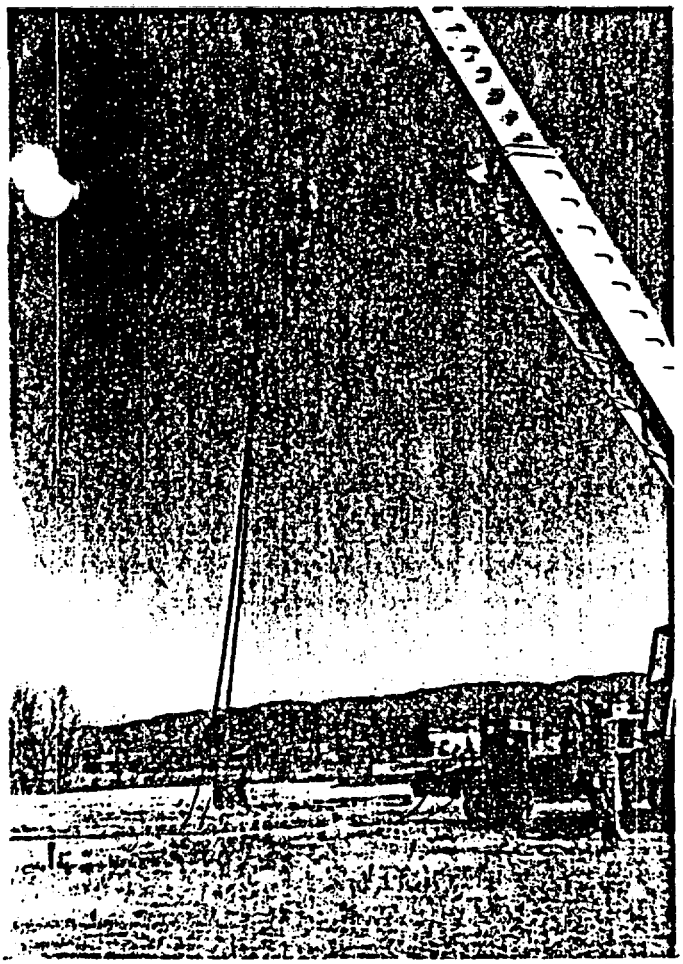
   c. K-2057, Rev. 1, Renovation of DOT Specification 21PF-1 Protective Shipping Packages, dated 11/21/86.

   d. K/PS-1128, Thermal Properties Evaluation of the UF_6 Cylinder Overpack Insulation, dated November, 1985.

   e. K/PS-5068, Thermal Analysis of UF_6 Cylinder Inside a Protective Overpack, dated November, 1986.

   f. Drawing Numbers: S1E-31536-J1, Rev. D
      E-S-31536-J, Rev. P
      S1E-31536-J2, Rev. B
      S1A-31536-V1. Rev. 0

