
Engineering Drawings for 10 CFR Part 71 Package Approvals

**Prepared by
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**Prepared for
U.S. Nuclear Regulatory Commission**

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ABSTRACT

This report provides information for preparing drawings of transportation packages submitted in an application for approval under 10 CFR Part 71. It discusses the purpose of these drawings and describes the recommended format and technical content appropriate for package applications. Examples of frequently used drawing symbols are also provided.

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ACRONYMS

| | |
|------|--|
| ANSI | American National Standards Institute |
| ASME | American Society of Mechanical Engineers |
| ASTM | American Society for Testing and Materials |
| AWS | American Welding Society |
| CFR | Code of Federal Regulations |
| MIL | Military |
| NRC | U.S. Nuclear Regulatory Commission |
| RG | Regulatory Guide |

1. INTRODUCTION

1.1 Background

Packages for transporting radioactive material are designed and constructed to meet the requirements of Title 10, Code of Federal Regulations, Part 71 (10 CFR Part 71).¹ As specified by this regulation, applications for package approval submitted to the U.S. Nuclear Regulatory Commission (NRC) must include a package description and an evaluation that demonstrates compliance with these regulatory requirements.

Regulatory Guide 7.9 (RG 7.9)^{2, 3} provides guidance on the format and content of the application. Chapter 1 of RG 7.9 specifies that drawings be included in the application as part of the package description. This report supplements that guidance and should not be considered a substitute for either 10 CFR Part 71 or RG 7.9.

1.2 Scope

This report provides information for preparing drawings submitted in an application for package approval under 10 CFR Part 71. Section 2 describes the purpose of the drawings and a recommended format. Section 3 discusses the technical content appropriate for drawings in package applications. The appendix illustrates frequently used drawing symbols.

2. PURPOSE AND FORMAT OF DRAWINGS

2.1 Purpose of Drawings

The primary purpose of drawings submitted in an application for package approval under 10 CFR Part 71 is to define the package design. As specified by 10 CFR 71.33, an application must include a description of the proposed package in sufficient detail to identify the package accurately and to provide an adequate basis for its evaluation. Drawings submitted in the application constitute an essential part of that description. Upon approval by the NRC, the package design defined by these drawings is generally specified as a condition of approval in the certificate of compliance.

10 CFR 71.3 requires that transport of radioactive material be authorized by a general license or a specific license issued by the NRC. The general license of 10 CFR 71.12, which authorizes transport of radioactive materials in a package approved by the NRC, requires that licensees have a copy of the certificate of compliance and comply with other provisions of the general license, including drawings and additional documents referenced in the approval of the package. Packages that do not conform to the approved drawings are not authorized for use since they do not meet the conditions of approval in the certificate of compliance. Only packagings that conform to the drawings may be marked with the package identification number, as required by 10 CFR 71.85(c).

2.2 Drawing Format

Drawings should be included in the appendix to Chapter 1 (General Information) of the application. A table of contents to the appendix should identify the drawing and sheet number, revision, and title of all drawings submitted.

Each drawing should include a title block that identifies the preparing organization, drawing number, sheet number, title, date, and signature or initials indicating approval of the drawing. Revised drawings should identify the revision number, date, and a description of the change in each revision. The signature or initials of the individual approving the revision should also be included.

Drawings should be legible and should conform to the page size, quality of paper and inks, and other physical specifications recommended by RG 7.9. The preferred page size is 8-1/2 x 11 inches, and the maximum size should be 11 x 17 inches. Drawings should be printed on one side only.

All symbols and other notation should be in accordance with established standards or otherwise defined on the drawings. The *Drawing Requirements Manual*⁴ describes common drawing practices and provides an extensive listing of standards endorsed by various government and professional organizations, including ASME Y14.5M⁵ and ANSI/AWS 2.4.⁶

4. References

In addition, drawing practices are usually prescribed by quality assurance or other procedures of the preparing organization. The appendix to this report illustrates symbols frequently used on package drawings.

Drawings submitted under the provisions of 10 CFR 2.790⁷ should be marked as proprietary, and the proprietary information should be clearly identified.

3. TECHNICAL CONTENT OF DRAWINGS

3.1 General Guidance

Because of the large number of different package types and the numerous variations in design features, no document can completely address every detail that should be included on the drawings. Based on the purpose of the drawings discussed in Section 2.1, the following general guidance should be considered for each proposed package design:

- The drawings should specify those details of the package design which affect its evaluation under 10 CFR Part 71.
- Conformance of the package to the design specified by the drawings will be a condition of approval for use of the package.

