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FREIGHT CONTAINER CONSIDERATIONS FOR NUCLEAR MATERIALS

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Exam Preview:

1. According to the reference material, when characterizing the waste placed in a freight container, the waste should be restricted to solids only, as per 49 CFR 173.411.
    a. True
    b. False
2. A freight container is considered used when purchased by its owner for international shipments and then removed from service. The service life is usually an average ____ years after the CSC plate was originally affixed to the freight container.
    a. 3-5
    b. 8-10
    c. 10-12
    d. 12-15
3. Using Table 7-1. Maximum Forces Acting on a Freight Container During Transport, what is the correct forward acting force value for a freight container for a rail transport that is subject to shunting?
    a. 0.5g
    b. 0.8g
    c. 1.0g
    d. 4.0g
4. According to the reference material, all materials used in freight container construction will be able to withstand extreme temperatures ranging from -70°C to 100°C without effect on the strength of the basic structure and weatherproofness of the cargo container.
    a. True
    b. False

5. Using Table 5-1. ISO 1496-1 Regulatory and Documentation Requirements, which of the following is a document that records the actual tests and their results of each test performed as required in the approved test plan?
    a. Production Certification
    b. Container Test Report
    c. Prototype Certificate
    d. Technical Specification
6. According to the reference material, a small freight container' is one, which has either one outer dimension less than 1.5 m (4.9 feet) or an internal volume of not more than 3.0 cubic meters (106 cubic feet).
    a. True
    b. False
7. The load securement ensures that, during normal conditions of transport, the packaging or items inside the freight container do not shift, therefore, causing an increase in dose rate at the surface of the package. If the increase of dose rate is greater than __%, it may cause the consignment to be out of compliance with 49 CFR 173.411(b) (6) (iii)(B)
    a. 10
    b. 20
    c. 30
    d. 40
8. According to the reference material, there are three types of freight containers that DOE contractors purchase for either onsite or off-site shipments.
    a. True
    b. False
9. According to the reference material, each packaging containing liquid in excess of an A2 quantity and intended for air shipment has been tested to show that it will not leak under an ambient atmospheric pressure of not more than __ kPa, absolute.
    a. 5
    b. 15
    c. 25
    d. 35
10. Using Table 7-2. Freight Container Markings per ISO 6346, which of the following markings matches the description: consists of three capital letters which are unique and shall be registered with the International Container Bureau?
    a. Check Digit
    b. Serial Number
    c. Equipment Category Identifier
    d. Owners Code

TABLE OF CONTENTS

TABLE OF TABLES

TABLE OF FIGURES

ACRONYMS

ABS	American Bureau of Shipping
ANSI	American National Standards Institute
CFR	Title 49 Code of Federal Regulations
CSC	Convention for Safe Containers
DOE	Department of Energy
DOT	Department of Transportation
EFCOG	Energy Facility Contractors Group
EM	Environmental Management
IICL	Institute of International Container Lessors
IP	Industrial Packagings
ISO	International Organization for Standardization
LSA	low specific activity
NNSA	National Nuclear Security Administration
OPT	Office of Packaging and Transportation
PMC	Packaging Management Council
PPE	personal protective equipment
QA	quality assurance
RAM	radioactive materials
SCO	surface contaminated objects
US	United States

1. INTRODUCTION

The Department of Energy (DOE) and its contractors use a number of Department of Transportation (DOT) packagings (e.g., Excepted, Industrial, Type A, and Type B) when transporting radioactive materials both on and off DOE sites. Among the DOT packagings are Industrial Packagings (IP), which are used to ship low specific activity (LSA) materials or surface contaminated objects (SCO) as defined in Title 49 Code of Federal Regulations (CFR), *Transportation,* Subtitle B, *Other Regulations Relating to Transportation,* Part 173, *Shippers-General Requirements for Shipments and Packagings,* Section 403, *Definitions*. (CFR 49 173.403) The requirements for Industrial Packagings are found in 49 CFR 173.411, *Industrial Packaging* (49 CFR 173.411). In 2004, the DOT modified the requirements in 49 CFR 173.411(b)(6), which allowed the use of a standard freight container (see Appendix A for definition) as an Industrial Packaging Type IP-2 or Type IP-3, as long as the requirements listed below are met.

Per 49 CFR 173.411(b)(6), "A freight container may be used as Type IP-2 or Type IP-3 packages provided:

> (i) The radioactive contents are restricted to solid materials;
> (ii) It meets the requirements for a Type IP-1 packages specified in paragraph (b)(1); and
> (iii) It meets the standards prescribed in the International Organization for Standardization document ISO 1496-1: "Series 1 Freight Containers—Specifications and Testing—Part 1: General Cargo Containers; excluding dimensions and ratings (IBR, see §171.7 of this subchapter)[1]. It must be designed such that if subjected to the tests prescribed in that document and the accelerations occurring during routine conditions of transport it would prevent:
> (A) Loss or dispersal of the radioactive contents; and
> (B) More than a 20% increase in the maximum radiation level at any external surface of the freight containers."

Over the past few years, freight containers have become the container of choice for DOE contractors in shipping LSA or SCO material. However, because the practices of procuring, loading and securing, modifying, and maintaining a freight container vary across the DOE complex, the Packaging Management Council (PMC) in coordination with the Energy Facility Contractors Group (EFCOG) Packaging and Transportation Subgroup and under the direction of the DOE Environmental Management (EM), Office of Packaging and Transportation (OPT) developed this Freight Container Guidance handbook.

[1] In 49 C.F.R. § 173.411(b)(6)(iii), the reference made to ISO 1496-1 is the 1990 Edition of the standard. This guidance document was prepared using the 1990 Edition; however, the users of this document should be aware that a 2013 Edition of ISO 1496-1 has been issued. The user of this document should also be knowledgeable as to what edition of the ISO 1496-1 standard was used in the manufacturing of any purchased freight container.

This handbbok provides guidance in order to comply with the DOT regulations, including. 49 CFR 173.411(b)(6). The document also provides additional practices and methods that may be over and above compliance with these regulations. This handbook is organized in a manner in which the user makes determinations beginning with the process of packaging selection, development of a technical specification, procurement, receipt inspection, and end user requirements. It is recommended that any user of this document be familiar with ISO 1496-1.

The appendices offer the user:

- Definitions (APPENDIX A)
- Historical information on the commercial practices associated with the freight container certification process (APPENDIX B)
- Commercial process for freight container certification (APPENDIX C)
- DOT regulatory requirements (APPENDIX D)
- Sample procurement specifications for new or like-new freight containers meeting the requirements of 49 CFR 173.411(b)(6) (APPENDIX E)
- Minimum safety factor of 3 against yielding (APPENDIX F)
- Manufacturers technical specifications (APPENDIX G)
- Twenty percent dose rate requirements (APPENDIX H)
- Example receipt inspection, pre-use inspection, and pre-shipment checklists (APPENDIX I)
- DOT letters of interpretations dealing with freight containers (APPENDIX J)
- Questions and answers from a discussion with the American Bureau of Shipping (APPENDIX K)
- Example of possible modifications that can be made to a freight container and still meets the requirements of 49 CFR 173.411(b)(6) (APPENDIX L)
- Matrix showing third party certification compliance to ISO 1496-1 (APPENDIX M)
- Example procurement specification for modifications to a freight container (APPENDIX N)
- Quality assurance matrix (APPENDIX O)
- Stress a freight container encounters during shipping (e.g., road, rail, and water) (APPENDIX P)
- Example of third party certification documents (APPENDIX Q)

This handbook is a living document and will continue to change as it matures. As it does, the PMC, in coordination with EFCOG and DOE/EM, will continue, when appropriate, to update this document so

DOE contractors can learn from each site's issues and concerns that will allow them to consistently apply methods associated with the procurement and use of freight containers. Thus, it is encouraged that DOE contractors submit questions and lessons learned to the PMC to improve this document.

2. PURPOSE

The purpose of this document is to provide guidance to the packaging community of DOE and National Nuclear Security Administration (NNSA) Complex in understanding the procurement, use, and maintenance of standard freight containers as radioactive material packagings.

3. SCOPE

The scope of this document is to provide guidance to DOE contractors who want to use a standard freight container as an Industrial Packaging Type IP-2 or Type IP-3 for domestic purposes based upon the DOT 49 CFR 173.411(b)(6).

4. PACKAGING SELECTION CONSIDERATIONS

When packaging radioactive materials (RAM), the goal is to contain and to protect the public from exposure to radiation hazards by complying with the DOT regulations. A freight container can be used as a Type IP-1, Type IP-2, or Type IP-3 when all applicable conditions for their respective packaging have been met. The process for selecting the correct radioactive material packaging (i.e., freight container) begins with an understanding and careful evaluation of the characteristics of the radioactive material contents, including physical form and radioactive properties with regard to activity, radiation type, and shielding.

When a freight container is used as Type IP-1 in accordance with 49 CFR 173.411.(b)(1), the container shall meet the general design requirements prescribed in 49 CFR 173.410. When the freight container is used as a Type IP-2 or Type IP-3 package, the radioactive material contents is restricted to solid materials. The regulatory requirements in 49 CFR 173.411(b)(6)(iii) require freight containers shall be designed to conform to the standards prescribed in ISO 1496-1 in addition to meeting the general design requirements for all radioactive material packages including Type IP-1. When the design is subjected to the tests prescribed in ISO 1496-1 and the accelerations occurring during routine conditions of transport, they will prevent:

- Loss or dispersal of the radioactive contents; and
- Loss of shielding integrity, which would result in more than a 20% increase in the radiation level at any external surface of the freight container.

The shipper/offeror provides guidance for meeting the above regulations by considering two categories of radioactive material contents: 1) dispersible; and 2) non-dispersible. It is imperative that the radioactive nature of the material being shipped be considered when showing compliance with the increase in radiation levels.

NOTE:

49 CFR 173.411(b)(6) applies only to ISO 1496-1: Series 1 freight containers –Specification and testing - Part 1: General cargo containers for general purposes. This freight container classification is explained in detail in ISO 668, Series 1 freight container – Classification, dimensions, and ratings. General cargo containers are for general-purpose cargo suitable for international exchange and conveyance by road, rail, and sea, and having top and bottom corner fittings meeting ISO 1161, Series 1 freight container – Corner fittings - Specification. Specialized containers such as thermal containers or tank containers are not included. Series 1 Freight Container refers to containers with specific dimensions. For example, a 1CC container is uniformly 8’ wide, 8’ to 9’6” high, and 20’ long, and a 1AA container is uniformly 8’ wide, 8’ to 9’6” high, and 40’ long. If the freight container is to be used for waste material, numerous waste acceptance criteria do not allow the use of a 40-foot container. For smaller waste streams, some generators have found that utilizing a 10-foot freight container helps with blocking/bracing and are easier to fill than the standard container.

The size, shape, and dispersible or non-dispersible nature of the contents will determine how the material is handled, loaded, and secured within the freight container. This will also ensure that the shielding levels remain compliant.

The following sections provide the user guidance on selecting a freight container with the necessary design features to enable shipment of dispersible or non-dispersible radioactive material contents.

4.1 Freight Container Considerations for Dispersible Radioactive Material

Dispersible contents consist of solid materials of a small particle size that can migrate, or become airborne, and thus are subject to leakage from the freight container. Dispersible contents include particulates, powders, fines or solid activated materials that can break or crumble during transportation. Migration of the dispersible contents can occur due to conditions of transport such as vibrations, accelerations, changes in pressure and temperature, and friction and motion between components. If dispersible material is available for release, the shipper needs to specifically ensure that it is contained and will not leak from the freight container. Examples of dispersible contents include unpackaged low level waste, piping or components with exterior contamination, oxidized radioactive components or materials packaged in degraded containers (see Figure 4-1) that will not withstand routine conditions of transport (e.g., badly deteriorated drums or boxes).

Figure 4-1. Degraded packagings with dispersible contents inside or packagings with external contamination are considered dispersible contents.

A freight container for dispersible contents shall be sufficiently particle tight, or sift-proof to meet the requirement of 49 CFR 173.411(b)(A), so that under the static loads imposed by ISO 1496-1, and simultaneously the accelerations occurring during routine conditions of transportation, radioactive material leakage does not occur. A standard freight container is designed for large cargo items and to be weather tight (keep rain out).

The design of a freight container is not intended to keep dispersible materials contained inside and as a result will not qualify as a packaging for small particle dispersible materials. In order to ensure dispersible materials are contained within the freight container additional sealing features need to be added so the (dispersible) contents remain confined within inner packagings.

The approach for packaging dispersible radioactive material contents is to either use a standard freight container with modifications (e.g., to door system, floors and vents) to tighten its sealing capability, or to provide further containment of the radioactive material content by using inner packagings.

Modifications to a standard freight container may include enhancements to the door sealing capability by providing back up or additional door seals, and/or applying caulk, tape, plastic films or coatings over the door seal joints. The floor system can be coated, covered, or lined, and wall vents can be replaced with nuclear filters that allow pressure equalization while retaining solid RAM particles. Modifications to freight containers that have been successful at DOE sites are discussed in APPENDIX L.

Another way dispersible RAM can be achieved is by packaging the RAM in boxes, drums, heavy gage plastic bags, plastic wrap, coating or otherwise immobilizing contaminated surfaces, or any enclosure that renders the dispersible RAM unavailable for release under routine conditions of transport. The inner packaging is required to maintain its structure and containment function (without tearing or failure) under

the routine conditions of transport. Per ANSI N14.5, the inner packaging shall ensure that dispersible material is not capable of release and migration within the freight container. The inner packaging combined with the freight container shall meet the general design requirements of 49 CFR 173.410.

4.2 Freight Container Considerations for Non-Dispersible Radioactive Material

Non-dispersible contents consist of solid radioactive materials of a sufficiently large (particle or component) size so as not to leak from the freight container. Non-dispersible contents include solid activated materials, metals, or alloys that will not break down or disintegrate into fine particles during transport. RAM, in the form of contamination, can be found inside hardware components such as piping, tanks, or HVAC duck work that may have closed openings (e.g., like flanges or ends encapsulated with a plastic bag (see Figure 4-2). Non-dispersible radioactive materials should either be of a form that is shown by the shipper to be:

- Robust enough to remain as a solid unit without disintegration or breaking down into smaller particles; or
- Be confined in inner packaging (bagging, drums, and boxes) that can be shown to withstand routine conditions of transport.

Figure 4-2. Piping with internal contamination and openings sealed with plastic and tape.

The shipper/offeror is responsible for evaluating the RAM contents to ensure the content is non-dispersible under the routine conditions of transport. This involves an evaluation of the radioactive content form and structure, how it is packaged, and how it is loaded and secured within the freight container. This evaluation needs to ensure that the requirements of 49 CFR 173.410 (f) and (g) are met.

Materials packaged, bagged, or large enough where they cannot be placed in an intermediate form of containment need to be retained or secured within the freight container. By securing the materials within the freight container they will not change position or sustain damage as a result of puncture, crushing, interaction with other cargo or friction during transport, or significantly degrade during transport. Tanks, piping or other hardware items need to be secured by blocking, bracing and/or tie down so that movement within the freight container is minimal and damage and a release in content will not occur (49 CFR Part 177, *Carriage by Public Highway*, Subpart B, *Loading and Unloading*, Section 842, *Class 7 (Radioactive) Materials*(d)).

5. DEVELOP THE TECHNICAL REQUIREMENTS FOR THE PACKAGING

5.1 International versus Domestic Use

When a shipper/offeror wants to use a freight container for an international shipment the regulatory requirements are different than when it is used for a domestic only shipment. The regulatory requirements for an international shipment are in 49 CFR Part 450, *General* to Part 453, *Control and Enforcement*. The United States Coast Guard states in 49 CFR Part 451, *Testing and Approval Containers*, Subpart A, *Approval of Existing Containers*, that a freight container shall be "manufactured to a design type which had been tested and found to comply with the technical conditions set out in Annex II" of the International Convention for Safe Containers (hereafter known as CSC). In June of 1996 the CSC supplemented section 15 to Annex II, which states, "Containers tested in accordance with the methods described in ISO Standard 1496-1 should be deemed to have been fully and sufficiently tested for the purpose of the CSC…" Therefore, if the freight container meets the requirements of ISO 1496-1, it also meets the requirements of the CSC.

The shipper/offeror knows that when a CSC plate is affixed to a freight container it signifies that the freight container meets the requirements of Annex II of the International Convention for Safe Containers; however, it does not mean that the freight container meets the requirements in ISO 1496-1. In order to ensure that the freight container complies with the requirements of ISO 1496-1 the shipper/offeror should obtain the manufacturer's or third party certifier's Prototype Certificate, Production Certificate and the Container Test Report. These documents will indicate what tests have been performed or what third party certifier document they are designed and tested to. For example, when the American Bureau of Shipping (ABS) is certifying a freight container they follow their Rules of Certification. This is a document published by the ABS that identifies what they require in order for ABS to certify a freight container. Similar documents are published by other third part certifiers (see APPENDIX A for the definition of Rules of Certification). Unless specific exceptions are made, the design and testing of a freight container in accordance with these Rules of Certification, will meet the ISO 1496-1 requirements. APPENDIX M lists the ISO 1496-1 testing requirements and various third party certifiers' documents used to show compliance.

When a shipper/offeror wants to use a freight container in a domestic shipment there are no regulatory requirements for design and testing of the container. Only when the shipper/offeror ships radioactive materials is a standard identified. That standard identified is found in 49 CFR 173.411(b)(6)(iii), which states:

(6) A freight container may be used as Type IP-2 or Type IP-3 provided:

(iii) It meets the standards prescribed in the International Organization for Standardization document ISO 1496-1 "Series 1 Freight Containers – Specifications and Testing – Part 1: General Cargo Containers; excluding dimensions and ratings.

5.2 Regulatory Requirements

The regulatory requirements for use of a freight container as an Industrial Packaging Type IP-2 or Type IP-3, are found in the 49 CFR 173 Subpart I, *Class 7 (Radioactive) Materials*. These regulations are identified in APPENDIX D of this document along with suggested methods of compliance. 49 CFR 173.410(b) lifting attachment requirements regarding: (1) a minimum safety factor of 3 against yielding; and (2) the exclusive load failure consideration, are addressed in APPENDIX F.

5.3 Use of New (one time use) or Used Containers

When a shipper/offeror decides they want to use a freight container as an Industrial Packaging they have two options: (1) obtain a new or like new freight container; or (2) obtain a used freight container. For the most part, both are manufactured in foreign countries for the purpose of exporting cargo.

5.3.1 New or One Time Used

Economically, one of the best options for the original owners of a freight container is a one-time shipment. A one-time-shipment involves a broker in the United States (US) who purchases a new container. To get the new container to the US, the original owner may fill them with cargo and ship them to the US, empty the cargo, and then deliver them to the broker so they can make them available to their customers as new (one time used) freight containers.

There are a number of benefits to purchasing a new freight container.

- The CSC plate is current.
- The container is structurally sound.
- Documentation is requested in the Procurement Documents that demonstrate compliance to ISO 1496-1.
- Gaskets on the door are in good condition.
- Door locks and mechanisms work.
- There is no rust or corrosion on the container that will affect its functionality.
- The flooring and floor joists are in good condition.

5.3.2 Used Freight Container

A freight container is considered used when purchased by its owner for international shipments and then removed from service. The service life is usually an average 8-10 years after the CSC plate was

originally affixed to the freight container. Once removed from service they are sold to either brokers or companies who modify them and in turn sell them to other companies. It is these containers that DOE contractors usually purchase and use. There are a number of concerns that need to be taken into account when a DOE contractor decides to purchase a used freight container.

- The CSC plate may be expired. This will be a concern if the freight container will be used for an international shipment.
- The freight container may not be structurally sound due to corrosion, damage, or degradation. If the CSC plated is expired, there is no guarantee that the container is structurally sound, therefore, the container will need to be re-inspected to ensure that it is structurally sound.
- Due to the age of the freight container, the availability of documentation needed to show compliance to ISO 1496-1, may be difficult to obtain.
- A detailed inspection will be required to ensure components (e.g., door mechanisms) are in good working order , gaskets are in good condition, minimal rust is found, damaged components are identified and replaced, and/or no holes are found in the freight container are found.

Choosing a used freight container may be based on cost and availability. If the shipper/offeror wants to have the freight container brought back in compliance with the CSC/ISO 1496-1 requirements, then the use of qualified inspectors and repair organizations such as the Institute of International Container Lessors (IICL) will be required. If the shipper/offeror does not need that level of rigor, then they may choose to use their own criteria to inspect the freight containers.

5.4 Documents Required to Meet Regulatory Requirements

A key to documentation demonstrating compliance to regulatory requirements is traceability. Each freight container is marked as per ISO 6346, *Freight container – Coding, identification and marking,* third edition, 1995. When a freight container is marked, there are four markings that are mandatory: owner code; equipment category identifier; serial number; and check digit. In Figure 5-1 below "ABZ" is the owner's code, "U" is the equipment category identifier, "001234" is the serial number, and the "5" in the box is the check digit. See Section 7.4 Marking, for additional information.

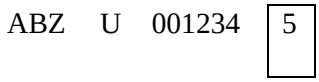

Figure 5-1. Mandatory Freight Container Markings

This is the marking that each owner is required to place on each freight container they have manufactured.

When meeting regulatory compliance, traceability to similar markings as noted above, is required for each freight container. With the exception of Type IP-1, the shipper/offeror needs to have documentation showing that the freight container meets the ISO 1496-1 requirements and the requirements identified in 49 CFR 173.411(c).

5.4.1 Meeting the Requirements of ISO 1496-1

In accordance to 49 CFR 173.411(b)(6), in order to use freight containers as an IP-2 or IP-3, the following requirements shall be met:

> (6) A freight container may be used as Type IP-2 or Type IP-3 packages provided:
>
> (i) The radioactive contents are restricted to solid materials;
>
> (ii) It meets the requirements for a Type IP-1 packages specified in paragraph (b)(1); and
>
> (iii) It meets the standards prescribed in the International Organization for Standardization document ISO 1496-1: "Series 1 Freight Containers—Specifications and Testing—Part 1: General Cargo Containers; excluding dimensions and ratings (IBR, *see* §171.7 of this subchapter). It must be designed such that if subjected to the tests prescribed in that document and the accelerations occurring during routine conditions of transport it would prevent:
>
> (A) Loss or dispersal of the radioactive contents; and
>
> (B) More than a 20% increase in the maximum radiation level at any external surface of the freight containers.