   g. Bills of Materials: S-31536-16, Rev.2
      S-31536-4, Rev. 9



3URE 13. Prep for 9M Bottom Drop

FIGURE 14. 9-Meter Bottom Drop Test

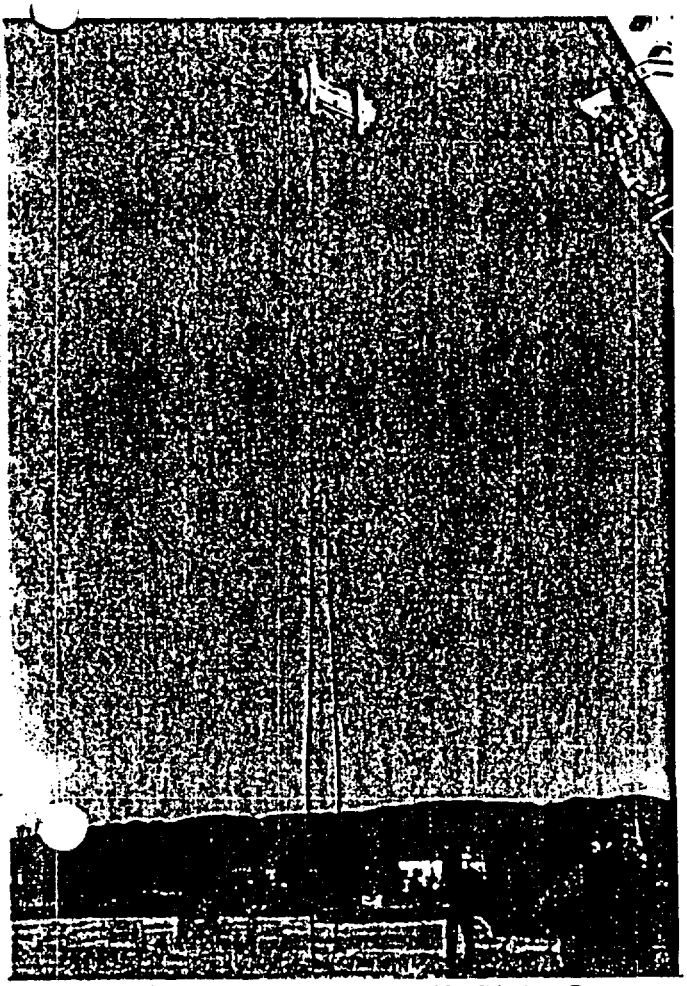


FIGURE 15. Prep for 9M Side Drop

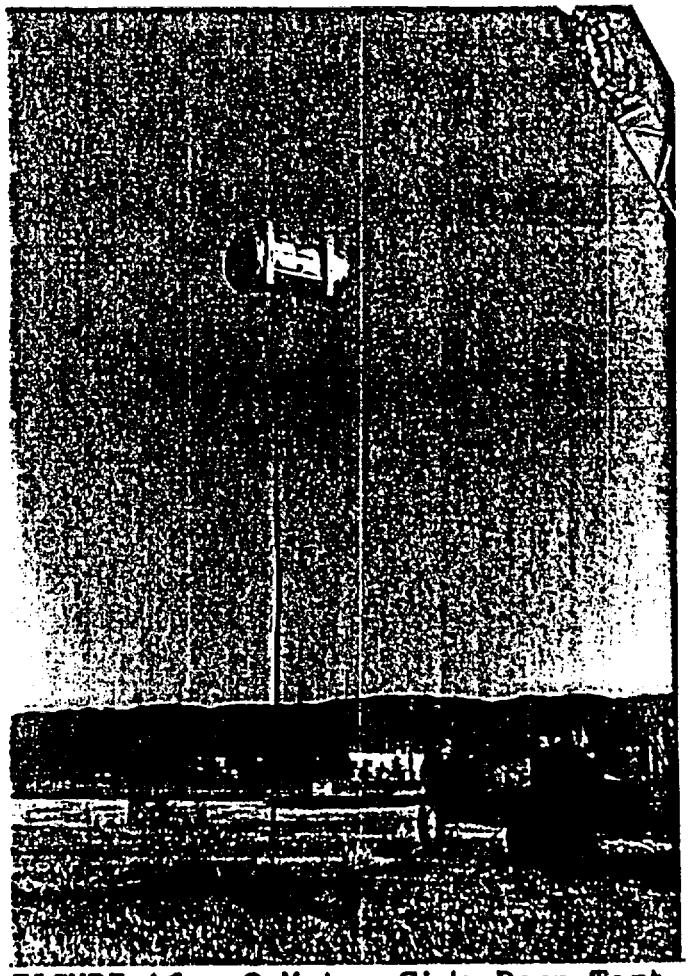


FIGURE 16. 9-Meter Side Drop Test

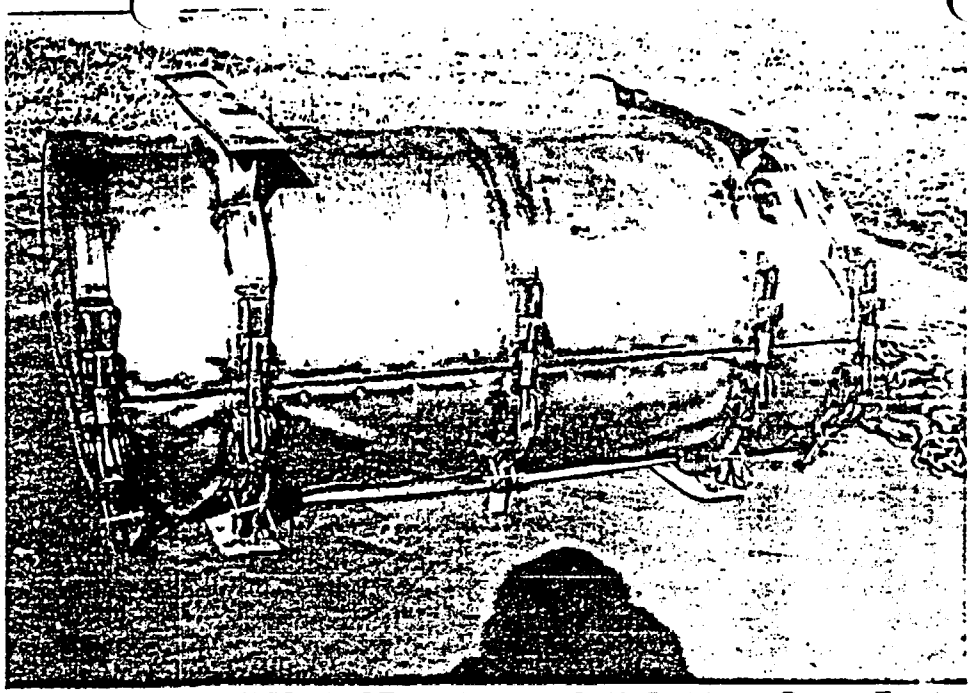


FIGURE 17. NCI-21PF-1 After 9-M Bottom Drop Test

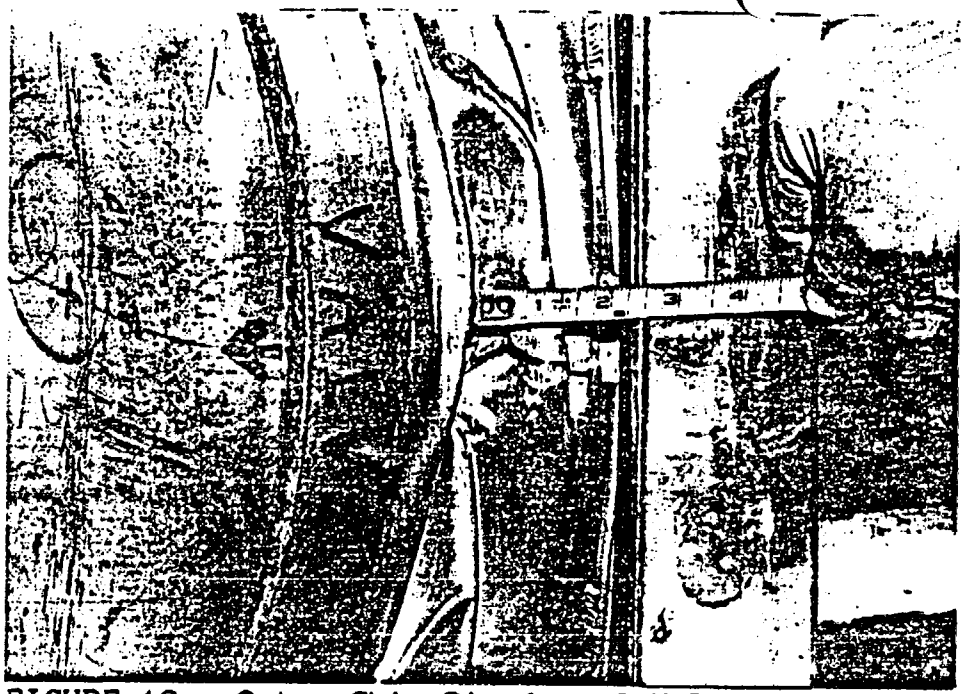


FIGURE 18. Outer Skin Rip from 9-M Bottom Drop

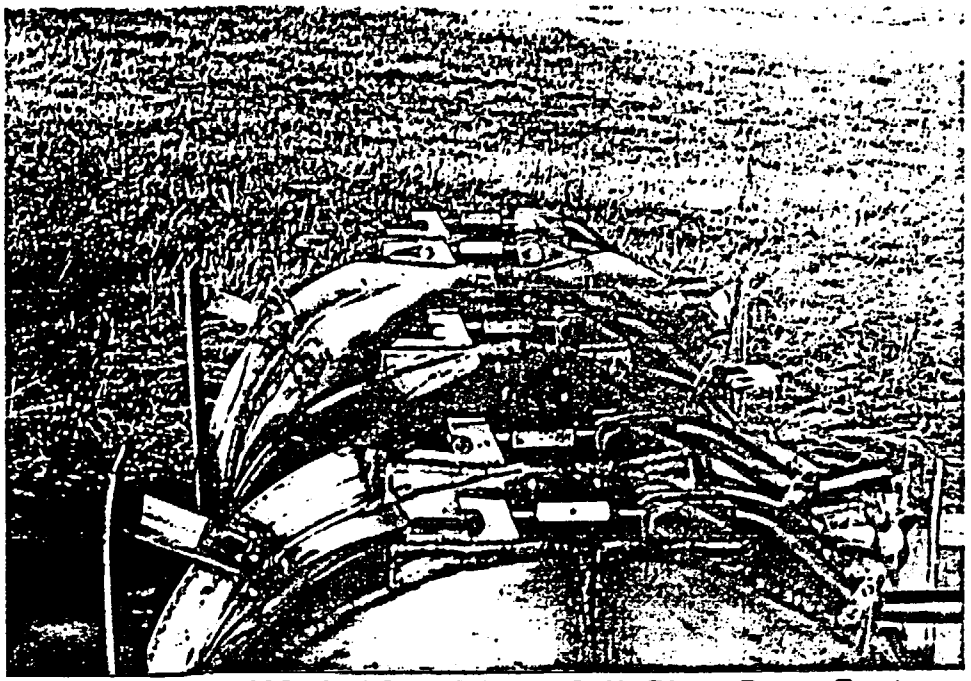


FIGURE 19. NCI-21PF-1 After 9-M Side Drop Test

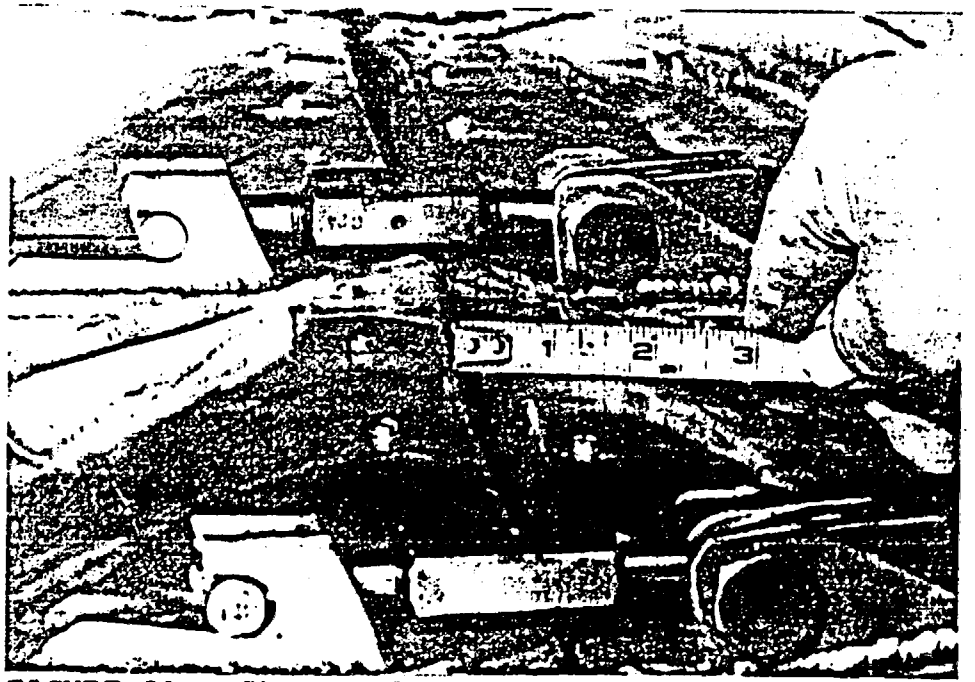


FIGURE 20. Closure Plane Gaps from 9-M Side Drop

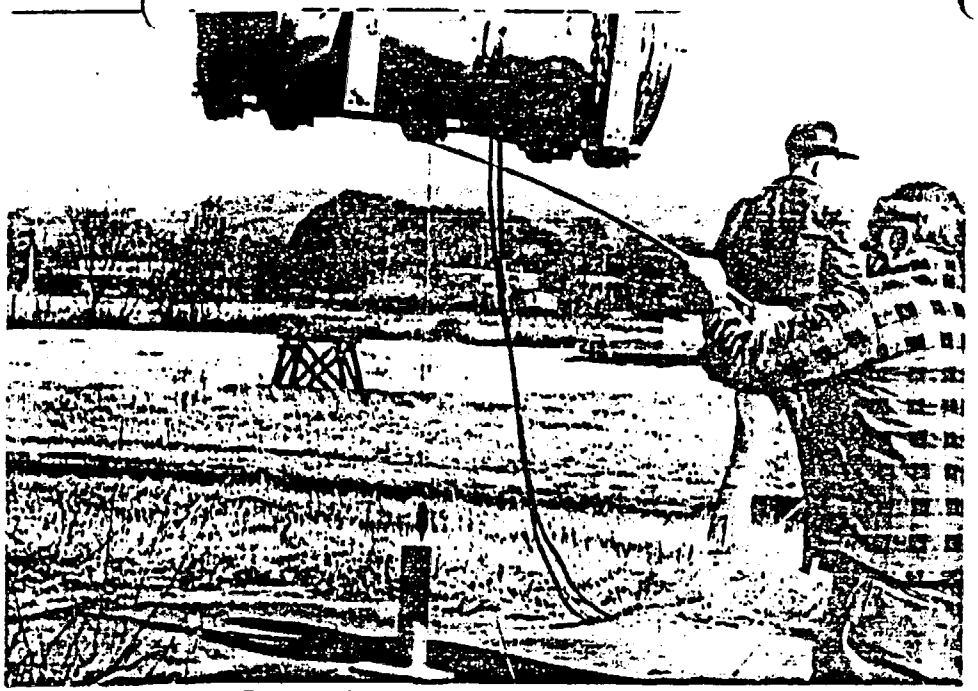


FIGURE 21. Prep for 1-M Puncture Drop on Closure

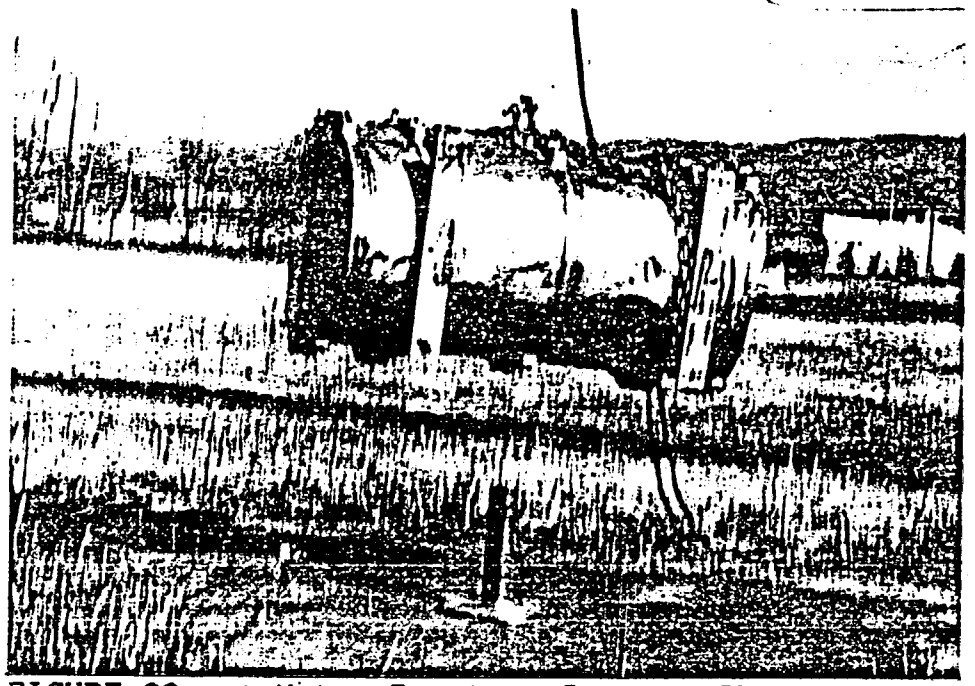


FIGURE 22. 1-Meter Puncture Drop on Closure

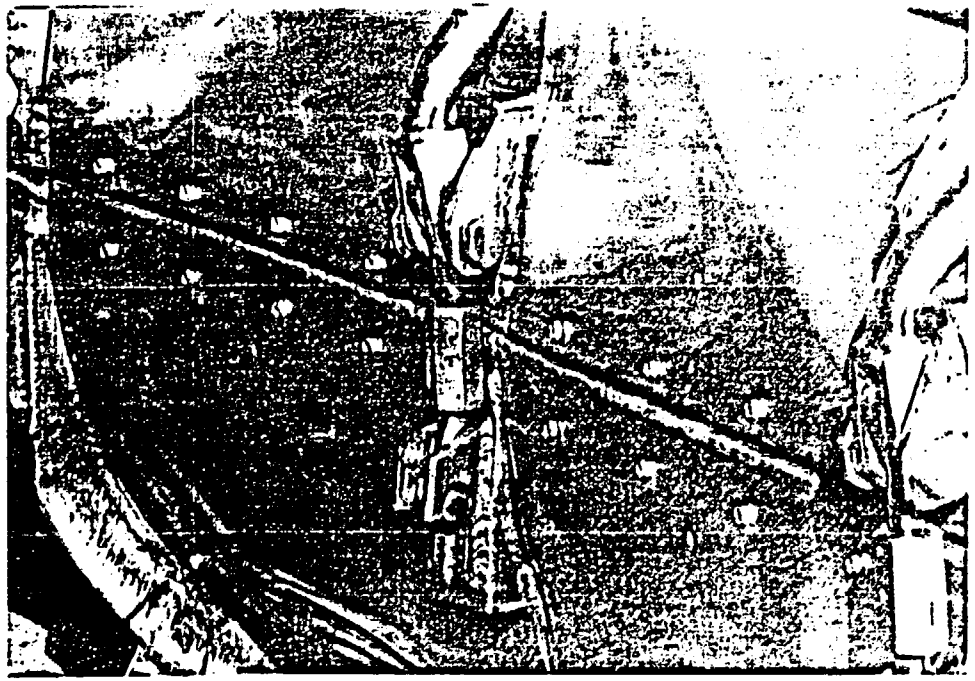


FIGURE 23. Closure Damage from 1-M Puncture Drop

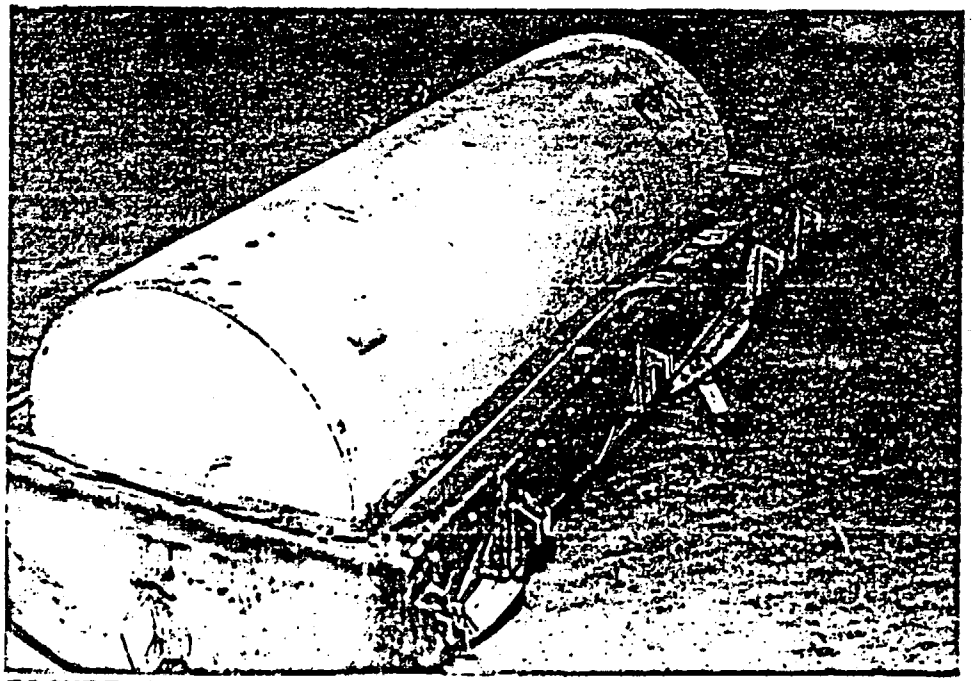


FIGURE 24. Condition of Cylinder After All Tests

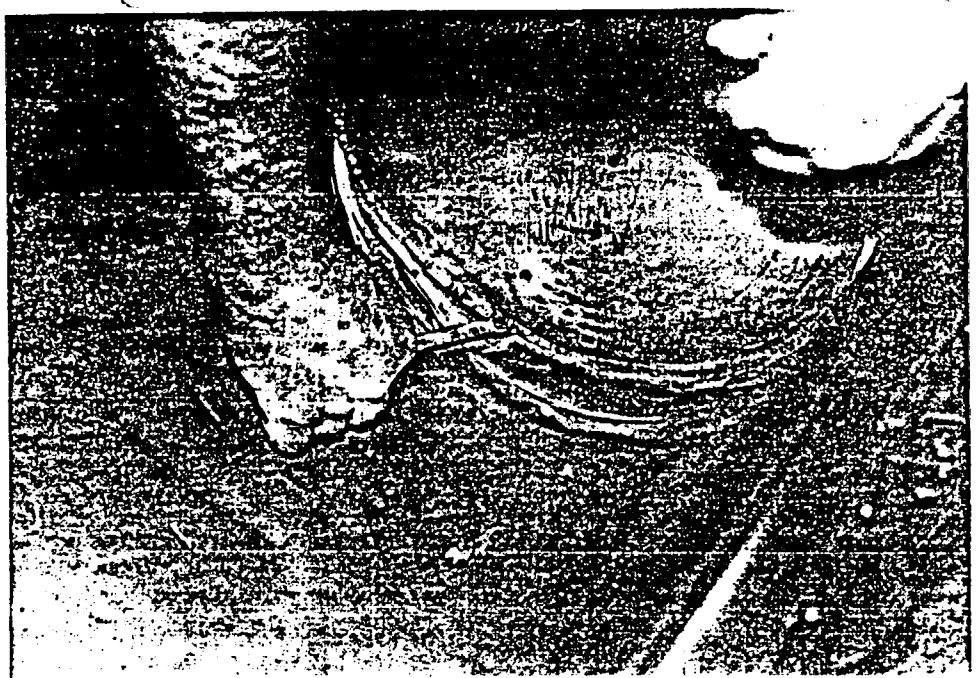


FIGURE 25. Condition of Inner Liner After Tests

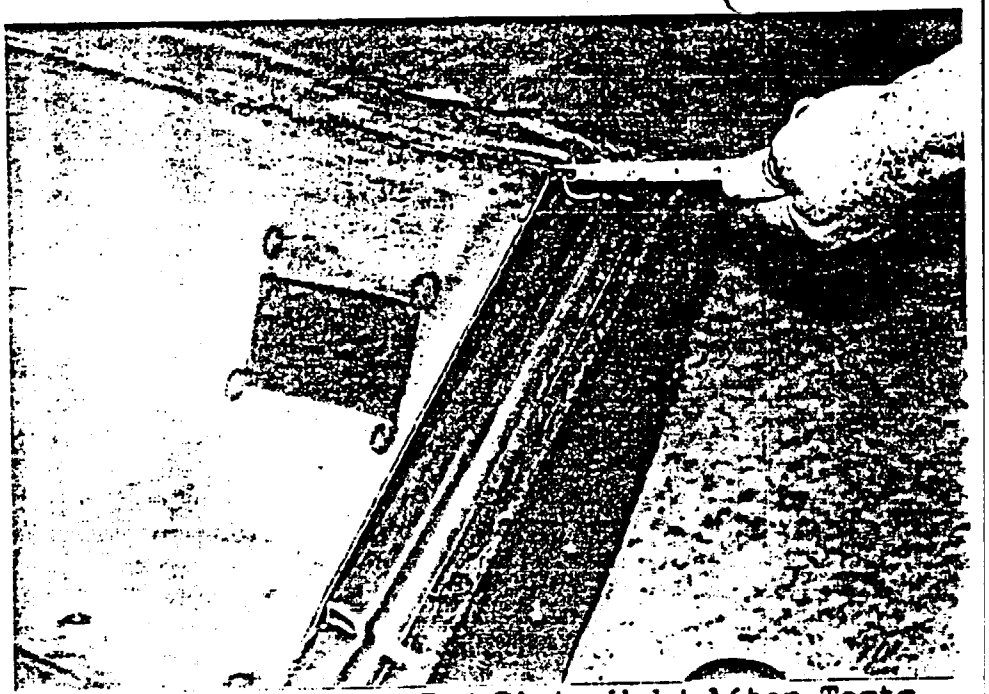


FIGURE 26. Break in End Plate Weld After Tests

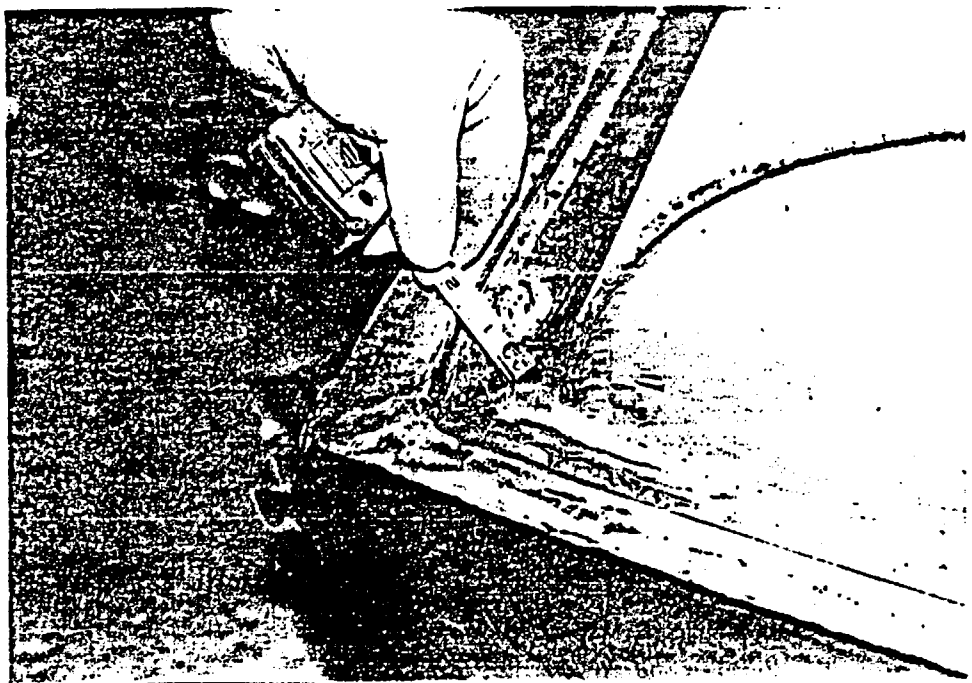


FIGURE 27. Crack in Wood Cover Plate After Tests

FIGURE WITHHELD UNDER 10 CFR 2.390

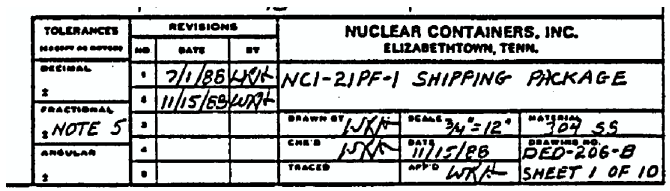


FIGURE WITHHELD UNDER 10 CFR 2.390

TOLERANCES	REVISIONS			NUCLEAR CONTAINERS, INC. ELIZABETHTOWN, TENN.		
DECIMAL ±	NO	DATE	BY	NCI-21FF-1 ASSEMELY DETAILS		
	1	7/1/88	WRH			
FRACTIONAL ± NOTE 5	2	11/15/88	WRH			
	3			DRAWN BY WRH	SCALE 1/5=12	MATERIAL 304 SS
ANGULAR ±	4			CHK'D WRH	DATE 6-1-88	DRAWING NO. DED-206-B
	5			TRACED	APP'D WRH	SHEET 2 OF 10

