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Performance-Oriented Packaging: A Guide to Identifying and Designing

Identifying and Designing Hazardous
Materials Packaging for Compliance with
Post HM-181 DOT Regulations

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LIST OF TERMS

CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EPA	U.S. Environmental Protection Agency
FDC	Functional Design Criteria
HMIX	Hazardous Materials Information Exchange
HMR	Hazardous Materials Regulations
HMT	Hazardous Materials Table
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
IMDG	International Maritime Dangerous Goods Code
IMO	International Maritime Organization
OHMT	Office of Hazardous Materials Transportation
PG	Packing Group
POP	Performance-Oriented Packagings
RQ	Regulated Quantity
RSPA	Research and Special Programs Administration
UN	United Nations

**Performance-Oriented Packaging:
A Guide to Identifying and Designing
Identifying and Designing Hazardous Materials Packaging
for Compliance with Post HM-181 DOT Regulations**

1.0 INTRODUCTION

With the initial publication of Docket HM-181 (hereafter referred to as HM-181), the U.S. Department of Energy (DOE), Headquarters, Transportation Management Division decided to produce guidance to help the DOE community transition to performance-oriented packagings (POP). As only a few individuals were familiar with the new requirements, elementary guidance was desirable. The decision was to prepare the guidance at a level easily understood by a novice to regulatory requirements.

This document identifies design development strategies for use in obtaining performance-oriented packagings that are not readily available commercially. These design development strategies will be part of the methodologies for compliance with post HM-181 U.S. Department of Transportation (DOT) packaging regulations. This information was prepared for use by the DOE and its contractors. The document provides guidance for making decisions associated with designing performance-oriented packaging, and not for identifying specific material or fabrication design details. It does provide some specific design considerations. Having a copy of the regulations handy when reading this document is recommended to permit a fuller understanding of the requirements impacting the design effort. While this document is not written for the packaging specialist, it does contain guidance important to those not familiar with the new POP requirements.

1.1 BACKGROUND

The HM-181 final rule, December 21, 1990, comprehensively revised the Hazardous Materials Regulations (HMR) Title 49 *Code of Federal Regulations* (CFR), Parts 171-180, with respect to hazard communication, classification and packaging requirements. The changes were based on the United Nations (UN) *Recommendations on the Transport of Dangerous Goods* (hereafter referred to as UN Recommendations) and the DOT, Research and Special Programs Administration's (RSPA) own initiative.

The intended effect of the final rule was to enable the following:

- Simplify and reduce the volume of the HMR
- Enhance safety through better classification and packaging
- Promote flexibility and technological innovation in packaging
- Reduce the need for exemptions from the HMR
- Facilitate international commerce.

These changes were made because the existing HMR was at that time thought to be:

- Difficult to use because of their length and complexity
- Relatively inflexible and outdated with regard to non-bulk packaging technology
- Deficient in terms of safety with regard to the classification and packaging of certain categories of hazardous materials
- Generally not in alignment with international regulations based on the UN Recommendations.

The final rule, "Performance-Oriented Packaging; Revisions and Response to Petitions for Reconsideration," was published December 20, 1991. HM-181 and its related rulemaking represent the culmination of RSPA's efforts since 1968 to better the HMR and align them with an internationally-based performance standards system. The importance of this rulemaking initiative has been recognized in the DOT's National Transportation Policy, which states that it is federal transportation policy to do the following:

1. Adopt hazardous materials packaging standards, based on performance criteria rather than detailed design specifications, to accommodate technical innovation
2. Implement federal hazardous materials standards for movements by the various modes that are, to the maximum extent, consistent with safety and compatible with international standards in facilitating foreign trade and maintaining the competitiveness of United States goods.

In contrast to the old DOT system of detailed specifications for packaging construction, HM-181 is a system of performance-oriented packaging standards developed in the form of UN Recommendations (DOT 1991). These standards address the same types of non-bulk containers (e.g., drums, barrels, boxes, bags, and carboys) and inside containers or receptacles as the old DOT specification packaging system. Typically, performance-oriented packaging standards have general requirements for materials and construction, a maximum capacity, and specific performance standards.

For example, the UN 1A1 steel drum must have the following: (1) welded seams, if it is to carry liquids; (2) welded or mechanically seamed chimes; (3) a maximum opening of 7 cm (2.75 in.); and (4) a maximum capacity of 450 L (118.9 gal). There are additional requirements for rolling hoops if the drum capacity is greater than 60 L (15.8 gal). Aside from these general construction requirements, the strength and integrity of the drum are established by a series of performance tests, which the drum must pass before it is authorized

(as indicated by marks on the drum) to carry hazardous materials; hence, the term "performance-oriented packaging standards." For drums, the principal tests are the drop test, hydraulic and leakage (leakproofness) tests, and stacking tests. The height specified for the drop test, and the pressure in the hydraulic and leakage tests in the UN system, are determined by the Packing Group (PG) of the hazardous material to be transported.

Within most hazard classes, the UN system segregates hazardous materials into three distinct PGs based on the relative danger of the materials. PG I consists of highly dangerous materials. PG II consists of dangerous materials. PG III consists of slightly dangerous materials. The UN 1A1 steel drum would have to survive a drop test of 1.8 m (5.91 ft) if it were to carry a material in PG I, 1.2 m (3.94 ft) for PG II materials, and 0.8 m (2.62 ft) for PG III materials. This assumes the specific gravity of the materials does not exceed 1.2. For denser materials, the drop height or density of the test material would be correspondingly increased.

The UN Recommendations are not regulations and, in general, do not assign packagings to individual hazardous materials. The UN system envisions that requirements (i.e., regulations) issued by national and international bodies would address the definitive requirements, tying a particular packaging or packaging system to an individual hazardous material.

At present, there are two international (i.e., worldwide) modal hazardous material regulatory systems in place; one under the auspices of the International Maritime Organization (IMO) and the second under the International Civil Aviation Organization (ICAO). The IMO system is known as the International Maritime Dangerous Goods Code (IMDG) and the ICAO system is known as the ICAO Technical Instructions for the Safe Transport of Dangerous Goods by Air. Shipments of hazardous materials (both international and domestic) are at the present time authorized (with certain exceptions) to be shipped under the ICAO system as fully equivalent to the HMR provided the trip involves transportation by aircraft and incidental motor vehicles.

1.2 STATUS

The HM-181 final rule effected a comprehensive revision of the HMR based on the UN Recommendations. To provide an orderly transition to the new requirements and to minimize any burdens associated with them, the DOT provided a transition period for compliance. During this transition period, persons may elect to comply with either the applicable old requirements of the HMR in effect on September 30, 1991; or the new requirements of the HM-181 HMR appearing in the December 21, 1990 rule, and the rule, which modified original transition periods, published in the Federal Register on September 18, 1991, and effective October 1, 1991.

The following are a list of transition dates that effect the packaging of hazardous materials:

1. On October 1, 1993--packaging requirements for all materials meeting the criteria for poisonous by inhalation are effective.
2. On October 1, 1994--package manufacturing and marking requirements, under the provisions of Subpart B of 173, and Parts 178 and 179 of the HMR, are effective. DOT specification packagings removed from Part 178 of the HMR by the December 21, 1990, rule may no longer be manufactured.
3. On October 1, 1996--requirements in Parts 172 and 173 of the HMR for maintenance and use of packagings that were not previously in effect are effective. (DOT specification packagings removed from Part 178 of the HMR by the December 21, 1990 final rule and packaging authorizations removed from Part 173 of the HMR by the December 21, 1990 final rule may no longer be used in place of new packaging requirements.)
4. October 1, 2001--Packages filled prior to October 1, 1991 may be offered for transportation and shipped before this date if it meets the following criteria:
 - a. Conforms to the old requirements of the HMR in effect on September 30, 1991
 - b. Is filled with hazardous materials before October 1, 1991
 - c. Is marked "Inhalation Hazard," if appropriate, in accordance with 172.313 of the HMR or Special Provision 13, as assigned in the 172.101 Table
 - d. Is not emptied and refilled on or after October 1, 1991.

The October 1, 1994 has the most impact, because after that date no DOT specification packagings removed from Part 178 of the HMR by the December 21, 1990, can be manufactured. This transition date gives shippers two alternatives, either have performance-oriented packaging designed, manufactured, and inventoried, or be prepared to procure large inventories of specification packaging to fulfill their packaging needs through October 1, 1996. The later alternative seems impractical because of cost, storage requirements, and inventory control. Therefore, for all intents and purposes, DOE and its contractors must have the bulk of their performance-oriented packaging in place before October 1, 1994.

1.3 IDENTIFICATION OF RESOURCES

This section identifies resources made available by the DOE, DOT, and International Air Transport Association (IATA). The resources are intended to assist shippers in complying with post HM-181 DOT regulations.

1.3.1 U.S. Department of Energy

The DOE Headquarters Transportation Management Division EM-561 sponsored the following guidance documents the *Resource Guide - Performance-Oriented Packagings for Hazardous Materials*, the *Performance-Oriented Packaging - A Guide to Identifying, Procuring and Using, Procurement and Use of Packaging Using HM-181 Regulations* (procurement guide), and this design guide. The intent is to provide resources to assist shippers in complying with post HM-181 DOT regulations.