When characterizing the waste placed in a freight container, the waste should be restricted to solids only, as per 49 CFR 173.411 (b) (6)(i). Documentation demonstrating that the waste is solid shall be maintained by the shipper/offeror per 49 CFRFR 173.411(c). It is recognized that there is some waste acceptance criteria within DOE that allow a certain percentage of liquids in the waste packaging for disposal. For transportation purposes, if the contents contain incidental liquids, the shipper/offeror will mitigate the presence of the liquid by including the appropriate amount of absorbent material in the freight container.

Documentation shall be obtained that demonstrates that the freight container's design/model meets the design and testing requirements identified in ISO 1496-1 in order to meet 49 CFR 173.411(c). The reference number identified in Figure 5-2 and the serial number described in section 5.1 is crucial to obtaining the appropriate freight container documentation.

Each freight container design is assigned a reference number by an approval agency. That number, along with the approval agency's identifier and country of origin, are entered on the CSC Plate (see Figure 5-2).

This is the reference number that explains the country of origin, "USA," the countries approval agency, "AB," American Bureau of Shipping, and freight container design reference number, "568/03-111."

The Approval Agency reference number identified on the CSC Safety Approval Plate provides traceability to the plan review, testing and certification for a particular container model from a specific manufacturer.

Figure 5-2. CSC Safety Plate

Once the approval agency has accepted the proposed design, it issues a Prototype Test Certificate. This certificate allows the manufacturer of the proposed design to build a number of freight containers to the proposed design and have them tested. The Prototype Test Certificate and Container Test Report usually document the tests that were conducted according to the approved test plan. The shipper/offeror should review these tests to ensure they are the tests identified in ISO 1496-1. Most Prototype Test Certificates list the tests results and state that the freight container has passed the tests. For the purpose of showing compliance with 49 CFR 173.411(b)(6)(iii)(B), DOE contractors may feel they need to obtain the actual test documentation showing if deformation occurred during the performance of these tests. Approval agencies do not approve designs that result in permanent deformations outside allowable tolerances of the ISO standard. (See ISO 1496-1, Sections 4.1 and 6.) In addition, the tests being performed are witnessed by the approval agency's surveyor and documented in the Container Test Report.

Once an approval agency evaluates and accepts test results, it issues the Production Certificate. This certificate allows the manufacturer of the approved design to fabricate the freight container. The Production Certificate also lists the assigned serial numbers for the quantity to be fabricated. These documents can be obtained from the third party approval agency that has been authorized by the country's designated competent authority. Some third party approval agencies combine both the Prototype Test and Production Certificates into a single document.

Table 5.1 identifies the documentation that would be acceptable when demonstrating compliance to ISO 1496-1 as required by 49 CFR 173.411(b)(6).

Table 5-1. ISO 1496-1 Regulatory and Documentation Requirements

Regulatory Compliance 49 CFR 173.411(b)(6)	Documentation
The radioactive contents are restricted to solid materials.	Documentation that the contents match the packaging used, i.e., freight container.

Regulatory Compliance 49 CFR 173.411(b)(6)	Documentation
Satisfy the requirements for Type IP-1 specified in 49 CFR 173.411(b)(1).	Documentation showing that each element in 49 CFR 173.410 has been met and if an element is determined to be "not applicable" justification is provided.
Containers shall be designed such that if subjected to the tests prescribed in ISO 1496-1 and the accelerations occurring during routine conditions of transport, they would prevent loss or dispersal of the radioactive contents.	Documentation showing a design evaluation has been performed to ensure that there will be no loss or dispersal of the radioactive contents during routine conditions of transport.
Containers shall be designed such that if subjected to the tests prescribed in ISO 1496-1 and the accelerations occurring during routine conditions of transport, they would prevent loss of shielding integrity, which would result in more than a 20% increase in the radiation level at any external surface of the freight containers.	Documentation showing a design evaluation has been performed to ensure that during routine conditions of transport there will be no loss of shielding integrity, which would result in more than a 20% increase in the radiation level at any external surface of the freight containers. This documentation could be in the form of a loading and load securement procedure. (See APPENDIX H for assistance.)
Containers are designed to conform to the standards prescribed in the International Organization for Standardization document ISO 1496-1.	Documentation shall be provided that demonstrates that all tests identified in ISO 1496-1 have been performed and the freight container has passed those tests. Documentation that can be obtained through the approval agency is, the Prototype Certificate, Container Test Report, and Production Certificate.
Each third party approval agency has developed their own Rules of Certification as documented in APPENDIX A, Definitions. As noted above, these agencies have developed similar documents showing compliance to the ISO 1496-1. Below are examples of four documents commonly used to show compliance to this standard.	
Prototype Certificate	Prototype Test Certificate is a document issued by the third party approval agency when they have verified all designs and calculations supporting the design and methods of construction have met the design considerations and the performance tests as required in the agency's Rules of Certification. Prior to this document being issued the surveyor (the attending approval agency's representative) will witness the construction of each freight container, verify the materials of construction are as designated

Regulatory Compliance 49 CFR 173.411(b)(6)	Documentation
	in the design drawings, verify fabrication techniques, i.e., welding, and witness each test that is required in their Rules of Certification. Therefore, when a prototype container meets the requirements of the Rules of Certification based on the surveyor's observations and it has been determined that the prototype has passed the required tests; this document is issued by the third party approval agency (See APPENDIX Q).
Container Test Report	Container Test Report is a document that records the actual tests and their results of each test performed as required in the approved test plan (See APPENDIX Q).
Production Certificate	Production Certificate is a document issued by the third party approval agency upon the satisfactory conclusion of container plan review, prototype approval, the production tests required by the approved test plan, the acceptance of the manufacturer's quality control procedures, and the survey of each container. These units, when considered acceptable to the third party approval agency, will be certified and a Production Certificate will be issued. The Production Certificate will list the serial numbers for each container. (See APPENDIX Q)
Technical Specification	Manufacturer's specification that includes the bullets listed in the third paragraph of 5.4.2 below. (See APPENDIX G)

5.4.2 Meeting the Requirements of 49 CFR 173.411(c)

Documentation requirements for industrial packaging are identified in 49 CFR 173.411(c). This documentation requirement is for meeting all types of industrial packaging identified in 49 CFR 173.411. For a freight container package to meet the requirements in 49 CFR173.411 (b)(6), the shipper/offeror needs to show compliance with the DOT design requirements of 49 CFR 173.410, *General design requirements*, and have documentation that the freight container meets the specifications and testing requirements of ISO-1496-1. 49 CFR 173.410 focuses on the entire package design (content, inner packaging and freight container) and ISO 1496-1 documentation focuses on the freight container structural design.

In accordance with 49 CFR 173.411(c) for IP-2 and IP-3, a shipper/offeror shall identify and be able to provide documentation/verification to DOT that the requirements of 49 CFR 173.410 and ISO 1496-1 were considered and complied with prior to the shipment being released. Inclusive within 49 CFR 173.410 are the requirements of 49 CFR 173, Section 24, *General Requirements for Packagings and Packages* and Section 24b, *Additional General Requirements for Bulk Packages*.

To comply with 49 CFR 173.411(c) for IP-2 and IP-3 packagings, the shipper/offeror is required to have on hand documentation showing compliance to all applicable requirements in 49 CFR 173.410, as noted in 49 CFR 173.411(b)(6), as well as a complete set of 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 for the package. Comparative data shall be an analysis that includes documents used for the basis of comparison identified in 49 CFR 173, Section 461. Some of the documents that would meet this requirement are in Table 5-1, but in addition to those documents the shipper/offeror may obtain, from the manufacturer, the technical specification for the type and model of the freight container. The manufacturer's technical specification is a document that provides the user with the following information:

- Operational environment: states the temperature range (e.g., -30°C (-22°F) to 70°C (158°F)).
- Classification societies: lists approval agencies.
- Requirements: Lists the standards, regulations, and rules required in the manufacturing of the freight container.
- Dimensions and ratings: describes of the freight container and its ratings.
- Construction: describes how the freight container will be manufactured.
- Preservation: describes surface preparation and the coatings to be applied.
- Markings: shows how the container will be marked. This does not include the IP-2 or IP-3 marking requirements.
- Testing and Inspection: describes the tests that will be performed, test load, how the test was performed, and how the freight container will be inspected.
- Materials of Construction: provides a listing of materials by component and the yield point and tensile strength of that material.
- Drawings: shows how the freight container is fabricated (e.g., configuration and design details, materials construction, joints/welds, location of vents/filters, and component details).

5.4.3 Conclusion

The information discussed in Sections 5.4.1 and 5.4.2 will provide the shipper/offeror the documentation needed to perform or conduct the engineering evaluation as required in 49 CFR 173.411(c). This evaluation also includes reviewing the requirements in 49 CFR 173.410(f), which requires "The

packaging will be capable of withstanding the effects of any acceleration, vibration or vibration resonance that may arise under normal conditions of transport", and 49 CFR 173.410(g), which requires "the materials of construction of the packaging and any components or structure to be physically and chemically compatible with each other and with the package contents".

APPENDIX P contains a link to an online document titled *Freight Container Handbook*, by German Marine Insurers. This handbook provides general information regarding cargo loss prevention and the types of stress a freight container might encountered during transport.

5.5 Quality Assurance Requirements

Quality Assurance (QA) requirements for freight containers may be imposed on the original manufacturer through the certification process by the approval agency, when a DOE contractor chooses to make modifications to a freight container, and/or when they purchase a used freight container.

5.5.1 Quality Assurance Requirements by Approval Agency

As part of the certification process, the approval agency may require the manufacturer to have a quality control program. For example, when a manufacturer uses the ABS as their approval agency, they are required to submit a quality control manual, which gives in detail those inspections, and controls to be followed to assure the quality of the production units are comparable to the prototype. The quality control manual should contain a description of the organization, material identification, workmanship quality, control records, fabrication quality control methods, and quality control surveillance. This manual is to be initially submitted to ABS for review in order that compliance may be verified with their Rules of Certification. Subsequent to a satisfactory review by ABS, the manufacturing facility is subject to an audit by the attending approval agency representative (surveyor) to confirm compliance with the quality control procedures outlined in the submitted manual. When changes or revisions are made to the manual, including any quality control procedures, they are to be submitted to the approval agency for review and acceptance.

When a DOE contractor desires to purchase a new freight container, they can work with the respective approval agency to determine what specific quality control or quality assurance program was in place at the time of manufacture. Knowing what quality processes were in place at the time of manufacture will help the DOE contractor determine the method of procurement and acceptance.

5.5.2 Quality Assurance Requirements Required by the Department of Transportation

With respect to quality assurance, the regulations are almost non-existent. Quality assurance is not found in the definitions cited in 49 CFR Part 171, *General Information, Regulations and Definitions*, Subpart A, *Applicability, General Requirements, and North American Shipments*, Section 8; *Definitions and Abbreviations*. Language about quality assurance and quality control appear only in 49 CFR 173 Subpart I, *Class 7 (Radioactive) Materials*. In 49 CFR 173.403, *Definitions*, DOT provides their definition of quality assurance:

> "Quality Assurance means a systematic program of controls and inspections applied by each person involved in the transport of radioactive material, which provides confidence that a standard of safety prescribed in this subchapter is achieved in practice."

The last portion of this definition states, "…which provides confidence that a standard of safety prescribed in this subchapter is achieved in practice." The use of the word subchapter means all the subparts included in Subchapter C, *Hazardous Materials Regulations*, Parts 171 through 180. Thus, DOT is implying that the shipper/offeror will have a process or program with systematic controls and inspections applied by an organization involved in the transport of radioactive materials. When implemented, these program controls ensure that the standard of safety prescribed in Subchapter C is achieved. The selection of a quality assurance program and its adequate implementation using a graded approach is the sole responsibility of the shipper/offeror.

5.5.2.1 Specific Quality Control Requirements by the DOT

DOT includes specific quality control requirements in 49 CFR 173 Subpart I—the only section of the regulations that deals specifically with quality. There are two sections that deal with quality control: (1) the construction of the package (Section.474, *Quality Control for Construction of Packaging*) and (2) the use of the package (Section.475, *Quality Control Requirements Prior to Each Shipment of Class 7 (Radioactive) Materials*).

5.5.2.1.1 Quality Control for the Construction of the Package (49 CFR 173.474)

As required by the regulations, the shipper/offeror shall perform the following prior to the first use of any packaging used for a shipment of Class 7 (radioactive) materials:

- Determine that the packaging meets the quality of design;
- Determine that the construction of the packaging meets the specific requirements as identified in 49 CFR Subchapter C Parts 171 – 180;and
- Determine that the shielding, containment, and, when required, the heat transfer characteristics of the package are effective within the applicable limits specified for the package design.

As noted in Section 5.5.2 above when a DOE contractor implements DOE Order 414.1D, *Quality Assurance*, they will meet the regulatory definition of quality assurance . Upon delivery of the freight container, the supplier provides the DOE contractor with all the required documentation identified in the purchase order that ensures the construction of the packaging meets all the applicable requirements identified in Subchapter C.

5.5.2.1.2 Quality Control Requirements Prior to Each Shipment (49 CFR 173.475)

DOT requires the verification of a number of elements prior to each shipment of a Class 7 (radioactive) material, including the following.

(a) The packaging is proper for the contents to be shipped;

(b) The packaging is in unimpaired physical condition, except for superficial marks;

(c) Each closure device of the packaging, including any required gasket, is properly installed, secured, and free of defects;

(d) For fissile material, each moderator and neutron absorber, if required, is present and in proper condition;

(e) Each special instruction for filling, closing, and preparation of the packaging for shipment has been followed;

(f) Each closure, valve, or other opening of the containment system through which the radioactive content might escape is properly closed and sealed;

(g) Each packaging containing liquid in excess of an A2 quantity and intended for air shipment has been tested to show that it will not leak under an ambient atmospheric pressure of not more than 25 kPa, absolute (3.6 psia). The test must be conducted on the entire containment system, or on any receptacle or vessel within the containment system, to determine compliance with this requirement;

(h) The internal pressure of the containment system will not exceed the design pressure during transportation; and

(i) External radiation and contamination levels are within the allowable limits specified in this subchapter.

As noted with the implementation of the DOE QA Program all of these elements can be verified through an inspection process aided with the use of a checklist. A sample checklist in APPENDIX I can be used to determine compliance to these regulatory requirements.

5.5.3 Quality Assurance Requirements Established by the Department of Energy

As a DOE contractor, QA requirements are imposed through DOE Order 414.1D (the Order) or 10 CFR, *Energy*, Part 830, *Nuclear Safety Management*, Subpart A, *Quality Assurance Requirements* (the Rule). Both the Order and the Rule require that the DOE contractors develop and implement a QA program and may be implemented by using a national or international standard, e.g., ISO 9001:2008, ASME NQA-1-2008/2009a. These standards may be used to implement the quality assurance and quality control requirements identified in Section 5.5.2 above. APPENDIX O has a matrix of how an 18-element program would implement the requirements in both the Order and the Rule. DOE also requires, as part of that QA program, that contractors flow down all applicable QA requirements to their suppliers. When determining the QA requirements to flow down for a freight container, it is recommended that the contractor determine the critical characteristics for a freight container and then determine which QA requirements will ensure those characteristics are properly implemented.

One concern when dealing with suppliers of freight containers is that the manufacturers of freight containers are usually outside of the United Sates and predominately in Southeast Asia. Therefore, if a DOE contractor were to purchase directly from a performance of a supplier evaluation at the manufacturer’s facility, would require additional cost and travel.

5.5.4 Conclusion

The DOE contractor should recognize that when purchasing a new or like new freight container or purchasing a used freight container they are usually already built and in the United States. The DOE contractor should also recognize the difference in purchasing a new, like new or used freight container. If the DOE contractor purchases a used freight container, it will already be built and ready for delivery. Thus, DOE would not be able to implement and enforce a DOE QA program for production. Only when purchasing a customized built freight container or a large quantity (250 or more) of freight containers can the DOE contractor actually pass specific QA requirements down to the manufacturer. Either the third party approval agency surveyor or a DOE contractor representative could then validate those requirements during the manufacturing process.

The QA requirements that a DOE contractor will pass down to their supplier will need to be requirements a supplier can implement. Suppliers of freight containers are usually freight brokers or suppliers who obtain freight containers to refurbish or modify for their customers.

It is recommended that since all of the freight containers in commercial use are approved by an independent third party approval agency (e.g., American Bureau Shipping, Lloyds Register), a DOE contractor is to work with their supplier to obtain the necessary documentation that shows that the freight container has passed all the necessary design and testing requirements identified in ISO 1496-1.

6. PROCUREMENT SPECIFICATIONS FOR FREIGHT CONTAINERS

As stated earlier, there are three types of freight containers that DOE contractors purchase for either onsite or off site shipments. First are new or like new freight containers. Second are used freight containers. A used freight container is one that has been in use and now has been taken out of service and sold to a broker. These containers may have some slight damage, expired CSC plate, or just may have reached their service life. Third are modified freight containers. This can be a new/like new or used freight container. These freight containers are modified based on the shipper/offeror's specific requirements. Some of these modifications include adding a steel floor, extra internal tie-down anchor points, additional gasket doorsills, or a slip-in bulk head just behind the door (APPENDIX L). All of these types of freight containers are made available to DOE contractors.

As described in Section 4, the shipper/offeror determines what the contents of the freight container will be (e.g., dispersible, non-dispersible) and will either use the freight container as an IP-2 or IP-3. Once these preliminary decisions have been made, the shipper/offeror develops the technical requirements for the freight container to be purchased. The technical requirements document contains criteria to be included in the purchase requisition such as regulatory requirements, standards, approval agency documentation that ensures compliance to ISO 1496-1, and any other documentation that documents compliance to regulatory and design requirements to purchase an acceptable freight container (See Appendices E and N).

Table 6-1 lists recommended technical requirements that a shipper/offeror may include in a purchase requisition for purchasing either a new/like new, used, or modified freight container.

Table 6-1. Recommend Technical Requirements for Freight Container Procurements

<table>
<tr><th colspan="3">General Requirements For All Freight Containers</th></tr>
<tr><td colspan="3">

Identify all regulatory requirements that effect a freight container (49 CFR parts 450-453, 49 CFR 173.411(b)(6))
Identify all the applicable ISO standards that affect a freight container (ISO 1496-1, 6346, 668, 1161)
Request the broker/supplier to use the reference number (see chapter 4) on the CSC plate, to obtain the Prototype Certificate, Production Certificate, drawings, and copy of the test plan and results of the tests demonstrating compliance to ISO 1496-1 from the approval agency. These documents are to be traceable to the serial number of the container.
When reviewing the regulatory requirements in 49 CFR 173.411(b)(1) documentation shall be obtained to show compliance with applicable requirements and meet 49 CFR 173.411(c).
Obtain a Certificate of Compliance issued by the broker/supplier verifying compliance to the technical requirements, regulatory and ISO requirements, material specification, purchase order, etc.
Identify the applicable critical components of the freight container

</td></tr>
<tr><th>New/Like New or
Single Trip Container</th><th>Used Freight Container</th><th>Modified Freight Container</th></tr>
<tr>
<td>

QA requirements that are passed down to the broker/supplier based on the critical components selected for a new/like new/ or single trip freight container.
Inspections of additional requirements, (e.g., IP-2, IP-3, Purchase order) by the DOE contractor.
Verify CSC plate is current and within the applicable time requirements.
Marking requirements (e.g., ISO 668 Markings)
Painting, inside and out, color, type of paint, e.g., lead free.

</td>
<td>

A used freight container is one that is no longer in service due to damage or an expired CSC plate. When this occurs the shipper/offeror will need to ensure the freight container still meets ISO 1496-1. Having IICL-5 inspector inspect the freight container will accomplish this. This inspector will ensure it meets the applicable requirements and either make the repairs or oversee the repairs. Once these are done they or the shipper/offeror will have a US Coast Guard Inspector or their authorized representative come and inspect the freight container. Upon approval, the inspector will mark the CSC plate. These two inspections demonstrate the freight container meets ISO 1496-1.
QA requirements that are passed down to the broker/supplier based on the

</td>
<td>

Complete specifications for the modification of the freight container. This may include drawings, regulatory and standard citations.
When a modification affects the structural integrity of the freight container the shipper/offeror may require that the approval agency review the modifications to ensure that the ISO 1496-1 requirements have not been violated.
When performing modifications to a new or used freight container, review the recommended technical requirements.
QA requirements that are passed down to the broker/supplier based on the critical components selected for a used freight container.
Inspections of additional requirements (e.g., IP-2, IP-3, Purchase order) by the DOE contractor.
Marking requirements (e.g., ISO 668 Markings).

</td>
</tr>
</table>

	critical components selected for a used freight container. ▪ Inspections of additional requirements (e.g., IP-2, IP-3, Purchase order) by the DOE contractor ▪ Marking requirements (e.g., ISO 668 Markings).	

7. END USE

7.1 Inspection

There are three inspections that may take place on a freight container. The first is upon receipt from the manufacturer. The second is prior to loading the freight container. The third is prior to shipment.

7.1.1 Receipt Inspection

Through the procurement process, the shipper/offeror has identified all of the requirements the manufacturer (i.e., the broker, fabricator, or organization that you have the purchase agreement with) should follow when providing a freight container to a DOE contractor. From the procurement document the shipper/offeror may develop a receipt inspection checklist that can be used to inspect the freight container upon arrival. APPENDIX I provides a sample receipt inspection checklist that a shipper/offeror may choose to use as is or use as a model to develop one of their own. The purpose of the receipt inspection process is to make sure all of the requirements identified in the purchase agreement, (e.g., design, testing, quality assurance, documents, records) are met. In all cases the DOE contractor is urged to use a graded approach to ensure the appropriate receipt inspection takes place.

