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REGULATORY COMPLIANCE GUIDE FOR DOT-7A TYPE A PACKAGING DESIGN

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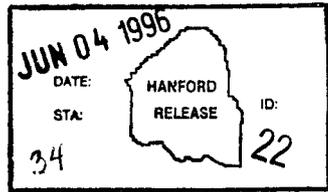
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Abstract: The purpose of this guide is to provide instruction for assuring that the regulatory design requirements for a DOT-7A Type A packaging are met. This guide also supports the testing and evaluation activities that are performed on new packaging designs by a DOE-approved test facility through the DOE's DOT-7A Test Program. This guide was updated to incorporate regulatory changes implemented by HM-169A (49 CFR, "Transportation").

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REGULATORY COMPLIANCE GUIDE FOR DOT-7A TYPE A PACKAGING DESIGN

1.0 INTRODUCTION

The purpose of this guide is to provide instruction for assuring that the regulatory designing requirements for a U.S. Department of Transportation Specification 7A (DOT-7A) Type A packaging are met. Another purpose for this guide is to support the evaluation and testing activities that are performed on new packaging designs by a U.S. Department of Energy (DOE) test facility. The test facilities are located at various DOE sites, and are operated under the direction of DOE-Headquarters (HQ), Office of Transportation, Emergency Management, and Analytical Services (EM-76). This evaluation and testing program is called the DOT-7A Program.

This guide should be used when a need for a Type A packaging has been identified, and no currently qualified design or any design available from commercial suppliers will suffice. In this case, the organization responsible for the shipments (the shipper) must develop and qualify a packaging. By qualifying the packaging through the DOE DOT-7A Program, the acceptability and use of the packaging throughout the DOE community is enhanced. Qualifying a Type A packaging through the DOE DOT-7A Program is accomplished by contacting EM-76, and requesting a docket be opened. The person or organization sponsor requesting a test docket is referred to herein as the applicant.

The Type A packaging development process is initiated when the applicant has determined that a DOT-7A, Type A packaging is needed and that no currently qualified designs or commercially available designs will suffice. Characterization of the material to be shipped should have already been performed to the extent needed to conclude that no available packagings are adequate. Design of a packaging requires the material to be characterized to some minimal level to ensure that the new design will be adequate. Accordingly, the first step in this guide focuses on content characterization. Content characterization generates important parameters to be considered in the design process.

The design of a DOT-7A, Type A packaging, in accordance with this document, will generate the following items. When qualifying the packaging through the DOT-7A Program, these items are forwarded to a DOE-approved test facility to be reviewed for completeness before the evaluation and testing activities are conducted.

- Packaging drawing
- Packaging specification
(Optional, if needed to supplement drawing)

- Analysis report
- Operating instruction
- Packaging Qualification Checklist (PQCL).

The PQCL is a checklist created to assure that all of the DOT-7A regulatory design requirements are addressed during the development of a Type A package. The design process will produce the information needed for the completion of the PQCL (see Appendix B).

When a package is qualified through the DOE DOT-7A Program, the DOT-7A Program team (located at a DOE-approved test facility) reviews these documents and resolves any comments with the applicant. The applicant will then prepare a sufficient number of prototype test units to satisfy the test requirements. The test units are then sent to the DOE-approved test facility where the final evaluations and performance testing are completed.

Packagings must be designed such that when subjected to the tests specified in Title 49 Code of Federal Regulations (49 CFR) 173.465, or evaluated against these tests by the methods authorized by 49 CFR 173.461(a), the packaging will prevent loss or dispersal of the radioactive contents, and any significant increase in the radiation levels recorded or calculated at the external surfaces for the condition before the test [49 CFR 173.412(j)].

The following sections detail the design process and the steps necessary to prepare for testing. Suggestions based on experience to date for materials and configurations are also included in the following sections.

2.0 CHARACTERIZATION OF CONTENTS

This section of the guide establishes what is considered the minimum level of characterization of the material to be shipped to support the design of a suitable packaging. It is not intended to define all aspects of content characterization that may be needed to fully document a shipment. The shipper is responsible for adequate content characterization to a level of detail to ensure compliance with the regulations.

2.1 RADIOLOGICAL

The following sections of 49 CFR pertain to the radiological characteristics of the material to be shipped:

173.417 Authorized fissile materials packages

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173.431	Activity limits for Type A and Type B packages
173.433	Requirements for determination of A_1 and A_2 values for radionuclides and for the listing of radionuclides on shipping on shipping papers and labels
173.441	Radiation level limitations
173.453	Fissile materials--exceptions
173.459	Mixing of fissile material packages.

Addressing these requirements for the purpose of packaging design will require the development of a design basis list of the isotopes to be present in the contents and their expected quantity on a per-loaded-package basis (isotopic inventory). This list will be used for design purposes and will not reflect the actual contents shipped, but should establish bounding values on actual contents for design purposes. The applicant is requested to provide this list in the appropriate area in the PQCL. Further, if fissile radionuclides are present, the fissile classification shall be indicated.

The important parameters are (1) total activity allowed in the packaging, and (2) radiation level limits. Decay heat is covered in Section 2.3, Thermal.

2.2 PHYSICAL FORM

The physical form of the material has a direct and an indirect effect on the applicability of a number of requirements; for example, the form affects the density of the material, which will affect the gross weight, which affects the requirements invoked for package handling features. The Contents Characterization section of the PQCL contains check-off blocks for the basic physical form of the material to be shipped with blanks for additional data, based on the form.

Solid materials are defined in WHC-EP-0558, *Test and Evaluation Document for DOT Specification 7A Type A Packaging* (Cruse 1992), as follows:

Form Number 1: Solids - any particle size.

- A packaging qualified for these contents is expected to contain radioactive contents of any representative particulate size.

Form Number 2: Solids - large particle size only (i.e., sand, concrete, debris, soil).

- Contents of a corresponding particulate size such as soil or construction debris. (Glass or plastic labware having fine particulate available for dispersion would not fit this category and would require a packaging qualified for fine particulate, Form Number 1.)

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Form Number 3: Solids - objects with no significant dispersible or removable contamination (for definition, see 49 CFR 173.443, Contamination Control).

- Metals with activation products
- Forms of metals/alloys/compounds of uranium, thorium
- Solid materials with the radioactive material firmly fixed in place, possibly by the application of a fixing media (i.e., paint)
- Solidified material.

NOTE: These are examples only and each form must be analyzed for compliance with the "no removable or dispersible contamination" criterion found in 49 CFR 173.443.

For heavy, bulky, materials (e.g., concrete chunks, motors, and pumps), equipment/materials with sharp corners or protrusions, or material/equipment geometries that could result in highly localized forces, the shipper must ensure that the contents are securely fastened/positioned within the package to prevent damage to the packaging.

Packaging intended to transport liquids and gases must be designed to withstand more severe test conditions than those designed for solids.

2.3 THERMAL

The following sections of 49 CFR pertain to the thermal limitations of packagings:

- 173.410(i) Air shipments, containment and shielding - temperature range
- 173.412(c) Containment and shielding - temperature range
- 173.442 Thermal limitations
- 173.448(b) Heat output.

For whatever reason, the thermal heat generation of the contents must not degrade the packaging. Normally Type A quantities of radionuclides do not generate enough decay heat to be of concern. For any heat-generating contents, the decay heat should be calculated and documented in the package design analyzed to ensure no problems. The applicant shall indicate a maximum design wattage value for the contents in the appropriate block of the PQCL.

2.4 CHEMICAL

The following sections of 49 CFR pertain to the chemical characteristics of the contents:

173.21	Forbidden materials and packages
173.24(b)(3)	Mixture, reaction
173.24(e)(2)	Reaction
173.24(e)(3)	Plastic compatibility/permeability
173.24(f)	Closures, gaskets
173.410(g)	Compatibility, behavior under irradiation
173.412(e)	Gas generation, radiolysis.

The contents must not react with the packaging so as to degrade it. The contents must not possess or develop chemical conditions that could lead to pressurization beyond design specification or an explosion.

The basic chemical makeup of the nonradioactive constituents of the contents to be shipped must be understood to adequately design a packaging. The applicant shall identify any nonradioactive materials in the contents that meet the definition of hazardous materials in accordance with 49 CFR 172. The applicant shall also identify all organic substances and the quantity expected to be present in a single package. The hazardous materials shall be listed by their proper shipping name and identification number in accordance with the Hazardous Materials Table (49 CFR 172.101). This information, or the document that the information may be found in, should be listed in the space provided in the PQCL.

Hydrogen gas generation has been a controlling parameter for a number of radioactive shipments. On September 10, 1984, the U.S. Nuclear Regulatory Commission (NRC) issued Information Notice Number 84.72, *Clarification of Conditions for Waste Shipments Subject to Hydrogen Gas Generation* (NRC 1984). The following generic requirements from that notice are included in certain Certificates of Compliance:

- (1) *For any package containing water and/or organic substances that could radiolytically generate combustible gases, it must be determined by tests and measurements of a representative package whether or not the following criteria are met over a period of time that is twice the expected shipment time:*
 - (a) *The hydrogen generated must be limited to a molar quantity that would be no more than 5% by volume (or equivalent limits for other inflammable gases) of the secondary container gas void, if present, at STP (i.e., no more than 0.063 g-moles/ft³ at 14.7 psia and 70°F), or*

- (b) *The secondary container and cask cavity must be inerted with a diluent to ensure that oxygen must be limited to 5% by volume in those portions of the package that could have hydrogen greater than 5%.*

For any package delivered to a carrier for transport, the secondary container must be prepared for shipment in the same manner in which determination for gas generation is made. The shipment period begins when the package is prepared (sealed) and must be completed within twice the expected shipment time.

- (2) *For any package containing materials with radioactivity concentration not exceeding that for low specific activity (LSA) material, and shipped within 10 days of preparation, or within 10 days after venting of drums or other secondary containers, the determination in (1) above need not be made, and the time restriction in (1) above does not apply.*

The notice also points out that the generation of combustible gases is dependent on the waste form, radioactive concentration and isotope, free volume, total mass and accumulated dose in the waste. This information should be considered when characterizing the packaging's contents.

3.0 PACKAGING DESIGN

The following sections of 49 CFR pertain to the design of a Type A packaging:

173.24(b)	Design and construction
173.24(e)(3)	Plastic packagings and receptacles
173.403	Definitions
173.410	General design requirements
173.412	Additional design requirements for Type A packages
173.462(c)	Containment system...specified
173.462(d)	External features...clearly identified
178.3	Marking of Packagings.

The designer should scan the data in WHC-EP-0558, *Test and Evaluation Document for DOT Specification 7A Type A Packagings* (Cruse 1992), and review designs qualified for similar contents for examples from which to work. Before beginning the design process, all regulatory requirements should be thoroughly reviewed and understood. For convenience, the applicable design-related Type A packaging requirements have been excerpted and included as Appendix A to this document. This material is for information only and cannot guarantee reflection of the latest revisions of the applicable regulations.