FIGURE WITHHELD UNDER 10 CFR 2.390

TOLERANCES	REVISIONS			NUCLEAR CONTAINERS, INC. ELIZABETHTOWN, TENN.		
DECIMAL ±	NO.	DATE	BY	TYPICAL ASSEMBLY DETAILS MODEL NCI-21PF-1 PACKAGE		
	1	7/1/88	WRH			
FRACTIONAL ± NOTE 5	2	11/15/88	WRH	DRAWN BY WRH	SCALE AS STATED	MATERIAL 304 SS
ANGULAR ±	3			CHK'D WRH	DATE 6-1-88	DRAWING NO DED-206-B
	4			TRACED	APP'D WRH	SHEET 3 OF 10
	5					

FIGURE WITHHELD UNDER 10 CFR 2.390

TOLERANCES (UNLESS AS NOTED)	REVISIONS			NUCLEAR CONTAINERS, INC. ELIZABETHTOWN, TENN.		
DECIMAL ±	NO.	DATE	BY	TYPICAL ASSEMBLY DETAILS MODEL NCI-21PF-1 PACKAGE		
	1	7/1/88	WRH			
	2	11/15/88	WRH			
FRACTIONAL ± NOTE 5	3			DRAWN BY WRH	SCALE HALF	MATERIAL 304 SS
	4			CHK'D MRH	DATE 6/1/88	DRAWING NO. DED-206-B
ANGULAR ±	5			TRACED	APP'D WRH	SHEET 4 OF 10

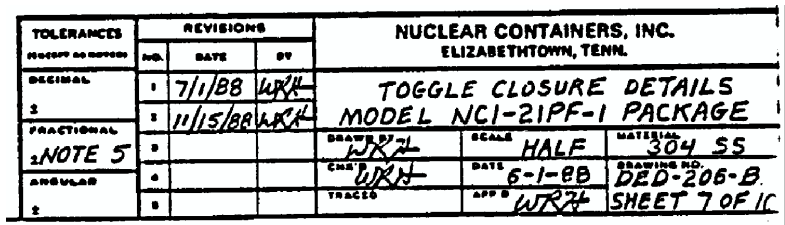
FIGURE WITHHELD UNDER 10 CFR 2.390

TOLERANCES	REVISIONS			NUCLEAR CONTAINERS, INC. ELIZABETHTOWN, TENN.		
	NO.	DATE	BY			
DECIMAL ±	1	7/1/85	WRH	TOGGLE BRACKETS MODEL NCI-21PF-1 PACKAGE		
	2	11/15/88	WRH			
FRACTIONAL ±NOTE 5	3			DRAWN BY WRH	SCALE 1/2	MATERIAL 304 SS
	4			CHK'D WRH	DATE 6-1-88	DRAWING NO DED-206-B
ANGULAR ±	5			TRACED	APP'D WRH	SHEET 5 OF 10

FIGURE WITHHELD UNDER 10 CFR 2.390

TOLERANCES	REVISIONS			NUCLEAR CONTAINERS, INC. ELIZABETHTOWN, TENN.		
	NO.	DATE	BY			
DECIMAL .XX ± .02 .XXX ± .002	1	7/1/88	WRH	TOGGLE DETAILS MODEL NCI-21PF-1 PACKAGE		
	2	11/15/88	WRH			
FRACTIONAL ± 1/32	3			DRAWN WRH	SCALE HALF	MATERIAL 17-4PH SS
	4			CHK'D WRH	DATE 6-1-88	DRAWING NO DED-206-B
ANGULAR ±	5			TRACED	APP'D WRH	SHEET 6 OF 10

FIGURE WITHHELD UNDER 10 CFR 2.390



TOLERANCES	REVISIONS			NUCLEAR CONTAINERS, INC. ELIZABETHTOWN, TENN.		
	NO.	DATE	BY			
DECIMAL ±	1	7/1/88	WRH	TOGGLE CLOSURE DETAILS MODEL NCI-21PF-1 PACKAGE		
FRACTIONAL ±NOTE 5	2	11/15/88	WRH	DRAWN BY WRH	SCALE HALF	MATERIAL 304 SS
ANGULAR ±	3			CHK'D WRH	DATE 6-1-88	DRAWING NO. DED-206-B
	4			TRACED	APP'D WRH	SHEET 7 OF 10
	5					

AP 124690

BILL OF MATERIALS

Quantities for one Model NCI-21PF-1 Protective Shipping Package; see Note 1 (Sheet 9) for material specifications. Items specified hereon by trade name provide minimum requirements only; equivalent or better items may be substituted.

ITEM	DESCRIPTION (QUANTITY REQUIRED)
Outer Shell	Sheet, 14 Ga x 72" x 91-3/4" (2 ea).
Outer Ends	Plate, 1/4" x 22" x 44" (4 ea).
Inner Shell	Sheet, 16 Ga x 60" x 82-5/8" (2 ea).
Inner Ends	Plate, 1/4" x 16" x 32" (4 ea).
Inner Angles	Angle, 2" x 2" x 1/4" by 91-1/2" length (2 ea).
Support Block Angles	Formed Angle, 1-1/2" x 1-1/2" x 16 Ga Sheet by 7" lengths (16 ea).
Wood Covers (Sides)	Sheet, 14 Ga x 7" x 92" (4 ea).
Wood Covers (Ends)	Sheet, 14 Ga x 5" x 43" (4 ea).
Closure Bands	Flat Bar, 1/4" x 3" by 72" length (6 ea).
Stiffener Rings	Angle, 3" x 3" x 3/8" by 80" length (4 ea).
Bottom Lift Angles	Angle, 3" x 3" x 1/4" by 56" length (2 ea).
Base Plates	Flat Bar, 1/2" x 6" by 43" length (4 ea).
Base Angle Legs	Angle, 2" x 2" x 1/4" by 12" length (8 ea).
Base Gussets	Plate, 1/2" x 2-1/8" x 3-1/8" (2 ea).
Lifting Eyes	Eye Bolt, 3/4"-10NC-2A x 2" long, with shoulder, galvanized carbon steel, 5200 lb. working load rating, McMaster Carr No. 3014T53 (4 ea).
Lifting Eye Nuts	Nuts, 3/4"-10NC-2B, ASTM A-194, Grade 8A Stainless Steel, ANSI B18.2.2.SF, Heavy Hex, with proper marking and material certification (4 ea).
Lifting Eye Washers	Lock Washer, 3/4" US Standard (4 ea).
Toggle Assemblies:	See Shts 5, 6, & 7 and Notes 1d, 3, & 14 (10 ea).
Upper Base	Plate, 1/4" x 7" x 10" (10 ea).
Upper Bracket	Flat Bar, 1/2" x 2-1/2" by 6" length (20 ea).
Lower Base	Plate, 1/4" x 7" x 9" (10 ea).
Lower Bracket	Flat Bar, 1/2" x 2-1/2" by 5-1/4" lgth (20 ea).
Arm Handle	Pipe, 1-1/4" Sch. 80 x 14" length (10 ea).
Arm Base	Flat Bar, 1/2" x 2" by 2-3/32" length (10 ea).
Arm Bracket	Flat Bar, 1/2" x 2" by 4" length (20 ea).
Upper T-Bolt	Casting, 1"-8NC-2A (10 ea).
Lower Swing-bolt	Casting, 1"-8NC-2A (10 ea).
Swing-bolt Pin	Rod, 1" dia. x 2" long (10 ea).
Pivot Bolts	Casting, 1-1/4"-7NC Hex Shoulder Bolt (20 ea).
Coupling Nut	Casting, 1-1/2" Hex x 1"-8NC (10 ea).
Set Screws	Hex Socket Set Screw, 1/4"-20NC-2A x 1/4", Self-Locking Stainless Steel, McMaster Carr No. 90251A533 (30 ea).
Lock-down Pin	Ball Lock Pin, 1/2" dia. x 2-1/2" long, Stainless Steel with attaching cable, Carr-Lane No. CL-8-BLP-T-2.5S (10 ea). McMaster Nr. 90293A413 Type C
Lock-down Bracket	Flat Bar, 1/4" x 1-1/2" by 3-1/4" lgth (20 ea).
Attaching Screw	1/4" Hex Head, Self Tapping SS Screw (10 ea).
Seal Lug	Pad Eye, 3/4", Stainless Steel, McMaster Carr No. 8892T12 (4 ea).

ITEM	DESCRIPTION (QUANTITY REQUIRED)
Lag Screws	1/4" x 2" Hex Head (136 ea).
Boat Nails	Plain Flat Head, #10 x 2-1/2" (100 ea).
Wooden Components:	Oak, moisture content less than 15%. Rails and Cap Boards--Select Grade; laminated components--No. 2 Common or better, see Note 6.
End Block	Cross-lamination 4-3/16" thick using 1-3/8" thick boards per Sheet 3 (4 ea, 150 board-feet).
End Rail	Board, 1-1/2" tk x 4-1/2" x 43" (4 ea, 16 brd-ft).
Upper End Cap	Board, 1" tk x 2-1/2" x 43" (2 ea, 4 board-feet).
Lower End Cap	Board, 5/8" tk x 2-1/2" x 43" (2 ea, 3 board-ft).
Side Rail	Board, 1-1/2" tk x 6-1/2" x 92" (4 ea, 45 brd-ft).
Upper Side Cap	Board, 1" tk x 3-1/2" x 92" (2 ea, 12 board-feet).
Lower Side Cap	Board, 5/8" tk x 3-1/2" x 92" (2 ea, 8 board-ft).
Support Block	Lamination, 6" thick x 5-1/2" x 9" made of five 1-3/8" thick boards, (8 ea, 25 board-feet).
Dowel Rod	Hardwood, 3/4" x 6" long (16 ea).
Wood Glue	Weldwood Waterproof Plastic Resin Adhesive (10 lb).
Concrete Nails	No. 10 x 2" and No. 10 x 3" (about 10 lb).
Phenolic Foam	Raw Materials for Fire Resistant Phenolic Foam Insulation per AEC Material and Equipment Specification No. SP-9, Rev. 1 and Supplement X/TL-729, see Notes 8 & 9 (about 260 lb total).
Upper Pad	Neoprene Sponge, 1/2" thick x 6" x 9", medium density, closed cell (4 ea).
Lower Pad	Neoprene, 3/16" thick x 6" x 9", 50 to 60 Durometer A (4 ea).
Rubber Adhesive	Rubber to Metal Cement, 3M No. 051135-08004 (2 oz) or Silicone Adhesive/Caulking described below.
Gasket	Silicone Sponge, 1/2" thick x 1-1/2" wide, medium density, closed cell, rated for continuous use at 400°F (21 feet).
Gasket Primer	Metal Primer, Clear, Albi 467S (1 pint).
Silicone Caulking	Silicone RTV Adhesive/Caulking, rated for continuous use at 400°F, Dow Silastic 732 (about 2 ea 10-oz tubes).
Paint, Fire	Fire Retardant Paint, White, Intumescent, Albi 107A (1 quart).
Vent Seals	Plastic Plugs for 1/4" holes, Caplug No. BPF-1/4 Polyethylene by Protective Closures Co., Buffalo, NY (40 ea).

TOLERANCES	REVISIONS			NUCLEAR CONTAINERS, INC. ELIZABETHTOWN, TENN.		
DECIMAL ±	NO.	DATE	BY	BILL OF MATERIALS MODEL NCI-21PF-1 PACKAGE		
	1	7/1/88	WKH			
FRACTIONAL ± NOTE 5	2	11/15/88	WKH	DRAWN BY WKH	SCALE	MATERIAL NOTE 1
ANGULAR ±	3			CHK'D LWKH	DATE 6-1-88	DRAWING NO DED-206-B
	4			TRACED	APP'D WKH	SHEET 8 OF 10
	5					

NORTHSIDE BLUEPRINT & SUPPLY CO.

AP 124699

NOTES

1. Unless otherwise specified, all metal items shall be as follows:

   (a) Sheet--ASTM A-240, Type 304 or 304L Stainless Steel, #2B Finish.

   (b) Plate--ASTM A-240, Type 304 or 304L Stainless Steel, #1 Finish.

   (c) Angle & Flat Bar--ASTM A276, Type 304 or 304L Stainless Steel, Hot Rolled, Annealed, and Pickled. It is acceptable for flat bar to be fabricated from sheet or plate meeting above specifications.

   (d) Toggle Castings and Swing Pins--Type 17-4PH Stainless Steel, solution heat treated at 1900 ± 25°F for 30 minutes in vacuum and nitrogen cooled to put material in Condition A; then hardened to Condition H1100 by heat treating at 1100°F for 4 hours and air cooling. Machining operations may be done in either Condition A or H1100.

   (e) Pipe--ASTM A-312, Type 304 or 304L Stainless Steel, seamless or welded, cold drawn, annealed, and pickled. Fittings shall be ASTM A-403, Type 304 or 304L Stainless Steel.

   (f) Boat Nails, Lag Screws, Set Screws, Pad Eyes, & Washers--300 Series, 18-8, or 17-4PH Stainless Steel.

2. Certifications and Test Reports:

   (a) Mill test reports must be obtained and maintained on file for all stainless steel raw materials including sheet, plate, angles, flat bar, pipe and pipe fittings, and casting metal for cast toggle components.

   (b) Manufacturer's certifications must be obtained and maintained on file for gasket materials and for lifting eye-bolts and nuts.

   (c) All other commercially available items may be purchased without certification, but copies of written purchase orders which stipulate the appropriate specifications must be maintained on file for each such item.

3. All cast toggle components shall be Investment Castings of Type 17-4PH Stainless Steel in the H1100 Condition as specified in Note 1(d) above; these castings shall meet the requirements of Section VIII, Articles UG-24(a)(1) & (5) and UG-24(b) & (c), ASME Boiler and Pressure Vessel Code. After heat treating, all castings shall be examined per ASME Code, Section VIII, Appendix VII, Articles UA-80; UA-81(b) & (c); UA-82(a)(1), (2), (4), & (5); UA-83; and UA-84. All items must be re-examined after any repairs and/or reheat treating required by UA-83.

4. Welds:

   (a) Unless otherwise specified, all welds shall be continuous and shall develop the full strength of the weakest member being joined; butt welds shall be full penetration welds. All welds shall be free from cracks, excessive undercutting, pits, or spatter, and shall not be oxidized beyond normal discoloration which can easily be removed by wire brushing.

   (b) Welds shall only be by GTAW or GMAW processes using welders and welding procedures qualified on P8 materials in accordance with Section IX, ASME Boiler and Pressure Vessel Code. Use only Type 308L weld rod and filler materials for welding.