For a freight container that has been modified, the receipt inspection process should include a process where the modification can be verified upon receipt. When the modification cannot be verified upon receipt, the manufacturer should provide the applicable documentation verifying that the modification has been performed correctly.

As a cautionary note, when performing the inspection for determining that a freight container is light tight from within the container, the inspector performs this activity with a minimum of two individuals, with the proper communication devices, and, when required, with the proper personal protection equipment (PPE).

7.1.2 Pre-Use Inspection

After performing the receipt inspection, DOE contractors, store their containers prior to use. Whether the container is stored or used upon arrival, the shipper/offeror performs a preload inspection prior to use. When the freight container is delivered to the location where the loading is to take place, there should be sufficient room to walk around the freight container, freely open the doors, and with access to easily enter and leave the freight container with the appropriate loading equipment. The freight container should also be on solid, level ground, so that doors will not have difficulty closing and sealing.

As a cautionary note, when performing this activity, employees should be aware of all safety requirements and, when required, use the proper PPE. APPENDIX I has a sample of a pre-use inspection

checklist that a shipper/offeror may use as is or use as a model to develop their own pre-use inspection checklist.

7.1.3 Inspection Prior to Shipment

The purpose of this checklist is to comply with 49 CFR 173.475, *Quality control requirements prior to each shipment of Class 7 (radioactive) materials* and to ensure the safe and contamination free handling and transport of containers packed with class 7, radioactive materials. The containers may be loaded on to either road or rail conveyances depending on the modes of transportation being deployed. APPENDIX I provides a sample receipt inspection checklist that a shipper/offeror may choose to use as is or use as a model to develop one of their own

7.2 Loading and Securing Contents

This section addresses the loading and securement of the radioactive material contents within a freight container (i.e., packaging). The radioactive material contents need to be securely packed, cushioned, and restrained within the freight container. General transportation in commerce has shown that most damage issues are the result of improper loading and internal cargo shifting due to being insufficiently secured. In other words, most containers are damaged and even destroyed from the inside (see Figure 7-1).

Figure 7-1. Damaged Freight Container from Internal Contents

The regulations that drive radioactive material content securement within the packaging are summarized below.

- 49 CFR173.448 (a): "Each shipment of Class 7 radioactive materials must be secured to prevent shifting during normal transportation conditions."
- 49 CFR 173.411(b)(6)(iii): "It (a freight container) must be designed such that if subjected to the tests prescribed in that document (ISO 1496-1) and the accelerations occurring during routine conditions of transport it would prevent:

  (A) Loss or dispersal of the radioactive contents; and

(B) Loss of shielding integrity, which would result in more than a 20% increase in the radiation level at any external surface of the freight container."

The above requirements are meant to ensure that radioactive material placed within a packaging remains stationary and does not shift or move under the shipping forces experienced during transportation (See Table 7-1 or Section 2.3.4 of the document referenced in APPENDIX P). Typical securement systems consist of blocking, bracing, and tie-downs. The packaging content (e.g., components, bags, drums, boxes, piping, tanks) shall withstand static shipping forces due to the weight, density, and stacking of the content, and dynamic shipping forces due to vibration, jolting, and accelerations arising from changes in direction, starting, and stopping as indicated by references (See Table 7-1 or Section 2.3.4 of the document referenced in APPENDIX P). The "1g" is defined as the acceleration due to gravity or in practical terms, 1g is equivalent to the weight of the item.

For domestic shipping, 49 CFR Chapter III, Federal Motor Carrier Safety Regulations, Part 393, Parts and Accessories Necessary for Safe Operation, Section 102, *What are the Minimum Performance Criteria for Cargo Securement Devices and Systems?* identifies that accelerations (0.8 g forward, 0.5g rearward, and 0.5g lateral) per Table 7-1, may be used to evaluate securement systems. Other requirements , such as those stated in 49 CFR 393, Section 106, *What are the General Requirements for Securing Articles of Cargo?* may be considered when determining load securement systems.

Table 7-1. Maximum Forces Acting on a Freight Container During Transport

Force	***Road Transport**	**Rail Transport Subject to Shunting**	**Rail Transport Combined**
Forward Acting Force	0.8g	4.0g	1.0g
Backward Acting Force	0.5g	4.0g	1.0g
Sideways Acting Force	0.5g	0.5g	0.5g
$1g = 9.81\ m/s^2$ *49 CFR 393.102 **Container Handbook, online http://www.containerhandbuch.de/chb_e/stra/index.html			

Example: What are the dynamic shipping forces on a 1000 pound (lbs.) component that needs to be secured within a freight container when transported on a road?

Answer: Using the "g-value" accelerations from Table 7-1, the resulting forces acting on the component are calculated in the bullets below. These forces shall be resisted by the securement system so that the component does not move. In accordance with 49 CFR 393.102, the securement system shall be sized to withstand these shipping forces to keep the component from moving:

- Forward (breaking): 1000 lbs. x 0.8g = 800 lbs.
- Rearward (acceleration): 1000 lbs. x 0.5g = 500 lbs.
- Lateral (cornering): 1000 lbs. x 0.5g = 500 lbs.

Shipping forces in rail transport can be much higher due to switching operations as shown in Table 7-1 and in APPENDIX P, Section 2.3.5. It is recommended that you carefully evaluate the securement system for keeping radioactive materials stationary within freight containers whenever shipping by rail.

One caution is if any additional anchor points are added (see Figure 7-2) for load securement to the inside of the freight container, an evaluation will need to be performed to ensure compliance with ISO 1496-1 design and testing requirements.

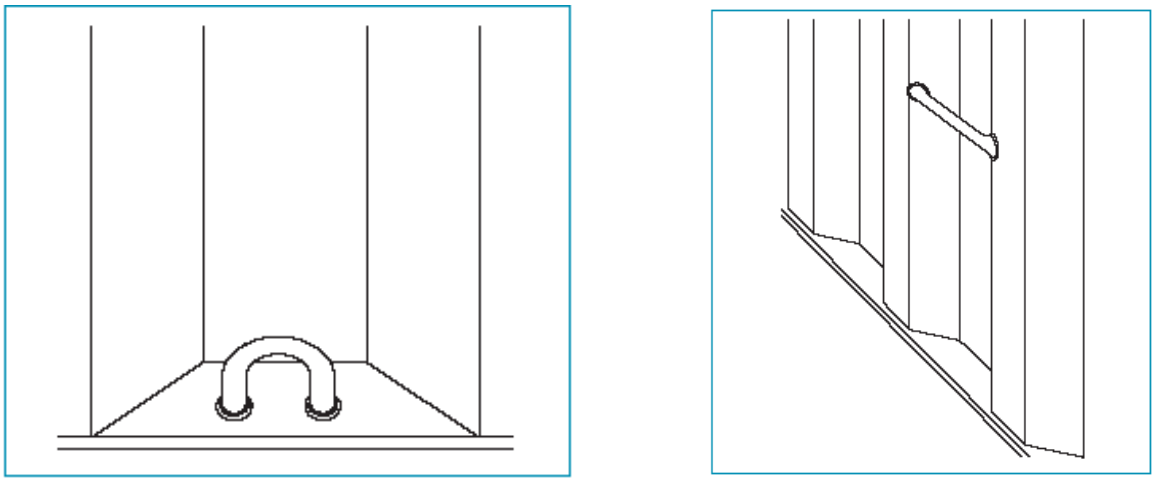

Figure 7-2. ***Freight container Anchor Points are attached to frame rails (left) and Lashing Points to other Freight Container components (right) for load securement***[2]

It is noted that all RAM content loaded into freight containers should consider the same three conditions outlined for cargo securement on a conveyance in the DOE *Load Securement Guide*. The load

[2] "Uranium Concentrates Industry Good Practices for ISO Containers in Multimodal Transports, Revision 0," World Nuclear Transport Institute www.wnti.co.uk.

securement conditions below have been slightly modified to address securement of RAM content within a freight container, rather than cargo on a conveyance.

- RAM content is fully contained by structures of adequate strength to withstand forward, rearward, and sideways forces. Fully contained cargo is deemed to meet the performance criteria of:
    - Content cannot shift or tip;
    - Content is restrained against horizontal movement by the freight container structure, other content, and/or dunnage, shoring bars, tie-downs, or a combination of these; and
    - Content fills the freight container.
- RAM inner packaging or components should be prevented from shifting or tipping if content is immobilized or secured within the freight container by (see Figure 7-3)::
    - Blocking;
    - Bracing;
    - Friction Mats;
    - Tie downs;
    - Other Content;
    - Void Fillers; or
    - A combination of these.

Content (e.g., drums) is immobilized by structures of adequate strength or a combination of structures, blocking, and bracing to prevent shifting or tipping. The drums in Figure 7-3 have been loaded tightly into freight container and braced so that movement is not possible. If drums are palletized as in Figure 7-4, the pallet should be sufficiently strong to hold the weight of the drums.

Figure 7-3. Drums that are properly blocked and braced

Figure 7-4. Properly palletized drums

All items that may be transported in a freight container (e.g., large bulk items, pipes, machinery, bagged material, boxes, metal waste boxes, burrito wraps, and lift liners bags) should be secured so that movement cannot occur during transport. With each type of package or item that is placed in freight containers the shipper/offeror should ensure that the items do not move during normal conditions of transport. The load securement ensures that, during normal conditions of transport, the packaging or items inside the freight container do not shift, therefore, causing an increase in dose rate at the surface of the package. If the increase of dose rate is greater than 20%, it may cause the consignment to be out of compliance with 49 CFR 173.411(b) (6) (iii)(B) (see APPENDIX H).

7.3 Closure Instructions

Closures, as required by 49 CFR 173.24(f), are not normally provided by the manufacturer of a freight container and, as a result, will need to be either produced by the broker or the shipper/offeror. Below is a sample of what a closure instruction might be for a new or used freight container without any modifications.

7.3.1 Example of a Closure Instruction for a Freight Container

With the doors closed and as you approach the doors look for the two sets of door-locking handles. The age of the freight container will determine the ease of operation in opening the doors. Each door will have two locking bars with door locking handles welded to them. Start by releasing the door-locking handle retainer to have access to the door-locking handle. With the right door, start by grabbing the top door-locking handle and rotate it out 90° or greater so the top and bottom cams attached to the locking bar release at the top and bottom of the door. Follow the same process for the left door.

With both doors cams having been released, grab the locking bar or door-locking handles and pull each door open. Swing each door open to allow the freight container to breathe and air out. Inspect the gasket around the door to ensure it is in good condition and does not need to be repaired or replaced. Once the freight container has been filled and the load is blocked and braced so that it cannot move, close the freight container. Prior to closing the doors re-check the door gasket to ensure that it has not been damaged during the loading process. If it has been damaged, repair or replace the door seal. To close the freight container doors, close the left door first and then the right door so they are flush up against the header. With the door-locking handles extended greater than 90° from the face of the door itself, and starting with the left door, engage the top and bottom cams that are attached to the locking bar into the cam retainer. Begin to push the door-locking handle towards the door panel until it becomes flush with the door. Lock the handle in place using the door-locking handle retainer. Once this is done, do the same for the door locking handle on the right door. With the right door closed, lock the handle in place using the door-locking handle retainer. When all the door-locking handle retainers are in place, secure with a padlock, if appropriate.

When a DOE contractor modifies a freight container, their closure instructions will need to include any additional work that the modification might require prior to or just before closing. As part of the closure of a freight container, the DOE contractor may choose to combine the closure of the container with their pre-shipment checklist in APPENDIX I.

7.4 Marking

Freight container markings are determined by ISO 6346, *Freight container – Coding, identification and marking.* The DOE contractor, when purchasing a new, like new, used, or modified freight container, can expect to find the markings as shown in Figure 7-5.

The markings shown in Figure 7-5 are mandatory as required by ISO 6346 Section 3.2, *Identification Marks*. Explanation of these markings is found in Table 7-2. *Freight Container Markings*.

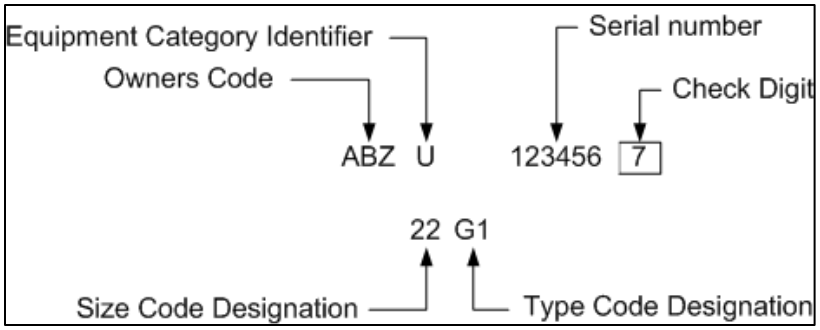

Figure 7-5. ISO Markings for a Freight Container per ISO 6346

Table 7-2. Freight Container Markings per ISO 6346

Marking	Explanation	Example
Owners Code	Consists of three capital letters which are unique and shall be registered with the International Container Bureau	"ABZ"
Equipment Category Identifier	The equipment category identifier consists of one capital letter of the Latin alphabet. "U" – For all Freight Containers "J" – For detachable freight container-related equipment "Z" – For trailers and Chassis	"U"
Serial Number	The container serial number shall consist of six Arabic numerals. If the series of significant numerals does not total six, sufficient zeroes to make up six numerals shall precede them.	"123456"
Check Digit	The check digit provides a means of validating the transmission accuracy of the owner code and serial number and shall be determined by ANNEX A, ISO 6346, *Freight Container – Coding, Identification and Marking*.	
The type and main external dimensions of the container shall be identified with codes and marked on the container. Only those freight containers which comply with both the ISO top-handling capability and structural stacking requirements set forth in ISO 1496 shall be marked with size and type codes in accordance ISO 6346, Section 4.2.1 and 4.2.2. **Note:** The size and type codes, when displayed on the container, shall be used as a whole, i.e., the information should not be broken into its component parts.		
Size Code	The container size (i.e., external dimensions) shall be indicated by two characters as follows: First character: numeric or alphabetic character representing length. Second character: numeric or alphabetic character representing the width and the length. **Note:** The two characters shall be selected in accordance with ISO 6346, ANNEX D	22
Type Code	The container type and main characteristics shall be indicated by two characters as follows:	G1

	First character: alphabetic character representing container type. Second Character: Numeric character representing main characteristics related to the container type. **Note:** The two characters shall be selected in accordance with ISO 6346, ANNEX E.	

Outside of the reference number on the CSC plate identified in section 5.4.1 of this document the number that can be used to trace the freight container back to its original owner is the owners code and the six-digit serial number.

ISO 6346 also requires other markings the DOE contractor may find useful: the maximum gross and tare weights in both kilograms and pounds, air/surface symbols, warning of overhead electrical dangers, or height marking for container higher than 8-feet 6-inches. The DOE contractor, if they choose to paint the freight container, may have these markings either removed or painted over, but it is recommended they keep as a minimum the owner's code, freight container serial number, and check digit for traceability and the maximum gross and tare weights in kilogram and pounds for operational use.

When a DOE contractor uses a freight container as a Type IP-2 or Type IP-3, there are regulatory marking requirements that are required to be placed on the freight container. These can be found in 49 CFR 172.310. The following markings shall be placed on a freight container with letters at least 13mm in height on the outside of the container. A package which does not conform to Type IP-2 and Type IP-3 requirements may not be so marked.

For a Type IP-2, the markings shall read, "Type IP-2, USA."

For a Type IP-3, the markings shall read, "Type IP-3, USA."

7.5 Pre-Shipment Inspection

Once you have completed the loading process and the shipment is properly blocked and braced verify that the freight container is securely loaded and ensure the container is still level. If not, work to ensure it is level. A level freight container ensures proper closure. Prior to closing the doors, visually inspect the door gasket to ensure that it has not been damaged during the loading process and, if so, repair as needed.

APPENDIX I provides a sample pre-shipment inspection checklist that a shipper/offeror may choose to use as is or use as a model to develop one of their own.

7.6 Freight Container Maintenance

When using a freight container for inter-modal shipments (i.e., internationally), the container shall be maintained accordance with 49 CFR Parts 450-453. This includes each time a container undergoes a major repair, refurbishment, or on-hire/off-hire interchange. Most of the freight containers that a DOE

contractor will use do not need to meet those requirements. If they do, it is recommended they either hire or employ trained, tested, and qualified personnel who meet the IICL requirements.

Even though a freight container may not need to be in a maintenance program, a DOE contractor may still need to have access to trained and qualified personnel who can evaluate modifications or evaluate damage to a freight container to ensure compliance with ISO 1496-1.

A DOE contractor needs to know that when a change is made or damage occurs to a freight container, an evaluation should take place (using a graded approach) to ensure it still meets the requirements of ISO 1496-1.

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APPENDIX A Definitions

Approved Test A proposed test plan submitted to the Third Party Approval Agency with the application for a new design as to how each of the tests in ISO 1496-1 will be conducted. When approved by the Third Party Approval Agency, their surveyor when witnessing the ISO 1496-1 tests, ensure these tests are performed as planned.

Carrier (49 CFR 171.8): A person who transports passengers or property in commerce by railcar, aircraft, motor vehicle, or vessel.

Closure: Those mating parts of a packaging system designed to be opened and closed and all associated devices needed to hold those components securely closed during transport, including any gaskets or sealants designed to prevent loss or dispersal of the contents.

Competent authority (49 CFR 171.8): A national agency responsible under national law for the control or regulation of a particular aspect of the transportation of hazardous materials (dangerous goods). The term "appropriate authority," as used in the International Civil Aviation Organization (ICAO) Technical Instructions (incorporated by reference; see 49 CFR 171.7), has the same meaning as "competent authority." For purposes of the hazardous materials regulations, the Associate Administrator for Hazardous Materials Safety of the DOT Pipeline and Hazardous Materials Safety Administration (PHMSA) is the competent authority for the United States.

Consignee: Any person, organization, or government that receives a consignment.

Container Test Report: A document that records the actual tests and their results of each test performed as required in the approved test plan.

Containment system (49 CFR 173.403): The assembly of components of the packaging (when assembled) intended to retain the Class 7 (radioactive) contents during transport.

Design (ANSI N14.7): A description of the packaging that may include specifications, engineering drawings, reports showing compliance with regulatory requirements, gross weight, materials of construction, materials used as shielding, external dimensions and cavity size, internal and external structures, valves, sampling ports, means of heat dissipation, lifting and tie-down devices, amount of shielding, closures, and means of containment. The containment and shielding components should be clearly identified. Overall and cutaway sketches of the package should be included as part of the design description, as well as drawings that clearly detail the safety features considered in the analysis, including material lists, dimensions, valves, and fasteners. Drawings should specify the requirements for all packaging weld joints; joints for gaskets should be sufficiently detailed to show the surface finish and flatness requirements of the closure surfaces; the gasket specification; and, if appropriate, the method of gasket retention.

Designer (ANSI 14.7): The person or organization that develops the design by selecting the assembly of components and materials to be used for the packaging of particular radioactive material contents. The designer should have a working knowledge of the proposed radioactive contents, packaging engineering concepts, DOT Type A design and performance requirements, and use or functionality of the packaging.

The designer applies this knowledge to determine the components of the packaging; ensures that the design demonstrates the capability to fulfill all design requirements; and specifies the criteria for which the packaging is to be fabricated, tested, and closed. In some instances the designer may also be the fabricator and/or the shipper/offeror.

Dispersible radioactive material: For the purpose of this document, dispersible materials are radioactive materials that could become released or leaked from the packaging due to conditions normal to transport (i.e., vibrations, accelerations, temperature, pressure). Examples of dispersible contents include unpackaged low level waste, piping or components with exterior contamination, or oxide contents, fines, powders in containers that cannot be shown to withstand routine vibrations or accelerations (e.g., badly deteriorated drums or boxes).

Engineering analysis (ANSI N14.7): Engineering analysis of a package design involves separating the design into components to demonstrate that containment, shielding, and thermal performance of the overall package are maintained under the testing and performance conditions specified in the regulations. Analysis methods include comparison, hand or computer calculations, and reasoned analysis.

Fabricator (ANSI N14.7): The person or organization that fabricates or assembles the packaging components of a specific design, as specified by a customer. In some instances the fabricator may also be the designer and/or the shipper/offeror.

Freight container (IAEA Safety Standards TS-R-1, 2005-223): An article of transport equipment that is designed to facilitate the transport of goods, either packaged or unpackaged, by one or more modes of transport without intermediate reloading which is of a permanent enclosed character, rigid and strong enough for repeated use, and must be fitted with devices facilitating its handling, particularly in transfer between conveyances and from one mode of transport to another. A small freight container is that which has either any overall outer dimension less than 1.5 m, or an internal volume of not more than 3 m3. Any other freight container is considered to be a large freight container.

Freight container (49 CFR 173.403): A reusable container having a volume of 1.81 cubic meters (64 cubic feet) or more, designed and constructed to permit it being lifted with its contents intact and intended primarily for containment of packages in unit form during transportation. A small freight container' is one, which has either one outer dimension less than 1.5 m (4.9 feet) or an internal volume of not more than 3.0 cubic meters (106 cubic feet). All other freight containers are designated as large freight containers.

Freight container (also see “Standard Freight Container” below)

Freight container modifications affecting original certification: Modifications that affect the previous approved design of the container by the competent authority (e.g., U.S. Coast Guard) or their designee (e.g., American Bureau of Shipping). In most cases, any modification that affects the structural integrity of the container and for which the competent authority can require new testing to be performed.

Freight Container Modifications that do not affect its original certification: Modifications that do not affect the certification of the container by the competent authority or their designee. In most cases, these are modifications that affect the structural integrity of the container.

Inner Containment: An inner receptacle or container that acts as a containment boundary of the contents, but is not capable of meeting all the requirements of the regulations. The inner containment must be placed in an outer packaging to meet all transportation requirements.