3.1 DESIGN DOCUMENTATION

The generation of adequate documentation for Type A packaging is important, as each offeror of a Type A packaging is required to have a copy of the documentation. The document should be maintained using a method that will allow the reproduction of clean usable copies. The regulatory requirements for the documentation are found in 49 CFR 173.415(a), "... Each offeror of a Specification 7A package must maintain on file for at least one year after the latest shipment, and shall provide to DOT on request, complete documentation of tests and an engineering evaluation or comparative data showing that the construction methods, packaging design, and materials of construction comply with that specification..." When deciding what documentation to maintain, the definitions in 49 CFR 173.403 should be consulted. The following definitions from that list are presented to show their importance.

Design means the description of a special form Class 7 (radioactive) material, a package, packaging, or LSA-III, that enables those items to be fully identified. The description may include specifications, engineering drawings, reports showing compliance with regulatory requirements, and other relevant documentation.

Package means, for Class 7 (radioactive) materials, the packaging together with its radioactive contents as presented for transport...

(2) "*Type A package*" means a packaging that, together with its radioactive contents limited to A₁ or A₂ as appropriate, meets the requirements of §§173.410 and 173.412 and is designed to retain the integrity of containment and shielding required by this part under normal conditions of transport as demonstrated by the tests set forth in §173.465 or §173.466, as appropriate...

Packaging means, for Class 7 (radioactive) materials, the assembly of components necessary to ensure compliance with the packaging requirements of this subpart. It may consist of one or more receptacles, absorbent materials, spacing structures, thermal insulation, radiation shielding, service equipment for filling, emptying, venting and pressure relief, and devices for cooling or absorbing mechanical shocks. The conveyance, tie-down system, and auxiliary equipment may sometimes be designated as part of the packaging.

The following areas of Section 3.0 present guidance on the types and contents of the required documentation, and subject areas to document.

3.1.1 Drawing

A packaging general arrangement drawing which specifies the materials and components to the extent necessary to assure compliance and reliability of manufacturing of the packagings shall be prepared. Any materials forming the containment boundary or related to performance shall be specified by characteristics that will ensure that the manufactured packagings will be equivalent to the prototypes used in testing or to the design qualified by evaluation.

The regulatory requirements that pertain to the content and packaging suggest that the packaging drawing address the following:

- 1) The packaging should be identified by a simple alpha-numeric model number. If the drawing identifies a series of packagings of similar design, a different number should be used for each to avoid confusion.
- 2) If steel is used in the packaging, it should be specified and the specification reviewed to assure the steel is low-carbon, commercial quality steel. Stainless, open hearth, electric, basic oxygen, or other similar quality steels are acceptable.
- 3) If lumber is used in the packaging, it should be specified as being well seasoned, commercially dry, and free from decay, loose knots, knots that would interfere with nailing, and other defects that would materially lessen the strength.
- 4) If the construction process includes welding or brazing, the drawing should include guidance in order to ensure that welding or brazing are performed in a workmanlike manner using suitable and appropriate techniques, materials, and equipment.
- 5) Geometric tolerances in accordance with ANSI Y14.5M (ANSI 1982) should be used whenever applicable.
- 6) Packaging features that are critical to the design and performance shall be dimensioned with appropriate tolerances.
- 7) The containment system of the packaging should be clearly specified on the drawing [49 CFR 173.462(c)].
- 8) External features of the packaging system should be clearly identified on the drawing so that they may be easily referenced [49 CFR 173.462(d)].

- 9) A number of Type A packagings listed in the WHC-EP-0558, *Test and Evaluation Document for DOT Specification 7A Type A Packaging* (Cruise 1992), use components that were specified in 49 CFR 178 (i.e., DOT-17C Steel Drum). However, docket HM-181 (HM-181 1990) eliminated many of these specification packagings.

CAUTION: The eliminated packagings have been replaced with Performance-Oriented packagings (POP). The POP are now specified by particular UN performance designs. As the packagings are based on performance and not design, it is possible to have many packagings design meeting the same performance specification. For this reason, designers are cautioned not to refer to such specifications in the design documentation for new packagings. New packagings should be identified in enough detail to ensure that the same packaging design will be used each time that particular packaging configuration is manufactured.

3.1.2 Specification

A specification for the packaging design may or may not be needed depending on its complexity. If the drawing becomes overly burdened with information, it is recommended that a specification be prepared to supplement the drawing. The specification is a useful place to state material and processing requirements for the packaging components (i.e., steel, lumber, gaskets).

3.1.3 Analysis Report

The following sections of 49 CFR pertain to the analysis report which documents the adequacy of the packaging:

173.410(b)	Lifting attachments
173.412(c)	Liquid, brittle fracture (if applicable)
173.412(i)	Tiedown, failure (if applicable)
173.441	Radiation level limitations (if shielding is required)
173.442	Thermal limitations.

The following sections of 49 CFR include a chemical compatibility evaluation that documents the regulatory requirements:

173.21	Forbidden materials and packages
173.24(b)(3)	No mixture of gasses and vapors
173.24(e)(2)	No significant chemical or galvanic reaction
173.24(e)(3)	Plastic packagings and receptacles
173.24(f)	Closures shall be adequate

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- 173.410(g) Compatibility of packaging materials and contents
- 173.412(e) Gas generation/radiolytic decomposition/radiolysis.

The analysis report shall be of sufficient detail so that it can be verified by an independent overcheck.

3.2 GENERAL ARRANGEMENT

The packaging design will generally fall into one of three basic configurations: (1) single packaging, (2) composite packaging, or (3) combination packaging (for definitions see 49 CFR 171.8). Single packagings are generally recommended for solids meeting the definition of Form Number 2 or Form Number 3, or gases. For packaging of solids classed as Form Number 1 and liquids, composite or combination packagings are recommended.

3.3 CONTAINMENT

The following sections of 49 CFR pertain to containment of contents:

- 173.24(b) Design and construction
- 173.24(e)(2) Reaction
- 173.24(e)(3) Plastic packagings and receptacles
- 173.24(f) Closures and gaskets
- 173.410(i) Air shipments, containment and shielding - temperature range
- 173.412(j)(1) Loss or dispersal
- 173.462(c) Containment system...specified
- 173.469(a)(4) Leaktightness.

All hazardous materials packages are to have "no significant release of the hazardous materials to the environment," and the packaging must remain effective when subjected to conditions normal to transport, with account being taken for any reactions between the contents and the packaging materials. In practice "no significant release" implies no measurable leakage based on visual evaluation. A Type A packaging when subjected to the "Type A packaging tests" is expected to prevent loss or dispersal of the radioactive contents. As the radioactive material is usually simulated using a nonradioactive substitute, the ability to meet this requirement is usually based on visually looking for a sign of contents outside the test package. For gases, loss of material may be determined by pressure measurement.

For some packaging a leakage rate may be measured to a leak detection sensitivity of 1×10^{-4} std-cm³/s. In special form tests, the leakage rate shall be measured to a leak detection sensitivity of 1×10^{-4} torr-1/s (1.3×10^{-4} atm-cm³/s), based on air at 25°C (77°F) and one atmosphere differential pressure for solid radioactive content, or 1×10^{-6} torr-1/s (1.3×10^{-6} atm-cm³/s) for liquid or gaseous radioactive content.

Containment is formed by those materials or components that are or may be in direct contact with the contents during shipment. The design process will involve choices of basic material, use of filters or other pressure relief devices, gaskets or other seal materials, closure mechanisms, and other features. Typical containment materials are high-density polyethylene (HDPE), polypropylene, glass, and steel. The designer should review all of the design-related regulatory requirements and address them in the design process.

3.4 SHIELDING

The following sections of 49 CFR pertain to the design of shielding for Type A packagings:

- 173.412(c) Temperature (-40 to 70°C [-40 to 158°F]), brittle fracture
- 173.412(h) Shielding/containment interface
- 173.412(j)(2) Significant increase in radiation levels
- 173.441 Radiation level limitations.

Shielding may be required for Type A quantities of radionuclides. Lead or steel are commonly used materials for shielding. The regulations require the shielding (if used), and containment systems of the packaging remain effective when subjected to normal conditions of transport.

When evaluated against the performance requirements and tests specified in §173.465 or using any of the methods authorized by §173.461(a), the packaging will prevent a significant increase in the radiation levels recorded or calculated at the external surfaces for the condition before the test. A significant increase may be defined as, "Loss of shielding integrity which would result in more than a 20 percent increase in the radiation level at any external surface of the package" (IAEA 1985).

3.5 LIFTING AND HANDLING

The following sections of 49 CFR pertain to the design of lifting and handling features of Type A packagings:

- 173.410(a) Handling, securing
- 173.410(b) Lifting attachments.

The exterior design of the packaging shall meet the above requirements. Analysis shall be provided to document that lifting attachments comply with 173.410(b), see Section 3.1, Design Documentation.

3.6 TIEDOWN

The following sections of 49 CFR pertain to the design of tie down features of Type A packagings:

- 173.410(a) Handling, securing
- 173.412(i) Tiedown, failure.

Package tie down features and equipment shall meet the above requirements.

4.0 PACKAGING OPERATIONS

4.1 GENERAL

The operating instructions for a packaging are the primary vehicle for the shipper to maintain control on the assembly, loading, and closure processes for a packaging and its preparation for shipment and other items. Accordingly, the applicant is requested to prepare an operating instruction for the packaging system and forward it along with the design documentation as discussed above.

4.2 OPERATING INSTRUCTION

The operating instruction shall consist of the following primary sections:

- Packaging description
- Authorized contents
- Preloading inspections
- Loading procedure
- Preparation for shipment
- Preshipment inspections
- Shipment requirements
- Unloading procedure
- Reuse/reconditioning (if applicable).

The packaging description and authorized contents sections shall be similar to the material for a packaging included in WHC-EP-0558, *Test and*

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Evaluation Document for DOT Specification 7A Type A Packaging (Cruse 1992). The applicant shall determine the preloading inspections to be performed and the acceptance criteria considered necessary to ensure that the packaging complies with the design [49 CFR 173.474]. The loading procedure shall address all operations necessary to correctly assemble the packaging components, load the contents, and close the packaging [49 CFR 178.2(c)]. This procedure will be followed when preparing the package (with simulated contents) for testing.

The procedure addressing preparation for shipment should meet labeling and placarding requirements (see 49 CFR, Part 172, Subpart E and Subpart F) and any other applicable requirements. If the packaging must be secured to the conveyance in a particular fashion, this should also be specified in a section to be entitled "Tiedown."

The document should be an applicant-controlled document with the number, revision, and date printed on each page.

The procedure addressing preshipment inspections shall require documentation of verifications for compliance with the following requirements:

- 173.441 Radiation level limitations
- 173.442 Thermal limitations
- 173.443 Contamination control
- 173.474 Quality control for construction of packaging
- 173.475 Quality control requirements prior to each shipment of radioactive materials.