1.3.1.1 Resource Guide. The Resource Guide provides a directory of currently qualified packagings of a particular packing group and design specifications. If one of the packagings included in this guide appears to meet the shipper's needs, the shipper can then contact the manufacturer for further information regarding its use and procurement.

The initial distribution of the *Resource Guide - Performance-Oriented Packagings for Hazardous Materials* was made in September 1991 (DOE 1991). Distribution of revision 1 of the guide was made in April 1994. (DOE/RL 1994). This document was issued based on the best available data on UN-standard packagings. DOE plans to continue its development through revisions based on new information, experience, and regulatory policy. Recipients were asked to identify any suppliers of performance-oriented packagings that were not listed in the Resource Guide.

The Resource Guide provides supplier data for several hazardous material packagings, which the manufacturers certify as meeting the requirements of the HM-181. The guide also provides a general overview of the performance-oriented packaging regulatory requirements implemented by HM-181. This document is intended to assist DOE facilities in locating manufacturers of UN performance-oriented packagings for hazardous materials.

In its current form, the Resource Guide does not address all packaging situations or qualified packagings, but future revisions with support from DOE shippers will fill these voids. The DOT also has limited information on suppliers of HM-181 packagings (See Subsection 1.3.2.1). Figure 1-1 is a typical Packaging Data Sheet as presented in the Resource Guide.

1.3.1.2 Procurement Guide. The procurement guide provides direction to DOE contractors for the acquisition and use of DOT performance-oriented packaging. It is expected that the majority of shipments of hazardous materials may be made in commercially

available performance-oriented packagings. This guide assists the shipper in the procurement of performance-oriented packaging. The document addresses procurement of non-bulk packaging of nonradioactive, hazardous materials that are offered for transport by highway. The basic procedure is the same when making shipments by other modes. However, other sections of the regulations may affect the packaging requirements when shipping by other modes.

Distribution of the document, WHC-SP-0864, *Performance-Oriented Packaging - A Guide to Identifying, Procuring and Using, Procurement and Use of Packaging Using HM-181 Regulations*, was made in September 1992.

1.3.1.3 Design Guide. The design guide (i.e., this document) assists DOE shippers who must design and develop their own performance-oriented packagings. It provides recommendations based on experience with other types of performance-based packagings. Methodologies for complying with the regulations are presented. In addition, it discusses strategies for materials and tolerances of test unit packages and how to translate them into manufacturable production units. This document supplies strategies for ensuring compliance with the DOT POP design requirements. This document does not provide specific design, material, or fabrication details.

1.3.2 U.S. Department of Transportation

1.3.2.1 United Nations Packaging Manufacturers. The DOT provides manufacturers of non-bulk packagings an open "UN Manufacturers" database within the larger Hazardous Materials Information Exchange (HMIX) database. This provides users of hazardous materials packagings information on the types of packagings that are manufactured. Only packagings meeting the performance-oriented criteria in the UN Recommendations should be listed. This includes packagings adopted in the international modal regulations from IMDG and ICAO. The information on this system is maintained by manufacturers. In providing this list, DOT makes no claim on the validity of the information provided, including the validity of packaging certifications. Likewise, the DOT does not endorse any particular manufacturer or packaging.

This database lists 60 packaging types, each identified by a two digit number, cross-referenced to its identification code. A manufacturer is able to identify the type of packagings it offers by listing the codes. The manufacturer can further identify the volume or size limits of the packagings and state whether the packagings are intended for liquids or solids. This database has been open to UN packaging manufacturers since September 1991. Table 1-1 provides a list of packaging types that the manufacturer's data are based upon.

Figure 1-1. Sample Packaging Data Sheet.

2.6.9 1A2, 210 L (55 gal), Berenfield

PACKAGING DATA SHEET	
Packaging designation (UN)	Basic description
UN 1A2/Y103/S/* USA/+AP0006	18/16 gauge steel drum with removable head
Manufacturer and model	Manufacturer's identification (i.e., drawing)
Berenfield/*	*
Exterior shape/dimensions	Payload cavity shape/dimensions
Cylindrical--upright d = 57.15 cm (22 1/2 in.) h = 87.31 cm (34 3/8 in.)	Cylindrical/*
Weight limitations--gross/net	Payload cavity volume
103 kg (225 lb)/*	210 L (55 gal)
Supplier contacts	Remarks
Technical: Mr. Harry W. Wise Berenfield Containers PO Box 350 Mason, OH 45040 Phone: (513) 398-1300 Sales: Same as above	Contact supplier for assistance regarding questions on chemical compatibility.

Resource Guide POP
Rev. 1, September 1993

1.3.2.2 Access to Hazardous Materials Information Exchange. The following information was extracted from the *Hazardous Materials Information Exchange (HMIX): User's Guide* published by Federal Emergency Management Agency (commonly referred to as FEMA) and the DOT. The HMIX is a hazardous materials information clearinghouse and exchange system designed to provide federal, state, local, and private sector organizations sharing timely and valuable information about the prevention of, preparation for, and mitigation of hazardous materials emergencies. The HMIX serves as a central source of reliable information to prepare for potentially dangerous occurrences. It is not intended, however, to provide assistance during an actual emergency.

The HMIX is set up as a "bulletin board" to provide information quickly and easily. Current information of immediate interest (e.g., current rulemaking action) is posted on the main bulletin board. The rest of the bulletin board is divided into nine compartments, which HMIX calls conferences. Each conference contains information about a following specific topic:

1. Federal Training Courses
2. Public and Private-Sector Hazardous Materials Information
3. Calendar of Conferences
4. Instructional Material and Literature Listing
5. Toll-free (800) Numbers and On-Line Data Bases
6. Laws and Regulations
7. Contacts
8. DOT
9. Federal Emergency Management Agency - Limited Access.

The information on HMIX is available in two ways, by computer or by phone.

Table 1-1. Packaging Types. (2 sheets)

No.	ID code	Description	No.	ID code	Description
01	1A1	Steel drums, non-removable head	31	5H3	Water resistant
02	1A2	Steel drums, removable head	32	5H4	Plastic film bags
03	1B1	Aluminum drums, non-removable head	33	5M1	Paper bags, multiwall
04	1B2	Aluminum drums, removable head	34	5M2	Paper bags, multiwall, water resistant
05	3A1	Steel jerricans, non-removable head	35	6HA1	Composite packagings (i.e., plastic), plastic receptacle with outer steel drum
06	3A2	Steel jerricans, removable head	36	6HA2	Composite packagings (i.e., plastic), plastic receptacle with outer steel crate or box
07	1D	Plywood drums	37	6HB1	Composite packagings (i.e., plastic), plastic receptacle with outer aluminum drum
08	2C1	Wooden barrels, bung type	38	6HB2	Composite packagings (i.e., plastic), plastic receptacle with outer aluminum crate or box
09	2C2	Wooden barrels, removable head	39	6HC	Composite packagings (i.e., plastic), plastic receptacle with outer wooden box
10	1G	Fiber drums	40	6HD1	Composite packagings (i.e., plastic), plastic receptacle with outer plywood drum
11	1H1	Plastics drums, non-removable head	41	6HD2	Composite packagings (i.e., plastic), plastic receptacle with outer plywood box
12	1H2	Plastic drums, removable head	42	6HG1	Composite packagings (i.e., plastic), plastic receptacle with outer fiber drum
13	3H1	Plastic jerricans, non-removable head	43	6HG2	Composite packagings (i.e., plastic), plastic receptacle with outer fiberboard box
14	3H2	Plastic jerricans, removable head	44	6HH1	Composite packagings (i.e., plastic), plastic receptacle with outer plastics drum

Table 1-1. Packaging Types. (2 sheets)

No.	ID code	Description	No.	ID code	Description
15	4C1	Boxes of natural wood, ordinary	45	6HH2	Composite packagings (i.e., plastic), plastic receptacle with outer solid plastic box
16	4C2	Boxes of natural wood, with sift-proof walls	46	6PA1	Composite packaging (e.g., glass, porcelain, or stoneware), receptacle with outer steel drum
17	4D	Plywood boxes	47	6PA2	Composite packaging (e.g., glass, porcelain, or stoneware), receptacle with outer steel crate or box
18	4F	Reconstituted	48	6PB1	Composite packaging (e.g., glass, porcelain, or stoneware), receptacle with outer aluminum drum
19	4G	Fiberboard boxes	49	6PB2	Composite packaging (e.g., glass, porcelain, or stoneware), receptacle with outer aluminum crate or box
20	4H1	Plastic boxes, expanded plastic	50	6PC	Composite packaging (e.g., glass, porcelain, or stoneware), receptacle with outer wooden box
21	4H2	Plastic boxes, solid plastic	51	6PD1	Composite packaging (e.g., glass, porcelain, or stoneware), receptacle with outer plywood drum
22	4A1	Steel boxes	52	6PD2	Composite packaging (e.g., glass, porcelain, or stoneware), receptacle with outer wickerwork hamper
23	4A2	Steel boxes with inner liner or coating	53	6PG1	Composite packaging (e.g., glass, porcelain, or stoneware), receptacle with outer fiber drum
24	4B1	Aluminum boxes	54	6PG2	Composite packaging (e.g., glass, porcelain, or stoneware), receptacle with outer fiberboard box
25	4B2	Aluminum boxes with inner liner or coating	55	6PH1	Composite packaging (e.g., glass, porcelain, or stoneware), receptacle with outer expanded plastics packaging