Low Specific Activity (LSA) material (49 CFR 173.403): Class 7 (radioactive) material with limited specific activity which satisfies the descriptions and limits set forth below. Shielding material surrounding the LSA material may not be considered in determining the estimated average specific activity of the package contents. LSA material must be in one of three groups LSA-1, LSA-2, or LSA-3.

Modified Freight Container: Containers that have been modified from their original design. The modifications that have been made may or may not violate the original certification of the container.

Non-Dispersible radioactive material: Contents consisting of solid radioactive materials of a sufficiently large (particle) size so as not to leak from the freight container. Non-dispersible contents include solid activated materials that will not break down or disintegrate into fines during transport, flanged hardware components with internal contamination, piping with wrapped ends with internal contamination, or bagged homogeneous/non-puncturing waste. Non-dispersible radioactive materials should either be of a form that is 1) robust enough to remain as a solid unit without disintegration; or 2) be confined in inner packaging (bagging, drums, and boxes) that can be shown to withstand routine conditions of transport.

Non-fixed radioactive contamination: Radioactive contamination that can be readily removed from a surface by wiping with an absorbent material. Non-fixed (removable) radioactive contamination is not significant if it does not exceed the limits specified in 49 CFR 173.443.

Normal conditions of transport (ANSI N14.7): A term used in both the DOT and IAEA regulations to encompass rough handling and minor mishaps during transportation. Type A packages are required to demonstrate that they can withstand normal conditions of transport by meeting the performance and containment requirements of 49 CFR 173.412, 465, and 466.

Off-the-shelf freight container: Containers that available for sale or lease, comply with their original design, and have not been modified.

Package (49 CFR 173.403): The packaging together with its radioactive contents as presented for transport.

(1) **Excepted package** means a packaging together with its excepted Class 7 (radioactive) materials as specified in Sec. Section 173.421-173.426 and 173.428.

(2) **Industrial package** means a packaging that, together with its low specific activity (LSA) material or surface contaminated object (SCO) contents, meets the requirements of Sections 173.410 and 173.411. Industrial packages are categorized in Section 173.411 as either:

(i) “Industrial package Type 1 (IP-1)”;

(ii) “Industrial package Type 2 (IP-2)”; or

(iii) "Industrial package Type 3 (IP-3)".

Packaging (49 CFR 173.403): For radioactive material, the assembly of components necessary to ensure compliance with the packaging requirements in 49 CFR 173, Subpart I. 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.

Person (49 CFR 107.1 and 171.8): An individual, firm, co-partnership, corporation, company, association, or joint-stock association (including any trustee, receiver, assignee, or similar representative) or a government or Indian tribe (or an agency or instrumentality of any government or Indian tribe) that transports a hazardous material to further a commercial enterprise or offers a hazardous material for transportation in commerce. Person does not include the following.

(1) The US Postal Service.
(2) Any agency or instrumentality of the federal government, for the purposes of 49 U.S.C. 5123 (civil penalties) and 5124 (criminal penalties).
(3) Any government or Indian tribe (or an agency or instrumentality of any government or Indian tribe) that transports hazardous material for a governmental purpose.

Person who offers or offeror (49 CFR 171.8):

(1) Any person who does either or both of the following:

(i) Performs, or is responsible for performing, any pre-transportation function required under this subchapter for transportation of the hazardous material in commerce.

(ii) Tenders or makes the hazardous material available to a carrier for transportation in commerce.

(2) A carrier is not an offeror when it performs a function required by this subchapter as a condition of acceptance of a hazardous material for transportation in commerce (*e.g.*, reviewing shipping papers, examining packages to ensure that they are in conformance with this subchapter, or preparing shipping documentation for its own use) or when it transfers a hazardous material to another carrier for continued transportation in commerce without performing a pre-transportation function.

Pre-transportation function (49 CFR 171.8): At least one of the pre-transportation functions specified in the definition section of 49 CFR 171.8 that are required to ensure the safe transportation of a hazardous material, including radioactive material.

Production Certificate: A document that is issued by the Third Party Approval Agency upon the satisfactory conclusion of container plan review, prototype approval, the production tests required by the approved test plan, the acceptance of the manufacturer's quality control procedures and the survey of each container. These units, when considered acceptable to the Third Party Approval Agency, will be certified and Production Certificate issued. The Production Certificate when issued will list the serial numbers for each container.

Prototype Test Certificate: A document that is issued by the Third Party Approval Agency when they have verified all designs, calculations supporting the design and methods of construction for the freight container meeting the design considerations and the performance tests as required in the Agency's Rules of Certification. Prior to this document being issued the surveyor will witness the construction of each freight container, verify the materials of construction are as designated in the design drawings, verify fabrication techniques, such as. welding, and witness each test that is required in their Rules of Certification. This document is issued by the Third Party Approval Agency when a prototype container meets the requirements of the Rules of Certification based on the surveyor's observations and it has been determined that the prototype has passed the required tests.

Quality assurance (49 CFR 173.403): A systematic program of controls and inspections applied by each person involved in the transport of radioactive material which provides confidence that a standard of safety prescribed in this subchapter is achieved in practice.

Radiation level (49 CFR 173.403): The radiation dose-equivalent rate expressed in millisieverts per hour or mSv/h (millirems per hour or mrem/h). It consists of the sum of the dose-equivalent rates from all types of ionizing radiation present including alpha, beta, gamma, and neutron radiation. Neutron flux densities may be converted into radiation levels according to Table 1 in 49 CFR173.403 (definitions).

Radiation shield (ANSI N14.7): Material incorporated in packaging to reduce the intensity of radiation from the package. The radiation shield surrounds the contents and may or may not qualify as a containment system.

Routine conditions of transport (ANSI N14.7): Routine conditions of transport are incident free with no mishaps. Type A packages are required to demonstrate that they can withstand routine conditions of transport by meeting the requirements of 49 CFR 173.24, 24a, 24b, and 173.410.

Routine Conditions of Transport (RCT): RCT are quantitatively defined in the international regulations (TS-R-1, *Regulations for the Safe Transport of Radioactive Material*, and TS-G-1.1, *Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material*). The Federal Motor Carrier Safety Administration (FMCSA) in 49 CFR 393 provides requirements and associated acceleration factors that can be applied for domestic NCT considerations.

RCT International: The Regulations for the Safe Transport of Radioactive Materials (e.g., TS-R-1 and TS-G-1.1) define routine conditions of transport (RCT) as follows:

	Acceleration Factors		
Transport Mode	**Longitudinal**	**Lateral**	**Vertical**
Highway	2g	1g	2g up, 3g down
Rail	5g	2g	2g up, 2g down
Sea	2g	2g	2g up, 2g down

- Incident free transport conditions (TS-R-1, 106);
- Accelerations, vibration or vibration resonance (TS-R-1, 612); and Acceleration factors for package retention for RCT from TS-G-1.1 Appendix IV, Table IV are listed in the table below.

Appendix V of TS-G-1.1 discusses conveyance package retention. The following are excerpts from TS-G-1.1, Appendix V:

- Package retention systems only have to be designed to meet the demands of routine conditions of transport. Therefore, in normal or accident conditions of transport, the package is permitted, and may be required as part of the design, to separate from the conveyance by the breakage or designed release of its restraint in order to preserve the package integrity.
- The methods of retention should not cause the package to be damaged, or even stress components of the package or its retention system beyond yield, during routine conditions of transport.
- The requirement that the integrity of the package should not be impaired by overstressing in normal or accident transport conditions can be satisfied by the designer incorporating quantifiable weak links in either the package attachment points or in the tie-downs specified for restraint. See Figure 3.6 for freight container attachment points.
- The forces imposed on the package may be determined by multiplying the acceleration factors by the mass of the package. For vertical accelerations, the factors are those experienced by the package, not allowing for gravity.

RCT Domestic: For domestic transport the Cargo Securement Rules of the Federal Motor Carrier Safety Administration (FMCSA) provides relevant package securement requirements. Excerpts (in italics) from the FMCSA (49 CFR 393) are provided below.

- FMCSA has adopted new performance requirements concerning deceleration in the forward direction, and acceleration in the rearward and lateral directions, those cargo securement systems must withstand. Deceleration is the rate at which the speed of the vehicle decreases when the brakes are applied, and acceleration is the rate at which the speed of the vehicle increases in the lateral direction or sideways (while the vehicle is turning), or in the rearward direction (when the vehicle is being driven in reverse and makes contact with a loading dock).
- FMCSA requires that cargo securement systems be capable of withstanding the forces associated with following three deceleration/accelerations, applied separately:
  - 0.8 g deceleration in the forward direction,
  - 0.5 g acceleration in the rearward direction, and
  - 0.5 g acceleration in a lateral direction.
  - 0.2 g acceleration in a vertical direction

These values were chosen based on researchers' analysis of studies concerning commercial motor vehicle performance.

The Shipper has the responsibility for evaluating the securement of packages or components within the Freight Container. Packages and components need to remain in place, without changing position, and not incur damage under the routine conditions of transport.

Rules of Certification: A document that is produced by a Third Party Approval Agency that is used by those organization who wish to have a freight container (cargo container) approved by that agency who represents the competent authority of the country they represent. This document may have varying titles as described in the table below.

Third Party Approval Agency	Title of their "Rules of Certification"
American Bureau of Shipping	Rules of Certification of Cargo Containers
Bureau of Veritas	Rules for the Classification and Certification of Freight Containers
Lloyds Register	EMEA Container Certification Scheme
DET Norske Veritas	Rules of Certification of Freight Containers
Germanischer Lloyd	Rules for Classification and Construction

Shall, must, should, and may: For the purposes of this document, the word "shall" is used to denote a requirement which is supported by a standard or regulation; the word "must" is denotes a requirement that is used as part of a quotation; the word "should," denotes a recommendation; and the word "may," denotes permission (neither a requirement nor a recommendation).

Shipment/Consignment (ANSI N14.7): Any package, packages, or load of radioactive material presented by a consignor for transport.

Shipper/Consignor (ANSI N14.7): Any person, organization, or government that prepares a consignment for transport and is named as consignor in the transport documents.

Standard Freight Container: A freight container complying with ISO 1496-1, Series 1 *freight containers-Specification and testing*-Part 1*: General cargo containers for general purposes*, Edition 1990, as identified in 49 CFR 173.411(b)(6) and for purposes of this document. (Also see ISO 668 – Series 1 *Freight container - Classification, dimensions and ratings*.)

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APPENDIX B Historical Background

During the 1960s, the rapid increase in the use of freight containers for the consignment of goods by sea and the development of specialized container ships caused the International Maritime Organization (IMO) to undertake a study of the safety of containerization in marine transport in 1967. The container itself emerged as the most important aspect to be considered. In 1972, a conference was held to consider a draft convention prepared by the IMO in cooperation with the Economic Commission for Europe. The conference was jointly convened by the United Nations and the IMO. The 1972 Convention for Safe Containers had two goals. One was to maintain a high level of safety of human life in the transport and handling of containers by providing generally acceptable test procedures and related strength requirements that would prove adequate over years of use. The other was to facilitate the international transport of containers by providing uniform international safety regulations, equally applicable to all modes of surface transport. In this way, proliferation of divergent national safety regulations could be avoided.

The requirements of the Convention apply to the great majority of freight containers used internationally, except those designed specifically for carriage by air. As it was not intended that all containers, vans, or reusable packing boxes should be affected, the scope of the Convention was limited to containers of a prescribed minimum size having corner fittings—devices that permit handling, securing, or stacking. The Convention established procedures whereby containers used in international transport will be safety approved by an administration of a contracting state or by the organization acting on its behalf. The administration or its authorized representative will authorize the manufacturer to affix a safety approval plate containing the relevant technical data to approved containers. The approval, evidenced by the safety approval plate granted by one contracting state, should be recognized by other contracting states. This principle of reciprocal acceptance of safety-approved containers is the cornerstone of the Convention; and once approved and plated, it is expected that containers will move in international transport with the minimum of safety control formalities.

The United States accepted the Convention requirements and adopted them on January 3, 1978. The United States designated the U.S. Coast Guard as the responsible organization to ensure compliance with the International Convention for Safe Containers (CSC) (See APPENDIX A). This was adopted by law and incorporated into 49 CFR Parts 450–453. The U.S. Coast Guard may elect to authorize other organizations to ensure compliance with the International Convention for Safe Containers (CSC) requirements, e.g., American Bureau of Shipping (ABS).

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APPENDIX C Commercial Process for Freight Container Certification

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The American Bureau of Shipping (ABS) has been designated as an authorized entity by the US Coast Guard (per 49 CFR 450, Subpart B) to ensure compliance with the International Convention for Safe Containers (CSC) requirements for the United States. Therefore, their process for freight container certification (i.e., ABS Rules for Certification for Cargo Containers) will be outlined in this APPENDIX C. Certification includes freight container design, design review, prototype and production testing, manufacturing controls and inspections, marking, and certification by the authorized authority. Periodic inspections and re-inspections (following repair or maintenance) required for continued CSC approval, in accordance with 49 CFR 452, will also be discussed.

C.1 Freight Container Certification Process

The certification process consists of a) the development of rules, guides, standards and other criteria for the design, construction and quality assurance of containers, materials, and equipment; b) the review of the design and survey during and after construction to verify compliance; and c) the issuance of certificates when such compliance has been verified. The rules, guides, and standards are developed by the specific bureau (e.g., ABS) and approved by committees made up of users, manufacturers, engineers, materials experts, operations and other technical/scientific personnel. The certification process is comprehensive and carried out by qualified personnel in accordance with the federal regulations. As such, the certification documentation should be fully adequate to demonstrate compliance to DOT requirements. Containers certified to the ABS rules of certification meet the CSC and ISO-1496-1 requirements.

C.1.1 Conditions of Certification

The requirements for freight container certification are determine by bureaus and approved by committees made up of experienced container manufacturers, users, marine/railroad/structural/materials engineers, ship builders, steel makers and other relevant technical experts. The conditions for certification consist of, but are not limited to, completion of the following:

- Compliance with specified rules, guides, standards, and other criteria for the design, testing and construction (e.g., CSC, ISO 1496-1);
- Review of container design, drawings and calculations;
- Use of appropriate materials of construction and equipment;
- Review of container plans for prototype design and performance testing;

- Review of quality programs, testing plans, procedures, and manufacturing facilities;
- Surveillance of prototype testing and production manufacturing (by bureau authorized inspectors); and
- Completion of reports documenting prototype testing and production fabrication.

Certification is granted when a bureau, through its reviews and surveillance, concludes that the conditions for certification have been satisfactorily met. Certification is a representation by the Bureau as to the structural fitness for the particular use or service in accordance with its Rules, guides and standards. Placement of a round ABS emblem (representing general service) signifies the container complies with the ABS Rules for Certification, which includes the CSC and ISO 1496-1 requirements.

C.1.2 Design Review

For new or modified freight container designs, a manufacturer is required to submit comprehensive information to the bureau for review. The submittal is to include a statement that the containers:

- will be built in conformance to the "Rules of Certification for Cargo Containers",
- will be manufactured under a quality control program acceptable to the bureau,
- will be available for inspection during manufacture and testing, and
- will be tested in accordance with prescribed procedures.

Additionally any changes in design, materials, or fabrication methods will not be made without written approval.

The information submitted varies depending on whether a new design series is being requested or whether additional units of an approved design or changes to an existing design are desired. These required documents are identified in Table C- 1 below.

Table C-1. Documents to submit to bureau for design review

New Design Series*	Approved Design Series*	Changes to existing Designs*
Application of each new design series is to include the following plans and data.	Application of additional units to be certified to an approved design series is to include the following.	When changes are being made to an application or to an approved design series, include the following.
Application Form	Container Data Form	Container Data Form

<table>
<tr><td>Container Data Form</td><td>Data Form Supplement for Thermal Containers if applicable</td><td>Data Form Supplement for Thermal Containers if applicable</td></tr>
<tr><td>Material identification form</td><td rowspan="4"></td><td>Design Comparison Table</td></tr>
<tr><td>Following drawings

▪ General arrangement
▪ Sub-assemblies
▪ Detail of components
▪ Markings, including data plates</td><td>Following Drawings

▪ Marking drawing – If owner has changed
▪ General Assembly
▪ Subassembly
▪ Detail drawing as appropriate showing any revision from original design
▪</td></tr>
<tr><td>Prototype Test Agenda</td><td rowspan="2">All changes will be reviewed and if the modifications are deemed significant retesting of those parts of the container affected by the modification may be required.</td></tr>
<tr><td>Quality Control Procedures – Required for each facility</td></tr>
<tr><td colspan="3">When the application includes a request for certification to governmental requirements, international conventions, or other standards, the submittal is to include the necessary information required for the reviews.</td></tr>
</table>

**Information in Table C-1 was extracted from the ABS Rules of Certification for Cargo Containers 1998*

Upon receipt of the documents identified under “New Design Series”, the bureau will perform a thorough design review of drawings, calculations, test agenda, and quality control procedures provided by the manufacturer. Upon completion of the design review, which is based primarily upon the container meeting the design considerations in Section C.1.5, the performance tests in Section C.1.6 will be performed. The bureau will then allow the manufacturer to fabricate the freight containers that will be used for the performance tests in Section C.1.6. During the manufacturing of these units, the bureau’s surveyor inspects the use of materials of construction along with verifies welding processes, quality assurance program, and the testing of units.

C.1.3 Materials and Fabrication

Materials and fabrication details are included in the documentation required by the shipper of IP-2 and IP-3 radioactive material packages per 49 CFR 173.411(c). The bureau's freight container certification process specifically addresses materials and fabrication in Section 3 (ref). All structural materials will conform to an established specification or recognized national standard. Since the majority of freight containers are fabricated in countries outside the US, due notice is given to practices in the specific country.

The bureau verifies the acceptability of materials and the welding processes. Welding is to be carried out in accordance with recognized standards by qualified welders. The bureau's rules go into significant detail on welding details, qualifications, and tests. Bureau surveillance personnel review all weld procedures and perform surveillance during manufacture. Since freight containers are primarily all-welded construction (except for doors, etc.) the acceptability of materials and welding practices and procedures is given attention during reviews, testing and surveillance. (Joint types, orientations, and acceptance criteria)

C.1.4 Quality Control

The Bureau will approve all prototype and production manufacturing and testing facilities and carry out periodic audits. The principal freight container manufacturers submit quality control manuals to the Bureau which gives in detail those inspections and controls to be followed to assure the quality of the production units are comparable to that of the prototype. The required quality elements are listed below. The manufacturer must submit its QC manual to the Bureau for review in order that compliance may be verified with QC requirements of the ABS Rules for Certification. The manufacturing facility is subject to audit by the ABS surveillance personnel to confirm compliance with the QC procedures specified in the submitted manual. All changes or revisions to the QC manual including any procedural changes are to be submitted to the bureau for review.

The QC manual is to include the following elements:

- Description of Organization: Manufacturer's organization including management, purchasing, production, and QC functions.
- Materials Identification: methods are to be in place to control and identify all materials, including methods for welding electrode identification.
- Workmanship Quality: methods are to be in place to ensure consistently acceptable quality (e.g., jigs, fixtures).
- Control Records: procedures for maintaining records are to be adequate to assure identification of material and checks on workmanship.
- Fabrication QC Methods: welding procedures and inspection techniques used in fabrication are to be acceptable to the Bureau surveillance personnel. Special attention is given to ensuring adequacy of corner fittings and their attachment to the structural members.

C.1.5 Design Considerations

Freight containers are designed to be structurally sound and weather tight under multi-modal (highway, rail, marine) loading, transport and handling conditions. The main frame, corner fittings, sides and ends are to have sufficient structural strength to withstand, without significant permanent deformation, the static and dynamic loads imposed by lifting, stacking, impact, vibration, and racking loads encountered under normal service conditions as well as protect the cargo from the environment. The floor structure must be strong enough to support the payload under dynamic loading and concentrated forklift truck axle loads. The design considers the loads from each transport mode and terminal handling, expressed as accelerations. Marine transport imposes significant transverse loads on the containers due to the sway of the ship and the high stacking heights. Rail transport imposes significant longitudinal loads due to coupling and humping loads. Handling equipment that loads and unloads containers imposes significant vertical accelerations on the container. Overall the freight container is designed to withstand the maximum normal loads from all modes of transport and handling. This results in a robust structure that remains serviceable and does not undergo elastic deformation under normal service.

The freight container design features include four top and four bottom corner fittings which defines a rectangular box. The corner fittings are welded to the top, bottom, and end rails to form the frame of the FC. The corner fittings are to protrude slightly above the highest point of the roof and the bottom corner fittings protrude slightly below the plane of the bottom, so that when stacked the load can be fully supported at the corners. Other design features include forklift pockets and special lifting and cargo securing devices.

The design loads required by Freight Containers take into account the normal service conditions outlined above. The design loads required by the ABS Rules (include CSC and ISO-1496-1 considerations) are summarized below. Note – the design loads are statically applied to prototype containers as discussed in Section C.1.6. For the bulleted items below: R = Gross Weight, P = Maximum Payload, T = Tare Weight.

- Corner Structure Loads – Stacking – to simulate stacking on a ship that is pitching and heaving: the corner structure is to have sufficient strength to allow stacking when transported by ship. Design load factor (static + dynamic) is 1.8 x 8 R (stacking 9 high) distributed among the four corner structures.
- Lifting Loads – to ensure top and bottom corner fittings and associated structures are capable of suspending a loaded container: Total weight of 2R, a) lifting vertically from top with each corner to carry ¼ the design load, b) lifting from 4 bottom corners at 45o angles to horizontal (for 20’ container), and c) lifting from fork-lift pockets in vertical upward direction.
- Floor Loads – to ensure floor is capable of carrying loads imposed by loading vehicles and cargo: a) wheel: floor is to withstand concentrated loads imposed by lift truck front axle (two wheels) loading of 12,000 lbs. over an area not greater than 22 in2/wheel, and b) cargo: 2P uniformly distributed from side to side over any 10’ of length.
- Floor and Rear Panel Loads – to ensure front and end panels can withstand cargo load forces resulting from rail coupling impacts or highway breaking: a) load of 0.4P uniformly distributed outward over the front and rear end panels, and b) transverse racking load of 33,700 lbs. applied at top of front and rear panel corners with bottom corners fixed.