   (c) Do not weld over foam materials; weld over wood only when it has been coated with fire retardant intumescent paint and then use appropriate means to reduce heat to a minimum to protect the wood.

   (d) All stainless steel wire brushes, grinding wheels, and cutting discs which are used for stainless steel shall be used for stainless steel only and shall be so marked. Carbon steel wire brushes shall not be used on stainless steel.

   (e) Welds shall be inspected in accordance with Section V, Article 9 of the ASME Code; the inner liner, outer shell, and wood cover seams shall be inspected visually--linear defects over 1/16" shall be ground out and repaired, other welds shall meet the minimum requirements indicated.

5. Tolerances; unless otherwise specified:

   (a) Dimensions up to 24" shall be ± 1/16".

   (b) Dimensions greater than 24" shall be ± 1/8".

   (c) Gasket sealing surfaces shall be flat ± 1/16" per 3 feet.

   (d) Overall diagonal lengths shall be within 1/8" of each other.

TOLERANCES (UNLESS OTHERWISE NOTED)	REVISIONS NO.	DATE	BY	NUCLEAR CONTAINERS, INC. ELIZABETHTOWN, TENN.		
DECIMAL ±	1	7/1/88	WRH	NOTES & SPECIFICATIONS MODEL NCI-21PF-1 PACKAGE		
FRACTIONAL ± NOTE 5	2	11/15/88	WRH	DRAWN BY WRH	SCALE	MATERIAL NOTE 1
ANGULAR ±	3			CHK'D WRH	DATE 6-1-88	DRAWING NO. DED-206-B
	4			TRACED	APP'D WRH	SHEET 9 OF 10
	5					

AF 124490

NOTES--continued:

6. All wood shall be inspected to ensure that it is free of rot, end splitting, loose knots, etc. prior to use; Select Grade lumber for rails and cap boards shall essentially be clear lumber with no knots greater than 1/2". Unacceptable portions may be cut off and discarded, but all boards shall be full length and shall not be spliced lengthwise; each rail or cap board must be a single board. All wood assemblies shall be glued with waterproof plastic resin glue and nailed with No. 10 concrete nails spaced no more than 6" apart.

7. Paint all wood with two coats of fire retardant intumescent paint prior to installation. Seal all screw and nail penetrations through the inner liner or outer shell with silicone RTV caulking when inserting the screw or nail; wipe off excess RTV caulking.

8. Insulation shall be Fire Retardant Phenolic Foam fabricated in accordance with US AEC Material and Equipment Specification SP-9, Rev. 1 and Supplement K/TL-729. Foam each package in place using 2 or 3 equal pours each for the cover half and the bottom half; weight of finished insulation shall be a minimum of 100 pounds in each half. Install and secure the wooden end block in each half immediately after the last pour has been made. After foaming is complete, inspect all vent holes to ensure that the foam has completely filled all void space; if any voids are found, the end blocks must be removed and foam must be added as needed to fill all voids.

9. After foam has cured, drill out all vent holes to a depth of 1/4" to 1/2" and seal each with a plastic cap-plug set in silicone RTV caulking; wipe away excess caulking and allow to cure.

10. Prior to installation of gaskets or rubber pads, use acetone or MEK solvent to thoroughly clean and degrease the metal in the areas to which the rubber is to adhere. Then apply one coat of clear metal primer to the cleaned area and allow to air dry for one hour at room temperature. Install the silicone sponge gaskets by applying a uniform layer (15 to 30 mils) of silicone RTV caulking to the metal surface and applying the gasket using only enough pressure to displace the air but not the adhesive. Seal all joints in the gasket using silicone RTV caulking; wipe away excess caulking and allow to cure. Install the rubber pads using rubber to metal cement per the manufacturer's instructions or use silicone RTV caulking as described above.

11. Seal all penetrations in inner and outer shells with Silicone RTV by setting the penetrating item (lag screw, nail, vent plug, or pop rivet) in the uncurred RTV and allow to cure per manufacturers instructions.

12. Items specified hereon by trade name provide minimum requirements only; equivalent or better items may be substituted.

13. Obtain weights of cover, of bottom, and of assembled package without a cylinder; these weights (in pounds and kilograms) must be recorded and included in package labeling and in marking package name plates; see Drawing No. DED-207-A for name plate marking.

14. After assembly of finished package, adjust all toggle closures to securely close the package giving a metal-to-metal seat without requiring excessive closing force; then tighten all set screws in each toggle coupling nut. Lock down each toggle handle using a ball-lock pin.

15. Attach the cable of each ball-lock pin to the lower toggle bracket just above it using a 1/4" self-tapping screw set in silicone caulking.

TOLERANCES (UNLESS OTHERWISE NOTED)	REVISIONS			NUCLEAR CONTAINERS, INC. ELIZABETHTOWN, TENN.		
DECIMAL ±	NO.	DATE	BY	NOTES & SPECIFICATIONS MODEL NCI-21PF-1 PACKAGE		
	1	7/1/88	WRH			
	2	11/15/88	WRH			
FRACTIONAL ± NOTE 5	3			DRAWN BY WRH	SCALE	MATERIAL NOTE 1
	4			CHK'D WRH	DATE 6-1-88	DRAWING NO. DED-206-B
ANGULAR ±	5			TRACED	APP'D WRH	SHEET 10 OF 10

MACHINIST BLUEPRINT & SUPPLY CO.

AF 12469A

PACKAGE IDENTIFICATION PLATE

A. PLATE SHALL BE 11" WIDE X 15" LONG X 16 TO 20 GAGE SHEET, ASTM A-240, TYPE 304 STAINLESS STEEL.

B. ENGRAVE PLATE WITH LETTERS 1/2" HIGH AS FOLLOWS:

USA/UUUU*/AF
RADIOACTIVE MATERIAL--TYPE AF
MFG BY: V----------V*
QA APPROVAL NO. X------X*
SERIAL NO. Y------Y*
TARE WT WITHOUT INNER CYL IN LBS (AND KGS):

DATE	COVER WITH EYE-BOLTS	BOTTOM WITH ALL HARDWARE	TOTAL PACKAGE
DDDD*	WWWW*(ZZZZ)*	WWWW*(ZZZZ)*	WWWW*(ZZZZ)*

(Leave bottom 8" blank for future dates and weights)

C. ATTACH PLATE TO CONTAINER AS SPECIFIED ON DWG. DED-206-B.

---

* UUUU - CERTIFICATE OF COMPLIANCE NO. (EXAMPLE: USA/4909/AF)
V--V - NAME AND ADDRESS OF MANUFACTURER AND DATE OF MANUFACTURE (EXAMPLE: NUCLEAR CONTAINERS, INC., ELIZABETHTON, TN, USA, 11-88)
X--X - TRANSPORTATION QA PROGRAM APPROVAL NO. (EXAMPLE: USNRC-9999)
Y--Y - SERIAL NO. OF INDIVIDUAL PACKAGE (EXAMPLE: NCI-1234)
DDDD - DATE OF WEIGHING (EXAMPLE: 11-88)
WWWW - ACTUAL TARE WEIGHT IN POUNDS (TOLERANCE: ± 5 LBS)
ZZZZ - ACTUAL TARE WEIGHT IN KILOGRAMS (TOLERANCE: ± 2 KGS)

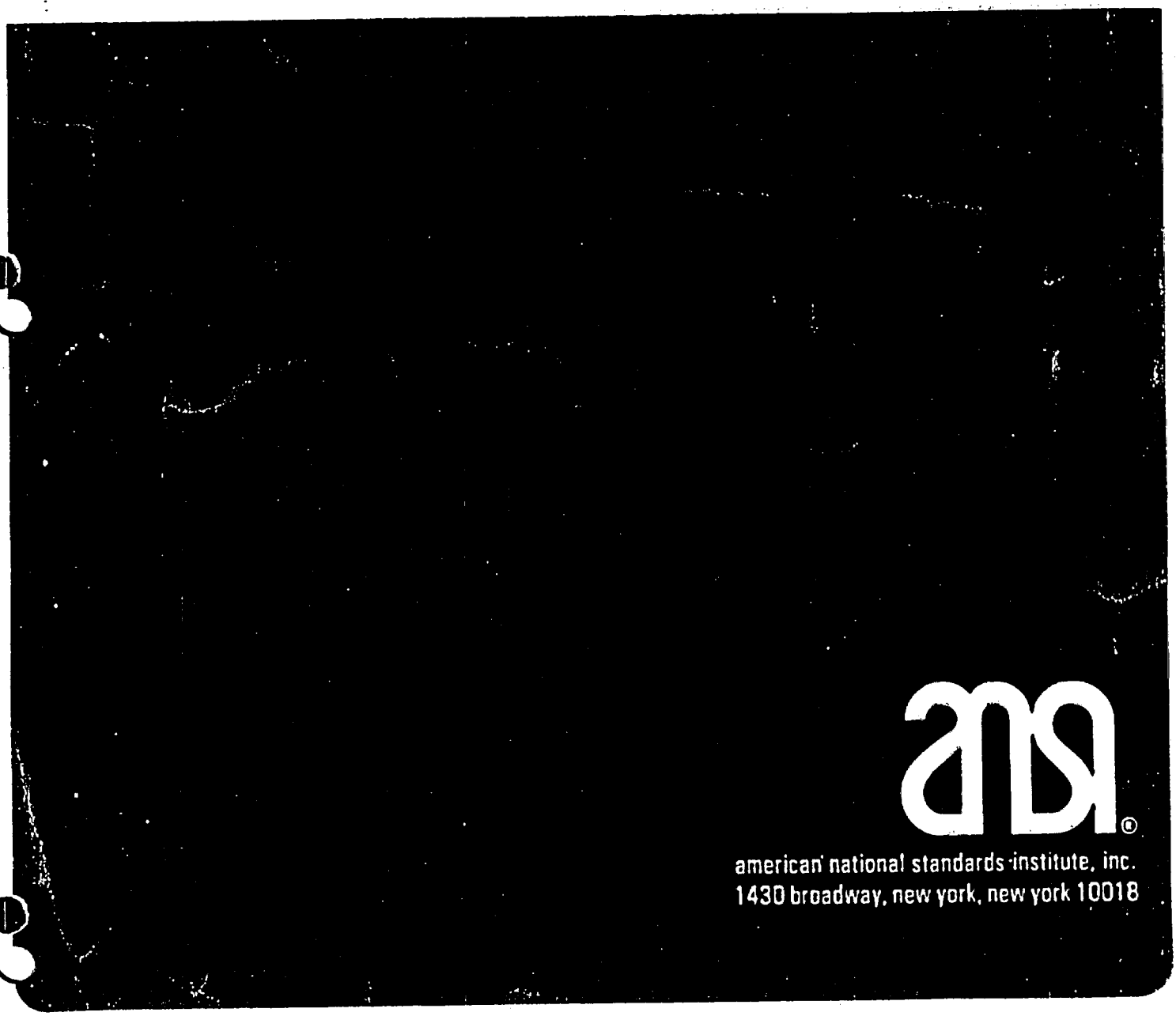
REFERENCE DRAWINGS: DED-206-B, SHEETS 1 THROUGH 10, LATEST REVISIONS.

NUCLEAR CONTAINERS, INC. ELIZABETHTOWN, TENN.		
NAMEPLATE FOR NCI-21PF-1 UF6 CYLINDER SHIPPING PACKAGE		
DECIMAL TOL.	SCALE NTS	REVISION (DATE) 0
FRACTIONAL TOL.	DATE 11/15/88	DRAWING NO. DED-207-A
ANGULAR TOL.	APP'D WRJ	

American National Standard

for nuclear materials –

uranium hexafluoride – packaging for transport



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ANSI®
N14.1-1987
Revision and
Consolidation of
ANSI N14.1-1982
and ANSI N14.1a-1986

American National Standard for Nuclear Materials –

Uranium Hexafluoride – Packaging for Transport

Approved October 30, 1987
American National Standards Institute, Inc

Secretariat
Institute of Nuclear Materials Management

American National Standard

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Published by

American National Standards Institute
1430 Broadway, New York, New York 10018

Printed in the United States of America

A1M288/25

Foreword

(This Foreword is not part of American National Standard N14.1-1987).

This standard was developed under the procedures of the American National Standards Institute by Subcommittee N14-8 (later changed to N14-1) of Accredited Standards Committee N14 on Packaging and Transportation of Fissile and Radioactive Materials. The secretariat of N14 is presently held by the Institute of Nuclear Materials Management. At the time this standard was being developed, it was held by the American Insurance Association.

The N14 Committee has the following scope:

Standards for the packaging and transportation of fissile and radioactive materials but not including movement or handling during processing and manufacturing operations.

Packaging of uranium hexaflouride (UF_6) for transport is an essential part of a safe and economical nuclear industry. This standard presents information on UF_6 cylinders, valves, protective packages, and shipping.

The packaging and transport of UF_6 is subject to regulation by government agencies having jurisdiction over packaging and transport. This standard does not take precedence over applicable U.S. Nuclear Regulator Commission (NRC), U.S. Department of Energy (DOE), U.S. Department of Transportation (DOT), or other governmental regulations.

This standard covers only those standard cylinders that meet all of the acceptance criteria for UF_6 handling and is recommended for all new cylinder construction. Cylinders currently in service and not in accordance with this standard are acceptable for continued use, provided that they are inspected, tested, and maintained so as to comply with the intent of this standard and used within their original design limitations.

It should be noted that some technical regulatory material has been restated in this standard. It was determined by the subcommittee that this is appropriate and convenient and would assist the user of the standard. For more detailed information, the user is encouraged to use the appropriate regulatory document.

Suggestions for improvement of this standard will be welcome. They should be sent to the Institute of Nuclear Materials Management, 60 Revere Drive, Suite 500, Northbrook, Illinois 60062.

This standard was processed and approved for submittal to ANSI by Accredited Standards Committee on Packaging and Transportation of Fissile and Radioactive Materials, N14. Committee approval of the standard does not necessarily imply that all committee members voted for its approval. At the time it approved this standard, the N14 Committee had the following members:

John W. Arendt, Chair
Edmund C. Tarnuzzer, Vice Chair, East USA
Richard T. Haelsig, Vice Chair, West USA
Miriam J. Welch, Secretary

Organization Represented	*Name of Representative*
AIF Committee on Radiopharmaceutical Industry	J.P. Gresh
American Industrial Hygiene Association	R.L. Hoover
American Institute of Chemical Engineers.	H.C. Carney
American Insurance Service Group	S.M. Fastman

Organization Represented	*Name of Representative*
American Nuclear Insurers	R.A. Oliveira
American Nuclear Society	D.M. Dawson
Atomic Industrial Forum Committee on Transportation	H. Walchli
Center for Devices and Radiological Health	G. Schmidt
	C.P. Froom (Alt)
Edison Electric Institute	E.C. Tarnuzzer
Factory Mutuals System	P.H. Dobson
Health Physics Society	D.A. Edling
Institute of Nuclear Materials Management	J.W. Arendt
International Association of Chiefs of Police	R.H. Sostkowski
International Association of Fire Chiefs	(Representation Vacant)
International Association of Fire Fighters	J. Sawicki
Military Traffic Management Command	S.F. Wawrzaszek
National Association of Governmental Labor Officials	J.F. Drayton
U.S. Coast Guard	R.H. Trainor
U.S. Department of Energy	L.H. Harmon
	P. Grimm (Alt)
	C. Mauck (Alt)
U.S. Department of Transportation	M.E. Wangler
U.S. Environmental Protection Agency	M.O. Semler
U.S. Nuclear Regulatory Commission	C. MacDonald
	A.W. Grella (Alt)
	D.R. Hopkins (Alt)

Individual Members

G. Chalfant
P.E. Eggers
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W.R. Taylor
R.H. Towell
R. Vaughn
R.T. Waite
B.H. Wakeman
M. Warrant
M.J. Welch
E.L. Wilmot

Subcommittee N14.1 on Packaging of Uranium Hexafluoride, which developed this revision, had the following members:

R.I. Reynolds, Chair
J.H. Alderson
R. Boelens
R.D. Clark
P.A. Craig
J.O. Dodson
R.H.D. Foleck
F. Hetzler
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J.V. Marler
G. McRae
R.D. Montgomery
W.A. Pryor
G.E. Rasel
R.R. Rawl
M.E. Wangler

Contents

SECTION PAGE

American National Standard for Nuclear Materials –

Uranium Hexafluoride – Packaging for Transport

1. Scope and Purpose

1.1 Scope. This standard provides criteria for packaging of uranium hexafloride (UF_6) for transport. It includes specific information on design and fabrication requirements for the procurement of new UF_6 packagings. This standard also defines the requirements for in-service inspections, cleanliness, and maintenance for packagings in service. Packagings currently in-service and not specifically defined in this standard are acceptable for use, provided they are used within their original design limitations and are inspected, tested, and maintained so as to comply with the intent of this standard. Also included are cylinder loadings, shipping details, and requirements for valves and valve protectors.