Table 1-1. Packaging Types. (2 sheets)

No.	ID code	Description	No.	ID code	Description
26	5L1	Textile bags, without inner liner or coating	56	6PH2	Composite packaging (e.g., glass, porcelain, or stoneware), receptacle with outer solid plastics packaging
27	5L2	Textile bags, sift-proof	57	4A1V	Steel boxes meeting UN Recommendations ¹ Paragraph 9.7.1.7
28	5L3	Water resistant	58	4DV	Plywood boxes meeting UN Recommendations ¹ Paragraph 9.7.1.7
29	5H1	Woven plastics bags without inner liner or coating	59	4GV	Fiberboard boxes meeting UN Recommendations ¹ Paragraph 9.7.1.7
30	5H2	Woven plastics bags, sift-proof	60		Other packagings not falling under any of the above identification codes

¹ Recommendations on the Transport of Dangerous Goods, sixth edition, United Nations, New York, New York, 1989.

To access HMIX by computer you need a personal computer, any communications software package, and a modem capable of transmitting at 2400, 1200, or 300 baud. The modem should be set at no parity, 8 data bits, and 1 stop bit. Dial the access number, commercial or FTS (708) 972-3275 through your computer terminal. Once you have dialed into the system and registered with the System Operator by following the appropriate instructions, you may log onto the system with a password of your own choosing. Upon registration, you are eligible to access all bulletins and public conferences, as well as communicate with and other system user or System Operator. The HMIX is a menu-driven system.

This service is free, the caller pays only for long-distance phone charges. A user is allotted 60 minutes of access time per day, which can be used at one time or through a series of calls. The bulletin board is available 24 hours a day, 7 days a week.

To obtain a "User's Guide" HMIX database call the toll-free telephone number, outside of Illinois 1-800-PLANFOR, within Illinois 1-800-367-9592. Assistance is provided Monday through Friday from 8:30 a.m. to 4:30 p.m. (Central Time). Answer machines are active all other times, and your call will be returned. Additional, copies of the "User's Guide" can be obtained by calling one of the HMIX Coordinators at (202) 646-3525-FEMA or (202) 366-4900-DOT.

To access HMIX information by phone call the toll-free number, outside of Illinois 1-800-PLANFOR, within Illinois 1-800-367-9592. An information systems technician is available to provide assistance Monday through Friday from 8:30 a.m. to 4:30 p.m. (Central Time). Answer machines are active all other times, and your call will be returned. Additional copies of the "User's Guide" can be obtained by calling one of the HMIX Coordinators at (202) 646-3525-FEMA or (202) 366-4900-DOT.

1.3.3 International Air Transport Association

The IATA in an appendix to the *Dangerous Goods Regulations* provides a list of UN packaging manufacturers and suppliers of performance-oriented packaging. They also supply a list of facilities that conduct performance tests required by the IATA regulations. The lists are provided to assist the shipper in the procurement of a UN performance-oriented packaging and testing services. The lists are compiled from a number of sources and are not part of the regulations or an endorsement of the companies or facilities listed.

1.4 PURPOSE

This document provides guidance in identifying the need for and designing Performance-Oriented Packagings. The guidance is intended to provide directions to those needing a performance-oriented packaging that fills a need not satisfied by commercially available packaging.

1.5 SCOPE

This document identifies design development strategies for performance-oriented packaging that may be pursued by the DOE and its contractors to effect transition to new performance-oriented packaging standards established by post HM-181 DOT regulations. Bulk and radioactive material packagings are not part of this category and are not covered.

2.0 STRATEGIES

The following identifies various strategies for accomplishing the activities conducted when designing a packaging.

2.1 GENERAL

Regardless of the complexity of a packaging design and development task, all work can be carried out using the following five step process.

1. Recognition of need--identifies the existence of a technical need before any work is initiated. The need may be a symptom of a problem, the quest for new information or improvements, additional equipment development, application to other uses, or correction of an obvious failure.
2. Planning--identifies the objectives, scope, methods, sequence, requirements, procedures, interfaces, organizational responsibilities, budget, and schedule expected to complete a task.
3. Criteria development--specifies the characteristics that the solution to the problem must have. Criteria must be established before the start of solution development. Criteria for work must be documented. The documentation may take the form of a Functional Design Criteria (FDC) document or specification. The conditions or criteria with which a particular solution must comply shall be specified depending on complexity, safety, and impact level, as required by planning or guidance requirements. Essential criteria shall be separated from the criteria that are desirable but not absolutely required.
4. Solution development--resolves or implements the identified need using the established criteria. The planning documentation, when used, defines the steps to be followed. The solution development activity may take the solution through conceptual, detailed, and implementation design phases. The conceptual phase may include studies, preliminary analysis, conceptual design, specification development and value analysis. The detailed phase may include definitive design, final analysis, prototype testing, feature testing, drawings, reports, operation and maintenance manual development, and spare parts list generation. The implementation phase may include such tasks as final fabrication, procurement, installation, construction, and acceptance testing.

5. **Certification**--identifies appropriate authorization for the packaging design and development task as specified in the planning or guidance requirements. Certification of designs and tests shall occur as required in the specified procedures and in accordance with applicable DOE orders and Federal regulations.

These five steps outline a packaging design and development process, which is useful for the performance of all work. This process may consist of one iteration, several reiteration through various steps, or a complete iteration of the process within the process.

The following sections discuss various methods for accomplishing the five steps.

2.2 RECOGNITION OF NEED

The recognition of the need for a performance-oriented packaging can be the result of a planned activity or unplanned emergency. If you are in an emergency situation and are sure what is needed skip the rest of this section and proceed to the section on planing. If you are not in an emergency take your time and clearly identify what is needed.

The basic need for performance-oriented packaging is driven by the post HM-181 DOT HMR. The materials covered by the regulations are identified in the HMR table. A review of the table before reviewing the need for packaging may be needed. It is not unusual to find materials listed that do not have obvious hazards. Also, changes in the list were instituted in the post HM-181 HMR.

Remember to use care when the materials being shipped are described by a chemical-like name. It is often a challenge to know how to comply with the transport regulations, because there are many synonyms for most chemicals. If the material is described by a synonym that is not listed in the DOT Hazardous Material Table (HMT) (49 CFR 172.101), it is possible that it could be shipped as a nonhazardous material even though it actually is listed by DOT under some other name as a hazardous material.

For example, the following are listed as synonyms in a data base of hazardous substances:

- Azide
- Azium
- Azoture de sodium
- Hydrazoic acid, sodium salt
- Kazoe
- Natriumazid
- Nitriummazide
- Nemazyd

- Nci-co6462
- Nsc 3072
- Smite
- Sodium azide
- Sodium, azoture de
- Sodium di azoturo
- U-3886.

Only one of these names is listed in the hazardous materials table. "Sodium azide" is listed with Hazard Class 6.1, PG II, UN1687, and labeled poison. None of the other names even references sodium azide. A material described as "smite" would be shipped as a nonhazardous material unless the toxic nature of the material was recognized and it was shipped as "Poisonous solids, n.o.s." Hazard Class 6.1, and UN2811. Its toxic nature would have to be adequately known to assign it the correct PG.

Even if "smite" were shipped as a hazardous material, the emergency responders would have to use a synonym cross reference in their database to determine what precautions they needed to take in handling any emergency. Thus, the material description should include as many names and synonyms as are known so the material can be identified as precisely as possible.

Another example of synonyms involves freon. Freon¹, a commercial name for refrigerant gas, is not listed in the HMT. "Refrigerant gas, n.o.s." is listed as nonflammable gas with UN-1078. There are 16 different refrigerant gases listed in the HMT. Each is listed with a different UN number for identification by emergency responders. There is no way for an emergency responder to use a cross reference in data base to determine the precise material being shipped. This is one reason DOT requires the proper shipping name to be as specific as possible. Thus, the material "dichlorodifluoromethane" should be shipped with that as the Proper Shipping Name instead the more generic "Refrigerant gas, n.o.s." Correctly choosing the Proper Shipping Name is more likely if the material description includes as many names and synonyms as possible.

To determine if there is a basic need for packagings meeting the new requirements, make the following determinations:

- Are hazardous materials procured? If so, identify the packaging.
- Are procured hazardous material broken down into smaller quantities and reshipped? If so, identify the packaging.
- Are activities conducted that produce a hazardous material that is shipped? If so, identify the packaging.
- Are activities conducted that produce a hazardous waste material that is shipped? If so, identify the packaging.

¹A trademark of E. I. du Pont de Nemours and Company.