- Side Panel Loads – to ensure side panels can withstand cargo load forces resulting from ship rolling or highway cornering: a) a load of 0.6P uniformly distributed over side walls in transverse direction (outward), and b) longitudinal racking load of 16,850 lbs. applied at each top corner of side wall with bottom corners fixed.
- Lashing – to simulate external forces transmitted to the corner fittings: concentrated loads applied individually or simultaneously to the corner fittings in the longitudinal, transverse and vertical directions.
- Roof Load – simulates two 220 lbs. workers on roof: a load of 440 lbs. uniformly distributed over a 2' x 1' area in a downward direction.
- Base Structure Loads – ensures base structure can withstand forces resulting from rail impacts: a load of 2R applied in a longitudinal direction through bottom apertures of the bottom corner fittings to simulate acceleration during rail car impact.
- Cargo Securing Devices (where provided) – to ensure anchor or lashing points can withstand inertial forces imposed by cargo in transit: concentrated load applied away from cargo securing device located inside FC, a) 2200 lbs. for anchor point in base structure, b) 1100 lbs. for lashing point in any other part of container (other than base).

C.1.6 Testing

C.1.6.1 Prototype tests

Full-sized prototype containers, manufactured to the same QC requirements as production containers, are tested to verify design adequacy. The test loads are primarily static to provide comparable and repeatable test data at reasonable costs. The test loads (described in C.1.6.2) take into account the combined static and dynamic loads anticipated in service. Bureau surveillance personnel witness prototype tests. Dimensional measurements are taken before testing and retaken, along with weather tightness, upon completion of all structural tests.

Testing acceptance criteria: a) when the prescribed load is applied the container is not to exhibit significant permanent deformation or weakening; and b) after removal of the load the dimensions are to return to the original values within allowable tolerances and the unit is to be fully suitable for service.

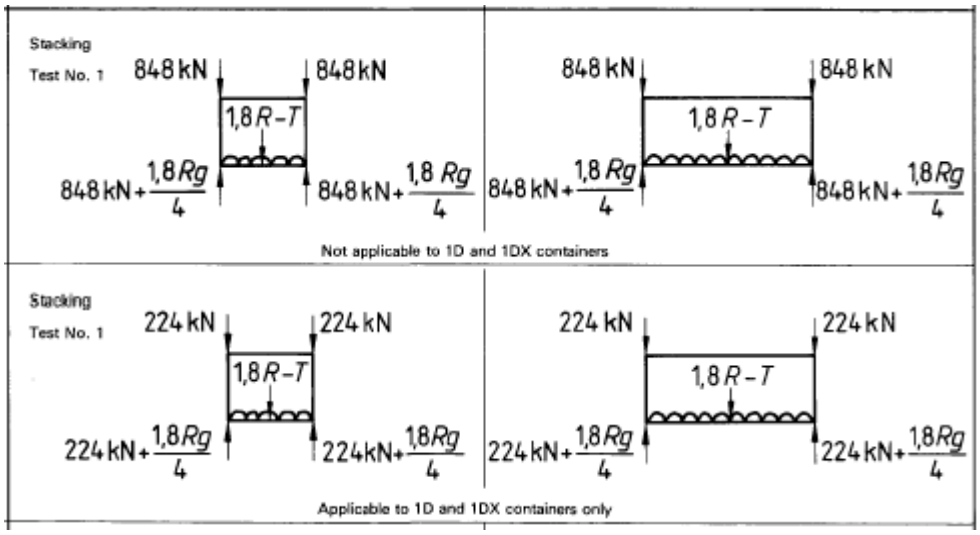
C.1.6.2 ISO-1496-1 tests

The ISO 1496-1 prototype tests are briefly paraphrased below. Compliance with these tests will generally satisfy the Design Requirements discussed in Section 5.4.1, meeting the ISO 1496-1, and are specifically the tests referred to in DOT 49 CFR 173.411(b)(6). It is noted that the CSC also contains testing requirements but they are slightly different than the ISO 1496 tests. A comparison of the differences between the ISO 1496-1 and CSC testing details is given in APPENDIX M. Note – for additional details on tests, see ISO 1496-1 Section 6. The first sentence of each test (except for test #12) provides the rational for structural test criteria excerpted from ISO TR 15070, Series 1 Freight Containers – Rationale for Structural Test Criteria. Other excerpts for each test below are taken from ISO 1496-1, Section 6.

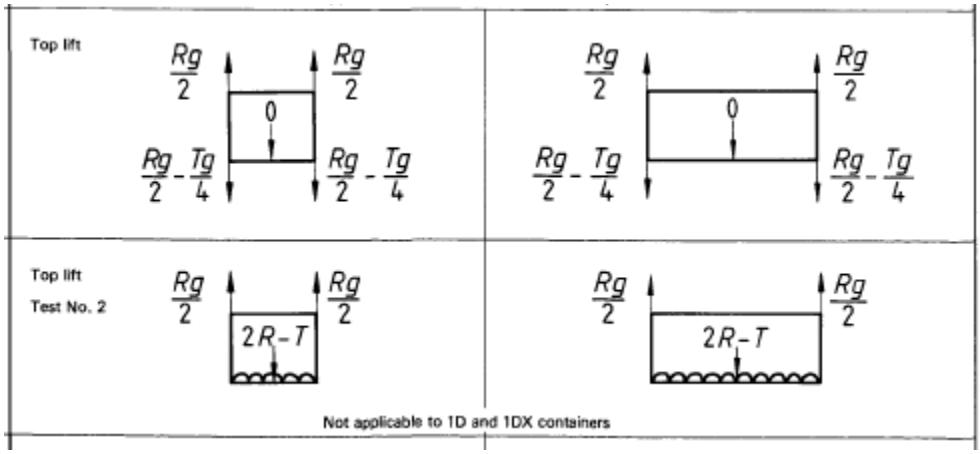
1. Stacking – The test is carried out to prove the ability of a fully loaded container to support a superimposed mass of containers, taking into account the conditions aboard ships at sea. The

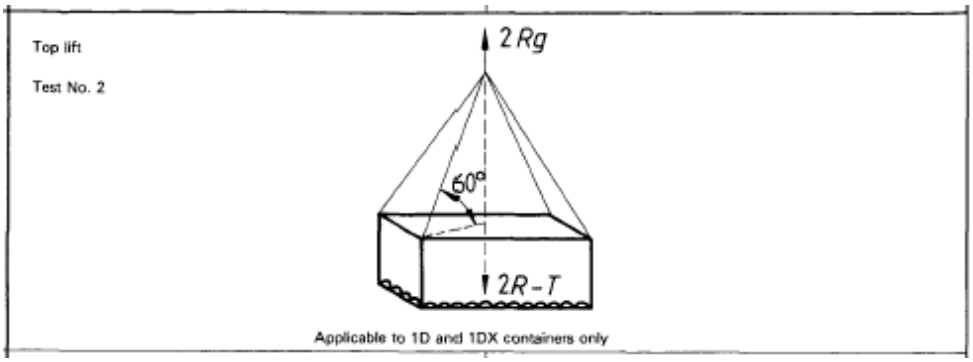
container shall be placed on four level pads, one under each bottom corner fitting and be floor of the container shall be uniformly loaded to a weight of 1.8R. The container shall be subjected to vertical force of 762,550 lbs. (nine-high stacking), applied to all four corner fittings simultaneously, or 381,275 lbs. to each pair of end fittings. Upon completion of the test, the container shall show neither permanent deformation nor any abnormality which will render it unsuitable for use.

Figure Definitions: R = Gross Weight, P = Maximum Payload, T = Tare Weight

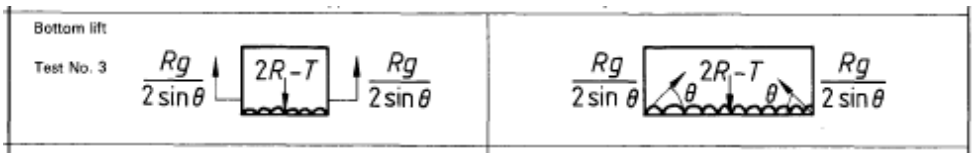


2. Lifting from the Four Top Corner Fittings – This test is carried out to prove the ability of a container, whether in a loaded or empty condition, to withstand being lifted vertically using its top corner fittings. It demonstrates the lifting capability not only of the top frame but also of the entire container frame and floor structure of the container. The container shall have a load uniformly distributed over the floor such that the combined weight of the container and payload is 2R and shall be lifted vertically from all top corners such that no significant acceleration or deceleration forces are applied. The container shall be suspended for 5 min. and then lowered to the ground. Upon completion the container shall show neither permanent deformation nor any abnormality, which will render it unsuitable for use, and the dimensional requirements shall be met.

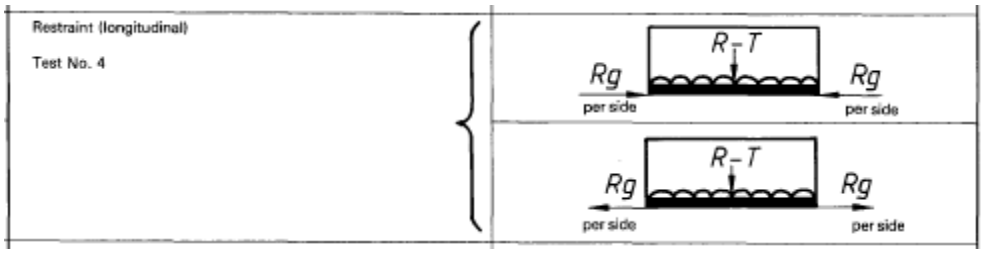




3. Lifting from Bottom Corners – This test is carried out to prove the ability of a container, whether in a loaded or empty condition, to withstand being lifted using the bottom corner fittings, in accordance with ISO 1161, Series 1 Freight Containers – Corner Fittings - Specifications, via slings which transmit the lifting force from the bottom corner fittings obliquely to a single transverse spreader beam. The container shall have a load uniformly distributed over the floor such that the combined weight of the container and payload is 2R and shall be lifted from the side apertures of all four-corner fittings in such a way that no significant acceleration or deceleration forces are applied. Lifting forces shall be applied at 45° to horizontal for a 20' container. The container shall be suspended for 5 min. and then lowered to the ground. Upon completion the container shall show neither permanent deformation nor any abnormality, which will render it unsuitable for use, and the dimensional requirements shall be met.

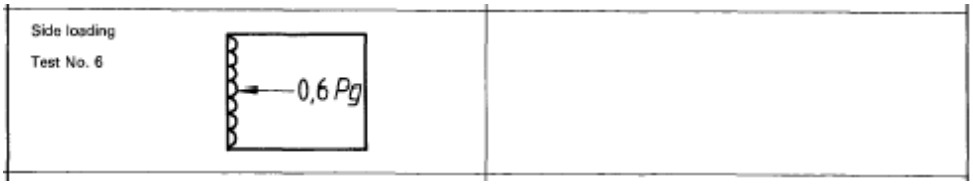


4. Restraint (longitudinal) – This test is carried out to prove the ability of a container to withstand longitudinal external restraint under dynamic conditions of railway operations. The container shall have a load uniformly distributed over the floor such that the combined weight of the container and payload is R, and be secured to anchor points through the bottom apertures of the bottom corner fittings at one end of the container. A force of 2R shall be applied horizontally to the container through the bottom apertures of the other bottom corner fittings, first towards and then away from the anchor points. Upon completion the container shall show neither permanent deformation nor any abnormality, which will render it unsuitable for use, and the dimensional requirements shall be met.

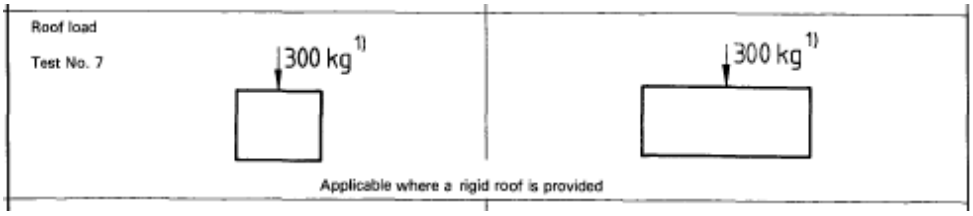


5. Strength of End Walls – This test is carried out to prove the ability of the end walls of a container to withstand the forces caused by the cargo under the dynamic conditions of railway operations. The container shall be subjected to an internal loading of 0.4P uniformly distributed over the wall. Both the blind end and door ends shall be tested. Upon completion the container shall show neither permanent deformation nor any abnormality, which will render it unsuitable for use, and the dimensional requirements shall be met.

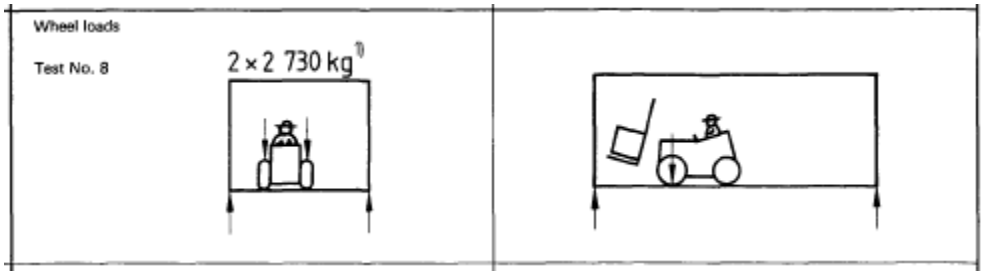
6. Strength of Side Walls – This test is carried out to prove the ability of the sidewalls of a container to withstand the forces caused by cargo under dynamic conditions of ship movement. Each side of the container shall be subjected to a uniformly distributed loading of 0.6P. Upon completion the container shall show neither permanent deformation nor any abnormality, which will render it unsuitable for use, and the dimensional requirements shall be met.



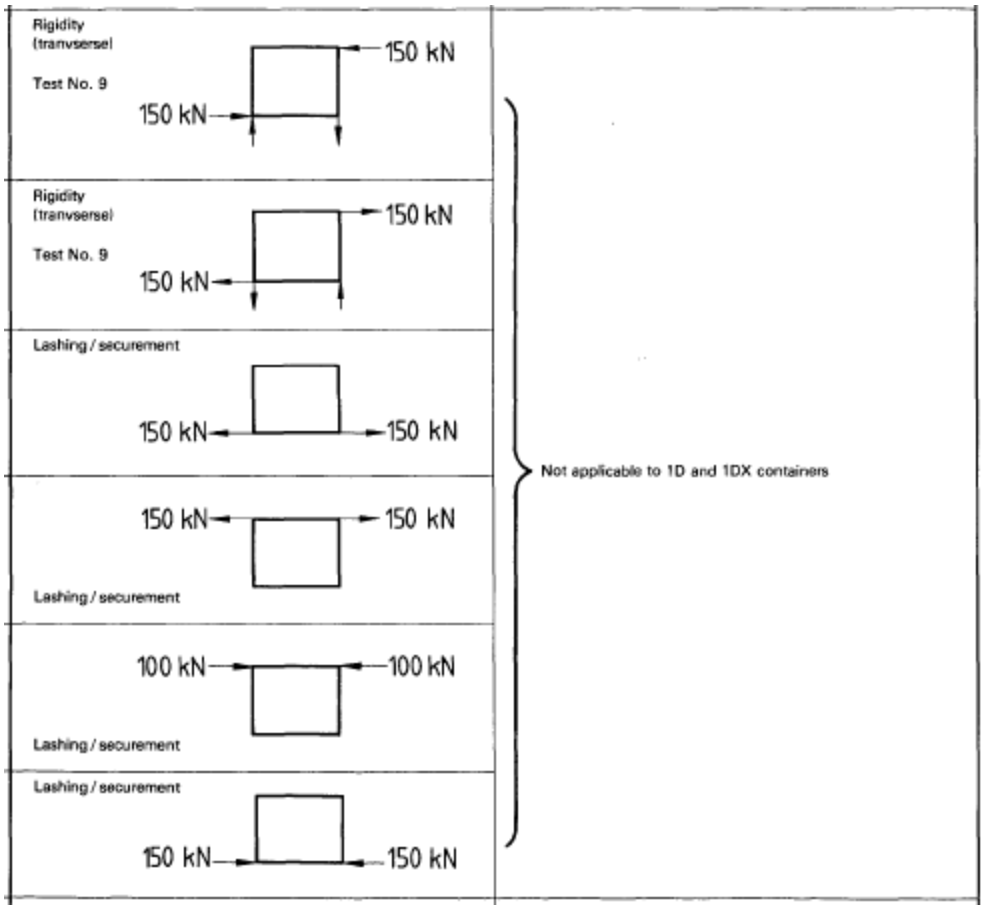
7. Strength of Roof – This test is carried out to prove the ability of the rigid roof of a container, where fitted, to withstand loads imposed by persons walking on it. A load of 440 lbs. shall be distributed over an area of 1’ x 2’ located at the weakest area of the rigid roof of the container. Upon completion the container shall show neither permanent deformation nor any abnormality, which will render it unsuitable for use, and the dimensional requirements shall be met.



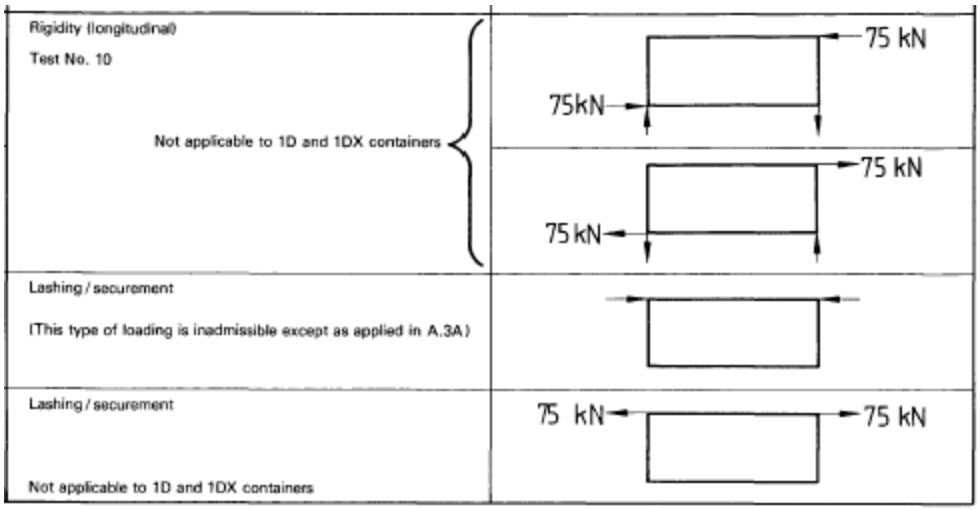
8. Floor Strength – This test is carried out to prove the ability of the floor of a fixed container to withstand concentrated dynamic forces imposed by wheeled vehicles placing and removing cargo. The test shall be performed using a test vehicle equipped with tires with an axle load of 12,000 lbs. (6,000 lbs. on each of two tires). The footprint (area) shall be no more than 22 in^2 per tire. The test shall be made with the container resting of four level supports under its four bottom corner fittings, with its base structure free to deflect. The test vehicle shall be driven over the entire floor area. Upon completion the container shall show neither permanent deformation nor any abnormality, which will render it unsuitable for use, and the dimensional requirements shall be met.



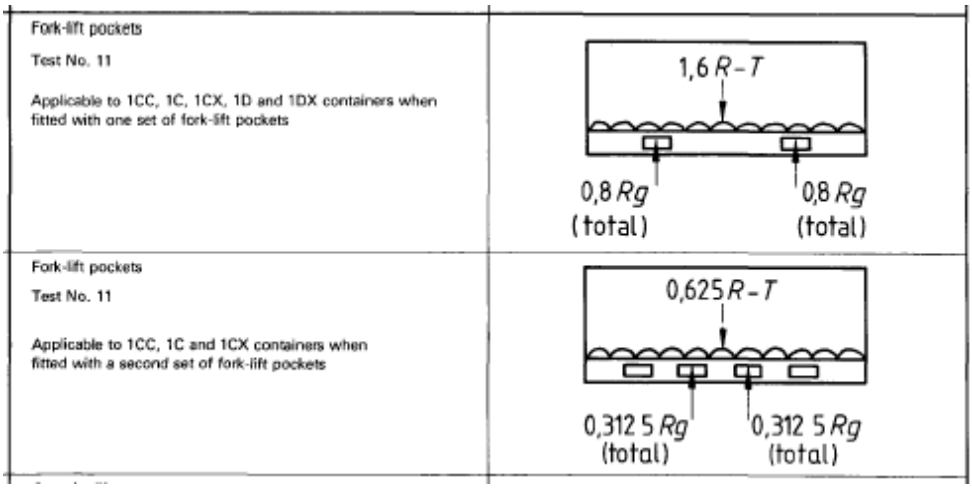
9. Rigidity (transverse) – This test is carried out to prove the ability of a container to withstand transverse racking forces resulting from ship movement. An empty container shall be placed on four level supports, one under each corner fitting and be restrained against lateral and vertical movement by anchor devices acting through the bottom apertures of the bottom corner fittings. Lateral restraint shall be provided only at a bottom corner fitting diagonally opposite to and in the same end frame as a top corner fitting to which the force is applied. A force (at right angles to long axis) of 33,700 lbs. shall be applied to each of the top corner fittings on one side of the container parallel both to the base and in the planes of the ends of the container. The forces shall be applied first towards and then away from the top corner fittings. The sideways deflection of the top of the container under full transverse loading shall not cause the sum of the changes in length of the two diagonals to exceed 2 3/8 inches. Upon completion the container shall show neither permanent deformation nor any abnormality, which will render it unsuitable for use, and the dimensional requirements shall be met.