The section addressing shipment requirements shall meet the requirements and procedures applicable when the package is en route to its destination. For example, the requirements of 49 CFR 173.447, storage incident to transportation, shall be addressed in this section.

The unloading procedure shall detail all steps necessary to safely unload the package from the conveyance and for unloading the contents from the packaging.

If the packaging may be reused, then the operating instruction shall include procedures for reconditioning the packaging to a state that will meet the design requirements, as established in the drawing and specification. The procedure shall require documented inspection of the condition of the packaging.

5.0 PACKAGING QUALIFICATION CHECKLIST

Appendix B contains the PQCL. Upon completion of the items discussed herein involving design documentation and operating instructions, the applicant is requested to complete the PQCL and forward it along with copies of the documentation to the DOE-approved test facility. The name and address of the test facility will be provided by the DOE when the docket is opened. It is recommended that packaging developers not using the DOE DOT-7A Program to qualify their package use the PQCL as a checklist to verify the applicable Type A packaging requirements are met.

6.0 PREPARATIONS FOR TESTING

Upon receipt of the documentation package from the applicant, the DOE-approved test facility will review this information and resolve any comments with the applicant. Testing may begin during or after this process at the discretion of the DOE-approved test facility. The applicant will generally be responsible for preparation of test unit packages for testing, and for delivering them to the DOE-approved test facility. For planning purposes, a minimum of three test units are usually required per package configuration to serve the testing needs. More units are normally required, the number depending on the packaging design. The DOE-approved test facility will inform applicants of the total number of test units required as soon as possible.

Proof testing, on behalf of the sponsor, may be required by the DOE-approved test facility prior to actual testing.

6.1 PROOF TESTING

Potential problems are never truly known; they can only be anticipated. In anticipation of possible problems, the DOE-approved test facility may request the sponsor to reveal any proof testing they may have conducted. During the design review, if a feature important to safety, with no history of use is revealed, proof testing of the feature may be requested. Test sponsors planning to proof test packagings are encouraged to work directly with the DOE-approved test facility in developing the best test sequence. The test facility will make recommendations to ensure the proof testing adequately represents the forces to be seen by the containment and shielding during actual testing. Remember, the purpose of the proof testing is to ensure that the packaging, when subjected to the DOT-required testing, provides containment, with no release of contents. Also, any increase in radiation levels are to be insignificant (less than 20 percent).

6.1.1 Considerations - Water Spray Test

The water spray test must precede each test or test sequence as described in 49 CFR 173.465. It is important that the exterior of the packaging materials are durable enough to withstand any degradation that may occur during Type A testing, without loss of contents or a significant increase in the radiation levels. In addition to the free drop test described in 49 CFR 173.465(c), fiberboard and wood packages require additional testing.

As required by 49 CFR 173.465(c)(3), fiberboard or wood rectangular packages, not exceeding 50 kg (110 lb) in weight, shall have a separate packaging subjected to a free drop onto each corner from a height of 0.3 m (1 ft). For fiberboard cylindrical packages weighing not more than 100 kg (220 lb), 49 CFR 173.465(c)(4) requires that a separate specimen be subjected to a free drop onto each of the quarters of each rim from a height of 0.3 m (1 ft). Here, it becomes extremely important that the packaging designer be aware of the requirements, and that the integrity of the materials of construction be well known.

6.1.2 Considerations - Reduced Pressure Test

Another important design consideration is in the area of reduction of ambient (external) pressure. Per 49 CFR 173.412(f), the containment system must retain its radioactive contents under the reduction of ambient pressure to 25 kPa (3.6 psi).

The reduced pressure test simulates the reduction of external pressure to the package to 25 kPa (3.6 psi). This may be achieved by pressurizing the internal cavity of the packaging to 78.0 kPa (11.3 psig), or by placing an empty but closed packaging into a chamber that can be evacuated to 25 kPa (3.6 psia). In both cases, leak detection by visual identification of loss of material, gas pressure drop, gas bubble, soap bubble, or other method sensitive to $10E^{-03}$ std-cc/sec will typically be used.

7.0 REFERENCES

- 49 CFR, "Transportation," Parts 100 to 177 and Parts 178 to 199, *Code of Federal Regulations*, as amended.
- ANSI, 1982, *American National Standard for Dimensioning and Tolerancing*, ANSI Standard Y14.5M-(1982), American National Standards Institute, New York, New York.
- Cruse, J. M., 1992, *Test and Evaluation Document for DOT Specification 7A Type A Packaging*, WHC-EP-0558, Revision 3, Westinghouse Hanford Company, Richland, Washington.
- HM-181, 1990, Federal Register, Part II, Department of Transportation, Research and Special Programs Administration, Vol. 55, No. 246, *Rules and Regulations*, Docket No. HM-181, dated December 21, 1990.
- HM-169A, 1995, Federal Register, Part III, Department of Transportation, Research and Special Programs Administration, Vol. 60, No. 188, *Rules and Regulations*, Docket No. HM-169A, dated September 28, 1995.
- IAEA, 1985, *IAEA Safety Standards, Safety Series No. 6*, Regulations for the Safe Transport of Radioactive Material, 1985 Edition, International Atomic Energy Agency, Vienna, Austria.
- NRC, 1984, *Information Notice 84-72*, dated September 10, 1984, Nuclear Regulatory Commission, Office of Inspection and Enforcement.

8.0 GLOSSARY

CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
DOE-HQ	U.S. Department of Energy-Headquarters
DOT	U.S. Department of Transportation
DOT-7A	U.S. Department of Transportation Specification 7A Type A
EM-76	Office of Transportation, Emergency Management, and Analytical Services (DOE-HQ)
HDPE	high-density polyethylene
ICAO	International Civil Aviation Organization
LSA	Low specific activity
NRC	U.S. Nuclear Regulatory Commission
POP	Performance-Oriented Packagings
PQCL	Packaging Qualification Checklist
STP	standard temperature and pressure
UN	United Nations
WHC	Westinghouse Hanford Company

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APPENDIX A

TITLE 49 CODE OF FEDERAL REGULATIONS EXCERPTS

A.1 TITLE 49 CFR 173.24, GENERAL REQUIREMENTS FOR PACKAGINGS AND PACKAGES

- (a) Applicability. Except as otherwise provided in this subchapter, the provisions of this section apply to--
- (1) Bulk and non-bulk packagings;
 - (2) New packagings and packagings which are reused; and
 - (3) Specification and non-specification packagings.
- (b) Each package used for shipment of hazardous materials under this subchapter shall be designed, constructed, maintained, filled, its contents so limited, and closed so that under conditions normally incident to transportation--
- (1) Except as otherwise provided in this subchapter, there will be no identifiable (without the use of instruments) release of hazardous materials to the environment;
 - (2) The effectiveness of the package will not be substantially reduced; for example, impact resistance, strength, packaging compatibility, etc. must be maintained for the minimum and maximum temperatures encountered during transportation;
 - (3) There will be no mixture of gases or vapors in the package which could, through any credible spontaneous increase of heat or pressure, significantly reduce the effectiveness of the packaging.
- (c) Authorized packagings. A packaging is authorized for a hazardous material only if--
- (1) The packaging is prescribed or permitted for the hazardous material in a packaging section specified for that material in Column 8 of the §172.101 Table and conforms to applicable requirements in the special provisions of Column 7 of the §172.101 Table and, for specification packagings (but not including UN standard packagings manufactured outside the United States), the specification requirements in parts 178 and 179 of this subchapter; or
 - (2) The packaging is permitted under, and conforms to, provisions contained in §§171.11, 171.12, 171.12a, 173.3, 173.4, 173.5, 173.7, 173.27, or 176.11 of this subchapter.
- (d) Specification packagings and UN standard packagings manufactured outside the U.S.--
- (1) *Specification packagings.* A specification packaging, including a UN standard packaging manufactured in the United States, must conform in all details to the applicable specification or standard in part 178 or part 179 of this subchapter.
 - (2) *UN standard packagings manufactured outside the United States.* A UN standard packaging manufactured outside the United States, in accordance with national or international regulations based on the UN Recommendations on the Transport of Dangerous Goods, may be imported and used and is considered to be an authorized packaging under the provisions of paragraph (c)(1) of this section, subject to the following conditions and limitations:

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- (i) The packaging fully conforms to applicable provisions in the UN Recommendations on the Transport of Dangerous Goods and the requirements of this subpart, including reuse provisions;
 - (ii) The packaging is capable of passing the prescribed tests in part 178 of this subchapter applicable to that standard; and
 - (iii) The competent authority of the country of manufacture provides reciprocal treatment for UN standard packagings manufactured in the U.S.
- (e) Compatibility.
- (1) Even though certain packagings are specified in this part, it is, nevertheless, the responsibility of the person offering a hazardous material for transportation to ensure that such packagings are compatible with their lading. This particularly applies to corrosivity, permeability, softening, premature aging and embrittlement.
 - (2) Packaging materials and contents must be such that there will be no significant chemical or galvanic reaction between the materials and contents of the package.
 - (3) Plastic packagings and receptacles.
 - (i) Plastic used in packagings and receptacles must be of a type compatible with the lading and may not be permeable to an extent that a hazardous condition is likely to occur during transportation, handling or refilling.
 - (ii) Each plastic packaging or receptacle which is used for liquid hazardous materials must be capable of withstanding without failure the procedure specified in Appendix B of this part ("Procedure for Testing Chemical Compatibility and Rate of Permeation in Plastic Packagings and Receptacles"). The procedure specified in Appendix B of this part must be performed on each plastic packaging or receptacle used for Packing Group I materials. The maximum rate of permeation of hazardous lading through or into the plastic packaging or receptacles may not exceed 0.5 percent for materials meeting the definition of a Division 6.1 material according to §173.132 and 2.0 percent for other hazardous materials, when subjected to a temperature no lower than--
 - (A) 18°C (64°F) for 180 days in accordance with Test Method 1 in Appendix B of this part;
 - (B) 50°C (122°F) for 28 days in accordance with Test Method 2 in Appendix B of this part; or
 - (C) 60°C (140°F) for 14 days in accordance with Test Method 3 in Appendix B of this part.
 - (iii) Alternative procedures or rates of permeation are permitted if they yield a level of safety equivalent to or greater than that provided by paragraph (e)(3)(ii) of this section and are specifically approved by the Associate Administrator for Hazardous Materials Safety.
 - (4) Mixed contents. Hazardous materials may not be packed or mixed together in the same outer packaging with other hazardous or

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nonhazardous materials if such materials are capable of reacting dangerously with each other and causing--

- (i) Combustion or dangerous evolution of heat;
- (ii) Evolution of flammable, poisonous, or asphyxiant gases; or
- (iii) Formation of unstable or corrosive materials.

(5) Packagings used for solids, which may become liquid at temperatures likely to be encountered during transportation, must be capable of containing the hazardous material in the liquid state.

(f) Closures.

(1) Closures on packagings shall be so designed and closed that under conditions (including the effects of temperature and vibration) normally incident to transportation--

- (i) Except as provided in paragraph (g) of this section, there is no identifiable release of hazardous materials to the environment from the opening to which the closure is applied; and
- (ii) The closure is secure and leakproof.