For each hazardous material packaging combination identified by the above review the applicable post HM-181 HMR and determine if the packaging meets the requirements. If any currently used packaging does not meet the requirements there is a potential need for a performance-oriented packaging. When a potential need is identified check with those conducting the operation to verify that the need is real.

In addition to basic packaging needs, needs can arise from a desire to improve the packaging, changes in equipment, or resolving problems.

The number of ways for identifying the need for performance-oriented packaging are numerous. They can vary from simple to complex. This section will discuss a few of them in that order. The size of the organization and the variety of hazardous materials to be moved strongly influence the choice of methods. Other factors influencing the choice is current level of knowledge about the materials to be moved, level of knowledge about the individual, current use of performance packaging, dispersal of operations, and available funding.

2.2.1 Simple Survey

For a small organization with an individual knowledgeable in hazardous materials transportation requirements a simple survey is suggested. The survey should accomplish the determinations identified in Section 2.2 above. The survey should include checking records and talking to the individuals involved. Remember to investigate what is done with the waste materials. While it is not required that a survey of this type be documented, it is recommended.

In addition to the basic survey, check records for problems involving hazardous materials packagings. Also talk to the individuals involved with their use. If problems are identified, determine whether a new packaging would help. Check to see if changes are planned that could result in the need for new packagings.

2.2.2 Formal Survey

For a large organization with one or more individuals knowledgeable in hazardous materials transportation requirements a more formal survey is suggested. The formal survey would involve the use of written questionnaires and possibly a written plan. When possible the questionnaires should be tailored to fit the organization receiving them, requesting only the information they are expected to have. When a single questionnaire is used, make it simple and easy to use. Be sure to set a due date and make the questionnaires easy to return. Design the survey to gather the information needed in make the determinations identified in Section 2.2 above. Follow up on questionnaires that are not returned or that contain responses that raise issues.

After the information is obtained, consolidate and organize the information into a form convenient for evaluation. Have the determinations identified in Section 2.2 above made by individuals knowledgeable in hazardous materials transportation requirements.

In addition to ensuring that the basic packaging requirements are met, surveys can be conducted to identify problems involving hazardous materials packagings or the need for new packagings arising from changes or desires for improvement.

2.2.3 Engineering Study (Needs Identification)

When problems involving hazardous materials packagings are anticipated or occurring, an engineering study may be needed. An engineering study will result in defining the problem or needs, identifying requirements, developing alternate solutions, evaluating and analyzing of alternative solutions, comparisons of the alternative solutions and recommendations of a course of action. The steps in the process are:

1. Prepare a clear definition of the problem.
2. Identify user and regulatory requirements and constraints. Separate requirements into musts and desired.
3. Identify assumptions.
4. Identify alternatives.
5. Identify interfaces requirements.
6. Collect and analyze the applicable data.
7. Review the alternatives and determine if changes are required.
8. Define the alternatives in enough detail to allow a comparison of alternatives.
9. Compare alternatives and select the preferred alternative.
10. Prepare documentation of the study, identifying the selected alternative and reason for selection.

2.2.4 Consultant (Needs Identification)

For organizations not having personnel knowledgeable in the transportation regulatory requirements available or who have a complex system, the use of a consultant to identify packaging needs provides the required impartial expertise fast. While the per hour cost may be high the overall cost is likely to be lower as there is a long learning curve associated with understanding and following the transportation regulations efficiently. Keep in mind however, that the consultant will need time to become familiar with the activities being conducted.

When contracting for a consultant clearly define the task to be conducted. Shop around and find several with experience in the areas you need assistance. Select the one that best suits the job. Before making a final selection, obtain recommendations from other organizations that have used consultants.

2.3 PLANNING

Having identified the need for a performance-oriented packaging, a method for obtaining one must be identified. Section 1.3 presents resources that provide guidance with sources and procurement of UN packagings. If a commercial packaging fitting the identified need can not be found, an alternative is to design and develop one.

While a design and development process should be planned, this document will not discuss planning methods. It is assumed that even the smallest organization needing a packaging will have experience in planning.

Planning like the recognition of need process is a function of the size of the organization. Other factors influencing the planing are the number of packagings required, complexity of the packaging, experience in designing and development of performance-oriented packaging, and available funding.

During planing, remember that there are specific requirements for activities and documentation that are required by the regulations. These requirements are going to make the process relatively expensive even for a simple package if only a few are required. For example, design qualification testing of a drum type packaging for solid materials would require a minimum of 12 packagings. The tested packagings are to be manufactured and prepared for testing using the same methods and procedures used in preparing the packages for shipment. Therefore, if you need two packages you will produce at least 14. For a combination packaging that is to be used for both liquids and solids the number required for testing will double. This doubling result from the DOT requirement that combination packagings to be tested for both forms.

Some of the activities conducted during a design and development effort of a performance-oriented packaging that require planning follow:

- Criteria development
 - Identification of FDC (user and regulatory requirements)
- Solution development
 - Preliminary design
 - Definitive design
 - Procurement/fabrication of packagings
- Certification
 - Test packagings
 - Certification
 - Complete packaging documentation
- Implementation of activity
 - Initiate packaging use.

Any or all of the identified activities can be conducted by the organization with the packaging need or contracted out as fits the organizations capabilities and available resources. If the organization has little or no experience in designing packagings for hazardous materials, contracting an experienced company to is recommend.

The uncertainty in the design development process calls for flexibility and reappraisal of the schedule as work progresses. This should be kept in mind during development of the original schedule. If funding or time is short careful planning is critical.

2.4 CRITERIA DEVELOPMENT

The packaging designer needs to know the requirements the packaging must meet before initiating the design effort. The functional requirements that result from the materials being shipped and the facilities, methods, and equipment that will be used when the package is stored, used, packed, transported, and unpacked must be identified. If functional requirements based on disposal of the empty packaging exists they should be identified.

Regulatory requirements are dependent on the type and quantities of material being shipped in the packaging. The mode of transportation may also change the applicable regulatory requirements. Regulatory requirements change when the shipment is international.

The materials being transported in the packaging and the quantity should be carefully identified as they are crucial to identifying appropriate regulatory requirements. The next two subsection describe the importance of the material characterization process and the identification of authorized packaging types.

Criteria development is a function of packaging complexity and the facilities in which it will be used, the variety of materials to be placed in the packaging, and the experience in designing and development of performance-oriented packaging of the performing organizations. A wide variety of methods can be employed in identifying the functional criteria. They vary from simple to complex. This section will discuss a few of them in that order.

Regardless of the method used for identifying criteria, a formal documentation of the criteria is recommended.

2.4.1 Material Characterization

The materials characterization process starts with identifying the characteristics of the material to be transported. Physical characteristics (i.e., solid, liquid, or gas) and chemical characteristics, such as corrosivity, flammability, or explosiveness are important in determining the proper packaging.

The following are content characteristics that must be considered when designing a hazardous material packaging:

- Physical form of the material when it is transported
- Specific gravity and vapor pressure if the material will be shipped as a liquid
- Specific chemical (i.e., technical) name recognized in scientific or technical handbooks, journals, and texts (i.e., 171.8)
- Whether the material to be shipped is a waste material
- Flash point of the material if the material has any tendencies toward flammability or combustibility
- LD50 value for material with any toxic characteristics

- Information as to the material's potential to melt, sublime, solidify, or otherwise change phase as a result of temperature or pressure changes that might occur during transport
- Information on the explosiveness if any potential phase change is accompanied by a sudden release of heat or energy
- Degree of corrosivity and the material affected, if the material has any corrosive characteristic toward skin, metal, plastic, or other material
- Any other properties (e.g., irritating to the eyes or pungent odor) that might make it unpleasant for transport workers.
- Materials that can result in damage to the environment.

This information is used in determining the correct type of packaging to use for the material and what performance tests the packaging must withstand. Keep in mind the precaution about chemical names presented in Section 2.2 make sure that the synonyms have been identified.

Steel, aluminum, other metals, wood, plywood, fiberboard, polyethylene, poly vinyl chloride and other plastics, glass, porcelain, and stoneware are common materials for packaging components. Elastomers, rubber, and various gasket materials are used for seals and gaskets. Thus, these and other less common materials may come into contact with hazardous materials during transport. Any chemical incompatibilities that are known, suspected, or questionable must be identified. If experience has shown specific materials are definitely compatible with the contents, that information should also be included.

A materials characterization check list appears in the procurement guide. The check list provides guidance for and documentation of the materials characterization process. A copy of the check list and the instructions for completion can be found in Appendix A. Use of the check list is recommended.

In addition to identifying the material in accordance with the applicable transportation regulations, it is necessary to identify the packaging authorized for those materials. The next subsection covers the selection of the packaging.

2.4.2 Packaging Selection

For a DOT packaging, the selection process starts by using the information obtained in the materials characterization process to identify all applicable hazard classes for the material to be shipped. The quantity of material per package needs to be considered as the quantity can impact hazardous class, mode selection, and other regulatory requirements. Remember

to consider the subsidiary hazard classes when selecting the packaging. The Proper Shipping Name is selected from the HMT using the requirements in 49 CFR 172.101(b) and 172.101(c). Proper Shipping Names are listed in Roman Type in the HMT.