The technical content appropriate for drawings submitted in a package application may differ substantially from that of other drawings routinely prepared for design and fabrication. Application drawings should be more detailed than package schematics illustrated in the main body of the application. Detailed fabrication (shop) drawings, however, may provide excessive detail that is not appropriate as a condition of approval.

Drawings submitted in an application should consist of a general arrangement drawing, with additional drawings of detailed design features, as necessary. Notes, material parts lists, specifications, and codes or standards for fabrication should also be included as part of the drawings, as discussed in the following sections of this report.

3.2 General Arrangement of Packaging and Contents

The general arrangement drawing should depict the package configuration as presented for shipment in both side and plan views. Alternate configurations, if applicable, should also be shown. The general arrangement drawing should include:

- Packaging and content dimensions
- Design features which affect the package evaluation
- Packaging markings
- Maximum allowable weight of package
- Maximum allowable weight of contents and secondary packaging.

The dimensions shown on the general arrangement drawing should specify the overall size of the packaging and the location and configuration of the contents. All dimensions indicated on drawings should include tolerances that are consistent with the package evaluation. Tolerances may be addressed by a drawing note that defines a general tolerance applicable to many features. If a design feature needs a more (or less) restrictive tolerance than indicated by the note, the appropriate tolerance should be specified explicitly in the dimensioning of that feature. In the discussion below, the term *dimension* should always be considered to mean dimension with appropriate tolerance.

Guidance on specifying design features is discussed in Section 3.3. To the extent practical, this information should be shown on the general arrangement drawing. Other design features, or additional detail for these features, may be included on separate drawings or sheets, which should be referenced as appropriate in the general arrangement drawing. Drawings should include all design features affecting the package evaluation.

The general arrangement drawing should show the location and size of durable markings applied to the packaging after verification that it has been fabricated in accordance with the approved design. As specified by 10 CFR 71.85(c), these markings

must include the package model number, serial number, gross weight, and package identification number. Additional marking and labeling requirements are specified in 49 CFR Part 172,⁸ Subparts D and E.

The maximum allowable weights of the package and contents should be indicated on the general arrangement drawing. The maximum weight of the package should include the packaging and its contents. The maximum weight of the contents should include the radioactive contents, secondary containers, wrapping, shoring, and any other material transported in the package that is not defined as part of the packaging. All weights should be consistent with those used in the evaluation.

3.3 Package Design Features

The drawings should specify design features in sufficient detail to assure that a package which conforms to the drawing specifications will be consistent with the design evaluated in the application. To the extent practical, design features should be depicted on the general arrangement drawing, with additional drawings or sheets provided as necessary. Design features affecting the package evaluation include:

- Containment systems
- Closure devices
- Internal supporting or positioning structures
- Neutron absorbing and moderating features affecting criticality
- Neutron shielding
- Gamma shielding
- Outer shell or outer packaging
- Heat-transfer features
- Impact limiters/Energy-absorbing features
- Lifting and tie-down devices
- Personnel barriers
- Other design features.

General specifications that should be included on drawings are described in Section 3.3.1. More detailed guidance for each of the above design features is presented in Sections 3.3.2 to 3.3.13.

3.3.1 General Specifications

The following information for each design feature should be shown on the drawings, as appropriate:

- Identification of the design feature and its components
- Materials of construction, including appropriate material specifications
- Codes, standards, or other similar specification documents for fabrication, examination, assembly, and testing
- Location with respect to other package features
- Dimensions (with appropriate tolerances)
- Operational specifications.

Drawings should specify the name, materials of construction, and quantity required for each design feature, component, or part, as applicable. This information may be provided by a parts list or other appropriate designation. Materials of construction should include a code or standard (e.g., ASME, ASTM, MIL), commercial equivalent, or other appropriate specification for the material. If this designation does not sufficiently define all material properties affecting the package evaluation, additional specifications should be provided by a drawing note or similar means. Examples in which additional specifications may be necessary are described in Sections 3.3.5 and 3.3.6 for neutron absorbing and moderating materials.