(2) Except as otherwise provided in this subchapter, a closure (including gaskets or other closure components, if any) used on a specification packaging must conform to all applicable requirements of the specification.

(g) Venting. Venting of packagings, to reduce internal pressure which may develop by the evolution of gas from the contents, is permitted only when--

- (1) Transportation by aircraft is not involved;
- (2) Except as otherwise provided in this subchapter, the evolved gases are not poisonous, likely to create a flammable mixture with air or be an asphyxiant under normal conditions of transportation;
- (3) The packaging is designed so as to preclude an unintentional release of hazardous materials from the receptacle; and
- (4) For shipments in bulk packagings, venting is authorized for the specific hazardous material by a special provision in the §172.101 Table or by the applicable bulk packaging specification in part 178 of this subchapter.

(h) Outage and filling limits--

(1) *General*. When filling packagings and receptacles for liquids, sufficient ullage (outage) must be left to ensure that neither leakage nor permanent distortion of the packaging or receptacle will occur as a result of an expansion of the liquid caused by temperatures likely to be encountered during transportation. Requirements for outage and filling limits for non-bulk and bulk packaging are specified in §§173.24a(d) and 173.24b(a), respectively.

(2) *Compressed gases and cryogenic liquids*. Filling limits for compressed gases and cryogenic liquids are specified in §§173.301 through 173.306 for cylinders and §§173.314 through 173.319 for bulk packagings.

(i) Air transportation. Packages offered or intended for transportation by aircraft must conform to the general requirements for transportation by aircraft in §173.27, except as provided in §171.11 of this subchapter.

**A.2 TITLE 49 CFR 173.24a, ADDITIONAL GENERAL REQUIREMENTS
FOR NON-BULK PACKAGINGS AND PACKAGES**

(a) Packaging design. Except as provided in §172.312 of this subchapter:

(1) *Inner packaging closures.* A combination packaging containing liquid hazardous materials must be packed so that closures on inner packagings are upright.

(2) *Friction.* The nature and thickness of the outer packaging must be such that friction during transportation is not likely to generate an amount of heat sufficient to alter dangerously the chemical stability of the contents.

(3) *Securing and cushioning.* Inner packagings of combination packagings must be so packed, secured and cushioned to prevent their breakage or leakage and to control their movement within the outer packaging under conditions normally incident to transportation. Cushioning material must not be capable of reacting dangerously with the contents of the inner packagings.

(4) *Metallic devices.* Nails, staples and other metallic devices shall not protrude into the interior of the outer packaging in such a manner as to be likely to damage inner packagings or receptacles.

(5) *Vibration.* Each non-bulk package must be capable of withstanding, without rupture or leakage, the vibration test procedure specified in §178.608 of this subchapter.

(b) Non-bulk packaging filling limits.

(1) A single or composite non-bulk packaging may be filled with a liquid hazardous material only when the specific gravity of the material does not exceed that marked on the packaging, or a specific gravity of 1.2 if not marked, except as follows:

(i) A Packing Group I packaging may be used for a Packing Group II material with a specific gravity not exceeding the greater of 1.8, or 1.5 times the specific gravity marked on the packaging, provided all the performance criteria can still be met with the higher specific gravity material;

(ii) A Packing Group I packaging may be used for a Packing Group III material with a specific gravity not exceeding the greater of 2.7, or 2.25 times the specific gravity marked on the packaging, provided all the performance criteria can still be met with the higher specific gravity material; and

(iii) A Packing Group II packaging may be used for a Packing Group III material with a specific gravity not exceeding the greater of

1.8, or 1.5 times the specific gravity marked on the packaging, provided all the performance criteria can still be met with the higher specific gravity material.

(2) Except as otherwise provided in this section, a single or composite non-bulk packaging may not be filled with a solid hazardous material to a gross mass greater than the maximum gross mass marked on the packaging.

(3) A single or composite non-bulk packaging which is tested and marked for liquid hazardous materials may be filled with a solid hazardous material to a gross mass, in kilograms, not exceeding the rated capacity of the packaging in liters, multiplied by the specific gravity marked on the packaging, or 1.2 if not marked. In addition:

(i) A single or composite non-bulk packaging which is tested and marked for Packing Group I liquid hazardous materials may be filled with a solid Packing Group II hazardous material to a gross mass, in kilograms, not exceeding the rated capacity of the packaging in liters, multiplied by 1.5, multiplied by the specific gravity marked on the packaging, or 1.2 if not marked.

(ii) A single or composite non-bulk packaging which is tested and marked for Packing Group I liquid hazardous materials may be filled with a solid Packing Group III hazardous material to a gross mass, in kilograms, not exceeding the rated capacity of the packaging in liters, multiplied by 2.25, multiplied by the specific gravity marked on the packaging, or 1.2 if not marked.

(iii) A single or composite non-bulk packaging which is tested and marked for Packing Group II liquid hazardous materials may be filled with a solid Packing Group III hazardous material to a gross mass, in kilograms, not exceeding the rated capacity of the packaging in liters, multiplied by 1.5, multiplied by the specific gravity marked on the packaging, or 1.2 if not marked.

(4) Packagings tested as prescribed in §178.605 of this subchapter and marked with the hydrostatic test pressure as prescribed in §178.503(a)(5) of this subchapter may be used for liquids only when the vapor pressure of the liquid conforms to one of the following:

(i) The vapor pressure must be such that the total pressure in the packaging [i.e., the vapor pressure of the liquid plus the partial pressure of air or other inert gases, less 100 kPa (15 psi) at 55°C (131°F), determined on the basis of a maximum degree of filling in accordance with paragraph (d) of this section and a filling temperature of 15°C (59°F)], will not exceed two-thirds of the marked test pressure;

(ii) The vapor pressure at 50°C (122°F) must be less than four-sevenths of the sum of the marked test pressure plus 100 kPa (15 psi); or

(iii) The vapor pressure at 55°C (131°F) must be less than two-thirds of the sum of the marked test pressure plus 100 kPa (15 psi).

- (5) No hazardous material may remain on the outside of a package after filling.
- (c) Mixed contents.
- (1) An outer non-bulk packaging may contain more than one hazardous material only when--
- (i) The inner and outer packagings used for each hazardous material conform to the relevant packaging sections of this part applicable to that hazardous material;
- (ii) The package as prepared for shipment meets the performance tests prescribed in part 178 of this subchapter for the packing group indicating the highest order of hazard for the hazardous materials contained in the package;
- (iii) Corrosive materials (except ORM-D) in bottles are further packed in securely closed inner receptacles before packing in outer packagings; and
- (iv) For transportation by aircraft, the total net quantity does not exceed the lowest permitted maximum net quantity per package as shown in Column 9a or 9b, as appropriate, of the §172.101 Table. The permitted maximum net quantity must be calculated in kilograms if a package contains both a liquid and a solid.
- (2) A packaging containing inner packagings of Division 6.2 materials may not contain other hazardous materials, except dry ice.
- (d) Liquids must not completely fill a receptacle at a temperature of 55°C (131°F) or less.

**A.3 TITLE 49 CFR 173.24b, ADDITIONAL GENERAL REQUIREMENTS
FOR BULK PACKAGINGS**

- (a) *Outage and filling limits.*
- (1) Liquids and liquefied gases must be so loaded that the outage is at least one percent of the total capacity of a cargo or portable tank, or compartment thereof, or at least one percent of the total capacity of the tank and dome for tank car and multi-unit tank car tanks at the reference temperature of 46°C (115°F) for uninsulated tanks and 41°C (105°F) for insulated tanks.
- (2) Hazardous materials may not be loaded into the dome of a tank car. If the dome of the tank car does not provide sufficient outage, vacant space must be left in the shell to provide the required outage.
- (3) Bulk packagings for materials poisonous by inhalation. For a material which meets the definition of poisonous by inhalation (see §178.1 of this subchapter), the outage in a bulk packaging must be at least five percent of the total capacity of the tank or compartment at the reference temperature of 46°C (115°F) for uninsulated tanks and 41°C (105°F) for insulated tanks.

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(b) *Equivalent steel*. For the purposes of this section, stainless steel is steel with a guaranteed minimum tensile strength of 51.7 deka newtons per square millimeter (75,000 psi) and a guaranteed elongation of 40 percent or greater. Where the regulations permit steel other than stainless steel to be used in place of a specified stainless steel (for example, as in §172.102 of this subchapter, special provision B30), the minimum thickness for the steel must be obtained from one of the following formulas, as appropriate:

Formula for metric units:

$$e_1 = (12.74e_0) / (Rm_1A_1)^{1/3}$$

Formula for non-metric units:

$$e_1 = (144.2e_0) / (Rm_1A_1)^{1/3}$$

Where:

e_0 = Required thickness of the reference stainless steel in millimeters or inches respectively;
 e_1 = Equivalent thickness of the steel used in millimeters or inches respectively;
 Rm_1 = Specified minimum tensile strength of the steel used in deka newtons per square millimeter or pounds per square inch respectively; and
 A_1 = Specified minimum percentage elongation of the steel used multiplied by 100 (for example, 20 percent times 100 equals 20). Elongation values used must be determined from a 50 mm or 2 inch test specimen.

- (c) Air pressure in excess of ambient atmospheric pressure may not be used to load or unload any lading which may create an air-enriched mixture within the flammability range of the lading in the vapor space of the tank.
- (d) A bulk packaging may not be loaded with a hazardous material that:
- (1) Is at a temperature outside of the packaging's design temperature range; or
 - (2) Except as otherwise provided in this subchapter, exceeds the maximum weight of lading marked on the specification plate.

A.4 TITLE 49 CFR 173.410, GENERAL DESIGN REQUIREMENTS

In addition to the requirements of subparts A and B of this part, each package used for the shipment of Class 7 (radioactive) materials must be designed so that--

- (a) The package can be easily handled and properly secured in or on a conveyance during transport.
- (b) Each lifting attachment that is a structural part of the package must be designed with a minimum safety factor of three against yielding when used to lift the package in the intended manner, and it must be

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designed so that failure of any lifting attachment under excessive load would not impair the ability of the package to meet other requirements of this subpart. Any other structural part of the package which could be used to lift the package must be capable of being rendered inoperable for lifting the package during transport or must be designed with strength equivalent to that required for lifting attachments.

(c) The external surface, as far as practicable, will be free from protruding features and will be easily decontaminated.

(d) The outer layer of packaging will avoid, as far as practicable, pockets or crevices where water might collect.

(e) Each feature that is added to the package will not reduce the safety of the package.

(f) The package will be capable of withstanding the effects of any acceleration, vibration or vibration resonance that may arise under normal conditions of transport without any deterioration in the effectiveness of the closing devices on the various receptacles or in the integrity of the package as a whole and without loosening or unintentionally releasing the nuts, bolts, or other securing devices even after repeated use (see §§173.24, 173.24a, and 173.24b).