Remember to determine if the material, or one of its synonyms, is listed in the Appendix A to the HMT, 49 CFR 172.101. If the material is listed in Appendix A, it is regulated by the U.S. Environmental Protection Agency (EPA) as a hazardous substance. If more than a "regulated quantity" (RQ) amount is being shipped in a single package, it must be packaged as a hazardous material and comply with the DOT regulations. Also, remember to determine if the material or one of its synonyms is listed in Appendix B to the "List of Marine Pollutants," 49 CFR 172.101. If the material is listed in Appendix B, it is a regulated marine pollutant. Materials appearing in Appendix B is not specially listed in Appendix A or the HMT are handled in accordance with the "Marine Pollutant" entry in the table.

NOTE: If the material is a hazardous waste or hazardous substance, the requirements in 49 CFR 172.101(f) also must be met.

Materials that meet the following: (1) are not defined in any hazard class, (2) are listed in the Appendix A or B to the HMT, and (3) are to be shipped in packages containing more than an RQ amount per package must be categorized as Class 9 and assigned one of the following HMT Proper Shipping Names:

- Environmentally hazardous substances, liquid, n.o.s.
- Environmentally hazardous substances, solid, n.o.s.
- Other regulated substances, liquid, n.o.s.
- Other regulated substances, solid, n.o.s.

Materials that do not meet any definition of Hazard Class but do qualify as Hazardous Waste, must be categorized as Class 9 and assigned one of the following HMT Proper Shipping Names:

- Waste environmentally hazardous substances, liquid, n.o.s.
- Waste environmentally hazardous substances, solid, n.o.s.
- Hazardous waste, liquid, n.o.s.
- Hazardous waste, solid, n.o.s.

Authorized Packagings are identified by reference in the HMT. This information is found as the tabular entry in the HMT Column 8B associated with the correct Proper Shipping Name, Hazard Class and Division, and Packing Group. Column 8B provides a reference to a section number of Part 173 in which the authorized nonbulk packagings are described. Additionally, one needs to watch for special packaging provisions identified in Column 7 of the HMT. Examples of the types of packagings found in the referenced sections are found in Table 2-1.

Table 2-1. Packaging Types.

Steel drum
Aluminum drum
Metal drum other than steel or aluminum
Plywood drum
Fiber drum
Plastic drum and jerrican
Wooden barrel
Steel jerrican
Steel or aluminum box
Natural wood box
Plywood box
Reconstituted wood box
Fiberboard box
Plastic box
Woven plastic bag
Plastic film bag
Textile bag
Paper bag
Composite packagings with inner plastic receptacles
Composite packaging with inner glass, porcelain, or stoneware receptacles
Combination packaging

Packaging selection may be an iterative process. The process starts by reviewing the list of authorized packagings identified in the section of 49 CFR 173 called out in Column 8B. A tentative selection from the authorized list would be based upon quantity to be transported, ease of use, packaging cost, packaging availability, transport mode, and other relevant factors. If the tentative selection is not disqualified by the special provisions in Column 7 of the HMT, the tentative selection could become the final selection.

A packaging selection check list appears in the procurement guide. The check list provides guidance for and documentation of the packaging selection process. A copy of the check list and the instructions for completion can be found in Appendix B. The check list was developed for transportation by highway and will require modification for transportation by other modes. Use of the check list is recommended.

2.4.3 Informal Study

In small organizations or for simple packaging needs in larger organizations an informal study can be used to identify the functional requirements. The study must include the activities identified in Subsections 2.4.1 and 2.4.2. The regulatory requirements part of the identification process is best conducted by personnel knowledgeable of the transportation regulations. The organizations that will handle the packaging and any safety organizations should be contacted to determine what functional requirements the packaging must meet when the package is stored, used, packed, transported, or unpacked. Their input combined with the regulatory requirements should be documented in a criteria or specification document. If conflicts between the regulatory requirements and those identified by organizations exist, the conflicts must be resolved to ensure regulatory compliance.

2.4.4 Formal Study

In larger organizations or for complex packaging needs a formal study is recommended for identifying functional requirements. The study must include the activities identified in Subsections 2.4.1 and 2.4.2. The regulatory requirements part of the identification process is best conducted by personnel knowledgeable of the transportation regulations. The organizations that will handle the packaging and any safety organizations should be formally contacted and requested to identify any functional requirements the packaging must meet when stored, used, packed, transported, or unpacked. Their input should be combined with the regulatory requirements and documented in a criteria or specification document. If conflicts between the regulatory requirements and those identified by organizations exist, the conflicts must be resolved to ensure regulatory compliance.

2.4.5 Engineering Study (Criteria Identification)

For complex packaging needs in organizations with an engineering staff, an engineering study is recommended for identifying functional requirements. The advantages and steps conducted as a part of an engineering study were discussed in Section 2.2.3. The study must include the activities identified in Subsections 2.4.1 and 2.4.2. The regulatory requirements part of the identification process is best conducted by or with the assistance of personnel knowledgeable of the transportation regulations. If conflicts between the regulatory requirements and those identified by organizations exist, the conflicts must be resolved to ensure regulatory compliance. The results of the engineering study should be used to prepare criteria or specification documents.

2.4.6 Consultant (Criteria Identification)

For organizations not have personnel knowledgeable in the transportation regulatory requirements available or who have a complex system, the use of a consultant to identify packaging criteria provides the required impartial expertise fast. While the per hour cost may be high the overall cost is likely to be lower as there is a long learning curve associated with understanding and following the transportation regulations efficiently. Keep in mind however that the consultant will need time to become familiar with the activities being conducted.

When contracting for a consultant clearly define the task to be conducted. Shop around and find several with experience in the areas you need assistance. Select the one that best suits the job. Obtain recommendations from other organization that have used consultants before making a final selection.

2.5 SOLUTION DEVELOPMENT

The solution development activity may take the solution through conceptual, detailed, and implementation design phases. The conceptual phase may include studies, preliminary analysis, conceptual design, specification development, and value analysis. The detailed phase may include definitive design, final analysis, prototype testing, feature testing, drawings, reports, operation and maintenance manual development, and spare parts list generation. The implementation phase may include such tasks as final fabrication, procurement, installation, construction, and acceptance testing. In this section the solution is discussed as if the design and construction are conducted or procured by the same organization. There is no reason why the activities that make up the solution cannot be divided up among several organizations. By dividing up the work, contracts can be used to obtain the services of the organization best suited to the job. The planning documentation, when used, can define the steps to be followed in obtaining the solution.

An organization with a simple packaging need may be tempted to do little solution development. For example, when a packaging need can be met by combination packaging assembled from off-the-shelf DOT single packagings, such as a cardboard box and a drum. In these situations there is a tendency to feel little need for design development and documentation. Some feel that the specification of the single packagings DOT identifications and how they are assembled is enough. This however, is not the case. All packagings carrying a particular marking are not necessarily created equal. The required markings only identify that the packaging has meet some particular set of regulatory requirements. The manufacture of a packaging carrying that marking may have had a reason to build a package that just meets the requirements or one that far exceeds the requirements. Without additional design information the packaging is still an unknown. When designing a packaging to be built from two other approved packagings one must be able to show that each and every package built is the same as the ones used for testing. This requires describing both

packagings and whatever else is used in assembling the packaging to a level that assures within the design tolerances that all packagings built will be the same. This requires the development of specifications or some other form of design media that describes the package to the level necessary to ensure consistent construction.

When assembling packaging from commercially available parts the use of a catalog number for identification is acceptable. However, when a catalog number is used for identification there must be a way of identifying significant changes to the part. For example, a plastic bottle may be constructed from high-density polyethylene (commonly called HDPE) and later changed to some other form of plastic. The regulations require evaluation and possible testing of the plastic containers for compatibility with the hazardous material. When a change in material occurs the new material must be evaluated and tested the same as the original to assure compatibility.

When new packaging is designed and developed, regardless of how it is produced, the shipper must receive assembly instructions from the organization responsible for manufacturing the packagings. The instructions must be detailed enough to ensure that the package is assembled, loaded, and closed in a manner that assures the package is identical to the tested packagings.

2.5.1 Simplified Packaging Design/Development

Packaging design and development activities need not be complex. For a simple package, personnel knowledgeable about preparing materials for shipment and others may be capable of designing and developing the packaging. This is likely to be true when commercially available parts are assembled into a packaging meeting identified requirements. When packaging is assembled from commercially available parts engineering and drafting personnel may not be required. The personnel involved however must be able to assemble design documentation that assures accurate reproduction of packagings. Examples of documentation are sketches that include part numbers, drawings with parts called out, or a specification. In addition to the design documentation, instructions on how to assemble the packaging are required. The instructions must be detailed enough to assure that each package is assembled the same within the tolerances of the design.