1.2 Purpose. This standard is intended to provide guidance and criteria for shipment of UF_6. It will assist in providing for compatibility of UF_6 packaging among different users within the nuclear industry.

2. Referenced Standards and Publications

2.1 Referenced American National Standards. This standard is intended to be used in conjunction with the following American National Standards. When the American National Standards referred to in this document are superseded by a revision approved by the American National Standards Institute, Inc., the revision shall apply:

ANSI B1.1-1982 and ANSI/ASME B1.1a-1984, Unified Inch Screw Threads (UN and UNR Thread Form)

ANSI B1.5-1977, Acme Screw Threads

ANSI B16.11-1980, Forged Steel Fittings, Socket-Welding and Threaded

ANSI/ASME Boiler and Pressure Vessel Code-1986

ANSI/ASME B1.20.1-1983, Pipe Threads, General Purpose

ANSI/ASME NQA-1-1986 and ANSI/ASME NQA-1a-1986, Quality Assurance Program Requirements for Nuclear Facilities

ANSI/AWS A5.1-81, Specification for Covered Carbon Steel Arc Welding Electrodes

ANSI/AWS A5.8-81, Specification for Brazing Filler Metal

ANSI/AWS A5.14-83, Specification for Nickel and Nickel Alloy Bare Welding Rods and Electrodes

ANSI/AWS A5.17-80, Specification for Carbon Steel Electrodes and Fluxes for Submerged Arc Welding

ANSI/AWS A5.18-79, Specification for Carbon Steel Filler Metals for Gas-Shielded Arc Welding

ANSI/AWS D1.1-86, Structural Welding Code — Steel

ANSI/CGA V-1-1977, Compressed Gas Cylinder Valve Outlet and Inlet Connections

2.2 Other Referenced Standards. This standard is also intended to be used in conjunction with the following standards:

ASTM A20-86, Specification for General Requirements for Steel Plates for Pressure Vessels[1]

ASTM A36-84, Specification for Structural Steel[1]

ASTM A53-84, Specification for Black and Hot-Dipped, Zinc-Coated Welded and Seamless Steel Pipe[1]

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[1]Available from ASTM, 1916 Race Street, Philadelphia, PA 19103.

ASTM A105-86, Specifications for Carbon Steel Forgings for Piping Components[1]

ASTM A108-81, Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality[1]

ASTM A131-85, Specification for Structural Steel for Ships[1]

ASTM A167-84, Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip[1]

ASTM A240-86, Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Fusion-Welded Unfired Pressure Vessels[1]

ASTM A285-82, Specification for Carbon Steel Low- and Intermediate-Tensile Strength Pressure Vessel Plates[1]

ASTM A370-77, Methods and Definitions for Mechanical Testing of Steel Products[1]

ASTM A516-84, Specification for Carbon Steel Pressure Vessel Plates for Moderate- and Lower-Temperature Service[1]

ASTM A570-85, Specification for Hot-Rolled Carbon Steel Sheets and Strip, Structural Quality[1]

ASTM A575-81, Specification for Merchant Quality Hot-Rolled Carbon Steel Bars[1]

ASTM B32-83, Specification for Solder Metal[1]

ASTM B127-85, Specification for Nickel-Copper Alloy Plate, Sheet, and Strip[1]

ASTM B150-85, Specification for Aluminum Bronze Rod, Bar, and Shapes[1]

ASTM B160-81, Specification for Nickel Rod and Bar[1]

ASTM B161-81, Specification for Nickel Seamless Pipe and Tube[1]

ASTM B162-85, Specification for Nickel Plate, Sheet, and Strip[1]

ASTM B164-84, Specification for Nickel-Copper Alloy Rod and Bar[1]

ASTM B165-81, Specification for Nickel-Copper Alloy Seamless Pipe and Tube[1]

ASTM B249-86, Specification for General Requirements for Wrought Copper and Copper-Alloy Rod, Bar, and Shapes[1]

ASTM B366-86, Specification for Factory-Made Wrought Nickel and Nickel-Alloy Welding Fittings[1]

AWS B3.0-77, Welding Procedure and Performance Qualification[2]

2.3 Other Publications. This standard is also intended to be used with the following publications:

[1] Standards for protection against radiation. Title 10, Code of Federal Regulations, Part 20, Washington, D.C.: Government Printing Office, January 1, 1986.[3]

[2] Special nuclear materials. Title 10, Code of Federal Regulations, Part 70, Washington, D.C.: Government Printing Office, January 1, 1987.[3]

[3] Packaging of radioactive material for transport. Title 10, Code of Federal Regulations, Part 71, Washington D.C.: Government Printing Office, January 1, 1987.[3]

[4] Radioactive materials; definitions. Title 49, Code of Federal Regulations, Part 173.389, Washington, D.C.: Government Printing Office, November 1, 1986.[3]

[5] Regulations applying to shippers. Title 49, Code of Federal Regulations, Part 173, Washington, D.C.: Government Printing Office, November 1, 1986.[3]

[6] Shipping container specifications. Title 49, Code of Federal Regulations, Part 178, Washington, D.C.: Government Printing Office, November 1, 1986.[3]

[7] Regulations for the safe transport of radioactive materials. Vienna: International Atomic Energy Agency, 1985.[4]

[8] Certificate of Compliance, USA-6553/BF(DOE-ORO). U.S. Department of Energy, P.O. Box E, Oak Ridge, Tennessee, September 6, 1983.[5]

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[2]Available from American Welding Society, 550 North LeJeune Road, Miami, FL 33135.

[3]Available from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

[4]Available from UNIPUB, Inc., P.O. Box 433, New York, NY 10016.

[5]Available from U.S. Department of Transportation, Washington, D.C. 20590.

[9] Fissile radioactive materials. Title 49, Code of Federal Regulations, Part 173.417, Washington, D.C.: Government Printing Office, November 1, 1986.[5]

[10] Certificate of Compliance, USA-6273-48/AF (DOE-ORO). U.S. Department of Energy, P.O. Box E, Oak Ridge, Tennessee, September 6, 1983.[5]

[11] Uranium hexafluoride handling procedures and container criteria, USAEC Report ORO-651. Oak Ridge, Tennessee: Oak Ridge Operations, U.S. Department of Energy, November 1986, Revision 5.[6]

[12] Directory of Certificate of Compliance for Radioactive Material Packages, NUREG-0383.[5]

[13] DOT 7A Type A Certification document, MLM-3245.[7]

3. Definitions

The definitions below are of a restricted nature for the purpose of this standard.

Terms defined in Title 10, Code of Federal Regulations (CFR), Parts 20 [1],[8] 70 [2], and 71 [3], and in Title 49, CFR, Part 173.403 [4] have the same meaning when used in this standard.

clean cylinder. A cylinder that has been previously used and has been cleaned to remove residual quantities of uranium and other contaminants.

curie (Ci). The special unit of activity. One curie equals 3.7×10^{10} disintegrations per second (d/s) exactly, which is also by definition 3.7×10^{10} becquerels (Bq). (A method for calculating the activity level in cylinders of UF_6 is provided in Appendix C.)

DOT specification container. A container whose design has been published by the U.S. Department of Transportaton (DOT) and is licensed under the general licensing provisions of the U.S. Nuclear Regulatory Commission (NRC). Its use is limited to the provisions prescribed for those containers in Title 49, CFR, Parts 173 [5] and 178 [6].

empty cylinder. A cylinder containing a residual amount of UF_6 and nonvolatile reaction products of uranium (heel) in quantities less than those specified in 8.1.2. This definition should not be confused with the category of empty packaging used in 49 CFR 173.427.

fabricator. One who manufactures, repairs, or modifies a packaging.

fissile classification. Classification of a package or shipment of fissile materials according to the controls needed to provide nuclear criticality safety during transportation, as given in (1) through (3).

(1) *Fissile Class I.* Packages that may be transported in unlimited numbers and in any arrangement and require no nuclear criticality safety controls during transportation. For purposes of nuclear criticality safety control, a transport index is not assigned to Fissile-Class-I packages.

(2) *Fissile Class II.* Packages that may be transported together in any arrangement but in numbers such that the sum of the individual transport index numbers does not exceed 50. For purposes of nuclear criticality safety control, individual packages may have a transport index of not less than 0.1 and not more than 10.0. However, the external radiation levels may require a transport index number higher than the value assigned for criticality safety control purposes, but not to exceed 10.

(3) *Fissile Class III.* Shipments of packages that do not meet the requirements of Fissile Classes I or II and are controlled in transporation by special administrative arrangements between the shipper and the carrier to provide nuclear criticality safety.

heel. A residual amount of UF_6 and nonvolatile reaction products of uranium.

low-specific-activity material. Unirradiated natural or depleted UF_6 or unirradiated UF_6 enriched to not more than 1.0 wt % ^{235}U.

new cylinder. An unused cylinder that has been cleaned to remove fabrication debris.

normal-form radioactive material. A radioactive material that has not been demonstrated to qualify as special form radioactive material. UF_6 is classified as a normal-form material.

owner. The individual, agency, contractor, company, or corporation that carries title to or will carry title to the packaging during its use.

packaging. A container to be used for the transport of UF_6, including the outer protective packaging when utilized.

[6] Available from National Technical Information Service, U.S. Department of Commerce, Springfield, Virginia 22151. (It is recommended that the latest edition be used.) This reference is not cited in the text.

[7] Available from Mound-MRC, P.O. Box 32, Miamisburg, OH 45342. Telephone: 513-865-3919.

[8] Numbers in brackets refer to corresponding numbers in Section 2.3.

protective packaging (overpack). Outer packaging used to enclose cylinders containing enriched UF_6 exceeding 1 wt% ^{235}U. Protective structural packaging that meets the criteria of the International Atomic Energy Agency (IAEA) [7] for Type-B packaging for fissile radioactive materials is described in this standard.

qualified inspector. An individual who has passed the written examination sponsored by the National Board of Boiler and Pressure Vessel Inspectors, and holds a current certificate of competency, or other competent inspector designated by the cylinder owner's inspection authority.

shall, should, and may. The word "shall" denotes a requirement, the word "should" denotes a recommendation, and the word "may" denotes permission, neither a requirement nor a recommendation. Conformance with this standard means that all operations are performed in accordance with its requirements but not necessarily with its recommendations.

shipper. One who offers the package of UF_6 for transport.

transport index. The number placed on a package to designate the degree of control to be exercised by the carrier during transportation. The transport index to be assigned to a package of radioactive materials shall be determined by either (1) or (2) whichever is larger:

(1) The highest radiation dose rate, in millirem per hour at 1 meter (3.3 feet) from any accessible external surface of the package.

(2) For Fissile-Class-II packages only, the transport index number calculated by dividing the number 50 by the number of similar packages that may be transported together.

The number expressing the transport index shall be rounded up to the next highest tenth.

type-A quantity of radioactive material. A quantity of UF_6 that does not exceed the limits of a type A package as specified in 49 CFR 173.431.

type-B quantity of radioactive material. A quantity of UF_6 greater than that of a type-A quantity.

4. Quality Assurance

The licensee-user shall have a documented quality assurance (QA) program that meets the applicable criteria of Subpart H, Title 10, CFR, Part 71 [3] or ANSI/ASME NQA-1-1986 and ANSI/ASME NQA-1a-1986, at least for those quality-related activities associated with procurement, maintenance, repair, and use of the cylinder and the protective packaging. The licensee-user shall ensure that all applicable QA requirements in Subpart H, Title 10, CFR, Part 71, for all parties are met to ensure that the product or service supplied meets the requirements of this standard. Certain quality-related activities (design, fabrication, inspection, test, modification, and the like) may be satisfied by obtaining certificates from cylinder and package suppliers (fabricators) stating that their activities were conducted in accordance with a QA program that meets the requirements of Subpart H, Title 10, CFR, Part 71.

5. Packaging Requirements

5.1 General Packaging Requirements. UF_6 is packaged for transport in cylinders meeting the inspection, testing, and in-service requirements of this standard and is shipped:

(1) In bare cylinders that incorporate a feature, such as a seal that, while intact, will be evidence that the package has not been illicitly opened, and that qualify as "strong, tight packages" for low specific activity material transport in accordance with 49 CFR 173.425; or

(2) In bare cylinders that incorporate a feature, such as a seal that, while intact, will be evidence that the package has not been illicitly opened, and that qualify as DOT Specification 7A packages; or

(3) In cylinders in outer protective packaging that meet DOT specification 20 PF or 21 PF or are authorized by NRC or DOE certificates of compliance. The outside of each package shall incorporate a feature, such as a seal that, while intact, will be evidence that the package has not been illicitly opened.

5.2 Packaging for Low Specific Activity UF_6

5.2.1 Shipping Less than Truckload (Nonexclusive Use). Depleted, natural, and enriched to 1.0 wt % or less UF_6 when transported in less than truckload (nonexclusive use) conditions shall be packaged in DOT Specification 7A packaging [49 CFR 173.425(a)]. Cylinders covered by this standard qualify as DOT-7A packagings. The shipper shall also comply with 49 CFR 173.415(a). Test results and certification information for these cylinders may be found in report MLM-3245 DOT 7A Type A Certification Document [13].[8]

5.2.2 Exlcusive Use Shipments. Depleted, natural, and enriched to 1.0 wt % or less UF_6 are excepted from specification packaging requirements when shipped

under exclusive use conditions [49 CFR 173.425(b)]. The UF_6 shall be packaged in cylinders covered by this standard. These cylinders satisfy the "strong, tight packaging" requirements of 49 CFR 173.425(b).

5.3 Packaging for UF_6 Enriched Greater than 1.0 wt % ^{235}U. UF_6 enriched to greater than 1 wt % shall be packaged in accordance with the DOT regulations of Title 49 CFR Parts 173 [5] and 178 [6] or in other NRC or DOE certified package designs. These packages consist of an inner UF_6 cylinder, excluding Type 48G and 48H, which are limited to 1.0 wt % assay or less, plus an outer protective package, except for "heels," which may be transported in bare cylinders. The acceptable amount of "heel" (residual uranium) in bare cylinders is defined in 8.1.2.

5.4 Physical Condition of UF_6. UF_6 shall be shipped only after it has solidified and the vapor pressure of the cylinder has been measured to be below 1 atm, or the measured purity of the cylinder contents is within specification. (It should be noted that solid UF_6 is a heavy crystalline mass that is readily sublimed at room temperature. "Cracking" sounds sometimes emanate from large UF_6 cylinder as the ambient temperature changes.)

5.5 Standard UF_6 Cylinders. Standard UF_6 cylinder data are shown in Table 1. Table 1 provides requirements for cylinders currently in service. Cylinders listed in Table 1 that are not specifically defined in this standard are acceptable for continued use, provided they are inspected, tested, and maintained in accordance with the intent of this standard and the requirements stated in Table 1.