(g) The materials of construction of the packaging and any components or structure will be physically and chemically compatible with each other and with the package contents. The behavior of the packaging and the package contents under irradiation will be taken into account.

(h) All valves through which the package contents could escape will be protected against unauthorized operation;

(i) For transport by air--

(1) The temperature of the accessible surfaces of the package will not exceed 50°C (122°F) at an ambient temperature of 38°C (100°F) with no account taken for insulation;

(2) The integrity of containment will not be impaired if the package is exposed to ambient temperatures ranging from -40°C (-40°F) to +55°C (131°F); and

(3) Packages containing liquid contents will be capable of withstanding, without leakage, an internal pressure that produces a pressure differential of not less than 95 kPa (13.8 lb/in²).

A.5 TITLE 49 CFR 173.412, ADDITIONAL DESIGN REQUIREMENTS FOR TYPE A PACKAGES

In addition to meeting the general design requirements prescribed in §173.410, each Type A packaging must be designed so that--

(a) The outside of the packaging incorporates a feature, such as a seal, that is not readily breakable, and that, while intact, is evidence that the package has not been opened. In the case of packages shipped in closed transport vehicles in exclusive use, the cargo compartment, instead of the individual packages, may be sealed.

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- (b) The smallest external dimension of the package is not less than 10 centimeters (4 inches).
- (c) Containment and shielding is maintained during transportation and storage in a temperature range of -40°C (-40°F) to 70°C (158°F). Special attention shall be given to liquid contents and to the potential degradation of the packaging materials within the temperature range.
- (d) The packaging must include a containment system securely closed by a positive fastening device that cannot be opened unintentionally or by pressure that may arise within the package during normal transport. Special form Class 7 (radioactive) material, as demonstrated in accordance with §173.469, may be considered as a component of the containment system. If the containment system forms a separate unit of the package, it must be securely closed by a positive fastening device that is independent of any other part of the package.
- (e) For each component of the containment system account is taken, where applicable, of radiolytic decomposition of materials and the generation of gas by chemical reaction and radiolysis.
- (f) The containment system will retain its radioactive contents under the reduction of ambient pressure to 25 kPa (3.6 pounds per square inch).
- (g) Each valve, other than a pressure relief device, is provided with an enclosure to retain any leakage.
- (h) Any radiation shield that encloses a component of the packaging specified as part of the containment system will prevent the unintentional escape of that component from the shield.
- (i) Failure of any tie-down attachment that is a structural part of the packaging, under both normal and accident conditions, must not impair the ability of the package to meet other requirements of this subpart.
- (j) When evaluated against the performance requirements of this section and the tests specified in §173.465 or using any of the methods authorized by §173.461(a), the packaging will prevent--
 - (1) Loss or dispersal of the radioactive contents; and
 - (2) A significant increase in the radiation levels recorded or calculated at the external surfaces for the condition before the test.
- (k) Each packaging designed for liquids will--
 - (1) Be designed to provide for ullage to accommodate variations in temperature of the contents, dynamic effects and filling dynamics;
 - (2) Meet the conditions prescribed in paragraph (j) of this section when subjected to the tests specified in §173.466 or evaluated against these tests by any of the methods authorized by §173.461(a); and
 - (3) Either--
 - (i) Have sufficient suitable absorbent material to absorb twice the volume of the liquid contents. The absorbent material must be compatible with the package contents and suitably positioned to contact the liquid in the event of leakage; or

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- (ii) Have a containment system composed of primary inner and secondary outer containment components designed to assure retention of the liquid contents within the secondary outer component in the event that the primary inner component leaks.
- (1) Each package designed for gases, other than tritium not exceeding 40 TBq (1000 Ci) or noble gases not exceeding the A_2 value appropriate for the noble gas, will be able to prevent loss or dispersal of contents when the package is subjected to the tests prescribed in §173.466 or evaluated against these tests by any of the methods authorized by §173.461(a).

A.6 TITLE 49 CFR 173.462, PREPARATION OF SPECIMENS FOR TESTING

- (a) Each specimen (i.e., sample, prototype or scale model) must be examined before testing to identify and record faults or damage, including:
- (1) Divergence from the specifications or drawings;
 - (2) Defects in construction;
 - (3) Corrosion or other deterioration; and
 - (4) Distortion of features.
- (b) Any deviation found under paragraph (a) of this section from the specified design must be corrected or appropriately taken into account in the subsequent evaluation.
- (c) The containment system of the packaging must be clearly specified.
- (d) The external features of the specimen must be clearly identified so that reference may be made to any part of it.

A.7 TITLE 49 CFR 178.2, APPLICABILITY AND RESPONSIBILITY

- (a) *Applicability.*
- (1) The requirements of this part apply to packagings manufactured--
 - (i) To a DOT specification, regardless of country of manufacture; or
 - (ii) To a UN standard, for packagings manufactured within the United States. For UN standard packagings manufactured outside the United States, see §173.24(d)(2) of this subchapter. For UN standard packagings for which standards are not prescribed in this part, see §178.3(b).
 - (2) A manufacturer of a packaging subject to the requirements of this part is primarily responsible for compliance with the requirements of this part. However, any person who performs a function prescribed in this part shall perform that function in accordance with this part.

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(b) *Specification markings.* When this part requires that a packaging be marked with a DOT specification or UN standard marking, marking of the packaging with the appropriate DOT or UN markings is the certification that--

(1) Except as otherwise provided in this section, all requirements of the DOT specification or UN standard, including performance tests, are met; and

(2) All functions performed by, or on behalf of, the person whose name or symbol appears as part of the marking conform to requirements specified in this part.

(c) *Notification.* Except as specifically provided in §§178.337-18 and 178.345-10 of this part, the manufacturer or other person certifying compliance with the requirements of this part, and each subsequent distributor of that packaging shall--

(1) Notify in writing each person to whom that packaging is transferred--

(i) Of all requirements in this part not met at the time of transfer, and

(ii) Of the type and dimensions of any closures, including gaskets, needed to satisfy performance test requirements.

(2) Retain copies of each written notification for at least one year from date of issuance; and

(3) Make copies of all written notifications available for inspection by a representative of the Department.

(d) Except as provided in paragraph (c) of this section, a packaging not conforming to the applicable specifications or standards in this part may not be marked to indicate such conformance.

(e) *Definitions.* For the purpose of this part--

Manufacturer means the person whose name and address or symbol appears as part of the specification markings required by this part or, for a packaging marked with the symbol of an approval agency, the person on whose behalf the approval agency certifies the packaging.

Specification markings mean the packaging identification markings required by this part including, where applicable, the name and address or symbol of the packaging manufacturer of approval agency.

A.8 TITLE 49 CFR 178.3, MARKING OF PACKAGINGS

(a) Each packaging represented as manufactured to a DOT specification or a UN Standard must be marked with specification markings conforming to the applicable specification, and with the following:

(1) In an unobstructed area, with letters, and numerals identifying the standards or specification (e.g., UN 1A1, DOT 4B240ET, etc.).

(2) Unless otherwise specified in this part, with the name and address or symbol of the packaging manufacturer or, where specifically authorized, the symbol of the approval agency

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certifying compliance with a UN standard. Symbols, if used, must be registered with the Associate Administrator for Hazardous Materials Safety. Duplicative symbols are not authorized.

(3) The markings must be stamped, embossed, burned, printed or otherwise marked on the packaging to provide adequate accessibility, permanency, contrast, and legibility so as to be readily apparent and understood.

(4) Unless otherwise specified, letters and numerals must be at least 12.0 mm (0.47 inches) in height except that for packagings of less than or equal to 30 L (7.9 gallons) capacity for liquids or 30 kg (66 pounds) capacity for solids the height must be at least 6.0 mm (0.2 inches). For packagings having a capacity of 5 L (1 gallon) or 5 kg (11 pounds) or less, letters and numerals must be of an appropriate size.

(5) For packages with a gross mass of more than 30 kg (66 pounds), the markings or a duplicate thereof must appear on the top or on a side of the packaging.

(b) A UN standard packaging for which the UN standard is set forth in this part may be marked with the United Nations symbol and other specification markings only if it fully conforms to the requirements of this part. A UN standard packaging for which the UN standard is not set forth in this part may be marked with the United Nations symbol and other specification markings for that standard as provided in the ICAO Technical Instructions or Annex 1 of the IMDG Code subject to the following conditions:

(1) The U.S. manufacturer must establish that the packaging conforms to the applicable provisions of the ICAO Technical Instructions or Annex 1 of the IMDG Code, respectively.

(2) If an indication of the name of the manufacturer or other identification of the packaging as specified by the competent authority is required, the name and address or symbol of the manufacturer or the approval agency certifying compliance with the UN standard must be entered. Symbols, if used, must be registered with the Associate Administrator for Hazardous Materials Safety.

(3) The letters "USA" must be used to indicate the State authorizing the allocation of the specification marks if the packaging is manufactured in the United States.

(c) Where a packaging conforms to more than one UN standard or DOT specification, the packaging may bear more than one marking, provided the packaging meets all the requirements of each standard or specification. Where more than one marking appears on a packaging, each marking must appear in its entirety.

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ALSO SEE:

- 173.415(a) Authorized Type A packages
- 173.442 Thermal limitations
- 173.461 Demonstration of compliance with tests
- 173.463 Packaging and shielding--testing for integrity
- 173.465 Type A packaging tests
- 173.466 Additional tests for Type A packagings designed for liquids and gases
- 173.474 Quality control for construction of packaging
- 173.475 Quality control requirements prior to each shipment of Class 7 (radioactive) materials
- 178.2 Applicability and responsibility
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APPENDIX B
DOT-7A TYPE A
PACKAGING QUALIFICATION CHECKLIST

DOT-7A TYPE A
PACKAGING QUALIFICATION CHECKLIST

When subjected to the tests specified in 49 CFR 173.465 (and 173.466 when applicable) or evaluated against these tests by any of the methods authorized by 49 CFR 173.461(a), the packaging will prevent:

- (1) Loss or dispersal of the radioactive contents; and
- (2) Any significant increase in the radiation levels recorded or calculated at the external surfaces for the condition before the test.

1.0 Characterization of Contents

Radiological

Limited to Type A Quantity of Radionuclides

Isotopic Inventory:

RADIONUCLIDES	QUANTITY (per package)			DECAY HEAT
	Curies	Grams	Grams Fissile	Watts/gram

(Use extra sheets if needed.)

Fissile Class: -Exempt -Fissile

Physical

Form Category: Normal Special (see 49 CFR 173.469)

Physical Form: Solid Form 1 Form 2 Form 3

Density: _____ (kg/m³)

Liquid Specific gravity: _____ Viscosity: _____

Gas Volume: _____ (cm³ at STP)

Thermal

Total wattage of contents: _____ (watts/package)

DOT-7A TYPE A
PACKAGING QUALIFICATION CHECKLIST

2.0 49 CFR 173.24 General requirements for packagings and packages.

173.24(a) Applicability.