2.5.2 Engineered Packaging Design/Development

The use of a design engineering organization to accomplish packaging design and development is recommended. A design organization will have the expertise to identify solutions and develop a design. Preferably the organization will have experience in the design of packaging similar to what is needed. Close coordination between the user and the designer can avoid wasted time and money by identifying problems with the proposed design that may not be obvious to the designer based on the supplied criteria. If close coordination is not possible a design review after the concept is complete and before detail design is recommended.

2.5.3 Contracted Design/Development

When an internal design engineering organization is not available an external engineering firm can be hired. By selecting an outside firm experienced in design of similar packaging consideration should be given to the time required to develop similar expertise onsite. Keep in mind the need for an interface between the designer and the user when selecting an engineering firm. If a particular manufacturing facility is to be used the designer will also need to know the capabilities of that organization.

When contracting for a design clearly define the task to be conducted. Shop around and find several experienced with your type of packaging. Select the one that best suits the job. Obtain recommendations from other organization that have used the firms when possible.

2.5.4 Consultant (Design/Development)

When packaging design/development expertise does not exist within the organization consider using a consultant. The complexity of the regulatory requirements impacting packaging design and development warrant the use of highly trained individuals. Training is needed to understand and interpret the regulatory requirements. The use of a consultant obtains the required expertise fast and they are impartial. While the per hour cost may be high the overall cost is likely to be lower as there is a long learning curve associated with being able to follow the transportation regulations efficiently.

When contracting for a consultant clearly define the task to be conducted. Shop around and find several with experience in the areas you need assistance. Select the one that best suits the job. Obtain recommendations from other organization that have used consultants when possible.

2.5.5 Packaging Production

Once a design has been established packaging must be produced to the design for use and testing. Regulations require that packagings used for transportation must be identical to the testing packagings. The design certification testing must be conducted and passed before use of packagings for the shipment of hazardous materials. Documentation should be available to show that all packages are the same within the design parameters. Note that in addition to the design certification testing some packagings require testing during the manufacturing process. Also, periodic testing of manufactured units to verify that packaging still meets the performance requirements is required. The manufacture is required to have the design certification testing documentation available at each facility where the packaging is produced.

When parts or raw materials for packaging are procured a method is needed to assure the parts and material are identical to the original parts within the design requirements. If a part or material cannot be shown to be identical to within the design requirements design certification testing will be required of packagings built from the materials before use for transporting hazardous materials.

If during production, changes are made to the methods or materials used to produce a packaging, the changes must be evaluated to determine if they impact the packaging design. For example, a new glue is chosen for use on the joints of a wooden box. The new glue must be evaluated to determine that it is identical to the original in the significant performance aspects. If it can not be shown to be identical, new certification testing is required.

2.5.6 Specialty Packaging Procurement

After packaging needs have been determined, one possible solution is to hire an organization to design and manufacture the number of packagings required. If this method is chosen, procurement documentation that clearly identifies the needs should be prepared. The procurement documentation should provide both engineering, quality and procurement requirements. When working with the procurement organization be sure to have the regulatory requirements that the packaging is to meet clearly identified. The Procurement Guide identified in Subsection 1.3.1.2. gives guidance on items to be identified when procuring a commercially available packaging. Most of the items are applicable to the procurement of a specialty packaging.

In the procurement documentation identify who is responsible for the design certification and what packing group level the design certification testing is to demonstrate compliance. Remember it is not necessary to identify what hazardous material is to be shipped in the packaging. However, if the hazardous material to be shipped in the packaging is not identified compatibility issues cannot be addressed by the manufacturer. When known, identify the material to be shipped and request certification of the packaging compatibility.

Be sure that the receiving inspections associated with receipt of procured packaging check not only the physical requirements of the package, but also that the required certifications and instructions are received.

2.6 CERTIFICATION

Hazardous materials packagings before use must have design certification testing completed. The certification testing is to be conducted on packagings randomly selected from those produced for use, and prepared for testing the same as they are prepared for shipment. Each different packaging must be tested before use. The DOT defines different packaging in 49 CFR 178.601(c)(4). When two manufactures make the same packaging each

must see to the testing of their product. This is true even when both manufactures are using the same materials and design. When a single packaging manufacturer use materials from more than one source, the manufacturer must assure that each supplier's material is virtually identical or test the various combinations that can result.

Note that the testing can be conducted even when the actual material to be shipped in the packaging is unknown. When testing is conducted without consideration of the contents compatibility, the test report should indicate that no compatibility testing was involved. Also, testing may be required even when you know the packaging will pass the tests. For example, you may have a can that passes the requirements and is used for shipments by highway. When you go to ship by air you find that a combination packaging is required. The addition of a fiberboard box around the can produces an authorized package, but the combination cannot be used without conducting the required combination packaging test. This is true even though it is known that the package will pass because the can passes. Additionally, if a combination packaging is to be used to move both solids or liquids, it must be tested with both solids and liquids.

If the package is to be shipped under either IMDG or ICAO certification, testing to meet the requirements of those regulations should also be conducted. Packages may be marked with dual certifications.

The DOT has provided three strategies to accomplish the certification testing. The following three subsections describe the strategies.

2.6.1 Self-Certification

In recognition of the past safety history for self-certified packagings, the DOT has maintained the option of shippers' self-certification. To this end, the DOT more clearly established manufacturer and shipper responsibilities in 49 CFR Sections 173.22 and 178.1. The DOT maintains the option of self-certification, both for original design qualification testing and for periodic retesting.

Based upon the single, composite, or combination packaging selected, the self-certifier must identify and perform the required design qualification testing in accordance with 49 CFR Subpart M - Testing of Non-Bulk Packagings and Packages.

The self-certifier must keep records of design qualification tests, including the following:

- Specific types
- Dates
- Locations
- Packaging specifications
- Test specifics (e.g., drop heights, hydrostatic pressures)
- Results
- Test operators' names or the name of the person responsible for testing.

This must be provided for each packaging, at each location where that packaging is manufactured and at each location where design qualification tests are conducted, as long as the packaging is produced and for at least two years thereafter.

2.6.2 Testing Agency/Self-Certification

As an alternative strategy, the self-certifier may elect to perform all the work tasks above except testing. The DOT has provided that the self certifier may use any testing agency equipped to perform the required tests and self-certify the packagings. A testing agency differs from a certification agency in that a testing agency is not subject to 49 CFR Subpart E - Designation of Approval and Certification Agencies. A testing agency may not issue approval certificates and certifications for types of packagings designed, manufactured, tested, or maintained in conformance with the requirements of the HMR and standards set forth in the UN recommendations (Transport of Dangerous Goods). A testing agency is limited to performing certain testing requirements for performance-oriented packagings identified in 49 CFR Subpart L and described in 49 CFR Subpart M - Testing of Non-Bulk Packagings and Packages.

The self-certifier must ensure that the testing agency provides detailed records of design qualification tests, including specific types, dates, locations, packaging specifications, test specifics (drop heights, hydrostatic pressures, etc.), results, and test operators' names or name of person responsible for testing, for each packaging tested. These records must be available at each location where that packaging is manufactured and at each location where design qualification tests are conducted, as long as the packaging is produced and for at least two years thereafter.

2.6.3 Third-Party Certification Agency

The third strategy available is to work in conjunction with a third-party certification agency. There is no need to become a third-party certification agency in hopes of gaining more credibility for testing activities. In fact, third-party certification agencies cannot certify any of their own packagings and mark them with their third-party mark. Third-party certification agencies must self-certify and use a self-certification mark on their packages.

When a packaging has been tested by a third-party packaging certification agency, the third-party's mark (symbol), with a four digit number assigned by the third-party packaging certification agency that identifies the packaging, should appear on the packaging after the "USA" marking. The packaging manufacturer or shipper may place a different mark on packagings in accordance with 49 CFR 178.0-3. However, in doing so, it would no longer be evident from the mark that the package has been third-party certified.

When packagings are third-party certified, the third-party laboratory must be approved by DOT as provided in 49 CFR Section 107.403. It is also critically important that all testing performed is documented accurately and in detail. The shipper should pay specific attention to any notification of testing requirements not met. For example, if a third-party agency does not perform the vibration test, the reasons for not doing so should be noted on the test and certification report. For example, the shipper may have had testing done elsewhere or have certified that the packaging "is capable of withstanding the test." [The vibration standard is a shipper responsibility (49 CFR 173.24(a))].

Notification requirements in 49 CFR 178.2(c) directly relate to the shipper's part 173 responsibility to assure that the integrity of packages constructed or assembled according to successfully tested design types is maintained under normal transportation conditions. This paragraph in the HMR closes a compliance loop with Parts 178 and 173 for persons who certify packagings and persons who prepare them for transportation to ensure notification is given to users of what remains to be done to prepare (close) packagings built to certified design types for transportation. For example, a drum user could be notified of the type of gasket described in the design type test documentation for closing a drum built to the successfully tested design type. A combination packaging user could be notified of the type of tape described in the documentation to close an outer 4G fiberboard box.

When selecting a third-party certification agency, ensure that the agency is familiar with all sets of regulations (49 CFR, ICAO, and IMDG), because of variations in the tests required. The variations in tests are generally based on modal considerations. Therefore, it is also important for the shipper to establish the modes of transportation for which the package is to be used and if there are different tests applicable they should be brought to the attention of the third-party agency.