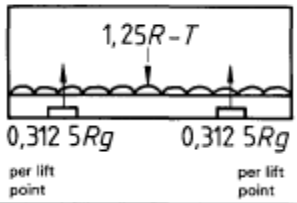
10. Rigidity (longitudinal) – This test is carried out to prove the ability of a container to withstand longitudinal racking forces resulting from ship movement. An empty container shall be placed on four level supports, one under each corner fitting and be restrained against lateral and vertical movement by anchor devices acting through the bottom apertures of the bottom corner fittings. Longitudinal restraint shall be provided only at a bottom corner fitting diagonally opposite to and in the same side frame as the top corner fitting to which the force is applied. A force of 16,850 lbs. shall be applied to each of the top corner fittings on one end of the container in lines parallel both to the base of the container and to the planes of the sides of the container. The forces shall be applied first towards and then away from the top corner fitting. The longitudinal deflection of the top of the container with respect to the bottom of the container, under full test load shall not exceed 1 inch. Upon completion the container shall show neither permanent deformation nor any abnormality, which will render it unsuitable for use, and the dimensional requirements shall be met.



1. Lifting from Fork-Lift Pockets (where fitted) – This test is carried out on any container which is fitted with forklift pockets to demonstrate its ability to be lifted by forklift equipment (40-ft freight containers may not have forklift pockets). The container shall have a load uniformly distributed over the floor in such a way that the combined weight of the container and payload is 1.6R and it shall be supported on two horizontal bars each 8 inches wide, projecting 72 inches into the forklift pockets. The container shall be supported for 5 minutes and then lowered to the ground. A second test shall be applied to the (additional) inner pockets, except that the combined weight of the container and payload shall be 0.625R and the bars shall be placed in the inner pockets. Upon completion the container shall show neither permanent deformation nor any abnormality, which will render it unsuitable for use, and the dimensional requirements shall be met



2. Lifting from the Base at Grappler Arm Positions (where fitted) – Grappler arms are infrequently used today. See ISO-1496-1 for details of tests.

Grappler lift Test No. 12 Applicable to all sizes when fitted with grappler arm lift positions	

3. Weatherproofness – This test is carried out to prove the ability of a container to remain watertight after a stream of water has been applied on all external joints. A stream of water shall be applied on all exterior joints and seams of the container. The nozzle shall be held at a distance of 5 feet from the container and be moved at a speed of 4 inches per second. Upon completion of the test, no water shall have leaked into the container.

C.1.6.3 Production tests

Each freight container that is manufactured for use is dimensionally and weather tight tested by the manufacturer. A pull test is also performed on each corner post assembly. If inspection personnel deem quality control procedures adequate, the pull test may be performed on one container from each lot of fifty (50) containers. The Bureau surveillance personnel witness representative production tests during manufacturing.

C.1.7 Marking

Each container (approved by ABS) is permanently marked by the manufacturer with the following information:

- Manufacturer’s name and address,
- Manufacturer’s serial number,
- Month and year of manufacture,
- American Bureau of Shipping emblem (or other third party emblem as applicable),
- Maximum gross weight,
- Tare,
- Payload, and
- Design type number
-

The International Convention for Safe Containers (CSC) plate is required for international shipment in accordance with 49 CFR 450.1. Note: the CSC plate and associated periodic inspections, are not required for domestic use of freight containers nor are they required for use of freight containers as Type IP-2 or Type IP-3 packagings in accordance with 49 CFR 411(b)(6). The CSC plate contains the following information:

- Country of Approval Reference,
- Date (month and year) of manufacture,
- Manufacturer’s identification number of the container,

- Maximum operating gross weight (kg and lb),
- Allowable Stacking Weight for 1.8g (kg and lb),
- Transverse Racking Test Load Value (kg and lb),
- End wall strength (only if end walls are designed to withstand a load of less than 0.4 times maximum permissible payload (i.e., 0.4P),
- Side wall strength (only if side walls are designed to withstand a load of less than or greater than 0.6 times maximum permissible payload (i.e., 0.6P), and
- First maintenance examination date (month and year) for new containers and subsequent maintenance examination dates (month and year) if plate is used for this purpose.

C.2 Periodic Examination per 49 CFR 452.1 (required for International use)

Except if under an approved continuous examination program (ACEP), each owner of an approved container subject to this part shall examine the container or have it examined in accordance with the procedures prescribed in §452.3 at intervals of not more than 30 months, except that for containers approved as new containers, the interval from the date of manufacture to the date of the first examination must not exceed five years. Note: the purpose of the "Examinations" is to ensure the FCs remain safe for use.

C.2.1 Elements of Periodic Examinations (49 CFR 452.3)

(a) Periodic examinations required by §452.1 must conform to the following minimum requirements:

(1) Each examination must include a detailed visual inspection for defects such as cracks, failures, corrosion, missing or deteriorated fasteners, and any other safety related deficiency or damage which could place any person in danger. Any such deficiencies disclosed by the examination must be corrected by the owner before the container is continued in service.

(2) Each examination must take into account the particular characteristics of various kinds of containers and materials of construction.

(3) Each examination must be performed by qualified personnel, trained and experienced in the detection of container structural damage.

(4) The examinations must be scheduled so as to allow adequate time for thorough performance.

(5) Each examination must apply owner established or industry accepted pass/fail criteria to determine whether a container has any deficiency that must be remedied before the container is returned to service.

(b) Examinations must be documented, and the records retained by the owner, until the next examination is completed and recorded. The records must include, in addition to identification of the container, a record of the date of last examination and a means of

identifying the examiner. The records must be maintained in an office under the control of the owner and be made available for inspection by the Coast Guard upon demand. If the original records are maintained outside the United States, its territories or possessions, supplementary records must be available in written or data processing form to be produced on demand of the Commandant or his representative.

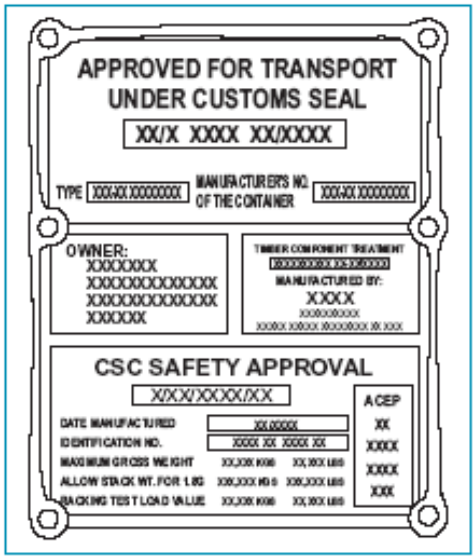
C.2.2 Continuous Examination Program 49 CFR 452.7

(a) In lieu of a periodic examination under §452.1, each owner of an approved container meeting §450.5 may examine the container or have it examined using an approved continuous examination program. An owner must submit the continuous examination program for approval to the Commandant (G-MSO), United States Coast Guard, 2100 Second Street, SW., Washington, DC 20593. When submitting a continuous examination program for approval, the owner must show the continuous examination complies with §452.9.

(b) The owner must mark the container with the letters "ACEP/USA/(year continuous examination program is approved)" to indicate the container is being periodically examined under an approved continuous examination program. This marking must be as close as practicable to the safety approval plate. This marking must be on all containers covered by a continuous examination program by January 1, 1987.

(c) The owner of containers subject to this section shall have those containers examined in accordance with the program prescribed in this section regardless of whether the examinations are performed within or outside the United States.

[1]CSC Plate with ACEP marking



[1]CSC Plate with current examination marking

C.2.3 Elements of Continuous Examination Program 49 CFR 452.9

Examinations required by §452.7 must conform to the following minimum requirements (excerpts from §452.9):

1. A thorough examination that must include a detailed visual inspection for defects such as cracks, failures, corrosion, missing or deteriorated fasteners, and any other safety related deficiency or damage that could place any person in danger. Any such deficiencies disclosed by the examination must be corrected by the owner before the container is continued in service. A thorough examination must be done each time a container undergoes a major repair, refurbishment or on-hire/off-hire interchange. In no case is the time period between thorough examinations to exceed 30 months.

2. Each thorough examination must be performed by qualified personnel, trained and experienced in the detection of container structural damage.

3. Thorough examinations must be documented, and the records retained by the owner, until the next examination is completed and recorded. The records must include, in addition to identification of the container, a record of the date of last examination and a means of identifying the examiner. The records must be maintained in an office under the control of the owner and be made available for inspection by the Coast Guard upon demand."

[1] "Uranium Concentrates Industry Good Practices for ISO Containers in Multimodal Transports, Revision 0," World Nuclear Transport Institute www.wnti.co.uk.

C.3 FREIGHT CONTAINER MAINTENANCE AND CSC CIRCULAR 134

Freight container maintenance and repair is required when damage or wear renders the container unsafe or unsatisfactory for use. Any repair that has the potential for affecting the structure of the FC must be reviewed and approved by an approval agency before the container is put back into use. If repairs are extensive the unit may require retesting. The FC industry has repair facilities that are certified by approval authorities to ensure that repairs are carried out in a quality manner. CSC Circular 134, "Guidance on Serious Structural Deficiencies in Containers", was written to enable approval authorities to assess the integrity of structurally sensitive components of containers and to help them decide if a container is safe to continue in transportation.

Structurally sensitive components (shown in Figure C.1 below) are those that enable the container to safely be used in transportation. Examples of structurally sensitive components are:

- Top and Bottom rails,
- Headers and Sills,
- Corner Posts,
- Corner Fittings, and
- Understructure and Locking Rod Assemblies.

Damage or alteration to any of the above components must be repaired before the container is put back into service.

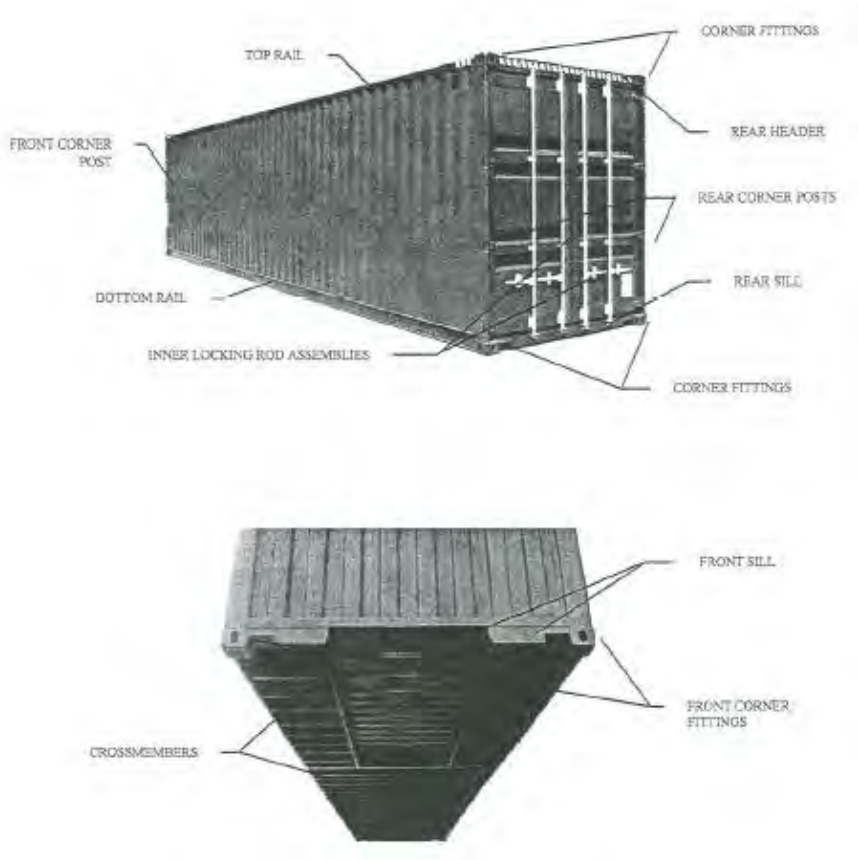


Figure C-1. Structurally sensitive components of a general-purpose freight container

APPENDIX D Regulatory Guidance

49 CFR Ref. October 1, 2009	49 CFR Requirement	Acceptance Criteria/Comments
Introduction to 49 CFR 172.310 and 49 CFR 172.310(a)	In addition to any other markings required by this subpart, each package containing Class 7 (radioactive) materials must be marked as follows: Each package with a gross mass greater than 50 kg (110 lb) must have its gross mass including the unit of measurement (which may be abbreviated) marked on the outside of the package.	**Comment:** The shipper/offeror complies with the regulation.
49 CFR 172.310(b)	Each industrial, Type A, Type B(U), or Type B(M) package must be legibly and durably marked on the outside of the packaging, in letters at least 13 mm (0.5 in) high, with the words “TYPE IP-1,” “TYPE IP-2,” “TYPE IP-3,” “TYPE A,” “TYPE B(U)” or “TYPE B(M),” as appropriate. A package which does not conform to Type IP-1, Type IP-2, Type IP-3, Type A, Type B(U) or Type B(M) requirements may not be so marked.	**Comment:** The shipper/ complies with the regulation.
49 CFR 172.310(c)	Each package which conforms to an IP-1, IP-2, IP-3 or a Type A package design must be legibly and durably marked on the outside of the packaging with the international vehicle registration code of the country of origin of the design. The international vehicle registration code for packages designed by a United States company or agency is the symbol “USA.”	**Comment:** The shipper/offeror complies with the regulation.
49 CFR 173.24(a)	Applicability. Except as otherwise provided in this subchapter, the provisions of this section apply to— (1) Bulk and non-bulk packagings;	**Comment:** Documentation of consideration during the packaging selection process is required and can be a one-time or reusable packaging.

49 CFR Ref. October 1, 2009	49 CFR Requirement	Acceptance Criteria/Comments
	(2) New packagings and packagings which are reused; and (3) Specification and non-specification packagings.	
49 CFR 173.24(b)	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, changes in humidity and pressure, and shocks, loadings and vibrations, normally 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; (4) There will be no hazardous material residue adhering to the outside of the package during transport.	**Comment:** The shipper/offeror complies with the regulation.
49 CFR 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	**Comments:** This standard provides guidance on Industrial Packaging. The shipper/offeror has the responsibility to ensure that the content is properly

49 CFR Ref. October 1, 2009	49 CFR Requirement	Acceptance Criteria/Comments
	Column 8 of the Sec. 172.101 table and conforms to applicable requirements in the special provisions of Column 7 of the Sec. 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 subparts B or C of part 171 of this subchapter or Sections 173.3, 173.4, 173.4a, 173.4b, 173.5, 173.5a, 173.6, 173.7, 173.8, 173.27, or Section 176.11 of this subchapter.	classified and appropriate for the package.
49 CFR 173.24(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 (IBR, see Sec. 171.7 of this subchapter), 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	**Comment:** The shipper/offeror complies with the regulation.

49 CFR Ref. October 1, 2009	49 CFR Requirement	Acceptance Criteria/Comments
	Recommendations 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.	
49 CFR 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. (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	**Comments:** Emphasis here is on the compatibility between the radioactive materials and packaging components. Secondary hazards need to also be considered.

49 CFR Ref. October 1, 2009	49 CFR Requirement	Acceptance Criteria/Comments
	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 Sec. 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. (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;	

49 CFR Ref. October 1, 2009	49 CFR Requirement	Acceptance Criteria/Comments
	(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.	
49 CFR 173.24(f)	Closures. (1) Closures on packagings shall be so designed and closed that under conditions (including the effects of temperature, pressure 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 leak proof and secured against loosening. For air transport, stoppers, corks or other such friction closures must be held in place by positive means. (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 and must be closed in accordance with information, as applicable, provided by the manufacturer's notification required by Section 178.2 of this subchapter.	**Acceptance Criteria:** The closure of a Industrial Package shall meet the design and performance requirements of 49 CFR 173.410 and 173.411 (b)(6). **Comment:** A "manufacturer" as identified here does not apply to Industrial Packaging. This role is fulfilled by the shipper/offeror, which has all the required information to certify that the Industrial Package meets all the applicable requirements.
49 CFR 173.24(g)	Venting. Venting of packagings, to reduce internal pressure which may develop by the	**Comments:** Venting of Industrial Packagings is acceptable. Venting is a

49 CFR Ref. October 1, 2009	49 CFR Requirement	Acceptance Criteria/Comments
	evolution of gas from the contents, is permitted only when— (1) Except for shipments of cryogenic liquids as specified in Section 173.320(c) and of carbon dioxide, solid (dry ice), 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; (4) For bulk packagings, other than IBCs, venting is authorized for the specific hazardous material by a special provision in the Section 172.101 table or by the applicable bulk packaging specification in part 178 of this subchapter; and (5) Intermediate bulk packagings (IBCs) may be vented when required to reduce internal pressure that may develop by the evolution of gas subject to the requirements of paragraphs (g)(1) through (g)(3) of this section. The IBC must be of a type that has successfully passed (with the vent in place) the applicable design qualification tests with no release of hazardous material.	consideration to deal with gas generation resulting from chemical reactions, biological decay, and radiolysis. Venting may not permit release of radioactive contents (e.g., Venting in combination with a particulate filter is acceptable). Packaging designed for transport by aircraft is not to be vented.
49 CFR 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	**Comments:** Consider temperature and pressure changes as well as volume changes due to phase change. Room within the packaging will be allowed to expand and contract for the payload.

49 CFR Ref. October 1, 2009	49 CFR Requirement	Acceptance Criteria/Comments
	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 Section 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 Sec. Section 173.301 through 173.306 for cylinders and Section 173.314 through 173.319 for bulk packagings. (i) Air transportation. Except as provided in subpart C of part 171 of this subchapter, packages offered or intended for transportation by aircraft must conform to the general requirements for transportation by aircraft in Section 173.27.	
49 CFR 173.24a(a)	Packaging design. Except as provided in Section 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 shifting within the outer packaging under conditions normally incident	**Comment:** The shipper/offeror complies with the regulation.

49 CFR Ref. October 1, 2009	49 CFR Requirement	Acceptance Criteria/Comments
	to transportation. Cushioning material must not be capable of reacting dangerously with the contents of the inner packagings or having its protective properties significantly weakened in the event of leakage. (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 Section 178.608 of this subchapter.	
49 CFR 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, 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	**Comment:** This requirement is not applicable for Industrial Packages.

49 CFR Ref. October 1, 2009	49 CFR Requirement	Acceptance Criteria/Comments
	(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 non-bulk packaging may not be filled with a 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	

49 CFR Ref. October 1, 2009	49 CFR Requirement	Acceptance Criteria/Comments
	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.	
49 CFR 173.24a(b) Continued	(4) Packagings tested as prescribed in Sec. 178.605 of this subchapter and marked with the hydrostatic test pressure as prescribed in Sec. 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 psia)) 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 psia); 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 psia).	**Comment:** This requirement is not applicable for Industrial Packages.

49 CFR Ref. October 1, 2009	49 CFR Requirement	Acceptance Criteria/Comments
	(5) No hazardous material may remain on the outside of a package after filling.	
49 CFR 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 Sec. 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— (i) Refrigerants, such as dry ice or liquid nitrogen, as authorized under the HMR; (ii) Anticoagulants used to stabilize blood or plasma; or	Not Applicable

49 CFR Ref. October 1, 2009	49 CFR Requirement	Acceptance Criteria/Comments
	(iii) Small quantities of Class 3, Class 8, Class 9, or other materials in Packing Groups II or III used to stabilize or prevent degradation of the sample, provided the quantity of such materials does not exceed 30 mL (1 ounce) or 30 g (1 ounce) in each inner packaging. The maximum quantity in an outer package, including a hazardous material used to preserve or stabilize a sample, may not exceed 4 L (1 gallon) or 4 kg (8.8 pounds). Such preservatives are not subject to the requirements of this subchapter.	
49 CFR 173.24a(d)	Liquids must not completely fill a receptacle at a temperature of 55°C (131°F) or less.	**Comment:** The shipper/offeror shall comply with the regulation.
49 CFR 173.24b(a)	Outage and filling limits. (1) Except as otherwise provided in this subchapter, liquids and liquefied gases must be so loaded that the outage is at least five percent for materials poisonous by inhalation, or at least one percent for all other materials, of the total capacity of a cargo tank, portable tank, tank car (including dome capacity), multi-unit tank car tank, or any compartment thereof, at the following reference temperatures— (i) 46°C (115°F) for a non-insulated tank; (ii) 43°C (110°F) for a tank car having a thermal protection system, incorporating a metal jacket that provides an overall thermal conductance at 15.5°C (60°F) of no more than 10.22 kilojoules per hour per square meter per degree Celsius (0.5 Btu per hour/per square foot/ per degree Fahrenheit) temperature differential; or (iii) 41°C (105°F) for an insulated tank.	Not Applicable

49 CFR Ref. October 1, 2009	49 CFR Requirement	Acceptance Criteria/Comments
	(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.	
49 CFR 173.24b(b)	(b) Equivalent steel. For the purposes of this section, the reference stainless steel is stainless steel with a guaranteed minimum tensile strength of 51.7 dekanewtons 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 Sec. 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 $e_1 = (12.74e_0) / (Rm_1 A_1)(1/3)$ Formula for non-metric units $e_1 = (144.2e_0) / (Rm_1 A_1)(1/3)$ Where: e_0 = Required thickness of the reference stainless steel in mm or inches respectively; e_1= Equivalent thickness of the steel used in mm or inches respectively; Rm_1 = Specified minimum tensile strength of the steel used in dekanewtons per square millimeter or pounds per square inch respectively; and A_1 = Specified minimum percentage elongation of the steel used multiplied by 100	**Comment:** This requirement is not applicable to Industrial packagings as no specific materials of construction are identified for Industrial Packaging.