Except as otherwise provided in this subchapter, the provisions of this section apply to--
(1) Bulk and non-bulk packagings;
(2) New packagings and packagings which are reused; and
(3) Specification and non-specification packagings.

This requirement applies. Please indicate the following.

Addressed in: Drawing Operating Instruction
 Specification Manufacturer Supplied Data
 Analysis Report Similarity or Documented Record

Specify:

173.24(b) Containment.

Each package used for the shipment of hazardous materials under this subchapter shall be designed, constructed, maintained, filled, its contents so limited, and closed, so that under conditions normally incident to transportation--

- (1) Except as otherwise provided in this subchapter, there will be no identifiable (without the use of instruments) release of hazardous materials to the environment;
- (2) The effectiveness of the package will not be substantially reduced; for example, impact resistance, strength, packaging compatibility, etc. must be maintained for the minimum and maximum temperatures encountered during transportation;
- (3) There will be no mixture of gases or vapors in the package which could, through any credible spontaneous increase of heat or pressure, significantly reduce the effectiveness of the packaging.

This requirement: Does not apply. Applies; indicate the following.

Addressed in: Drawing Operating Instruction
 Specification Manufacturer Supplied Data
 Analysis Report Similarity or Documented Record

Specify:

DOT-7A TYPE A
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173.24(c) Authorized Packagings.

A packaging is authorized for a hazardous material only if--

- (1) The packaging is prescribed or permitted for the hazardous material in a packaging section specified for that material in Column 8 of the §172.101 Table and conforms to applicable requirements in the special provisions of Column 7 of the §172.101 Table and, for specification packagings (but not including UN standard packagings manufactured outside the United States), the specification requirements in parts 178 and 179 of this subchapter; or
- (2) The packaging is permitted under, and conforms to, provisions contained in §§171.11, 171.12, 171.12a, 173.3, 173.4, 173.5, 173.7, 173.27 or 176.11 of this subchapter.

This requirement: Does not apply. Applies; indicate the following.

Addressed in: Drawing Operating Instruction
 Specification Manufacturer Supplied Data
 Analysis Report Similarity or Documented Record

Specify:

173.24(d)(1) Specification Packagings and UN Standard Packagings Manufactured Outside the U.S.--

(1) Specification packagings. A specification packaging, including a UN standard packaging manufactured in the United States, must conform in all details to the applicable specification or standard in part 178 or part 179 of this subchapter.

This requirement: Does not apply. Applies; indicate the following.

Addressed in: Drawing Operating Instruction
 Specification Manufacturer Supplied Data
 Analysis Report Similarity or Documented Record

Specify:

DOT-7A TYPE A
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**173.24(d)(2) Specification Packagings and UN Standard Packagings
Manufactured Outside the U.S.--**

(2) UN standard packagings manufactured outside the United States. A UN standard packaging, manufactured outside the United States, in accordance with national or international regulations based on the UN Recommendations of the Transport of Dangerous Goods, may be imported and used and is considered to be an authorized packaging under the provisions of paragraph (c)(1) of this section, subject to the following conditions and limitations:

- (i) The packaging fully conforms to applicable provisions in the UN Recommendations on the Transport of Dangerous Goods and the requirements of this subpart, including reuse provisions;
- (ii) The packaging is capable of passing the prescribed tests in part 178 of this subchapter applicable to that standard; and
- (iii) The competent authority of the country of manufacture provides reciprocal treatment for UN standard packagings manufactured in the U.S.

This requirement: Does not apply. Applies; indicate the following.

Addressed in:	<input type="checkbox"/> Drawing	<input type="checkbox"/> Operating Instruction
	<input type="checkbox"/> Specification	<input type="checkbox"/> Manufacturer Supplied Data
	<input type="checkbox"/> Analysis Report	<input type="checkbox"/> Similarity or Documented Record

Specify:

173.24(e) Compatibility.

- (1) Even though certain packagings are specified in this part, it is, nevertheless, the responsibility of the person offering a hazardous material for transportation to ensure that such packagings are compatible with their lading. This particularly applies to corrosivity, permeability, softening, premature aging and embrittlement.
- (2) Packaging materials and contents must be such that there will be no significant chemical or galvanic reaction between the materials and contents of the package.

This requirement: Does not apply. Applies; indicate the following.

Addressed in:	<input type="checkbox"/> Drawing	<input type="checkbox"/> Operating Instruction
	<input type="checkbox"/> Specification	<input type="checkbox"/> Manufacturer Supplied Data
	<input type="checkbox"/> Analysis Report	<input type="checkbox"/> Similarity or Documented Record

Specify:

DOT-7A TYPE A
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173.24(e)(3) Plastic packagings and receptacles.

- (i) Plastic used in packagings and receptacles must be of a type compatible with the lading and may not be permeable to an extent that a hazardous condition is likely to occur during transportation, handling or refilling.
- (ii) Each plastic packaging or receptacle which is used for liquid hazardous materials must be capable of withstanding without failure the procedure specified in appendix B of this part ("Procedure for Testing Chemical Compatibility and Rate Permeation in Plastic Packagings and Receptacles")...

This requirement: Does not apply. Applies; indicate the following.

Addressed in: Drawing Operating Instruction
 Specification Manufacturer Supplied Data
 Analysis Report Similarity or Documented Record

Specify:

173.24(e) Compatibility. (Continued)

- ...(4) Mixed contents. Hazardous materials may not be packed or mixed together in the same outer packaging with other hazardous or nonhazardous materials if such materials are capable of reacting dangerously with each other and causing--
 - (i) Combustion or dangerous evolution of heat;
 - (ii) Evolution of flammable, poisonous, or asphyxiant gases; or
 - (iii) Formation of unstable or corrosive materials.
- (5) Packagings used for solids, which may become liquid at temperatures likely to be encountered during transportation, must be capable of containing the hazardous material in the liquid state.

This requirement: Does not apply. Applies; indicate the following.

Addressed in: Drawing Operating Instruction
 Specification Manufacturer Supplied Data
 Analysis Report Similarity or Documented Record

Specify:

DOT-7A TYPE A
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173.24(f) Closures.

- (1) Closures on packagings shall be so designed and closed that under conditions (including the effects of temperature and vibration) normally incident to transportation--
 - (i) Except as provided in paragraph (g) of this section, there is no identifiable release of hazardous materials to the environment from the opening to which the closure is applied; and
 - (ii) The closure is secure and leakproof.
- (2) Except as otherwise provided in this subchapter, a closure (including gaskets or other closure components, if any) used on a specification packaging must conform to all applicable requirements of the specification.

This requirement: Does not apply. Applies; indicate the following.

Addressed in: Drawing Operating Instruction
 Specification Manufacturer Supplied Data
 Analysis Report Similarity or Documented Record

Specify:

173.24(g) Venting.

Venting of packagings, to reduce internal pressure which may develop by the evolution of gas from the contents, is permitted only when--

- (1) Transportation by aircraft is not involved;
- (2) Except as otherwise provided in this subchapter, the evolved gases are not poisonous, likely to create a flammable mixture with air or be an asphyxiant under normal conditions of transportation;
- (3) The packaging is designed so as to preclude an unintentional release of hazardous materials from the receptacle; and
- (4) For shipments in bulk packagings, venting is authorized for the specific hazardous material by a special provision in the §172.101 Table or by the applicable bulk packaging specification in part 178 of this subchapter.

This requirement: Does not apply. Applies; indicate the following.

Addressed in: Drawing Operating Instruction
 Specification Manufacturer Supplied Data
 Analysis Report Similarity or Documented Record

Specify:

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173.24(h) Outage and Filling Limits.

(1) General. When filling packagings and receptacles for liquids, sufficient ullage (outage) must be left to ensure that neither leakage nor permanent distortion of the packaging or receptacle will occur as a result of an expansion of the liquid caused by temperatures likely to be encountered during transportation. Requirements for outage and filling limits for non-bulk and bulk packagings are specified in §§173.24a(d) and 173.24b(a), respectively.

(2) Compressed gases and cryogenic liquids. Filling limits for compressed gases and cryogenic liquids are specified in §§173.301 through 173.306 for cylinders and §§173.314 through 173.319 for bulk packagings.

This requirement: [] Does not apply. [] Applies; indicate the following.

Addressed in: [] Drawing [] Operating Instruction
[] Specification [] Manufacturer Supplied Data
[] Analysis Report [] Similarity or Documented Record

Specify:

173.24(i) Air Transportation.

Packages offered or intended for transportation by aircraft must conform to the general requirements for transportation by aircraft in §173.27, except as provided in §171.11 of this subchapter.

This requirement: [] Does not apply. [] Applies; indicate the following.

Addressed in: [] Drawing [] Operating Instruction
[] Specification [] Manufacturer Supplied Data
[] Analysis Report [] Similarity or Documented Record

Specify:

DOT-7A TYPE A
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3.0 49 CFR 173.24a Additional general requirements for non-bulk packagings and packages.

173.24a (a) Packaging Design.

Except as provided in §172.312 of this subchapter:

- (1) Inner packaging closures. A combination packaging containing liquid hazardous materials must be packed so that closures on inner packagings are upright.
- (2) Friction. The nature and thickness of the outer packaging must be such that friction during transportation is not likely to generate an amount of heat sufficient to alter dangerously the chemical stability of the contents.
- (3) Securing and cushioning. Inner packagings of combination packagings must be so packed, secured and cushioned to prevent their breakage or leakage and to control their movement within the outer packaging under conditions normally incident to transportation. Cushioning material must not be capable of reacting dangerously with the contents of the inner packagings.
- (4) Metallic devices. Nails, staples and other metallic devices shall not protrude into the interior of the outer packaging in such a manner as to be likely to damage inner packagings or receptacles.

This requirement: [] Does not apply. [] Applies; indicate the following.

Addressed in: [] Drawing [] Operating Instruction
 [] Specification [] Manufacturer Supplied Data
 [] Analysis Report [] Similarity or Documented Record

Specify:

173.24a (a) Packaging Design. (Continued)

- (5) Vibration. Each non-bulk package must be capable of withstanding, without rupture or leakage, the vibration test procedure specified in §178.608 of this subchapter.

This requirement: [] Does not apply. [] Applies; indicate the following.

Addressed in: [] Drawing [] Operating Instruction
 [] Specification [] Manufacturer Supplied Data
 [] Analysis Report [] Similarity or Documented Record

Specify:

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173.24a (b) Non-bulk Packaging Filling Limits.

- (1) A single or composite non-bulk packaging may be filled with a liquid hazardous material only when the specific gravity of the material does not exceed that marked on the packaging, or a specific gravity of 1.2 if not marked...
 - ... (2) Except as otherwise provided in this section, a single or composite non-bulk packaging may not be filled with a solid hazardous material to a gross mass greater than the maximum gross mass marked on the packaging.
 - (3) A single or composite non-bulk packaging which is tested or marked for liquid hazardous materials may be filled with a solid hazardous material to a gross mass, in kilograms, not exceeding the rated capacity of the packaging in liters, multiplied by the specific gravity marked on the packaging, or 1.2 if not marked...
 - ... (5) No hazardous material may remain on the outside of a package after filling.
- NOTE: Type A limits are identified in 49 CFR 173.443.