The shipper must also make sure that the third-party agency actually performs all the required tests. Comparing materials and construction of packagings currently being produced to those of the original tested packagings is not allowed. Also, where the regulations specify a number of samples to be tested for a particular test, that number must be used unless a reduced number has been specifically approved by DOT. For example, testing one sample five times does not meet the requirement to test five samples. Five samples must be tested.

There are perceived benefits to using third-party certification agencies.

1. European governments and industry are generally distrustful of United States self-certification because in Europe, packages generally are certified based on testing by government-approved laboratories. The use of a third-party testing agency for export packagings would likely be more acceptable.
2. United States third-party certification agencies undergo an approval process, including a check list of equipment on hand, employee training, and

recordkeeping, as specified in Section 107.402(b) before being approved by the DOT. Being able to identify a packaging as third-party certified by its marking, will likely make it less subject to investigation.

If the third-party packaging certification agency does not know what materials are to be shipped in the packaging, it may certify the packaging to a specific packing group level and for a specified maximum gross weight or specific gravity. The packaging can then be used for other hazardous materials so long as the packaging test requirements are equal to or less severe than the levels to which the packaging was tested. Additionally, the package must be assembled and closed in the same manner as the tested package.

3.0 PACKAGING DESIGN CONSIDERATIONS

The following sections identify potential problem areas that arise when designing a performance-oriented packaging. The areas have been identified through the experience gained in designing and certifying radioactive material packaging and through information exchanges sponsored by the DOT.

3.1 GENERAL CONSIDERATIONS

The following subsections provide some general guidance applicable to the design of performance-oriented packaging.

3.1.1 Regulatory Design Limitations

Before the move to performance-oriented packaging hazardous materials packagings were built to specific DOT design specifications. If one wanted to design a new packaging or modify an old one the design change had to be approved by the DOT. In the post HM-181 DOT regulations most design specifications were replaced by performance-oriented design standards. The move to performance-oriented packaging provides for more flexibility in hazardous material packaging. Under the new regulations a new packaging may be designed without applying for DOT approval so long as it fits within the regulatory standards.

The regulations designate acceptable packaging types for a hazardous material and provide general design requirements. The HMT in 49 CFR 172.101, column 8 identifies for each proper shipping name the sections of the regulations that designate the acceptable packaging types. For the acceptable performance-oriented packaging types general design guidance and performance standards are provided in 49 CFR 178. When designing a packaging be sure that all applicable requirements are identified. Note that some requirements that impact the design may be applicable to only one mode of transportation for a particular type of material. For example, 49 CFR 173.27 - general requirements for transportation by aircraft, requires that some packages meet higher performance levels.

3.1.2 The Language of Hazardous Material Transportation

To design a packaging for hazardous materials it is necessary to understand what the regulations mean. Basic to that understanding is knowing the meaning of a word when used in the regulations. In 49 CFR 171.8 - definitions and abbreviations, the DOT presents the interpretation to be used when following the regulations. Before using the regulations be

sure to review the listing, the common usage might differ enough to result in an error. The following definitions from that list are presented to assist in understanding the discussion in this document:

- **Bag** means a flexible packaging made of paper, plastic film, textiles, woven material, or other similar materials.
- **Bottle** means an inner packaging having a neck of relatively smaller cross section than the body and an opening capable of holding a closure for retention of the contents.
- **Box** means a packaging with complete rectangular or polygonal faces, made of metal, wood, plywood, reconstituted wood, fiberboard, plastic, or other suitable material.
- **Bulk packaging** means a packaging, other than a vessel or a barge, including a transport vehicle or freight container, in which hazardous materials are loaded with no intermediate form of containment and which has the following criteria: (1) a maximum capacity greater than 450 L (119 gal) as a receptacle for a liquid; (2) a maximum net mass greater than 400 kg (882 lb) and a maximum capacity greater than 450 L (119 gal) as a receptacle for a solid; or (3) a water capacity greater than 454 kg (1000 lb) as a receptacle for a gas as defined in 49 CFR 173.115.
- **Closure** means a device which closes an opening in a receptacle.
- **Combination packaging** means a combination of packaging, for transport purposes, consisting of one or more inner packagings secured in a non-bulk outer packaging. It does not include a composite packaging.
- **Competent Authority** means a national agency responsible under its 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 ICAO Technical Instructions, has the same meaning as "Competent Authority." For purposes 49 CFR - the Associate Administrator for Hazardous Materials Safety, is the Competent Authority for the United States.
- **Composite packaging** means a packaging consisting of an outer packaging and an inner receptacle, so constructed that the inner receptacle and outer packaging form an integral packaging. Once assembled it remains thereafter an integrated single unit; it is filled, stored, shipped, and emptied as such.
- **Crate** means an outer packaging with incomplete surfaces.
- **Division** means a subdivision of a hazard class.

- **Drum** means a flat-ended or convex-ended cylindrical packaging made of metal, fiberboard, plastic, plywood, or other suitable material. This definition also includes packagings of other shapes made of metal or plastic (e.g., round taper-necked packagings or pail-shaped packagings) but does not include cylinders, jerricans, wooden barrels or bulk packagings.
- **Gross weight or Gross mass** means the weight of a packaging plus the weight of its contents.
- **Hazard class** means the category of hazard assigned to a hazardous material under the definitional criteria of 49 CFR 173 and the provisions of the 49 CFR 172.101 Table. A material may meet the defining criteria for more than one hazard class but is assigned to only one hazard class.
- **Hazardous material** means a substance or material, which has been determined by the Secretary of Transportation to be capable of posing an unreasonable risk to health, safety, and property when transported in commerce, and has been so designated. The term includes hazardous substances, hazardous wastes, marine pollutants, and elevated temperature materials as defined in 49 CFR 171.8, materials designated as hazardous under the provisions of 49 CFR 172.101 and 172.102, and materials that meet the defining criteria for hazard classes and divisions in 49 CFR 173
- **Hazardous substance**, for the purposes of 49 CFR, means a material, including its mixtures and solutions, that-- (1) is listed in the Appendix A to 49 CFR 172.101; (2) is in a quantity, in one package, which equals or exceeds the RQ listed in the Appendix A to 49 CFR 172.101; and (3) when in a mixture or solution-- (3)(i) for radionuclides, conforms to paragraph 6 of the Appendix A to 49 CFR 172.101; (3)(ii) for other than radionuclides, is in a concentration by weight which equals or exceeds the concentration corresponding to the RQ of the material, as shown in the following table.

Table 3-1. Hazardous Substances.

Reportable quantity lb (kg)	Concentration by weight	
	Percent	PPM
5,000 (2,270)	10	100,000
1,000 (454)	2	20,000
100 (45.4)	0.2	2,000
10 (4.54)	0.02	200
1 (0.454)	0.002	20

This definition does not apply to petroleum products that are lubricants or fuels.

- **Hazardous waste**, for the purposes of this chapter, means any material that is subject to the Hazardous Waste Manifest Requirements of the U.S. EPA specified in 40 CFR Part 262.
- **Hermetically sealed** means closed by fusion, gasketing, crimping, or equivalent means so that no gas or vapor can enter or escape.
- **Inner packaging** means a packaging for which an outer packaging is required for transport. It does not include the inner receptacle of a composite packaging.
- **Inner receptacle** means a receptacle that requires an outer packaging to perform its containment function. The inner receptacle may be an inner packaging of a combination packaging or the inner receptacle of a composite packaging.
- **International transportation** means transportation:
 - Between any place in the United States and any place in a foreign country
 - Between places in the United States through a foreign country
 - Between places in one or more foreign countries through the United States.
- **Jerrican** means a metal or plastic packaging of rectangular or polygonal cross-section.

- **Limited quantity**, when specified as such in a section applicable to a particular material, means the maximum amount of a hazardous material for which there is a specific labeling or packaging exception.
- **Liquid** means a material with a vertical flow of over 2 in. (50 mm) within a three minute period, or a material having 1 g or more liquid separation, when determined in accordance with the procedures specified in ASTM D 4359-84, "Standard Test Method for Determining whether a Material is a Liquid or Solid," 1984 edition.
- **Liquid phase** means a material that meets the definition of "liquid" when evaluated at the higher of the temperature at which it is offered for transportation or at which it is transported, not at the 37.8 °C (100 °F) temperature specified in ASTM D 4359-84.
- **Marking** means the descriptive name, identification number, instructions, cautions, weight, specification, or UN marks or combinations thereof, required by 49 CFR, Subchapter C, on outer packagings of hazardous materials.
- **Maximum capacity** means the maximum inner volume of receptacles or packagings.
- **Maximum net mass** means the maximum allowable net mass of contents in a single packaging or, as used in subpart M of 49 CFR 178, the maximum combined mass of inner packaging, and the contents thereof.
- **Mixture** means a material composed of more than one chemical compound or element.
- **Mode** means any of the following transportation methods; rail, highway, air, or water.
- **Motor vehicle** includes a vehicle, machine, tractor, trailer, or semitrailer, or any combination thereof, propelled or drawn by mechanical power and used upon the highways in the transportation of passengers or property. It does not include a vehicle, locomotive, or car operated exclusively on a rail or rails, or a trolley bus operated by electric power derived from a fixed overhead wire, furnishing local passenger transportation similar to street-railway service.
- **Name of contents** means the proper shipping name as specified in 49 CFR 172.101.
- **Non-bulk packaging** means a packaging that has the following criteria: (1) a maximum capacity of 450 L (119 gal) or less as a receptacle for a liquid;

(2) a maximum net mass of 400 kg (882 lb) or less or an internal volume of 450 L (119 gal) or less as a receptacle for a solid; or (3) a water capacity of 454 kg (1,000 lb) or less as a receptacle for a gas as defined in 49 CFR 173.115.