The drawings should indicate codes, standards, or other similar specification documents for fabrication, examination, assembly, and testing (e.g., ANSI, ASME, MIL, AWS). These specifications should be consistent with those used for the package design and may be included in drawing notes, as appropriate. Special requirements (e.g., surface finishes), should also be depicted, if applicable. Welding specifications should include location, type of weld, dimensions,

4. References

face and root contour, process specifications, examination method, and other applicable information consistent with the package evaluation. Welding details should be depicted by an appropriate welding symbol, with additional information included in drawing notes, as necessary. Further guidance on fabrication and welding criteria is provided in NUREG/CR-3854⁹ and NUREG/CR-3019,¹⁰ respectively. Examples of welding symbols are shown in the appendix.

Design features should include dimensions of components and dimensions that identify their location relative to other package features. Dimensions should be consistent with those in the parts list and those used in the package evaluation. As discussed above, dimensions should include appropriate tolerances.

Operational specifications such as bolt torque, pressure-relief settings, or similar information should also be shown on the drawings, as applicable.

3.3.2 Containment Systems

The drawings should depict the complete boundary of the containment system. This may include the containment vessel, welds, drain or fill ports, vent ports, test ports, valves, seals, lids, cover plates, and other closure devices. If multiple seals are used for a single closure, the seal defined as the containment-system seal should be clearly identified. The drawings should include, as appropriate:

- Location of components
- Materials of construction, overall dimensions, wall thickness, and dimensions of the transition from the vessel shell to the closure device
- Welds and weld specifications
- Location and dimensions of penetrations
- Requirements for straightness, roundness, flatness, or surface finish, as applicable
- Closure devices, as discussed in Section 3.3.3.

3.3.3 Closure Devices

The drawings should show all closure devices for the containment system, outer packaging, and other closed volumes (e.g., expansion tanks). Closure devices may include flanges, seals, cover plates, lids, bolts, closure rings, welds, valves, and pressure-relief devices. The drawings should include, as appropriate:

- Location of components
- Dimensions and materials of construction of flanges, seals, lids, cover plates, and closure rings
- Containment seal specifications
- Dimensions of seal grooves
- Surface-finish specifications for flanges and grooves
- Welds and weld specifications
- Number, size, materials of construction, and thread specifications for bolts or other fastening devices
- Closure bolt torques
- Specifications for valves and pressure-relief devices
- Dimensions of gaps or clearances to reduce or eliminate differential thermal expansion or mechanical loading on other components
- Requirements for straightness, roundness, flatness, or surface finish
- Lifting devices of the closure component, as discussed in Section 3.3.11
- Tamper-indicating device.

3.3.4 Internal Supporting and Positioning Structures

The drawings should show the design features that support or position the contents. These structures may be fastened to other packaging components or to the contents. Internal structures may include strongbacks, shock absorbers, baskets, gamma shields, spacers, shims, pellet trays, foam, insulation, or similar features. The outer shell of

the packaging and impact limiters are discussed separately in Sections 3.3.8 and 3.3.10, respectively. The drawings should include, as appropriate:

- Location, dimensions, and materials of construction
- Density of foam, insulation, or similar materials
- Dimensions of gaps or clearances to reduce or eliminate loading on other components
- Method of attachment to contents or other packaging components
- Welds and weld specifications
- Form of shims and spacers (e.g., wooden blocks, metal sheets, rubber pads).

3.3.5 Neutron Absorbing and Moderating Features Affecting Criticality

The drawings should identify neutron absorbing and moderating features that affect the criticality evaluation of the package. The drawings should include, as appropriate:

- Location, dimensions, materials of construction, and chemical composition of neutron absorbers and moderators
- Minimum density of neutron absorbing materials and moderators
- Minimum isotopic composition of neutron absorbing materials (e.g., wt% ^{10}B)
- Maximum quantity and density of moderating materials affecting criticality, gas generation, or other package evaluation (e.g., plastic bags, moisture content, and spacers)
- Method of attachment to contents or structural components
- Location and dimensions of voids or other floodable volumes (including those in which preferential flooding is possible) that could affect neutron absorption or moderation
- Expansion voids, piping, valves, seals, and associated mounting details for expansion-tank

systems that provide neutron absorption or moderation.

3.3.6 Neutron Shielding

Although some design features important for shielding are similar to those for criticality, several important differences exist. The drawings should show, as appropriate:

- Location, dimensions, materials of construction, and chemical composition of neutron absorbers and moderators (e.g., NS4-FR, polyethylene, water)
- Physical form (solid or liquid)
- Minimum density of neutron absorbing and moderating nuclides (e.g., B and H)
- Minimum isotopic composition of neutron absorbing materials (e.g., wt% ^{10}B)
- Details of penetrations through the shield (e.g., heat transfer fins, trunnions)
- Applicable gaps, voids, clearances, joining methods, or other details affecting streaming paths
- Special treatments to liquid shields (e.g., addition of antifreeze)
- Special features (e.g., expansion tanks, pressure relief valves).