6. Cylinders

6.1 Design and Fabrication

6.1.1 General. Design, fabricaton, inspection, testing, and cleaning of UF_6 cylinders shall be as specified in 6.4 through 6.15. Design conditions and materials specified therein for pressure-containing portions of the cylinders shall be adhered to. The -40°F specified in the design conditions for each cylinder of this standard is to assure impact resistance of the shell and heads in the event of an accident in a cold climate in order to comply with the transport regulatory requirements. Since the pressure in the cylinder is below atmospheric at subzero temperatures, and the -40°F low-temperature condition is not a requirement of the ANSI/ASME Boiler and Pressure Vessel Code - 1986, the -40°F is not required to be marked on the nameplate.

The manufacturer shall be notified concerning quality assurance and his/her participation therein.

In order to minimize points of leakage, it is desirable to install only one valve and one plug. However, if additional valves or plugs are deemed necessary by the purchaser, they may be provided if they are installed in accordance with that specified in 6.10.6, 6.11.6, 6.12.6, and 6.13.6

Cylinder, valve, and valve protector details are given in Figures 1 through 14.

The weld fabrication details shown in the figures are recommended for cylinder fabrication. Equivalent joint details provided in the ANSI/ASME Code, Section VIII, Division 1, may be used in fabricating the cylinders, provided that the alternate method is approved prior to fabrication by the purchaser.

6.1.2 Reports, Certification, and Records. For each cylinder fabricated in accordance with this standard, the manufacturer shall supply to the purchaser and to the National Board of Boiler and Pressure Vessel Inspectors, copies of the Manufacturer's Data Report, Form U-1 or U-1A, as provided in Section VIII, Division 1, of the ANSI/ASME Code.

The manufacturer shall provide for the purchaser (1) a copy of the "as built" drawing pertaining to the cylinder or cylinders involved and (2) one copy of each radiograph, properly identified with the cylinder and location to which it applies.

The manufacturer shall measure the actual water capacity of each cylinder, and shall certify to the purchaser the water weight in pounds at a temperature of 60°F. This weight shall be accurate to the percentage specified for each type cylinder in 6.4 through 6.13. For a cylinder to be acceptable, the quotient of the certified water weight divided by 62.37 (the weight in pounds of 1 ft^3 of water at 60°F) shall not be less than the minimum capacity specified in the design conditions (see 6.4 through 6.13). The certified water capacity shall also be stamped on the cylinder as part of the nameplate data, except that the 1S and 2S cylinders are exempt from this capacity stamping requirement.

The manufacturer shall retain fabrication and inspection records in accordance with Section VIII, Division 1 of the ANSI/ASME Code. The purchaser shall retain the copies of the Manufacturer's Data Report, drawings, and certifications on file throughout the use or ownership of the cylinder. Radiographs and other related papers shall be retained for a minimum of 5 years. The documents shall be transferred with the cylinder upon change of ownership.

Table 1
Standard UF_6 Cylinder Data

Model Number	Nominal Diameter (in)	Material of Construction	Minimum Volume (ft^3)	Approximate Tare Weight (without valve protector) (lb)	Maximum Enrichment (wt% ^{235}U)	Maximum Fill Limit (lb UF_6)
1S	1.5	Nickel	0.0053	1.75	100.0	1.0*
2S	3.5	Nickel or Nickel-copper alloy≠	0.0254	4.2	100.0	4.9*
5A	5	Nickel-copper alloy≠	0.284	55	100.0	55*
5B	5	Nickel	0.284	55	100.0	55*
8A	8	Nickel-copper alloy≠	1.319	120	12.5	255*
12A§	12	Nickel	2.38	185	5.0	460*
12B	12	Nickel-copper alloy≠	2.38	185	5.0	460*
30B††	30	Steel	26.0	1400	5.0¶	5020*
48A†	48	Steel	108.9	4500	4.5¶	21030*
48X	48	Steel	107.9	4500	4.5¶	21030*
48F†	48	Steel	140.0	5200	4.5¶	27030*
48Y	48	Steel	142.7	5200	4.5¶	27560*
48T≠≠	48	Steel	107.2	2450	1.0	20700**
48O≠≠	48	Steel	135	2650	1.0	26070**
48OM Allied≠≠	48	Steel	140	3050	1.0	27030**
48OM≠≠	48	Steel	135	2650	1.0	26070**
48H, 48HX≠≠	48	Steel	140	3250	1.0	26030**
48G	48	Steel	139	2650	1.0	26840**

* Fill limits are based on 250°F maximum UF_6 temperature (203.3 lb UF_6 per ft^3), certified minimum internal volumes for all cylinders, and a minimum safety factor of 5%. These operating limits apply to UF_6 with a minimum purity of 99.5%. More restrictive measures are required if additional impurities are present. This maximum temperature shall not be exceeded. It should be noted that initial cylinder heating may result in localized pressures above a normal UF_6 vapor pressure. This may be evidenced by an audible bumping similar to a water hammer.

† Cylinders 48A and 48F are identical to 48X and 48Y, respectively, except that the volumes are not certified.

≠ For example, Monel or the equivalent.

§ This cylinder is presently in service. New procurement should be model 12B.

¶ These maximum enrichments require moderation control equivalent to a UF_6 purity of 99.5%. Without moderation control the maximum permissible enrichment is 1.0 wt% ^{235}U.

** Fill limits are based on 235°F maximum UF_6 temperature and minimum UF_6 purity of 99.5%. The allowable fill limit for tails UF_6 with a minimum UF_6 purity of 99.5% may be higher but shall not result in a cylinder ullage of less than 5% when heated to the cylinder design temperature of 235°F based on the actual certified volume.

†† This cylinder replaces the Model-30A cylinder, which has a fill limit of 4950 pounds.

≠≠ This cylinder is similar in design to the 48G in that their design conditions are based on 100 psig at 235°F.

6.2 Cleanliness

6.2.1 New Cylinders. New cylinders shall meet the cleanliness requirements of 6.4 through 6.15. The cleaning procedure to be used shall be described in detail to the cylinder fabricator. A cleaning method is provided in Appendix A.

CAUTION

The cleanliness of UF_6 cylinders is of serious concern to the nuclear industry, since the reaction of UF_6 with hydrocarbon oils and some other impurities is quite vigorous and can result in serious explosions. The purity of the UF_6 contained can also be appreciably affected.

6.2.2 **In-Service Cylinders.** Cylinders containing residual quantities of UF_6 may require cleaning prior to refilling to ensure product purity and also when maintenance or hydrostatic testing is performed. An example of a decontmination method for large cylinders, which contained enriched UF_6 <5 wt% ^{235}U, is provided in Appendix B. A similar procedure with modifications can be used for smaller cylinders.

6.2.3 **Cylinder Outer Surfaces.** Cylinder surfaces shall be monitored and cleaned when required to meet applicable radiation requirements.

6.3 Service Inspections, Tests, and Maintenance

6.3.1 **Routine Operational Inspections.** All UF_6 cylinders shall be routinely examined as received and prior to sampling, withdrawal, filling, or shipping to ensure that they remain in a safe, usable condition. Leakage, cracks, excessive distortion, bent or broken valves or plugs, broken or torn stiffening rings or skirts, or other conditions that may affect the safe use of the cylinder shall warrant appropriate precautions, including removing the cylinder from service until the defective condition is satisfactorily corrected. Questionable conditions should be referred to a qualified inspector for evaluation and for recommendations concerning use, repair, or condemnation of the cylinder in question.

6.3.2 **Periodic Inspections and Tests.** All cylinders shall be periodically inspected and tested throughout their service life at intervals not to exceed 5 years, except that cylinders already filled prior to the 5-year expiration date need not be tested until the cylinder has been emptied. However, cylinders that have not been inspected and tested within the required 5-year period shall not be refilled until they are properly reinspected, retested, and restamped. Prior to shipment, cylinders that have not been recertified within the 5-year requirement shall be visually inspected for degradation of the cylinder wall. Any questionable conditions should be investigated further, including ultrasonic wall thickness measurements, if appropriate.

The periodic inspection shall consist of an internal and external examination of the cylinder by a qualified inspector along with a hydrostatic strength test of the type set forth in Section VIII, Division 1, of the ANSI/ASME Code, and an air leak test. The hydrostatic test shall be applied at a pressure equal to the original test pressure. Prior to the air test, all couplings from which valves or plugs were removed shall be thoroughly inspected. The air test shall be applied after valves and plugs have been reinstalled or replaced. All valves and plugs shall meet the original design requirements, including tinning. After testing, the cylinder may have the outer shell cleaned and repainted. At each 5-year recertification the cylinder should have the tare weight reestablished. Cylinders that pass the periodic inspection and tests shall be restamped with the month and year in which the inspection and tests were performed. This stamping shall be placed in close proximity to the previous or original stamping. Records of periodic inspections and tests shall be retained by the cylinder owner for a period of 5 years or until a subsequent periodic inspection and test have been performed and recorded.

A UF_6 cylinder shall be removed from service (for repair or replacement) when it is found to contain leaks, corrosion, cracks, bulges, dents, gouges, defective valves, damaged stiffening rings or skirts, or other conditions that, in the opinion of the qualified inspector, render it unsafe or unserviceable in its existing condition. Cylinders shall no longer be used in UF_6 service when their shell thicknesses have decreased below the following values:

Cylinder Model	*Minimum Thickness (inches)*
1S	1/16
2S	1/16
5A	1/8
5B	1/8
8A	1/8
12A and B	3/16
30B	5/16
48A,F, X, and Y	1/2
48T, O, OM, OM Allied HX, H, and G	1/4

NOTE: Cylinders 48A and 48F are identical to 48X and 48Y, respectively, except that the volumes are not certified.

6.3.3 **Cylinder Maintenance.** Cylinder repairs and alterations are authorized provided: (1) they meet the approval of the inspector; (2) they comply with the design, material, fabrication, and welding qualification requirements of the ANSI/ASME Code, Section VIII, Division 1, and Section IX, Welding and Brazing Qualifications, for unfired pressure vessels; and (3) they do not deviate from the intent of this standard.

Welded repairs or alterations to pressure parts shall require the use of welding procedures qualified in Section IX of the ANSI/ASME Code and welders whose qualifications are active.

Such repairs shall also be inspected and accepted by a qualified inspector in accordance with the fabrication inspection requirements in Section VIII, Division 1, of the ANSI/ASME Code.

Repairs or alterations to pressure parts shall be followed by a hydrostatic strength test. Plug or valve

replacements should be followed by air leak tests. Repairs to structural attachments will not require pressure or leak tests of the cylinder unless repair of torn or deformed areas of pressure-containing materials is involved.

If valves are reused, careful inspection and testing shall be made to ensure their compliance with Figures 11 and 12 before installation.

6.4 1S Cylinder (See Figure 1)

6.4.1 Design and Fabrication. The cylinder shall be of nickel construction with a minimum wall thickness of 1/16 inch. One end shall contain a 1/4-inch NPT female connection threaded in accordance with ANSI/ASME B1.20.1-1983. The design pressure shall be 25 psig external and 200 psig internal. The design temperature shall be from -40°F to 250°F. The minimum volume shall be 9.16 in^3.

6.4.2 Materials. The materials used in the fabrication of new cylinders shall meet the following requirements:

(1) *Cylinder.* Nickel, ASTM B162

(2) *Adaptors*

(a) Brass ASTM B16 or nickel ASTM B160, with tube socket weld male connector to accommodate 3/8-inch O.D. tubing on one end and with male 1/4-inch NPT threads on the other end. Cajon Part No. B-6TSW-1-4 or approved equal.

(b) Cajon connector, nickel-copper alloy, ASTM B164, male flare, 1/2-inch to 3/8-inch O.D.T. socket, or an approved equivalent.

(3) *Valve.* Nickel copper alloy Monel 400, diaphragm sealed, Hoke Part No. 4618N4M straight welded, or an approved equivalent.

(4) *Brazing Alloys and Flux.* ANSI/AWS A5.8, AWS classification BAg-7 or BAg-8 with EUTECTOR flux, autochemic compound 190 or an approved equivalent.

6.4.3 Marking. The following data shall be lightly stamped on the valve end of the cylinder using 1/8-inch characters. Care shall be taken to prevent cylinder deformation.

(1) Manufacturer's identification

(2) Owner's identification symbol and serial number (not to exceed four digits)

(3) WP 200

(4) 250°F max.

(5) 1 lb UF_6 max.

(6) Date of manufacture

6.4.4 Cleaning. The inside of the cylinder shall be thoroughly cleaned of all grease, scale, slag, oxides, dirt, moisture, and other foreign matter. Surfaces shall be left dry, clean, bright, and free of contamination. When cylinders are purchased without valves, the openings shall be sealed to prevent contamination of the interior during shipment.

6.4.5 Valve Installation and Leak Test. The cylinder shall be hydrostatically pressured to 400 psig, and the pressure shall then be lowered to 300 psig while the cylinder is inspected for leaks. No leaks shall be permitted. Defects, if any, shall be repaired as permitted by the ANSI/ASME Code, Section VIII, Division 1.

Care shall be taken to keep the valve body cool when the adaptors are silver brazed onto the inlet and outlet connections. The valve and connections shall be clean, dry, and free of contamination before the valve is threaded into the cylinder. Thread lubricants may be used providing they are compatible with UF_6.

Following the valve installation, the cylinder shall be pressured with air at 100 psig and all connections, including the valve seat and bonnet, shall be leak tested using Carbona soapless lather or an approved equivalent. No leakage shall be permitted. When the cylinder is purchased without valves, these requirements shall be the responsibility of the purchaser.

6.4.6 Certification. The manufacturer shall certify in writing to the purchaser that the cylinders comply with all fabrication, test, and cleanliness requirements specified in this standard, and shall also provide for the purchaser's retention a certified mill test report of the materials used in fabricating the cylinders.

The manufacturer shall measure the water volume (at 60°F) of each cylinder, and shall provide written certification of the measured volume, identified by cylinder serial number, to the purchaser. The actual water weight shall be accurate to ±0.1%.

6.5 2S Cylinder (See Figure 2)

6.5.1 Design, Fabrication, Testing, and Inspection. The design pressure shall be 25 psig external and 200 psig internal. The design temperature shall be from -40°F to 250°F. The minimum volume shall be 44 in^3.

6.5.2 Materials. The materials used in the fabrication of new cylinders shall meet the following requirements:

(1) *Cylinder.* Nickel, ASTM B-162

(2) *Adaptors*

(a) Brass ASTM B16 or nickel ASTM B160 with tube socket weld male connector to accommodate 3/8-inch O.D. tubing on one end and male 3/8-inch NPT threads on the other end, Cajon Part No. B-6TSW-1-6, or an approved equal.

(b) Connector, brass ASTM B16, 1/2-inch by 1/4-inch half flare, Eastman Part No. 48F08X04, or an approved equal.

(3) *Valve.* Nickel-copper alloy Monel 400, dia-

(9) *Dip Pipe Tab.* Nickel-copper alloy, 1/4-inch thick, ASTM B127.

(10) *Filler Metal*

(a) Brazing ANSI/AWS A5.8 (BAg-7).

(b) Welding ANSI/AWS A5.14 (ERNi-1, ERNiCu-7).

(11) *Nameplate (See Figure 13a).* Nickel-copper alloy, 20 gage, ASTM B127.

6.9.6 Valve Installation. In general, the valves shall be disassembled and cleaned before brazing and installation. The dip pipe shall be silver brazed to the applicable valve. Valve bodies shall be installed in the couplings with a thread engagement of 7 minimum and 12 maximum. The valve bodies shall be silver brazed to couplings before reassembly of the valves.

6.9.7 Cylinder Marking. The following data shall be stamped on the nameplate in characters a minimum of 5/16-inch high:

(1) ASME Code and National Board Stamping

(2) Model 12B

(3) Owner's name or identification symbol and serial number (not to exceed four digits)

(4) Tare wt. _____ lb.