49 CFR Ref. October 1, 2009	49 CFR Requirement	Acceptance Criteria/Comments
	(for example, 20 percent times 100 equals 20). Elongation values used must be determined from a 50 mm or 2 inch test specimen.	
49 CFR 173.24b(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.	Not Applicable
49 CFR 173.24b(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.	**Comment:** The shipper/offeror complies with the regulation.
49 CFR 173.24b(e)	Stacking of IBCs and Large Packagings. (1) IBCs and Large Packagings not designed and tested to be stacked. No packages or freight (hazardous or otherwise) may be stacked upon an IBC or a Large Packaging that was not designed and tested to be stacked upon. (2) IBCs and Large Packagings designed and tested to be stacked. The superimposed weight placed upon an IBC or a Large Packaging designed to be stacked may not exceed the maximum permissible stacking test mass marked on the packaging.	Not Applicable
49 CFR 173.24b(f)	UN portable tanks. (1) A UN portable tank manufactured in the United States must conform in all details to the applicable requirements in parts 172, 173, 178 and 180 of this subchapter.	Not Applicable

49 CFR Ref. October 1, 2009	49 CFR Requirement	Acceptance Criteria/Comments
	(2) UN portable tanks manufactured outside the United States. A UN portable tank manufactured outside the United States, in accordance with national or international regulations based on the UN Recommendations (IBR, see Sec. 171.7 of this subchapter), which is an authorized packaging under Section 173.24 of this subchapter, may be filled, offered and transported in the United States, if the Section 172.101 Table of this subchapter authorizes the hazardous material for transportation in the UN portable tank and it conforms to the applicable T codes, and tank provision codes, or other special provisions assigned to the hazardous material in Column (7) of the Table. In addition, the portable tank must— (i) Conform to applicable provisions in the UN Recommendations (IBR, see Sec. 171.7 of this subchapter) and the requirements of this subpart; (ii) Be capable of passing the prescribed tests and inspections in part 180 of this subchapter applicable to the UN portable tank specification; (iii) Be designed and manufactured according to the ASME Code (IBR, see Section 171.7 of this subchapter) or a pressure vessel design code approved by the Associate Administrator; (iv) Be approved by the Associate Administrator when the portable tank is designed and constructed under the provisions of an alternative arrangement (see Section 178.274(a)(2) of this subchapter); and (v) The competent authority of the country of manufacture must provide reciprocal	

49 CFR Ref. October 1, 2009	49 CFR Requirement	Acceptance Criteria/Comments
	treatment for UN portable tanks manufactured in the United States.	
Introduction to 49 CFR 173.410 and 49 CFR 173.410(a)	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.	**Comment:** The shipper/offeror should be able to easily handle and secure the package in the conveyance through the use of standard handling and securing devices.
49 CFR 173.410(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 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.	**Acceptance Criteria:** By calculation the designer will use the yield point of the material to determine that the lifting attachment meets the minimum safety factor of three against yield. Also by calculation and design the designer will make sure that if a lifting attachment does fail it will not impact the ability of the package to perform its proper function (i.e., the attachment would fail but would not tear out of the packaging and therefore containment and shielding would be maintained). **Comment:** The use of a marking (e.g., “DO NOT LIFT”) on the structural part of the package which could be used to lift the package is not sufficient to render that part inoperable for lifting.

49 CFR Ref. October 1, 2009	49 CFR Requirement	Acceptance Criteria/Comments
49 CFR 173.410(c)	The external surface, as far as practicable, will be free from protruding features and will be easily decontaminated.	**Comment:** The shipper/offeror complies with the regulation.
49 CFR 173.410(d)	The outer layer of packaging will avoid, as far as practicable, pockets or crevices where water might collect.	**Comment:** The shipper/offeror complies with the regulation.
49 CFR 173.410(e)	Each feature that is added to the package will not reduce the safety of the package.	**Comment:** The shipper/offeror complies with the regulation.
49 CFR 173.410(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 Sections 173.24, 173.24a, and 173.24b).	**Acceptance Criteria:** No visible leakage at the conclusion of either the test performed or through an engineering evaluation. Additionally, if structural damage occurs during the vibration test/engineering evaluation, this would indicate an unacceptable design. Showing the package can meet the vibration requirements identified in 49 CFR 178.608 is an acceptable method for demonstrating compliance.
49 CFR 173.410(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.	**Comment:** When designing a Industrial Packaging, the designer will document that the packaging will not suffer any significant chemical or galvanic reactions. This requirement is also identified in 49 CFR 173.24(e)(2). For Industrial Packages, the evaluation should include the effects that irradiation may have on materials. Documentation should include discussion of the reactions between

49 CFR Ref. October 1, 2009	49 CFR Requirement	Acceptance Criteria/Comments
		materials of construction and the radioactive payload.
49 CFR 173.410(h)	All valves through which the package contents could escape will be protected against unauthorized operation.	**Comment:** The designer should document the features of the packaging that ensure all valves are protected from unauthorized operation.
49 CFR 173.410(i)(1)	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;	**Comment:** A thermal evaluation should be carried out with the package immersed in an ambient temperature of 38°C (100°F) with maximum payload wattage. The evaluation is to show that no accessible surface will exceed 50°C (122°F). Screens and barriers may be used to restrict access from package surfaces that may exceed 50°C (122°F).
49 CFR 173.410(i)(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	**Comment:** The designer evaluates the containment system to ensure that it will not significantly degrade under the conditions of (a) maximum or minimum payload wattage and (b) high or low temperatures. Low temperatures can embrittle materials and high temperatures can soften materials such that containment can be impaired.
49 CFR 173.410(i)(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/in^2).	Not Applicable
49 CFR 173.411 (a)	General. Each industrial packaging must comply with the requirements of this section which specifies packaging tests, and record retention applicable to Industrial Packaging Type 1 (IP-1), Industrial Packaging Type 2	Shipper/Offeror shall meet all requirements

49 CFR Ref. October 1, 2009	49 CFR Requirement	Acceptance Criteria/Comments
	(IP-2), and Industrial Packaging Type 3 (IP-3).	
49 CFR 173.411 (b)(1)	Each IP-1 must meet the general design requirements prescribed in Section 173.410.	Shipper/Offeror shall meet all requirements
49 CFR 173.411 (b)(2)	Each IP-2 must meet the general design requirements prescribed in Section 173.410 and when subjected to the tests specified in Section 173.465(c) and (d) or evaluated against these tests by any of the methods authorized by Section 173.461(a), must prevent: ▪ Loss or dispersal of the radioactive contents; and ▪ A significant increase in the radiation levels recorded or calculated at the external surfaces for the condition before the test.	Shipper/Offeror when meeting the requirements of 49 CFR 173.411 (b)(6) are not required to perform the tests required in Section 173.465(c) and (d), but are required to meet all the requirements in 49 CFR 173.410
49 CFR 173.411 (b)(3)	Each IP-3 packaging must meet the requirements for an IP-1 and an IP-2, and must meet the requirements specified in Section 173.412(a) through (j).	Shipper/Offeror when meeting the requirements of 49 CFR 173.411 (b)(6) are not required to perform the tests required in Section 173.412 (j), but are required to meet all the requirements in 49 CFR 173.410
49 CFR 173.411 (b)(4)	Tank containers may be used as Industrial package Types 2 or 3 (Type IP-2 or Type IP-3) provided that: ▪ They satisfy the requirements for Type IP-1 specified in paragraph (b)(1); ▪ They are designed to conform to the standards prescribed in Chapter 6.7, of the United Nations Recommendations on the	Not Applicable

49 CFR Ref. October 1, 2009	49 CFR Requirement	Acceptance Criteria/Comments
	Transport of Dangerous Goods, (IBR, see Sec. 171.7 of this subchapter), "Requirements for the Design, Construction, Inspection and Testing of Portable Tanks and Multiple-Element Gas Containers (MEGCs)," or other requirements at least equivalent to those standards; ▪ They are capable of withstanding a test pressure of 265 kPa (37.1 psig); and ▪ They are designed so that any additional shielding which is provided shall be capable of withstanding the static and dynamic stresses resulting from handling and routine conditions of transport and of preventing a loss of shielding integrity which would result in more than a 20% increase in the radiation level at any external surface of the tank containers.	
49 CFR 173.411 (b)(5)	Tanks, other than tank containers, including DOT Specification IM 101 or IM 102 steel portable tanks, may be used as Industrial package Types 2 or 3 (Type IP-2) or (Type IP-3) for transporting LSA-I and LSA-II liquids and gases as prescribed in Table 6, provided that they conform to standards at least equivalent to those prescribed in paragraph (b)(4) of this section.	Not Applicable
49 CFR 173.411 (b)(6)	Freight containers may be used as Industrial packages Types 2 or 3 (Type IP-2) or (Type IP-3) provided that: ▪ The radioactive contents are restricted to solid materials; ▪ They satisfy the requirements for Type IP-1 specified in paragraph (b)(1); and	Shipper/Offeror meets all requirements

49 CFR Ref. October 1, 2009	49 CFR Requirement	Acceptance Criteria/Comments
	(iii) They are designed to conform to the standards prescribed in the International Organization for Standardization document ISO 1496-1: "Series 1 Freight Containers--Specifications and Testing--Part 1: General Cargo Containers; excluding dimensions and ratings (IBR, see Sec. 171.7 of this subchapter)." They shall be designed such that if subjected to the tests prescribed in that document and the accelerations occurring during routine conditions of transport they would prevent: o Loss or dispersal of the radioactive contents; and o Loss of shielding integrity, which would result in more than a 20% increase in the radiation level at any external surface of the freight containers.	
49 CFR 173.411 (b)(7)	Metal intermediate bulk containers may also be used as Industrial package Type 2 or 3 (Type IP-2 or Type IP-3), provided that: ▪ They satisfy the requirements for Type IP-1 specified in paragraph (b)(1); and ▪ They are designed to conform to the standards prescribed in Chapter 6.5 of the United Nations Recommendations on the Transport of Dangerous Goods, (IBR, see Sec. 171.7 of this subchapter), ``Requirements for the Construction and Testing of Intermediate Bulk Containers," for Packing Group I or II, and if they were subjected to the tests prescribed in that document, but with the drop test conducted in the most damaging orientation, they would prevent:	Not Applicable

49 CFR Ref. October 1, 2009	49 CFR Requirement	Acceptance Criteria/Comments
	o Loss or dispersal of the radioactive contents; and o Loss of shielding integrity which would result in more than a 20% increase in the radiation level at any external surface of the intermediate bulk containers.	
49 CFR 173.411 (c)	Except for IP-1 packagings, each offeror of an industrial package must maintain on file for at least one year after the latest shipment, and shall provide to the Associate Administrator 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.	Shipper/Offeror meets all requirements.

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APPENDIX E Example of a New or Like New Freight Container Procurement Specification

Sample Procurement Specification for ISO 1CC Type Steel Dry Cargo Containers Having Dimensions of 20'x8'x8'-6"

Scope

This specification covers the procurement of new or like new ISO 1CC Type Steel dry cargo containers, with 3 or 4 door lock rods and having a dimension of 20'x8'x8'-6".

Operational Environment

The container is to be designed and manufactured for the transportation of general cargo by marine, highway, and rail throughout the world. All Materials used in construction will be able to withstand extreme temperatures ranging from-40°C (-40°F) to 70°C (158°F) without effect on the strength of the basic structure and weatherproofness of the cargo container.

Standards and Regulations

The seller will ensure that the containers comply with the following requirements and regulations in their latest edition:

1. ISO/TC-104 freight containers publications:

   - 668 - Series 1 freight containers – Classification, dimensions, and ratings
   - 1496-1 - Series 1 freight containers – Specifications And testing – Part 1: General cargo containers for general purposes
   - 1496-1 - Amendment 1, Series 1 freight Containers – Specifications and Testing – Part 1: General Cargo Containers for General Purposes. Amendment 1: 1AAA and 1BBB Containers
   - 1161 – Series I freight containers – Corner Fittings – Specification
   - 6346 - Freight Containers – Coding, identification, and marking
   - 830 – Freight containers – Vocabulary
   - 6359 – Freight container – Consolidated Data plate

2. The International Union of Railway (UIC) code 592 OR

3. The Customs Convention on the International Transport Goods (TIR)

4. The International Convention for Safe Containers (CSC)

5. Transport Cargo Containers and Unit Loads Quarantine Aspects and Procedures by Commonwealth of Australia Department of Health (TCT)

6. 49 CFR Parts 450 – 453

Approval and Certificate Documents Requested

The seller will ensure that each container purchased under this specification has the following documentation:

- The seller shall obtain a copy of the manufacturers "Technical Specification," which will have a set of drawings attached. 20'x8'x8'6" ISO Type, Dry Cargo Steel Container. This is to be reviewed by organization who issued the purchase order to ensure that it meets the regulatory requirements in 49 CFR 173.411 (c).
- All the containers will be certified for design type and individually inspected by Classification Society. The seller will provide a copy of the prototype certificate that was issued for the design type showing it met the applicable Standards and Regulations identified above.
- The Production Certificate of series containers to be issued by the Classification Society. The seller will ensure that the Society's seal is applied to the container and that the production certificate covers the serial numbers of the containers purchased.
- All the containers will be certified and comply with the requirements of the International Convention for Safe Containers. The seller shall ensure that a CSC plate is affixed to the container ensure the container meets the requirements International Convention for Safe Containers.

Handling

The seller will ensure that the container is be capable of being handled without any permanent deformation which will render it unsuitable for use or any other abnormality during the following conditions:

- Lifting, full or empty, at the top corner fittings vertically by means of spreaders fitted with hooks, shackles or twist locks.
- Lifting, full or empty, at the bottom corner fittings using slings with appropriate terminal fittings at slings angle of forty five (45°) degrees to horizontal.
- Lifting, fully or empty, at two fork pocket by fork lift truck. Moving or stationary.
- Side lifting from two top corner fittings when fully laden. (The reaction force will be supported by the corner posts only).

Transportation

The seller will ensure that the container will be constructed suitable for transportation by marine, road, and rail without any permanent deformation which will render the container unsuitable to use or any other abnormality.

Dimensions and Ratings

The seller will ensure that the container meets the applicable requirements in ISO 668, *Series 1 freight containers – Classification, dimensions, and ratings*

Construction

The seller will ensure the container is constructed with steel frame, fully vertically corrugated steel side and end walls, die-stamped corrugated steel roof, wooden flooring, corrugated double hinged doors and ISO corner fittings at eight corners.

All steelwork will be built up by means of automatic and semi-automatic CO_2 gas arc welding or an equitable process. All exterior welds including that on base structure will be continuous to insure water-tightness, all the welds, even spots, will have full penetration without undercutting or porosity. All material identified in the construction of the container will meet their applicable standards or codes.

Markings

All sellers will ensure the containers are marked in accordance with the following requirements:

- ISO 6346 - Freight Containers – Coding, identification, and marking
- 49 CFR Part 172, Subpart D-*Marking*, Section 310 *Class 7 (radioactive) materials*
- Additional markings that may be required in the purchase order

Quality Assurance Requirements

The requesting organization does not require that the Seller or broker have a fully documented QA program as they purchase them from an owner who purchases the containers from a manufacturer. Only when the order is large enough (i.e., lot of 200), will the seller be able to purchase directly from the manufacturer.

The seller will be required to provide the appropriate documentation identified in this specification and where applicable the seller may be requested to seal the vents and paint the inside and outside of the cargo container. Because of the minor work performed on the cargo container we require the seller to meet the following QA requirements:

- Criteria 5, *Work Processes* - This is to ensure that the seller will perform the necessary work required by this specification in a consistent and safe manner.
- Criteria 7, *Procurement* - This is to ensure that the seller will procure the items in accordance with this specification.
- Criteria 8, *Inspection and Acceptance Testing* – This is to ensure that the seller performs the required inspections as identified in this specification.

Inspection Checklist

The seller will complete the visual inspection checklist to verify that the cargo container is in a new or like new condition prior to delivery. If repairs need to be made prior to delivery, the seller will contact the requesting organization to discuss the repairs. The last page of the Visual Inspection Checklist is where the seller will enter the information shown on the customs seal and CSC plate.

By completing, signing and dating the Visual Inspection checklist, the seller certifies compliance with requirements stated in this specification.

Visual Inspection Checklist
Container Specific Inspection Requirements

Cargo Container Serial Number(s): _____

(Company) Release or PO Number: _____

Indicate compliance by checking each box below: √

General Requirements

Verify that the certifying seals from approval agency (e.g., ABS, Bureau of Veritas) are applied and can be seen.	
Has the cargo container been painted? If so, was it painted with one coat of mercury free, lead free, enamel paint?	
Cargo container has the following information or markings on the right door ▪ Purchase order number, ▪ Date of purchase (month – day – Year), ▪ Tare and maximum gross weight, ▪ Cargo container serial number plus check digit Verify CSC plate is readable and shows that the cargo container is with its first year of a 5 year certification.	
Prior to delivery, the seller will re-enter the cargo container with the doors closed and verify that the container was inspected for any light entering the container through holes or non-sealing door gaskets.	

Visual Inspection Checklist
Container Specific Inspection Requirements

The supplier will visually inspect each component of the cargo container using the checklist below. The supplier will show compliance by √ each box below.

Container Corner Post	
Shall not have any cracks, splits or missing welds	
Shall not have any tears or fractures	
Shall not have any dents	
Shall not have any rust	

Container Corner Fitting	
Shall be fully square	
Shall not have any pieces broken away	
Shall not be fractured or cracked	
Shall not be mis-aligned with the corner post	
Shall not have any missing or cracked welds	
Shall not have any rust	

Container Rear End Frame	
Shall not have any missing or cracked welds	
Door header shall have no splices	
Shall not have any dents or bends	
Shall not be cut or torn	
Door sill shall not have any splices	
Shall not have any rust	
Rain gutter shall not be damaged	

Container Top and Bottom Side Rails	
Shall not have any cracked or missing welds	
Shall not have splices in the rails	
Shall not have any dents or bends	
Shall not have any cuts, tears or fractures	
Shall not have any rust	

Container Front End Frame	
Shall not have any cracks, fractures or tears	
Shall have no splices in the top or bottom end rails	
Shall not have any dents or bends	
Shall not have any cracked or missing welds	
Shall not have any rust	

Visual Inspection Checklist
Container Specific Inspection Requirements

Container Side Walls	
Shall not have any cracks, fractures or tears	
Shall not have any inward or outward dents or bulges	
Shall not have any cracked or missing welds	
Shall not have any rust	

Container Roof Exterior	
Shall not have any cracks, fractures or tears	
Shall not have cracked roof reinforcement plate	
Shall not have any cracked or missing welds	
Shall not have any rust	

Container Roof Interior	
Shall not have any broken roof bows or welds	
Shall not have any missing, cracked or bent roof bows	
Shall not have any missing rivets or bolts	

Container Floor - Exterior Undercarriage	
Shall not have any cracked or missing welds on any connected steel member	
Cross members shall not be fractured, torn, twisted or disconnected from the side rail	
Shall have no splices	
Forklift pockets shall be no less than 4-1/2" high by 14" wide	
Shall not have any rust	

Container Floor - Inside	
Shall not be fractured or warped	
Shall have all required fasteners	
Shall not have any debris inside the container	
Shall be capable of supporting a forklift or small tractor	

Visual Inspection Checklist
Container Specific Inspection Requirements

Container Doors	
Shall not have torn or damaged door seals	
Each door shall have two locking bars	
Shall not have any broken, bent or inoperative door locking bars	
Hinges shall not be broken or unfastened	
Shall not have any holes or tears in door panels	
Shall not have any broken or loose cam handles	
Door locking handle shall not be broken or inoperative	
Shall not have any rust	
Locking bar mounting brackets shall not be broken or unfastened	
Shall not have any cracked or missing welds	
Door gaskets shall not have any tears, holes, cracks, patches or overlapping corner tabs	

Supplier Quality Assurance Representative

Date

Visual Inspection Checklist
Container Specific Inspection Requirements

Cargo Container Custom Seal Plate and CSC Plate

Record the following information found on the cargo container Custom Seal Plate and Container Safety Approval Plate (CSC). These two plates may be combined into one plate and usually are found on one of the doors.

Purchase Order Number _____

Cargo Container Number Plus Check Digit _____

<table>
<tr><td colspan="4">Approved for Transport
Under Customs Seal</td></tr>
<tr><td colspan="2">Type</td><td colspan="2">Manufactures number of The Container</td></tr>
<tr><td colspan="2" rowspan="2">Owner Information</td><td colspan="2">Timber Component Treatment</td></tr>
<tr><td colspan="2">Manufactured by Information</td></tr>
<tr><td colspan="4">CSC Safety Approval Plate</td></tr>
<tr><td>Date Manufactured</td><td colspan="2"></td><td rowspan="6">First Maintenance Examination Due</td></tr>
<tr><td>Identification Number</td><td colspan="2"></td></tr>
<tr><td></td><td>Kilograms</td><td>Pounds</td></tr>
<tr><td>Maximum Gross Weight</td><td></td><td></td></tr>
<tr><td>Allowable Stacking Weight for 1.8g</td><td></td><td></td></tr>
<tr><td>Racking Test Load Value</td><td></td><td></td></tr>
</table>

_____ _____
Receipt Inspector Date

APPENDIX F Sample 3:1 Margin of Safety Against Yielding 3:1 Safety Margin Discussion

1. Purpose

This document provides a template for evaluation of the ISO-1161[1] fittings for loads imposed during lifting of the bulkhead freight containers. This document was provided by Savannah River Nuclear Solutions to be used in this APPENDIX F.

2. Discussion

The following analysis template is intended to provide a standard model for evaluation of the bulkhead freight container corner fittings. The top and bottom fittings are evaluated for lift loads when lifted using standard lift attachments, using the methodology shown below.