This requirement: [] Does not apply. [] Applies; indicate the following.

Addressed in: [] Drawing [] Operating Instruction
 [] Specification [] Manufacturer Supplied Data
 [] Analysis Report [] Similarity or Documented Record

Specify:

DOT-7A TYPE A
PACKAGING QUALIFICATION CHECKLIST

173.24a (c) Mixed Contents.

- (1) An outer non-bulk packaging may contain more than one hazardous material only when--
 - (i) The inner and outer packagings used for each hazardous material conform to the relevant packaging sections of this part applicable to that hazardous material;
 - (ii) The package as prepared for shipment meets the performance tests prescribed in part 178 of this subchapter for the packing group indicating the highest order of hazard for the hazardous materials contained in the package;
 - (iii) Corrosive materials (except ORM-D) in bottles are further packed in securely closed inner receptacles before packing in outer packagings; and
 - (iv) For transportation by aircraft, the total net quantity does not exceed the lowest permitted maximum net quantity per package as shown in Column 9a or 9b, as appropriate, of the §172.101 Table. The permitted maximum net quantity must be calculated in kilograms if a package contains both a liquid and a solid.
- (2) A packaging containing inner packagings of Division 6.2 materials may not contain other hazardous materials, except dry ice.

This requirement: Does not apply. Applies; indicate the following.

Addressed in: Drawing Operating Instruction
 Specification Manufacturer Supplied Data
 Analysis Report Similarity or Documented Record

Specify:

173.24a (d) Liquid Fill Level.

Liquids must not completely fill a receptacle at a temperature of 55°C (131°F) or less.

This requirement: Does not apply. Applies; indicate the following.

Addressed in: Drawing Operating Instruction
 Specification Manufacturer Supplied Data
 Analysis Report Similarity or Documented Record

Specify:

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4.0 49 CFR 173.24b Additional general requirements for bulk packagings.

173.24b (a) Outage and Filling Limits.

(1) Liquids and liquified gases must be so loaded that the outage is at least one percent of the total capacity of a cargo or portable tank, or compartment thereof, or at least one percent of the total capacity of the tank and dome for tank car and multi-unit tank car tanks at the reference temperature of 46°C (115°F) for uninsulated tanks and 41°C (105°F) for insulated tanks.

(2) Hazardous materials may not be loaded into the dome of a tank car. If the dome of a tank car does not provide sufficient outage, vacant space must be left in the shell to provide the required outage.

(3) Bulk packagings for materials poisonous by inhalation. For a material which meets the definition of poisonous by inhalation (see §171.8 of this subchapter), the outage in a bulk packaging must be at least five percent of the total capacity of the tank or compartment at the reference temperature of 46°C (115°F) for uninsulated tanks and 41°F (105°F) for insulated tanks.

This requirement: [] Does not apply. [] Applies; indicate the following.

Addressed in: [] Drawing [] Operating Instruction
[] Specification [] Manufacturer Supplied Data
[] Analysis Report [] Similarity or Documented Record

Specify:

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173.24b (b) Stainless Steel Substitution.

Equivalent steel. For the purposes of this section, stainless steel is steel with a guaranteed minimum tensile strength of 51.7 deka newtons per square millimeter (75,000 psi) and a guaranteed elongation of 40 percent or greater. Where the regulations permit steel other than stainless steel to be used in place of a specified stainless steel (for example, as in §172.102 of this subchapter, special provision B30), the minimum thickness for the steel must be obtained from one of the following formulas, as appropriate:

Formula for metric units:

$$e_1 = (12.74e_0) / (Rm_1A_1)^{1/3}$$

Formula for non-metric units:

$$e_1 = (144.2e_0) / (Rm_1A_1)^{1/3}$$

Where:

e_0 = Required thickness of the reference stainless steel in millimeters or inches respectively;

e_1 = Equivalent thickness of the steel used in millimeters or inches respectively;

Rm_1 = Specified minimum tensile strength of the steel used in deka newtons per square millimeter or pounds per square inch respectively; and

A_1 = Specified minimum percentage elongation of the steel used multiplied by 100 (for example, 20 percent times 100 equals 20). Elongation values used must be determined from a 50 mm or 2 inch test specimen.

This requirement: Does not apply. Applies; indicate the following.

Addressed in: Drawing Operating Instruction
 Specification Manufacturer Supplied Data
 Analysis Report Similarity or Documented Record

Specify:

173.24b (c) Pressurized Loading:

Air pressure in excess of ambient atmospheric pressure may not be used to load or unload any lading which may create an air-enriched mixture within the flammability range of the lading in the vapor space of the tank.

This requirement: Does not apply. Applies; indicate the following.

Addressed in: Drawing Operating Instruction
 Specification Manufacturer Supplied Data
 Analysis Report Similarity or Documented Record

Specify:

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173.24b (d) Design Temperature Range/Weight:

A bulk packaging may not be loaded with a hazardous material that:

- (1) Is at a temperature outside of the packaging's design temperature range; or
- (2) Except as otherwise provided in this subchapter, exceeds the maximum weight of lading marked on the specification plate.

This requirement: Does not apply. Applies; indicate the following.

Addressed in:	<input type="checkbox"/> Drawing	<input type="checkbox"/> Operating Instruction
	<input type="checkbox"/> Specification	<input type="checkbox"/> Manufacturer Supplied Data
	<input type="checkbox"/> Analysis Report	<input type="checkbox"/> Similarity or Documented Record

Specify:

DOT-7A TYPE A
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5.0 49 CFR 173.410 General design requirements.

173.410(a) Handling and Securing.

In addition to the requirements of subparts A and B of this part, each package used for the shipment of Class 7 (radioactive) materials must be designed so that--

- (a) The package can be easily handled and properly secured in or on a conveyance during transport.

This requirement: Does not apply. Applies; indicate the following.

Addressed in: Drawing Operating Instruction
 Specification Manufacturer Supplied Data
 Analysis Report Similarity or Documented Record

Specify:

173.410(b) Lifting Attachments.

Each lifting attachment that is a structural part of the package must be designed with a minimum safety factor of three against yielding when used to lift the package in the intended manner, and it must be designed so that failure of any lifting attachment under excessive load would not impair the ability of the package to meet other requirements of this subpart. Any other structural part of the package which could be used to lift the package must be capable of being rendered inoperable for lifting the package during transport or must be designed with strength equivalent to that required for lifting attachments.

This requirement: Does not apply. Applies; indicate the following.

Addressed in: Drawing Operating Instruction
 Specification Manufacturer Supplied Data
 Analysis Report Similarity or Documented Record

Specify:

DOT-7A TYPE A
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173.410(c) External Surface Protrusions, Decontamination.

The external surface, as far as practicable, will be free from protruding features and will be easily decontaminated.

This requirement: [] Does not apply. [] Applies; indicate the following.

Addressed in:	[] Drawing	[] Operating Instruction
	[] Specification	[] Manufacturer Supplied Data
	[] Analysis Report	[] Similarity or Documented Record

Specify:

173.410(d) Outer Layer - Pockets, Crevices (Water Collection).

The outer layer of packaging will avoid, as far as practicable, pockets or crevices where water might collect.

This requirement: [] Does not apply. [] Applies; indicate the following.

Addressed in:	[] Drawing	[] Operating Instruction
	[] Specification	[] Manufacturer Supplied Data
	[] Analysis Report	[] Similarity or Documented Record

Specify:

DOT-7A TYPE A
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173.410(e) Features Added at Time of Transport.

Each feature that is added to the package will not reduce the safety of the package.

This requirement: [] Does not apply. [] Applies; indicate the following.

Addressed in:	[] Drawing	[] Operating Instruction
	[] Specification	[] Manufacturer Supplied Data
	[] Analysis Report	[] Similarity or Documented Record

Specify:

173.410(f) Acceleration, Vibration.

The package will be capable of withstanding the effects of any acceleration, vibration or vibration resonance that may arise under normal conditions of transport without any deterioration in the effectiveness of the closing devices on the various receptacles or in the integrity of the package as a whole and without loosening or unintentionally releasing the nuts, bolts, or other securing devices even after repeated use (see §§173.24, 173.24a, and 173.24b).

This requirement: [] Does not apply. [] Applies; indicate the following.

Addressed in:	[] Drawing	[] Operating Instruction
	[] Specification	[] Manufacturer Supplied Data
	[] Analysis Report	[] Similarity or Documented Record

Specify:

DOT-7A TYPE A
PACKAGING QUALIFICATION CHECKLIST

173.410(g) Physical/Chemical Compatibility, Irradiation.

The materials of construction of the packaging and any components or structure will be physically and chemically compatible with each other and with the package contents. The behavior of the packaging and the package contents under irradiation will be taken into account.

This requirement: Does not apply. Applies; indicate the following.

Addressed in: Drawing Operating Instruction
 Specification Manufacturer Supplied Data
 Analysis Report Similarity or Documented Record

Specify:

173.410(h) Valve - Protection, Enclosure.

All valves through which the package contents could escape will be protected against unauthorized operation;

This requirement: Does not apply. Applies; indicate the following.

Addressed in: Drawing Operating Instruction
 Specification Manufacturer Supplied Data
 Analysis Report Similarity or Documented Record

Specify:

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173.410(i) For Transport by Air--

- (1) The temperature of the accessible surfaces of the package will not exceed 50°C (122°F) at an ambient temperature of 38°C (100°F) with no account taken for insulation;
- (2) The integrity of containment will not be impaired if the package is exposed to ambient temperatures ranging from -40°C (-40°F) to +55°C (131°F); and
- (3) Packages containing liquid contents will be capable of withstanding, without leakage, an internal pressure that produces a pressure differential of not less than 95 kPa (13.8 lb/in²).

This requirement: [] Does not apply. [] Applies; indicate the following.

Addressed in:	[] Drawing	[] Operating Instruction
	[] Specification	[] Manufacturer Supplied Data
	[] Analysis Report	[] Similarity or Documented Record

Specify:

DOT-7A TYPE A
PACKAGING QUALIFICATION CHECKLIST

6.0 49 CFR 173.412 Additional design requirements for Type A packages.

173.412 Tamper Indication.

In addition to meeting the general design requirements prescribed in §173.410, each Type A packaging must be designed so that--

(a) The outside of the packaging incorporates a feature, such as a seal, that is not readily breakable, and that, while intact, is evidence that the package has not been opened. In the case of packages shipped in closed transport vehicles in exclusive use, the cargo compartment, instead of the individual packages, may be sealed.

This requirement: [] Does not apply. [] Applies; indicate the following.

Addressed in: [] Drawing [] Operating Instruction
[] Specification [] Manufacturer Supplied Data
[] Analysis Report [] Similarity or Documented Record

Specify:

173.412(b) Smallest External Dimension.