(5) Water Cap. _____ lb.

(6) Max. net wt. pure UF_6 460 lb.

(7) Date of manufacture

6.9.8 Cleaning. After welding and hydrostatic testing are completed, the inside of the cylinder shall be thoroughly cleaned of all grease, scale, slag, oxides, dirt, moisture, and other foreign matter. Surfaces shall be left clean, bright, and free of all contamination. When the cylinders are purchased without valves, the openings shall be sealed to prevent contamination of the interior during shipment.

6.9.9 Certification. The manufacturer shall certify in writing to the purchaser that the cylinders comply with all fabrication, test, and cleanliness requirements specified in this standard, and shall also provide for the purchaser's retention a certified mill test report of the materials used in fabricating the cylinders.

The manufacturer shall measure the water volume (at 60°F) of each cylinder and shall provide written certification of the measured volume, identified by cylinder serial number, to the purchaser. The actual water weight shall be accurate to ± 0.1%.

6.10 30B Cylinder (See Figure 7)

6.10.1 Design Conditions

(1) *Design Pressure.* 25 psig external and 200 psig internal.

(2) *Design Temperature.* -40°F to 250°F.

(3) *Minimum Volume.* 26 ft^3.

6.10.2 Fabrication. Cylinders shall be fabricated in accordance with Section VIII, Division 1, of the ANSI/ASME Code and shall be ASME Code stamped. Cylinders should be National Board registered. All welders and welding procedures (brazing included) shall be qualified in accordance with Section IX of the ANSI/ASME Code. All welds shall be full penetration unless otherwise specified.

At least one test weld representing each welding procedure to be used in the fabrication of the cylinder shall be impact tested. These impact tests shall be performed to the test temperature specified in ASTM A20 in accordance with ASTM A370 for the type and grade of steel to be used in fabrication of the cylinder. The results shall meet acceptance criteria listed in ASTM A20 for the type and grade of steel used and shall be submitted to, and approved by, the purchaser prior to cylinder fabrication.

6.10.3 Radiography. A minimum of one spot X-ray examination for each cylinder shall be required in accordance with Section UW-52 of the ANSI/ASME Code using a fine-grain X-ray film (Kodak Type AA, or a purchaser-approved equivalent). Unless otherwise directed by the ASME Code inspector, locations of the spot shall be at the juncture of the longitudinal seam and the circumferential head weld, alternating ends for successive cylinders. The weld imperfections indicated by the radiographs shall not exceed the defects permitted by Section UW-52 of the ANSI/ASME Code, except for rounded indications, which shall be required to meet Section UW-51 of the ANSI/ASME Code.

6.10.4 Testing

(1) The cylinder shall be hydrostatically pressured to 400 psig, and the pressure shall then be lowered to 300 psig while the cylinder is inspected for leaks. No leaks shall be permitted. Defects, if any, shall be repaired as permitted in the ANSI/ASME Code and a retest shall follow.

(2) Following the cleaning operation and valve installation, an air test at 100 psig shall be carried out, and all connections and fittings (including the valve seat and packing) shall be leak tested using Carbona soapless lather or an approved equivalent. No leakage shall be permitted. When the cylinder is purchased without valves, this test shall be carried out by the purchaser.

6.10.5 Materials. The materials used in the fabrication of new cylinders shall meet the following requirements:

(1) *Cylinder.* Cylinder shell, heads, backing rings, and skirts shall conform to ASTM A516, Grade 55, 60, 65, or 70 steel and shall be normalized. ASTM A36 normalized steel may be substituted for the backing rings only. All steel shall be Charpy V-notch impact

tested meeting the applicable Charpy supplementary requirement specification.

(2) *Seal Loop.* Steel, ASTM A36.

(3) *Pipe Plug.* Upset forged, extruded or extruded and drawn aluminum bronze Copper Development Association (CDA) Alloy 61400 conforming to ASTM B150 with 0.2% to 0.3% tin by weight. An acceptable alternate is copper alloy C61300 conforming to ASTM B150 except, that tin shall be in the range of 0.2%–0.3% by weight, and the mechanical property requirements of C61400 shall be met. Plugs shall have solid hex-head, with 1-inch, 11-1/2 NPT conforming to ANSI/ASME B1.20.1-1983. After machining, plugs shall be stress relieved for at least 1 hour at 800°F minimum.

(4) *Valve.* See Figure 12 and 6.15.

(5) *Couplings.* 1-inch, half-coupling, 6000-pound, forged steel, ASTM A105, ANSI B16.11-1980, modified. Threads 1-inch, 11-1/2 NGT. Tapped threads shall be free of all burrs, gouges, scratches, and the like.

NOTE: ASTM A106 Grade C may be used in lieu of ASTM A105.

(6) *Solder.* ASTM B32, Grade 50A.

(7) *Solder Flux.*. Phosphoric acid.

(8) *Nameplate (see Figure 13a).* Stainless steel, 20-gage, ASTM A167 or A240, Type 304.

(9) *Valve Protector.* Sheet metal, 11-gage steel, ASTM A570, Grade A.

(10) *Filler Metal.* ANSI/AWS A5.1, A5.17, or A5.18.

6.10.6 Valve and Plug Installation. In general, the valves shall be disassembled and cleaned before installation. The valve and plug inlet threads shall be tinned with a thin uniform coating of the specified solder. A valve thread engagement of 7 minimum and 12 maximum shall be obtained by using a minimum of 200 and maximum of 400 foot-pounds of wrench torque applied to the valve body only. The plug thread engagement of 5 minimum and 8 maximum shall be obtained using a minimum of 150 and maximum of 650 foot-pounds of torque. The valve and plug couplings should be installed by first screwing in a 1-inch, 11-1/2 NPT pipe nipple into the coupling before any welding to coupling is accomplished. After welding is completed, the coupling should be allowed to cool before removal of pipe nipple. A 1-inch, 11-1/2 NGT tap may be used only if necessary for a light chase.

6.10.7 Cylinder Marking. The following data shall be stamped on the nameplate in characters a minimum of 5/16-inch high:

(1) ASME Code and National Board Stamping

(2) Model 30B

(3) Owner's name or identification symbol and serial number (not to exceed four digits)

(4) Tare wt. _____ lb.

(5) Water Cap. _____ lb.

(6) Max. net wt. pure UF_6 5020 lb.

(7) Month and year of manufacture

6.10.8 Cleaning. The inside of the cylinder shall be thoroughly cleaned of all grease, scale, slag, oxides, dirt, moisture, and other foreign matter. The surfaces shall be left clean, dry, and free of all contamination. The cylinders shall be purged with filtered dry air to a maximum dew pont of -30°F. When the cylinders are purchased without valves, the openings shall be sealed with threaded plugs.

6.10.9 Certification. The manufacturer shall certify in writing to the purchaser that the cylinders comply with all fabrication, test, and cleanliness requirements specified in this standard, and shall also provide for the purchaser's retention a certified mill test report of the materials used in fabricating the cylinders.

The manufacturer shall measure the water volume (at 60°F) of each cylinder and shall provide written certification of the measured volume, identified by cylinder serial number, to the purchaser. The actual water weight shall be accurate to ± 0.1%.

6.11 48X Cylinder (See Figure 8)

6.11.1 Design Conditions

(1) *Design Pressure.* 25 psig external and 200 psig internal.

(2) *Design Temperature.* -40°F to 250°F.

(3) *Minimum Volume.* 108.9 ft^3.

6.11.2 Fabrication. Cylinders shall be fabricated in accordance with Section VIII, Division 1 of the ANSI/ASME Code and shall be ASME Code stamped. Cylinders should be National Board registered. All welders and welding procedures shall be qualified in accordance with Section IX of the ANSI/ASME Code. All welds shall be full penetration unless otherwise specified.

At least one test weld representing each welding procedure to be used in the fabrication of the cylinders shall be impact tested. Test plates, including those for the appendages, shall have butt-type weld joints. The weld metal specimens shall be taken across the weld with the notch in the weld metal. Each specimen shall be oriented so that the notch is normal to the surface of the material, and one face of the specimen shall be within 1/16-inch of the surface of the material. For A516 steel, these impact tests shall be performed to the test temperature specified in ASTM A20 in accordance with ASTM A370 for Charpy V-Notch tests. The results shall meet the acceptance criteria listed in ASTM A20 for the grade of A516 steel used. For A131

After the packing parts have been installed and with the valve stem fully closed, the packing nut shall be tightened to compress the packing.

Only a six-point socket wrench shall be used to apply or break the torque on the nut. The wrench shall be manually operated only. The initial packing compaction shall be in the range of 100 to 110 foot-pounds as measured by an indicating torque wrench. The use of an impact wrench shall *not* be permitted.

6.14.8 Testing

> **CAUTION**
> Air pressure tests shall be applied with extreme caution to prevent personal injury. Pressure shall be raised slowly to the test pressure. The valve packing nut, cap, and body threads shall not be tightened with the valve at high pressure. The pressure shall be bled off before any components are retightened, and the test pressure shall be restored slowly. The air pressure source shall be valved off when the test pressure is attained.

Each valve shall be pressure tested for leak-tightness, as follows:

(1) On a test bench or fixture, couple the 3/4-inch, 14-NGT inlet to a high-pressure air source, oil free or filtered for elimination of oil.

(2) Open and close the valve stem twice, using not more than 10 foot-pounds torque, to seat the valve. An adjustable or indicating torque wrench shall be used. The application of excessive torque will damage the valves and is cause for rejection.

(3) Pressure test for seat leakage at 400 psig by bubble bottle, by striking a soap bubble across the face of the valve outlet, or by immersing the valve in water.

No leakage shall be permitted. The valve stem shall not be overtorqued to stop a leak.

(4) If no seat leakage is found, bleed off the pressure, cap the outlet securely, and open the valve approximately halfway. Pressure test the entire valve to 400 psig. No leakage shall be permitted past the stem, around the cap or packing nut, or through the body, as determined by application of the soap test solution all over the exterior of the valve or by immersion in water.

(5) If leakage at the stem or at either cap occurs, the corresponding packing or gasket may be retightened (see "caution" above) and the test repeated. Excessive force shall not be used in an attempt to eliminate the leak. The maximum torque permitted to retighten the packing nut is 110 foot-pounds and to retighten the port cap is 50 foot-pounds. Valves that show leakage at the juncture of the packing nut, cap, or coupling threads with the body threads shall be carefully examined for possible porosity in the valve body in the threaded areas. Parts showing any evidence of porosity shall not be used.

(6) Valves that fail to pass either pressure test shall be removed from the test fixture and immediately segregated and tagged to prevent mixing with acceptable valves. Valves rejected owing to packing leaks may have the packing replaced and be retested.

(7) After a valve has been tested and found acceptable, and while it is still coupled to the text fixture, any soap solution shall be washed off completely with water and the valve blown dry. A semipermanent mark shall be made on the cap to indicate acceptance.

6.14.9 Packaging. Each valve shall be packaged in an individual carton together with a protective packing material to fill the voids in the carton and afford protection during shipment and handling. Each carton shall be identified with the lot number appearing on the inspection report. Individual valve cartons shall be placed in containers for shipment, and a copy of the inspection report shall be placed inside each shipping container.

Each shipping container shall be sturdily constructed to prevent damage to the contents during shipping. Each shipping container shall be identified with the purchase order number and lot number, in addition to the purchaser's name and address.

6.14.10 Certification. The manufacturer shall certify in writing to the purchaser that the valves comply with all fabrication, test, and cleanliness requirements specified in this standard.

6.15 Cylinder Valve 51 (1 Inch) (See Figure 12)

6.15.1 Design Conditions

(1) *Design Pressure.* 25 psig external and 200 psig internal.

(2) *Design Temperature.* -40°F to 250°F.

(3) *Medium.* UF_6.

6.15.2 Material Specifications

(1) *Body, Part 1.* Forging, aluminum bronze CDA alloy 636.[10]

(2) *Cap, Part 4.* Bar, aluminum bronze, CDA alloy 636,[10] stress relieved, Rockwell hardness B55–B80.

(3) *Packing Nut, Part 3.* Bar, aluminum bronze, CDA alloy 636,[10] stress relieved, modified as shown below.

After any necessary cold finishing or straightening, the finished bar stock shall be subjected to a thermal stress relief. The bar stock temperature shall attain 700°F minimum for 1 hour minimum.

After the thermal stress relief, no additional finish-

[10]Material certification is required in accordance with 6.15.3

ing or straightening shall occur, and the material shall meet the following mechanical properties:

(a) *Ultimate Tensile Strength.* 45,000 psi minimum.

(b) *Yield Strength (0.5% Extension).* 25,000 psi minimum.

(c) *Elongation in 2 Inches.* 30% minimum.

(4) *Packing Follower, Part 5; Packing Ring, Part 7.* Bar, aluminum bronze CDA alloy 636[10] as extruded or rolled.

(5) *Stem, Part 2.* Bar, monel, ASTM B164, Class A[10] or B,[10] cold drawn and stress relieved.

(6) *Packing, Part 6; Cap Gasket, Part 8.* Teflon, 100% Virgin TFE (unfilled).

(7) *Solder.* Tin-lead, ASTM B32, alloy 50A.

(8) *Fluorinated Lubricant.* Occidental-Hooker HO-125 or the equivalent.

CDA alloy 636[10] has the following composition limits, except that the lead content has been modified as noted.

Element	*Percentage*
Copper and the sum of other named elements	99.5 min
Lead	0.01 max for part 3 0.03 max for parts 1, 4, and 7
Tin	0.20 max
Iron	0.10 max
Silicon	0.7–1.3
Aluminum	3.0–4.0
Nickel	0.15 max
Zinc	0.35 max
Arsenic	0.15 max

Each individual pour shall meet these composition limits.

The valve body shall be forged and shall contain no laps seams, porosity, or other objectionable defects. The data shown in Figure 12 plus a forging identification symbol, traceable to the heat number(s) from which the forgings were produced, shall be forged, stamped, or engraved into the body. Forgings shall be cleaned to a bright or matte finish and shall have the die-flash removed. No mechanical finishing of the valve body (such as buffing, peening, grinding, or blasting) shall be permitted.

Aluminum bronze bar stock for the caps shall be stress relieved. Surface hardness after stress relieving shall be not more than Rockwell B80 nor less than Rockwell B55. Bar stock shall be stress relieved at 700°F minimum for at least 1 hour.

The finish machined packing nuts shall be stress relieved at 700°F for a minimum of 1 hour.

6.15.3 Material Certification Requirements. The seller shall require the manufacturer(s) of aluminum bronze materials to furnish mill certification, including the results of tests to determine the chemical composition, tensile strength, yield strength, and hardness of the materials. The tests shall be conducted in accordance with the applicable test methods referenced in ASTM B249.

Mill test reports shall be obtained for each separate lot of material produced by a different mill manufacturing process or of a different size, such as forging stock, as-extruded bar, and rolled and tempered (stress-relieved) bar. The mill test reports shall include heat numbers from which the manufactured products were produced.

The seller shall obtain a manufacturer's certification that the Monel material supplied has been manufactured and tested in accordance with ASTM B164.

The seller shall submit certification in writing that all materials requiring mill certification in 6.15.2 conform to the specification requirements.

6.15.4 Manufacturing Requirements. All parts shall conform to the dimensional requirements of Figure 12. In addition to the specific requirements of the drawing, acceptable practices such as deburring, breaking corners, and the like shall be used in the machining and finishing of parts. Close control over the manufacture of threaded element shall be maintained to meet the drawing requirements. Threads shall conform to applicable American National Standards for manufacturing and gaging, modified as necessary to conform to the drawing. The applicable standards are ANSI/CGA V-1-1977 for tapered NGT thread, ANSI B1.5-1977 for Acme threads, and ANSI B1.1-1982 and ANSI/ASME B1.1a-1984 for the straight threads.