3.3.7 Gamma Shielding

The drawings should include design features that are used to reduce the external gamma radiation. These may include lead or depleted uranium, as well as other components that also provide structural support or thermal protection. The drawings should include, as appropriate:

- Location, dimensions, materials of construction, and maximum weight
- Details of penetrations through the shield
- Applicable gaps, voids, clearances, joining methods, or other details affecting streaming paths
- Method of attachment to other packaging structural components.

4. References

3.3.8 Outer Shell or Outer Packaging

The drawings should include, as appropriate:

- Location, dimensions, and materials of construction
- Specifications for drum chimes and rolling hoops
- Welds and weld specifications
- Location and dimensions of penetrations
- Closure devices, as discussed in Section 3.3.3, including features to prevent water leakage under normal conditions of transport
- Heat transfer features, as discussed in Section 3.3.9
- Method of impact-limiter attachment, as discussed in Section 3.3.10
- Lifting and tie-down devices, as discussed in Section 3.3.11
- Applicable surface-finish specifications
- Coatings or paints (may be designated as optional if they serve no safety function).

3.3.9 Heat-Transfer Features

The drawings should depict all features that affect the transfer of heat within the package and between the package and the environment. These may include gaps and surface contacts, fill-gas, thermal shields, fins, surface finishes, as well as components described in other design features. The drawings should include, as appropriate:

- Dimensions, location, and other appropriate specifications for gaps and surface contacts between packaging components or between packaging components and the contents
- Fill-gas material and pressure specifications
- Location, dimensions, and materials of construction of fins or similar features, and their method of attachment
- Location, dimensions, and materials of construction of thermal shields, and their method of attachment

- Surface-finish specifications.

3.3.10 Impact Limiters/Energy-Absorbing Features

The drawings should include, as appropriate:

- Location, dimensions, and materials of construction, including outer and inner shells, energy absorbing materials, and other components
- Method of attachment, including location, number, size, materials of construction and specifications for bolts and lugs, or similar devices.

3.3.11 Lifting and Tie-Down Devices

Lifting and tie-down devices may include trunnions, lugs, threaded sockets, eyebolts, skids, and similar devices. The drawings should include, as appropriate:

- Location, dimensions, materials of construction, and interface with other packaging components
- Interface specifications with lifting device or vehicle, as evaluated in the application.

3.3.12 Personnel Barriers

Personnel barriers can be used to meet the external radiation limits of 10 CFR 71.47(a) or (b), or the temperature limits of 10 CFR 71.43(g). The drawings should indicate, as appropriate:

- Location, dimensions, and materials of construction
- Method of attachment to packaging.

3.3.13 Other Design Features

The drawings should show any other design features relevant to the package evaluation. Features that are not important to package performance may be illustrated for information. The drawings should clearly identify optional features or arrangements.

4. REFERENCES

1. U.S. Code of Federal Regulations, “Packaging and Transportation of Radioactive Materials,” Part 71, Title 10, “Energy.”
2. U.S. Nuclear Regulatory Commission, “Standard Format and Content of Part 71 Applications for Approval of Packaging for Radioactive Material,” Task FC 416-4, Proposed Revision 2 to Regulatory Guide 7.9.
3. U.S. Nuclear Regulatory Commission, “Standard Format and Content of Part 71 Applications for Approval of Packaging of Type B, Large Quantity, and Fissile Radioactive Material,” Regulatory Guide 7.9.
4. J. J. Liebllich and G. Whitmire, *Drawing Requirements Manual*, Ninth Edition, Global Engineering Documents, Englewood, Colorado, 1995.
5. American Society of Mechanical Engineers, ASME Y14.5M-1994, “Dimensioning and Tolerancing,” New York.
6. American National Standards Institute/American Welding Society, ANSI/AWS 2.4-1997, “Symbols for Welding, Brazing, and Nondestructive Examination,” AWS, Miami, Florida.
7. U.S. Code of Federal Regulations, “Rules of Practice for Domestic Licensing Proceedings and Issuance of Orders,” Part 2, Title 10, “Energy.”
8. U.S. Code of Federal Regulations, “Hazardous Materials Table, Special Provisions, Hazardous Material Communications, Emergency Response Information, and Training Requirements,” Part 172, Title 49, “Transportation.”
9. U.S. Nuclear Regulatory Commission, “Fabrication Criteria for Shipping Containers,” NUREG/CR-3854, March 1985.
10. U.S. Nuclear Regulatory Commission, “Recommended Welding Criteria for Use in the Fabrication of Shipping Containers for Radioactive Materials,” NUREG/CR-3019, March 1984.