The smallest external dimension of the package is not less than 10 centimeters (4 inches);

This requirement: [] Does not apply. [] Applies; indicate the following.

Addressed in: [] Drawing [] Operating Instruction
[] Specification [] Manufacturer Supplied Data
[] Analysis Report [] Similarity or Documented Record

Specify:

DOT-7A TYPE A
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173.412(c) Containment and Shielding.

Containment and shielding is maintained during transportation and storage in a temperature range of -40°C (-40°F) to 70°C (158°F). Special attention shall be given to liquid contents and to the potential degradation of the packaging materials within the temperature range.

This requirement: [] Does not apply. [] Applies; indicate the following.

Addressed in: [] Drawing [] Operating Instruction
[] Specification [] Manufacturer Supplied Data
[] Analysis Report [] Similarity or Documented Record

Specify:

173.412(d) Secure Containment System.

The packaging must include a containment system securely closed by a positive fastening device that cannot be opened unintentionally or by pressure that may arise within the package during normal transport. Special form Class 7 (radioactive) material, as demonstrated in accordance with §173.469, may be considered as a component of the containment system. If the containment system forms a separate unit of the package, it must be securely closed by a positive fastening device that is independent of any other part of the package.

This requirement: [] Does not apply. [] Applies; indicate the following.

Addressed in: [] Drawing [] Operating Instruction
[] Specification [] Manufacturer Supplied Data
[] Analysis Report [] Similarity or Documented Record

Specify:

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173.412(e) Radiolytic Decomposition, Chemical Reaction, Radiolysis.

For each component of the containment system account is taken, where applicable, of radiolytic decomposition of materials and the generation of gas by chemical reaction and radiolysis.

This requirement: Does not apply. Applies; indicate the following.

Addressed in:	<input type="checkbox"/> Drawing	<input type="checkbox"/> Operating Instruction
	<input type="checkbox"/> Specification	<input type="checkbox"/> Manufacturer Supplied Data
	<input type="checkbox"/> Analysis Report	<input type="checkbox"/> Similarity or Documented Record

Specify:

173.412(f) Reduction of Ambient Pressure.

The containment system will retain its radioactive contents under the reduction of ambient pressure to 25 kPa (3.6 pounds per square inch).

This requirement: Does not apply. Applies; indicate the following.

Addressed in:	<input type="checkbox"/> Drawing	<input type="checkbox"/> Operating Instruction
	<input type="checkbox"/> Specification	<input type="checkbox"/> Manufacturer Supplied Data
	<input type="checkbox"/> Analysis Report	<input type="checkbox"/> Similarity or Documented Record

Specify:

Docket: _____

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173.412(q) Valve - Protection, Enclosure.

Each valve, other than a pressure relief device, is provided with an enclosure to retain any leakage.

This requirement: Does not apply. Applies; indicate the following.

Addressed in: Drawing Operating Instruction
 Specification Manufacturer Supplied Data
 Analysis Report Similarity or Documented Record

Specify:

173.412(h) Shielding (Enclosure).

Any radiation shield that encloses a component of the packaging specified as part of the containment system will prevent the unintentional escape of that component from the shield.

This requirement: Does not apply. Applies; indicate the following.

Addressed in: Drawing Operating Instruction
 Specification Manufacturer Supplied Data
 Analysis Report Similarity or Documented Record

Specify:

DOT-7A TYPE A
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173.412(i) Tiedown (Failure).

Failure of any tie-down attachment that is a structural part of the packaging, under both normal and accident conditions, must not impair the ability of the package to meet other requirements of this subpart.

This requirement: [] Does not apply. [] Applies; indicate the following.

Addressed in: [] Drawing [] Operating Instruction
[] Specification [] Manufacturer Supplied Data
[] Analysis Report [] Similarity or Documented Record

Specify:

173.412(j) Evaluation and Testing.

When evaluated against the performance requirements of this section and the tests specified in §173.465 or using any of the methods authorized by §173.461(a), the packaging will prevent--

- (1) Loss or dispersal of the radioactive contents; and
- (2) A significant increase in the radiation levels recorded or calculated at the external surfaces for the condition before the test.

NOTE: A significant increase may be defined as, "Loss of shielding integrity which would result in more than a 20 percent increase in the radiation level at any external surface of the package" (IAEA Safety Series No. 6, Paragraph No. 537, 1985 Edition).

This requirement: [] Does not apply. [] Applies; indicate the following.

Addressed in: [] Drawing [] Operating Instruction
[] Specification [] Manufacturer Supplied Data
[] Analysis Report [] Similarity or Documented Record

Specify:

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173.412(k)(1) Design Requirement for Liquid Packagings.

Each packaging designed for liquids will--

(1) Be designed to provide for ullage to accommodate variations in temperature of the contents, dynamic effects and filling dynamics;

This requirement: [] Does not apply. [] Applies; indicate the following.

Addressed in:	[] Drawing	[] Operating Instruction
	[] Specification	[] Manufacturer Supplied Data
	[] Analysis Report	[] Similarity or Documented Record

Specify:

173.412(k)(2) Evaluation and Testing of Liquid Packagings.

Meet the conditions prescribed in paragraph (j) of this section when subjected to the tests specified in §173.466 or evaluated against these tests by any of the methods authorized by §173.461(a); and

This requirement will be addressed by the test facility.

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173.412(k)(3) Choice of Design Requirement for Liquid Packagings.

Either--

- (i) Have sufficient suitable absorbent material to absorb twice the volume of the liquid contents. The absorbent material must be compatible with the package contents and suitably positioned to contact the liquid in the event of leakage; or
- (ii) Have a containment system composed of primary inner and secondary outer containment components designed to assure retention of the liquid contents within the secondary outer component in the event that the primary inner component leaks.

This requirement: Does not apply. Applies; indicate the following.

Addressed in: Drawing Operating Instruction
 Specification Manufacturer Supplied Data
 Analysis Report Similarity or Documented Record

Specify:

173.412(l) Evaluation and Testing of Gas Packagings.

Each packaging designed for gases, other than tritium not exceeding 40 TBq (1000 Ci) or noble gases not exceeding the A2 value appropriate for the noble gas, will be able to prevent loss or dispersal of contents when the package is subjected to the tests prescribed in §173.466 or evaluated against these tests by any of the methods authorized by §173.461(a).

This requirement will be addressed by the test facility.

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7.0 49 CFR 178.3 Marking of Packagings

178.3(a) What and How to Mark.

Each packaging represented as manufactured to a DOT specification or a UN Standard must be marked with specification markings conforming to the applicable specification, and with the following:

- (1) In an unobstructed area, with letters, and numerals identifying the standards or specification (e.g., UN 1A1, DOT 4B240ET, etc.).
- (2) Unless otherwise specified in this part, with the name and address or symbol of the packaging manufacturer or, where specifically authorized, the symbol of the approval agency certifying compliance with a UN standard. Symbols, if used, must be registered with the Associate Administrator for Hazardous Materials Safety. Duplicative symbols are not authorized.
- (3) The markings must be stamped, embossed, burned, printed or otherwise marked on the packaging to provide adequate accessibility, permanency, contrast, and legibility so as to be readily apparent and understood.
- (4) Unless otherwise specified, letters and numerals must be at least 12.0 mm (0.47 inches) in height except that for packagings of less than or equal to 30 L (7.9 gallons) capacity for liquids or 30 kg (66 pounds) capacity for solids the height must be at least 6.0 mm (0.2 inches). For packagings having a capacity of 5 L (1 gallon) or 5 kg (11 pounds) or less, letters and numerals must be of an appropriate size.
- (5) For packages with a gross mass of more than 30 kg (66 pounds), the markings or a duplicate thereof must appear on the top or on a side of the packaging.

This requirement: Does not apply. Applies; indicate the following.

Addressed in:	<input type="checkbox"/> Drawing	<input type="checkbox"/> Operating Instruction
	<input type="checkbox"/> Specification	<input type="checkbox"/> Manufacturer Supplied Data
	<input type="checkbox"/> Analysis Report	<input type="checkbox"/> Similarity or Documented Record

Specify:

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178.3(b) Marking.

A UN standard packaging for which the UN standard is set forth in this part may be marked with the United Nations symbol and other specification markings only if it fully conforms to the requirements of this part. A UN standard packaging for which the UN standard is not set forth in this part may be marked with the United Nations symbol and other specification markings for that standard as provided in the ICAO Technical Instructions or Annex 1 of the IMDG Code subject to the following conditions:

- (1) The U.S. manufacturer must establish that the packaging conforms to the applicable provisions of the ICAO Technical Instructions or Annex 1 of the IMDG Code, respectively.
- (2) If an indication of the name of the manufacturer or other identification of the packaging as specified by the competent authority is required, the name and address or symbol of the manufacturer or the approval agency certifying compliance with the UN standard must be entered. Symbols, if used, must be registered with the Associate Administrator for Hazardous Materials Safety.
- (3) The letters "USA" must be used to indicate the State authorizing the allocation of the specification marks if the packaging is manufactured in the United States.

This requirement: Does not apply. Applies; indicate the following.

Addressed in: Drawing Operating Instruction
 Specification Manufacturer Supplied Data
 Analysis Report Similarity or Documented Record

Specify:

178.3(c) Multiple Markings.

Where a packaging conforms to more than one UN standard or DOT specification, the packaging may bear more than one marking, provided the packaging meets all the requirements of each standard or specification. Where more than one marking appears on a packaging, each marking must appear in its entirety.

This requirement: Does not apply. Applies; indicate the following.

Addressed in: Drawing Operating Instruction
 Specification Manufacturer Supplied Data
 Analysis Report Similarity or Documented Record

Specify:

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8.0 Proof Testing By Sponsor

Please mark the appropriate box(es) shown below to identify any proof testing that has been completed prior to providing test packages to the DOE-approved test facility for Type A testing. If any documentation exists from the proof testing conducted, the sponsor should include that information along with this checklist.

[] Reduction in ambient (external) pressure or equivalent

Method: _____

Pressure: _____ Duration: _____

[] Vibration Duration: _____

[] Water Spray Inches: _____ Duration: _____

[] Compression Weight: _____ Duration: _____

[] Penetration Height: _____ Location: _____

[] Free Drop Height: _____ # of Drops: _____

Orientation: _____

9.0 Other Items

Enclose a copy of the following documents, along with this completed checklist, and forward to the DOE/HQ-approved test facility. The name and address of the test facility are provided when a docket is opened as discussed in Section 5.0:

- Packaging drawing
- Packaging specification (if developed)
- Analysis report
- Operating instruction

Docket: _____

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Completion

Applicant:

Signature _____

Date _____

Name (print)/ _____

Company/Address _____

Phone: _____

E-Mail Address: _____

Test Facility Use Only

Document review:

Test engineer
(sign/date) _____

Reviewed by:
(sign/date) _____

Packaging drawing _____

Packaging specification _____

Analysis report _____

Operating instruction _____

Packaging Qualification Checklist _____

Proof testing (sponsor) _____