6.15.5 Cleaning. Prior to tinning, the valve bodies shall be degreased. Prior to assembly, all parts, including valve bodies, shall be cleaned to remove all traces of machining lubricants, metal chips, and other foreign substances. A chlorinated-hydrocarbon, solvent-degreasing procedure is acceptable for removal of lubricants.

6.15.6 Tinning. Prior to assembly, one valve body out of each fifty shall be selected at random for shipment without tinning. The remaining bodies shall have the tapered inlet thread tinned over its full length with a uniform coating of tin-lead solder, ASTM B32 alloy 50A. The thread roots shall be filled approximately half full. The tinning flux used shall be suitable for use with the aluminum bronze alloy. The composition of the solder in the pot shall be certified correct prior to its use.

Tinning shall be accomplished by dipping the tapered thread into a pot of solder maintained at the proper temperature. The tinning temperature range

shall be included in the seller's proposed procedures and submitted for approval. The inlet shall be plugged to prevent entry of solder or flux into the port, or solder and flux entering the port shall be completely removed. The body shall be preheated prior to dipping. Excess solder shall be removed and the valve allowed to cool without quenching before the flux residue is removed. All traces of the flux shall be removed.

6.15.7 Assembly. Parts shall be assembled as shown in Figure 12. Cleanliness control shall be exercised to ensure that parts and assemblies are not contaminated during or after assembly. Care shall be exercised during assembly to avoid damage to the threaded elements and to ensure that all packing parts, including a full complement of packing, are installed. During assembly, a very light coat of fluorinated lubricant shall be carefully applied only to the Acme thread, the tapered surface of the stem, and the packing nut thread.

After the packing parts have been installed and with the valve stem fully closed, the packing nut shall be tightened to compress the packing. Only a six-point socket wrench shall be used to apply or break the torque on the nut. The torque for initial packing compaction shall be in the range of 120 to 150 foot-pounds as measured by an indicating torque wrench. after the packing has been compressed, the top surface of the packing nut shall be flush with, or be not more than 3/32-inch below, the shoulder of the wrench grip of the stem. Variations outside this range indicate improper packing or nonconforming parts, and the deficiency shall be corrected.

6.15.8 Testing

> **CAUTION**
>
> Air pressure tests shall be applied with extreme caution to prevent personal injury. Pressure shall be raised slowly to the test pressure. The valve packing nut, cap, and body threads shall not be tightened with the valve at high pressure. The pressure shall be bled off before any components are retight ened, and the test pressure shall be restored slowly. The air pressure source shall be valved off when the test pressure is attained.

Each valve shall be pressure tested for leak-tightness, as follows:

(1) On a test bench or fixture, couple the 1-inch, 11-1/2 NGT inlet port to a high-pressure air source, filtered and oil free.

(2) Open and close the valve stem twice, using not more than 55 foot-pounds torque, to seat the valve. The use of an adjustable or indicating torque wrench is required. Application of excessive torque will damage the valves and lead to their rejection.

(3) Pressure test for seat leakage at 400 psig by bubble bottle, by striking a soap bubble across the face of the valve outlet, or by immersing the valve in water. No leakage shall be permitted. The valve stem shall not be overtorqued to stop a leak.

(4) If no seat leakage is found, bleed off the pressure, cap the outlet securely, and open the valve approximately halfway. Pressure test the entire valve to 400 psig. No leakage shall be permitted past the stem, around the cap or packing nut, or through the body, as determined by application of the soap test solution all over the exterior of the valve or by immersion in water.

(5) If leakage at the stem or at the cap occurs, the corresponding packing or gasket may be retightened (see "caution" above) and the test repeated. Excessive force shall not be used in an attempt to eliminate the leak. The maximum torque permitted to retighten the packing nut is 150 foot-pounds and to retighten the cap is 50 foot-pounds. Valves that show leakage at the juncture of the packing nut, cap, or coupling threads with the body threads shall be carefully examined for possible porosity in the valve body in the threaded areas. Parts showing any evidence of porosity shall not be used.

(6) Valves that fail to pass either pressure test shall be removed from the test fixture and immediately segregated and tagged to prevent mixing with acceptable valves. Valves rejected owing to packing leaks may be repacked and retested.

(7) After a valve has been tested and found acceptable, and while it is still coupled to the text fixture, any soap solution shall be washed off completely with water and the valve blown dry. A semipermanent mark shall be made on the cap to indicate acceptance.

6.15.9 Packaging. One untinned valve shall be sent with each lot consisting of fifty valves or less. As far as possible, all valves in one lot shall be sent in a single shipment. Each valve shall be packaged in an individual carton together with a protective packing material to fill the voids in the carton and afford protection during shipment and handling. Each carton shall be identified with the lot number appearing on the inspection report, and the cartons containing untinned valves shall be identified. Individual cartons shall be placed in a common container for shipment, and a copy of the inspection report shall be placed *inside* the shipping container. The shipping container shall be sturdily constructed to prevent damage to the contents during shipping. The shipping container shall be identified with the purchase order number and lot

number, in addition to the purchaser's name and address.

6.15.10 Certification. The manufacturer shall certify in writing to the purchaser that the valves comply with all fabrication, test, and cleanliness requirements specified in this standard.

7. Outer Protective Packagings

7.1 General. Outer protective packagings are essential for the protection of cylinders against the release of UF_6 enriched to more than 1 wt % from puncture or fire should a transportation accident occur. A breach of the cylinder could allow uncontrolled geometries of enriched UF_6 which could result in a criticality incident. Proper maintenance of the outer protective packaging is essential so that the integrity of the package as a fire and shock resistant housing will be assured. The outer protective packaging shall be kept structurally sound, provide a tight seal between the cover and base and be protected from damage to the insulation by moisture. The minimum inspection and maintenance requirements are listed in 7.4.

7.2 Design

7.2.1 Design Certification. Outer protective packaging for the transport of non-LSA enriched UF_6 shall be designed and fabricated in accordance with the appropriate specification in 49 CFR, Part 178 [6] or in accordance with the requirements of an NRC or DOE Certificate of Compliance.

7.2.2 NRC Certified Outer Protective Packaging Designs. A listing of NRC certified designs can be found in the Directory of Certificates of Compliance for Radioactive Material Packages, NUREG-0383.

7.3 Fabrication

7.3.1 Manufacturer Qualifications. All outer protective packagings, including DOT specification or DOE or NRC approved designs, shall be fabricated in accordance with an NRC approved quality assurance plan meeting the requirements of 10 CFR 71, Subpart H or ANSI/ASME NQA-1-1986 and ANSI/ASME NQA-1a-1986, or both. Prior to fabrication, a specific quality assurance plan shall be prepared for the manufacture of the protective packaging to be fabricated. The specific quality assurance plan shall meet the requirements of and be approved by the NRC, DOE, or other regulatory body having jurisdiction of the procurement.

7.3.2 Fabrication Tests and Certifications. The manufacturer shall fabricate the outer protective packaging in accordance with 49 CFR, Part 178 [6] or drawing approved in an NRC or DOE Certificate of Compliance. The manufacturer shall provide a certification for the weight of each completed packaging. The tare weight shall also appear on the packaging nameplate. The scales used for the weight certification shall be accurate to ±0.1%. All welding shall be performed by ANSI/AWS or ANSI/ASME code qualified welders qualified in accordance Section IX of the ANSI/ASME Boiler and Pressure Vessel Code or Section 5 of ANSI/ASME D1.1-1986. The manufacturer shall provide the owner with certifications of weld procedures, welder qualifications and other certifications necessary to confirm that the packaging meets the requirements of 49 CFR Part 178 and ANSI N14.1-1987. The owner shall retain copies of all certifications and other manufacturing data furnished by the manufacturer throughout the use or ownership of the protective packaging.

7.4 In-Service Inspections and Maintenance

7.4.1 Routine Operational Inspections. The outer protective packaging shall be inspected by each shipper or by an agent of the shipper in accordance with written inspection procedures prior to each use to ensure its integrity. The inspection shall be documented on an inspection form prepared specifically for each type of outer protective packaging used. The inspection shall be performed by personnel trained in the inspection of the type of outer protective packaging used. The following shall be cause for further investigation or removal from service for repair: excessive warping, distortion, or other damage of the liner or shell that would prevent a tight closure of the package, allow excessive clearances from the inner container within the liner, reduce the assembly fastener strength of the container, reduce the thermal insulation thickness in any area or otherwise make the integrity of the outer protective package questionable as a fire and shock resistant housing. The outer protective packaging shall also be inspected for evidence of the inleakage of water into the packaging. Any evidence of inleakage of water shall require an investigation of the packaging to determine the amount of water present in the packaging. The packaging may be required to have the weight recertified if found necessary by the investigation. The water shall be removed prior to repair of the outer protective packaging. Any nonconforming conditions found by the inspector shall be referred to personnel designated by the shipper to evaluate for the use, repair, or condemnation of protective packaging. The representative of the shipper shall contact the owner and user of the protective packaging for recommendations concerning any repair or modification of the packaging.

7.4.2 Periodic Inspections, Tests, and Recertification. In addition to the routine inspections performed prior to each use, each protective packaging shall be recertified every 5 years. This recertification shall include the inspections specified in 7.4.1 and detailed inspection for degradation of welds and the presence of rusting of the protective packaging. Welds shall receive a full visual inspection for the presence of cracks. Any weld defect shall be repaired in accordance with 7.4.3 prior to returning the protective packaging to service. Any questionable condition of a weld shall be subject to further examination, such as dye penetrant testing, to assure that no cracks are present. Outer protective packaging shall receive a full visual inspection for rusting and the presence of corrosion. This inspection shall include assurance that corrosion has not reduced the skin wall thickness by 10% of the nominal thickness. When visual inspection cannot assure sufficient wall thickness, other examinations shall be utilized, such as ultrasonic testing, to assure acceptability.

7.4.3 Repairs. All repairs shall be performed by competent sources. All repairs that require welding shall be made by welders who are qualified in accordance with Section IX of the ANSI/ASME Boiler and Pressure Vessel Code or Section 5 of ANSI/AWS D1.1-1986. The repair shop shall provide certification of weld procedures and welder qualifications. Any repairs that required partial or total replacement of the insulation shall be performed in accordance with an NRC approved quality assurance plan meeting the requirements of 10 CFR 71, Subpart H or ANSI/ASME NQA-1-1986, and ANSI/ASME NQA-1a-1986, or both. Caution should be exercised to perform welding in a manner that does not damage adjacent thermal insulation or wood material by charring. Any repairs that result in a significant weight change should be cause for recertification of the total outer protective packaging weight.

8. Shipping

8.1 Cylinders

8.1.1 Full Cylinders. Full cylinders to be shipped shall be packaged as specified in Section 5.

8.1.2 Empty Cylinders. Empty cylinders with valve protection may be shipped without outer protective packaging provided the residual quantities ("heels") of uranium, considered to be in the form of UF_6 are not exceeded as follows:

Cylinder Model No.	*Heel (lb)[10]*	*Maximum ^{235}U, wt%[10]*
5A or 5B	0.1	100.00
8A	0.5	12.50
12A or 12B	1.0	5.00
30B[1]	25.0	5.00
48A[2] or 48X	50.0	4.50
48F[2] or 48Y	50.0	4.50
48G or 48H	50.0	1.00
48O, 48OM, 48OM Allied or 48T	50.0	1.00

[1]This cylinder replaces the 30A cylinder. The 30A cylinder has the same heel and maximum ^{235}U limit as the 30B.
[2]Cylinder 48A and 48F are identical to 48X and 48Y, respectively, except that the volumes are not certified.

8.1.3 Cylinders. Clean cylinders, including new cylinders, may be shipped with no special precautions other than those used in normal shipping operations, provided the shipper is confident that no residual contamination remains in the cylinder that has a specific activity that exceeds 0.002 μ Ci/g (which would classify it as a radioactive material in accordance with 49 CFR 173.403). If this condition cannot be assured the cylindershall be shipped in accordance with 49 CFR 173.427 or Section 5 of this standard and applicable DOT regulations. All bare cylinders shall incorporate a feature such as a seal that, while intact, shall provide assurance that the package has not been illicitly opened.

8.2 Valve Protectors and Seals. Valve protectors shall be used on all cylinders (except new and cleaned ones) that are not contained in an outer protective package during shipment. All UF_6 packages when shipped shall incorporate a feature, such as a seal which, while intact, shall provide assurance that the package has not been illicitly opened.

8.3 Labeling. Packages shipped in accordance with 5.2.1 (nonexclusive use LSA Material shipment) and CFR 172.403 displayed on the label, and the label shall be selected in accordance with 8.3.1 through 8.3.4.

8.3.1. Radioactive White-I Label. The white-I label shall be used for radiation not exceedding 0.5 millirem per hour at any point on the external surface of the package. The white label is not authorized for Fissile Class II packages.

8.3.2 Radioactive Yellow-II Label.. The yellow-II label shall be used for packages exceeding the white-I limits but which have radiation levels not exceeding 50 millirem per hour at the package surface and a transport index not exceeding 1.0.

8.3.3 Radioactive Yellow-III Label. The yellow-III label shall be used for packages exceeding the yellow-II limits, that is with radiation levels exceeding 50 millirem/hour at the package surface or a transport index exceeding 1.0.

8.3.4 Corrosive Labels. corrosive lebels shall be applied to all packages containing UF_6, except those transported in accordance with 5.2.2 (exclusive use LSA shipments) or 8.1.3 (when the cylinder is sufficiently clean to be classed nonradioactive or is shipped in accordance with 49 CFR 173.427 for empty packaging).

8.4 Placarding

8.4.1 Radioactive Placards. "Radioactive" placards shall be displayed on all conveyances transporting uranium hexafluoride in accordance with 5.2.2, and on all conveyances transporting a package labeled "Radioactive Yellow-III."

8.4.2 Corrosive Placards. "Corrosive" placards shall be displayed on all conveyances transporting UF_6 for which the gross weight of UF_6 plus packaging exceeds 1000 pounds.

8.5 Marking

8.5.1 Low Specific Activity UF_6 in Less Than Truckload (Nonexclusive Use) Conditions. Cylinders transported in accordance with 5.2.1 shall be marked with:

(1) USA DOT 7A Type A
(2) Radioactive material
(3) Uranium hexafluoride, low specific activity
(4) UN 2978
(5) Name and address of consignor or consignee
(6) Gross weight

8.5.2 Low Specific Activity UF_6 Under Exclusive Use Conditions. Cylinders transported in accordance with 5.2.2 shall be marked "RADIOACTIVE-LSA" in accordance with 49 CFR 173.425(b)(8).

8.5.3 Marking of Packages of UF_6 Enriched to Greater Than 1 wt% ^{235}U. Packages used to transport UF_6 enriched to greater than 1 wt% ^{235}U shall be marked as follows as specified in the applicable NRC certificate of compliance or DOT/IAEA competent authority certificate and DOT regulations:

(1) Bare cylinders containing "heels" shall comply with 8.5.1

(2) DOT specification outer protective packages shall be marked with the DOT specification number in conjunction with "USA-DOT-" (for example, "USA-DOT-20PF-1"), and if the inner shell is constructed of stainless steel, the type of stainless steel used (for example, "304L-SS")

(3) NRC and DOE certified outer protective packages designs and DOT specification outer protective packages that will be exported shall be marked with the package design identification number, such as "USA/4904/AF"

(4) All protective outer protective packages shall be marked per DOT regulations:

(a) Uranium hexafluoride, fissile
(b) UN 2977
(c) Name and address of consignor or consignee
(d) Gross weight
(e) Type A

8.6 Shipping Papers. Complete transportation documentation (shipping) papers shall accompany each shipment. All of the information required by the DOT regulations (49 CFR Part 172, Subpart C) shall be included.

FIGURE WITHHELD UNDER 10 CFR 2.390

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