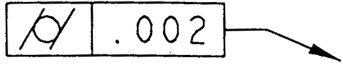
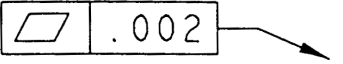
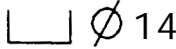
4. References

APPENDIX: EXAMPLES OF FREQUENTLY USED DRAWING SYMBOLS

This appendix illustrates examples of drawing symbols frequently used in engineering drawings for package approval under 10 CFR Part 71. These symbols are shown only as examples and should not be construed as a complete list of symbols that may be needed for package drawings.

Units designated on the symbols should be consistent with those used in the drawing, as explained in a drawing note or other appropriate manner on the drawings.

Feature Control Symbols

| | |
|---|--|
|  | Cylindricity of a surface. All points on the surface are equidistant from the axis within the specified tolerance. |
|  | Flatness of a surface. No more than the designated variation over the entire surface. |
| $\phi \pm .1$ | Diameter with designated tolerance |
| ID | Inner diameter |
| OD | Outer diameter |
| $R \pm .1$ | Radius with designated tolerance |
|  $\phi 14$ | Counterbore with designated diameter |
| $\nabla 20$ | Depth as indicated |

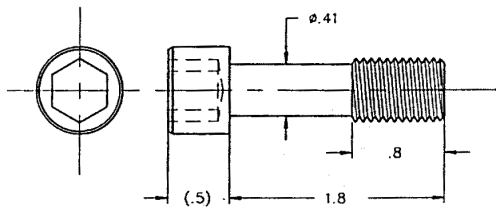
Welding and Nondestructive Evaluation Symbols

| | |
|-----------------------|--|
| | <p>Intermittent fillet weld arrow side. Weld size on left, length and pitch (center-to-center spacing) on right. Flag indicates weld performed in field. Older drawings may show field weld by solid circle on reference line, rather than flag.</p> |
| | <p>Square groove weld. Weld size on left. Minimum penetration (0.12) cannot be greater than thickness of part.</p> |
| | <p>V groove weld. Preparation angle designated. Full penetration.</p> |
| | <p>Arc seam weld. Weld size on left.</p> |
| | <p>Complete penetration of weld required</p> |
| | <p>Flush contour of weld face and finishing method (G = grind)</p> |
| | <p>Weld all around part, both sides</p> |
| | <p>Staggered fillet weld</p> |
| <p>PT, RT, UT, VT</p> | <p>Type of weld examination: penetrant, radiographic, ultrasonic, visual</p> |

Types of Lines

| | |
|--|--------------------------------|
| | Center line |
| | Dimension and extension line |
| | Break (long) |
| | Symmetry line |
| | Hidden |
| | Cutting plane or viewing plane |

Bolt Symbols and Designations



Fabricated hexagonal head bolt with controlled length, diameter, and thread runout. Head is reference dimension (see Miscellaneous Symbols and Abbreviations).

.25-13 UNC-2A x 1 3/4

Unified inch-series threads. Nominal bolt diameter (1/4 inch), threads per inch (13), unified course pitch (UNC) thread series, thread class (2A), overall length 1 3/4 inch.

M 48x5-6g x 40

Metric series threads. Nominal bolt diameter (48 mm), thread pitch (5 mm), thread class (6g), overall length 40 mm.

Miscellaneous Symbols and Abbreviations

| | |
|--------|-----------------|
| APPROX | Approximate(ly) |
| DIA | Diameter |
| MAX | Maximum |

Appendix: Examples of Frequently Used Drawing Symbols

| | |
|------------|---|
| MIN | Minimum |
| NOM | Nominal |
| REF or () | Reference. A dimension that is an accumulation of other dimensions. Reference callouts state either the mean or nominal dimension; the tolerance may be stated when necessary. A reference dimension is not used for manufacturing or inspection purposes. May also be used for a dimension that is specified elsewhere in the drawing. Reference dimensions may also be indicated by enclosing the dimension value in parentheses. |
| TYP | Typical. Designation applies to other identical features. Should be avoided. Use number of places instead (see below). |
| 8X | Number of places (8) for identical features. |