Stress Analysis of Fittings (49CFR Part 173.410(b))

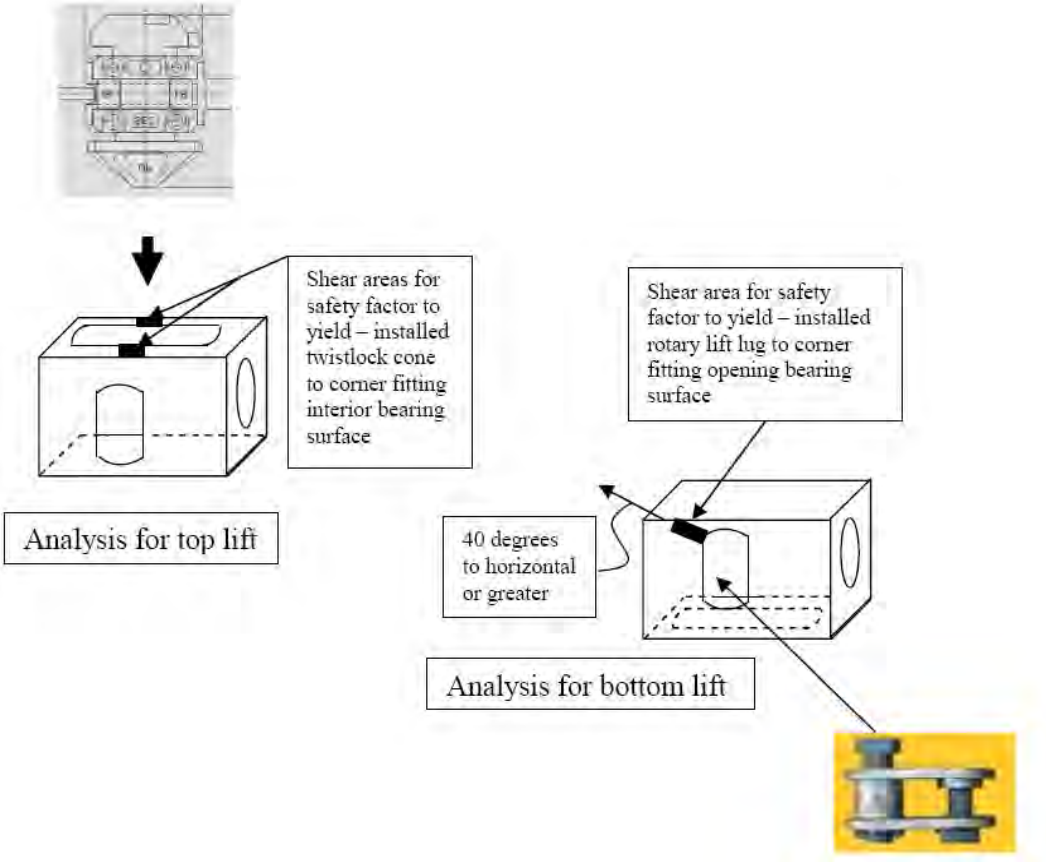


Figure F-1. Corner Fitting Loads and Analysis Model

Stress Analysis of Top Fitting, Lifted with Twistlock Lifting Device

The top fitting is loaded in shear by the twistlock lift device, and has a shear area as depicted in Figure 1. Refer to Figures F-2 and F- 4 for the top corner fitting and twistlock connector configuration.

Shear Stress at Top of Fitting

Applied load = Total supported weight (W) / 4 fittings = W/4 lbs. per fitting, for vertical lift at top fittings

Shear stress $S_s = \frac{P}{A_s} = \frac{W}{4 \cdot A_s}$

For pure shear, the maximum equivalent tensile stress is equal to twice the shear stress = $2S_s$.

The factor to yield (S_y) is:

Shear Stress Factor = $\frac{S_y}{2 \cdot S_s}$

The shear stress factor must be greater than or equal to 3.

Example, using the dimensions provided in ISO 1161, Annex B (twistlock) and Figure F- 2 (top corner fitting):

Width of slot in fitting: 2.5 in

Twistlock head dimensions: 3 7/8 x 1 3/16 in

Overlap per side = (3.875 – 2.5) / 2 = .6875 in

Wall thickness of top of fitting = 1.125 - .0625 = 1.0625 in

Shear area (adjusted for 5/16" chamfers) A_s = 1.0625 * (2*(.6875)+1.188) – (.3125)*(.3125) = 2.63 in^2 per side (= 5.25 in^2 total)

Assume the container has a weight of 67,200 lbs. The shear stress is:

$$S_s = \frac{W}{4 \cdot A_s} = \frac{67{,}200 \text{ lb}}{4 \cdot \left(5.25 \text{ in}^2\right)} = 3200 \text{ psi}$$

Assume the corner fitting has yield strength of 39,000 psi. The shear stress factor is:

$$\text{Factor} = \frac{S_y}{2 \cdot S_s} = \frac{39{,}000 \text{ psi}}{2 \cdot (3200 \text{ psi})} = 6.1 > 3$$

Bearing stress between the twistlock and upper fitting:

Bearing area = 2*(.6875)*(1.188) = 1.64 in^2

$$\text{Bearing stress} = \frac{16{,}800 \text{ lb}}{1.64 \text{ in}^2} = 10{,}250 \text{ psi}$$

The bearing stress is evaluated per the requirements of ASME BTH-1[2], Equation 3-38, which provides an allowable bearing stress equal to 1.5 * S_y / (Design Factor).

$$\text{Factor to Yield: } F = \frac{39{,}000 \text{ psi}}{10{,}250 \text{ psi}} = 3.8 > 3$$

Top Fitting to Corner Post / Side Rail Weld Stresses

The top fitting is welded to the adjacent corner post and side rail(s) using fillet welds. Lift loads are transmitted through the welds, loading the post in tension and the side rails in shear. It is assumed that the side rails at open ends of the container do not react to the lift loads due to their comparatively low stiffness. All welds are assumed to be loaded in shear. It is assumed that the line of action of the lift loads acts through the center of the weld group consisting of the post and side rail welds. Based on this assumption, no net bending or torsional loads act on the weld group, which attaches the fitting to the post and side rails.

From the geometry of the attached post and side rails, the total length of weld, L_w, can be determined. Assume all welds are of the same material (S_y) and weld size (t_w). The stress in the weld is:

$$S_{weld} = \frac{\text{Load}}{.707 \cdot t_w \cdot L_w}$$

Since the welds are assumed to be loaded in shear, the allowable stress is S_y / 2. The factor to yield is calculated as:

$$\text{Factor} = \frac{S_y}{2 \cdot S_{weld}} \geq 3$$

Base Metal at Top Fitting to Corner Post / Side Rail Weld

The base metal at the welded connections must be checked to ensure sufficient margin exists. The minimum material yield strength of the fitting, post, and side rails should be used for this calculation. The effective area is the same as the weld area, except the full weld thickness, t_w is applicable. It is conservatively assumed that the base metal at the welds is loaded in shear. The relations are:

$$S_{Base} = \frac{Load}{t_w \cdot L_w}$$

$$Factor = \frac{S_y}{2 \cdot S_{Base}} \geq 3$$

Failure Mode Under Excessive Load Application

The factor to yield for the "Top Fitting to Corner Post / Side Rail Weld Stresses" evaluation shall be greater than that for the "Shear Stress at Top of Fitting" evaluation. This is accomplished by ensuring the weld size and length which attaches the corner fitting to the post and rails is sufficient to provide the required margin to yield. Therefore, if an excessive load were applied to the lifting attachments during a lift using the top corner fittings, the failure mode would be shear through the ISO corner fitting. This would not impair the ability of the package to perform its intended function (e.g., containment of particles and radiation shielding).

Bottom Fitting, Lifted With Rotary Lug Lift Device

Lifts from the bottom fittings are commonly performed using a rotary lug lift device.[3] Refer to Figures F-3 and F-5a, -5b for the bottom corner fitting and rotary lug lift device configuration. The rotary lug lift device fits into the long container side slot for lifting, and the lug is turned 90 degrees after installation to lock it in place. When loaded, the lug bears against the upper inside surface of the bottom fitting, and the pin bears against the upper edges of the side slot (see Figure F-1). The bottom fitting is not evaluated for shear loads, as no shear failure plane exists for this lift configuration. However, the lug bears against the free edge of the slot in the bottom fitting, and bearing stresses are evaluated below.

For a minimum sling angle of θ from horizontal, the lift load is resolved into components below:

Lifted load per fitting = Vertical load = F_v

Horizontal component: $F_H = \frac{F_V}{\tan\theta}$

The rotary lug lift device has a turned down section which bears against the side and top edges of the slot, and a t-head which bears against the inner top surface of the fitting. The configuration of the lift device is such that the t-head is subjected to most of the vertical load component, and the turned down section of the lug is subjected to most of the lateral load component. Bearing stresses are determined for both regions of the fitting.

Inside edge of slot:

$$A_{b\_slot} = D \cdot t$$

Where D is the pin diameter and t is the thickness of the fitting.

$$S_{b\_slot} = \frac{F_H}{A_{b\_slot}}$$

The bearing stress is evaluated per the requirements of ASME BTH-1, Equation 3-38, which provides an allowable bearing stress equal to 1.5 * S_y / (Design Factor). Solving in terms of the design factor gives:

$$DF_{slot} = \frac{1.5 \cdot S_Y}{S_{b\_slot}} > 3$$

Upper inside surface of fitting:

$$A_{b\_upper} = w \cdot h$$

$$S_{b\_upper} = \frac{F_V}{A_{b\_upper}}$$

The design factor is calculated the same as above for the slot:

$$DF_{upper} = \frac{1.5 \cdot S_Y}{S_{b\_upper}} > 3$$

Bottom Fitting to Corner Post / Side Rail Weld Stresses

See discussion in Section 2.1.1, under "Top Fitting to Corner Post / Side Rail Weld Stresses."

Base Metal at Bottom Fitting to Corner Post / Side Rail Weld

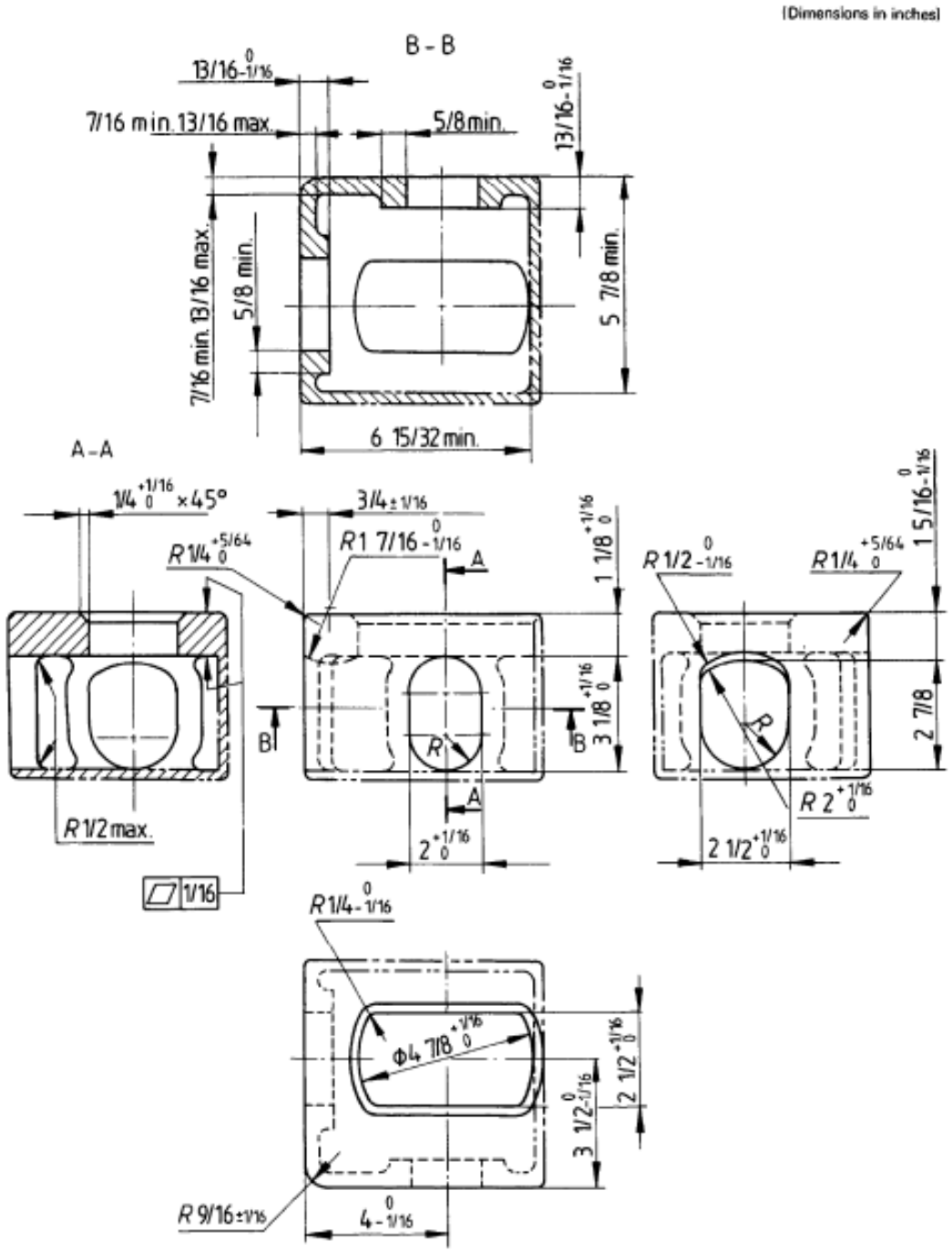
See discussion in Section 2.1.1, under "Base Metal at Top Fitting to Corner Post / Side Rail Weld."

Failure Mode Under Excessive Load Application

If an excessive load were applied to the lifting attachments during a lift using the bottom corner fittings, the failure mode is indeterminate. It is shown through calculations that the bottom corner fittings and their attachment welds are robust and can withstand lift loads with significant margin. If significant overload occurred, some deformation of the fitting wall would occur, and possible disengagement of the rotary lift device from the fitting could result. In addition, buckling of the container frame is expected at significant overload conditions. Analysis to determine the magnitude of load required for these failure modes is beyond the scope of this document.

References:

1. ISO 1161, Series 1 Freight Containers – Corner Fittings – Specification, 1984
2. “Design of Below-the-Hook Lifting Devices”, ASME BTH-1-2005
3. Tandemloc catalog, Replacement Rotary Lug, Final Assembly (416000B-LTZ). http://www.tandemlock.com



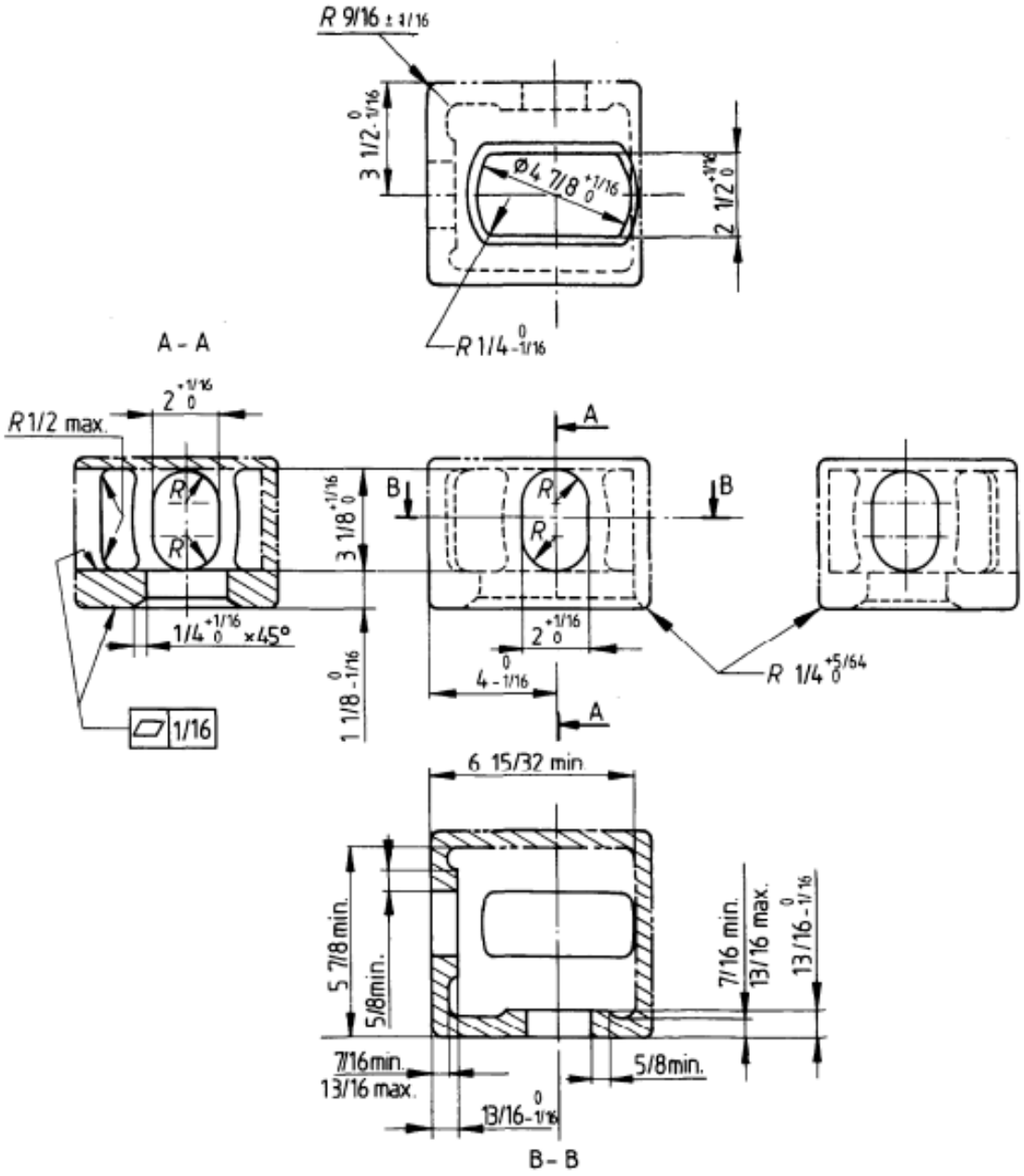
NOTES

1 Solid and broken lines (— and ---) show surfaces and contours which shall be physically duplicated in the fitting.

2 Phantom lines (— · — · —) show optional walls, which may be used to develop a box-shaped fitting.

Figure F-2. Top Corner Fitting (From ISO 1161)

[Dimensions in inches]



NOTES

1 Solid and broken lines (— and ---) show surfaces and contours which shall be physically duplicated in the fitting.

2 Phantom lines (— · — · —) show optional walls, which may be used to develop a box-shaped fitting.

Figure F-3. Bottom Corner Fitting (From ISO 1161)

Annex B

Typical examples of twistlock lifting devices

(For information purposes only)

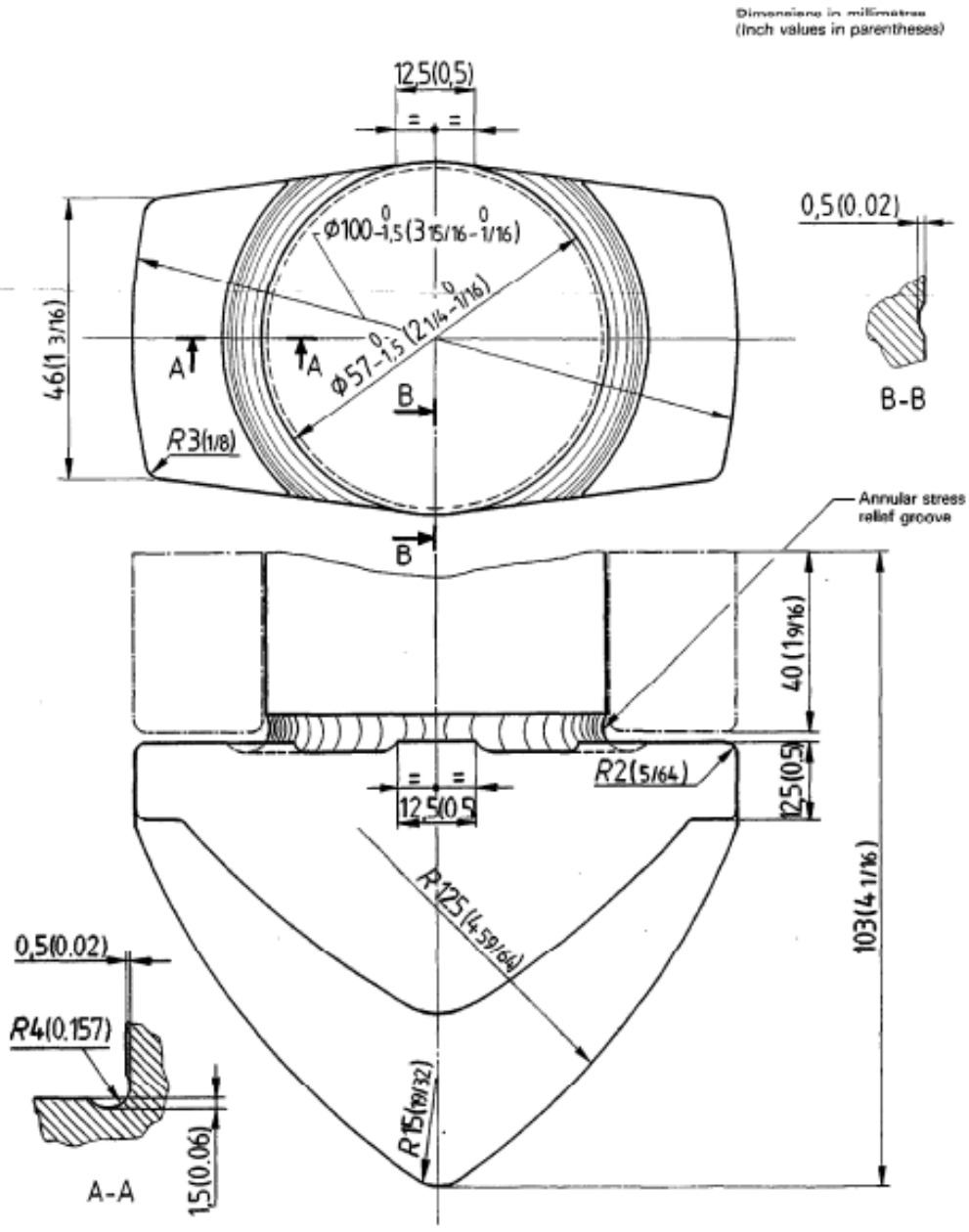


Figure F-4. Twistlock Lifting Device (From ISO 1161)