- **NOS** means not otherwise specified.
- **n.o.s. description** means a shipping description from 49 CFR 172.101 Table which includes the abbreviation "n.o.s.," and as contained in the lists in 49 CFR 172.203(k)(3), regarding additional description requirements.
- **NPT** means an American Standard taper pipe thread in compliance with the requirements of Federal Standard H28, Part II, Section VII. See 49 CFR 171.7(d)(12).
- **Outage or ullage** means the amount by which a packaging falls short of being liquid full, usually expressed in percent by volume.
- **Outer packaging** means the outermost enclosure of a composite or combination packaging together with any absorbent materials, cushioning, and any other components necessary to contain and protect inner receptacles or inner packagings.
- **Overpack**, except when referenced to a packaging specified in 49 CFR 178, means an enclosure that is used by a single consignor to provide protection or convenience in handling of a package or to consolidate two or more packages. "Overpack" does not include a freight container.
- **Package or Outside Package** means a packaging plus its contents. For radioactive materials, 49 CFR 173.403.
- **Packaging** means a receptacle and any other components or materials necessary for the receptacle to perform its containment function in conformance with the minimum packing requirements of 49 CFR. For radioactive materials packaging, see 49 CFR 173.403.
- **Packing group** means a grouping according to the degree of danger presented by hazardous materials. Packing Group I indicates great danger; Packing Group II, medium danger; Packing Group III, minor danger. See 49 CFR 172.101(f).
- **Person** means an individual, firm, copartnership, corporation, company, association, joint-stock association, including any trustee, receiver, assignee, or similar representative thereof, or government, Indian tribe, or agency or instrumentality of any government or Indian tribe when it offers hazardous materials for transportation in commerce or transports hazardous materials in

furtherance of a commercial enterprise, but such term does not include: (1) The United States Postal Service; or (2) for the purposes of Sections 110 and 111 of the Hazardous Materials Transportation Act (49 App. U.S.C. 1809-1810), any agency or instrumentality of the Federal Government.

- **Primary hazard** means the hazard class of a material as assigned in the 172.101 Table.
- **Proper shipping name** means the name of the hazardous material shown in Roman print (not italics) in 49 CFR 172.101.
- **psi** means pounds per square inch.
- **psia** means pounds per square inch absolute.
- **psig** means pounds per square inch gauge.
- **Receptacle** means a containment vessel for receiving and holding materials, including any means of closing.
- **Research** means an investigation of experimentation aimed at the discovery of new theories or laws and the discovery and interpretation of facts or revision of accepted theories or laws in the light of new facts.
- **Residue** means the hazardous material remaining in a packaging, including a tank car, after its contents have been unloaded to the maximum extent practicable and before the packaging is either refilled or cleaned of hazardous material and purged to remove any hazardous vapors.
- **SCF (standard cubic foot)** means one cubic foot of gas measured at 60 °F and 14.7 psia.
- **Sheathing** means a covering consisting of a smooth layer of wood placed over metal and secured to prevent any movement.
- **Shipping paper** means a shipping order, bill of lading, manifest or other shipping document serving a similar purpose and containing the information required by 49 CFR 172.202, 172.203, and 172.204.
- **Single packaging** means a non-bulk packaging other than a combination packaging.

- **Solid** means a material that has a vertical flow of 2 in. (50 mm) or less within a three-minute period, or a separation of 1 g or less of liquid when determined in accordance with the procedures specified in ASTM D 4359-84 "Standard Test Method for Determining Whether a Material is a Liquid or Solid," 1984 edition.
- **Solution** means any homogeneous liquid mixture of two or more chemical compounds or elements that will not undergo any segregation under conditions normal to transportation.
- **Specification packaging** means a packaging conforming to one of the specifications or standards for packagings in 49 CFR 178 or 179.
- **State** means a state of the United States, the District of Columbia, the Commonwealth of Puerto Rico, the Commonwealth of the Northern Mariana Islands, the Virgin Islands, American Samoa, Guam, or any other territory or possession of the United States designated by the Secretary.
- **Strong outside container** means the outermost enclosure that provides protection against the unintentional release of its contents under conditions normally incident to transportation.
- **Subsidiary hazard** means a hazard of a material other than the primary hazard. (See "primary hazard.")
- **Table in 49 CFR 172.101 or 172.101 Table** means the "Hazardous Materials Table" in 49 CFR 172.101.
- **Technical name** means a recognized chemical name or microbiological name currently used in scientific and technical handbooks, journals, and texts. Generic descriptions are authorized for use as technical names provided they readily identify the general chemical group, or microbiological group. Examples of acceptable generic descriptions are organic phosphate compounds, petroleum aliphatic hydrocarbons, and tertiary amides. For proficiency testing only, generic microbiological descriptions such as bacteria, mycobacteria, fungus, and viral samples may be used. Except for names that appear in Subpart B of 49 CFR 172, trade names may not be used as technical names.
- **Transport vehicle** means a cargo-carrying vehicle such as an automobile, van, tractor, truck, semitrailer, tank car, or rail car used for the transportation of cargo by any mode. Each cargo-carrying body (trailer, rail car, etc.) is a separate transport vehicle.
- **UN standard packaging** means a specification packaging conforming to the requirements in subpart L and M of 49 CFR 178.

- **United States** means the 50 states of the United States, the District of Columbia, the Commonwealth of Puerto Rico, the Commonwealth of the Northern Mariana Islands, the Virgin Islands, American Samoa, Guam, or any other territory or possession of the United States designated by the Secretary.
- **Vessel** includes every description of watercraft, used or capable of being used as a means of transportation on the water.
- **Viscous liquid** means a liquid material that has a measured viscosity in excess of 2,500 centistokes at 25 °C (77 °F) when determined in accordance with the procedures specified in ASTM Method D 445-72 "Kinematic Viscosity of Transparent and Opaque Liquids (and the Calculation of Dynamic Viscosity)" or ASTM Method D 1200-70 "Viscosity of Paints, Varnishes, and Lacquers by Ford Viscosity Cup."
- **Volatility** refers to the relative rate of evaporation of materials to assume the vapor state.
- **Water resistant** means having a degree of resistance to permeability by and damage caused by water in liquid form.
- **Wooden barrel** means a packaging made of natural wood, of round cross-section, having convex walls, consisting of staves and heads and fitted with hoops.
- **WT** means watertight.

3.1.3 General Thrust of Performance-Oriented Packaging

The intent of performance-oriented packaging standards is to obtain the desired level of safety through the ability of the packaging types to successfully pass a series of performance tests. The performance tests are designed to test the ability of the packaging to withstand the conditions normally incident to transportation. The standards apply to non-bulk packagings, they do not apply to cylinders, bulk, and radioactive materials packagings. The performance-oriented packaging standards are graded based on the relative hazard. The relative level of hazard is identified by assignment of a PG number. The PG and their relative hazard are as follows:

- **Packing Group I:** Very dangerous materials (Greatest Danger)
- **Packing Group II:** Moderately dangerous materials (Moderate Danger)
- **Packing Group III:** Slightly dangerous materials (Least Danger).

The basic tests for a packaging type are the same, the demand on performance of the packaging increases with the PG. For example the drop height increases from 0.8 m for PG III to 1.8 m for PG I.

Differing packaging types have differing initial conditions to be met before testing. For example, some cardboard containers must be conditioned in a humidity and temperature controlled environment. Some plastic containers must be chilled before drop testing.

Performance-oriented packaging standards are intended to permit freedom in the packaging design. This freedom comes with a price. The designer must become familiar with the many varying requirements and when they apply to the packaging being designed. The standards do not permit using packaging types that are not authorized for the material to be transported. For example, if the regulations authorize a metal box one cannot substitute a metal drum even if it appears to be a better packaging. To use a packaging type that is not authorized requires requesting permission from the competent authority.

3.1.4 Tolerancing and Performance-Oriented Packaging

Experiences with radioactive material packaging suggested a need to discuss tolerancing of the packaging. Instances have occurred where test units were built and tested without consideration for evaluating the effects of design tolerances on performance. When the evaluations were conducted difficulties arose that could have been avoided. For example, by preparing the test units with tolerances at their minimum or maximum level some strength evaluations can be greatly simplified.

The performance-oriented packaging standards do not discuss tolerances or evaluation of the impact of design tolerances on performance. The regulations do require that the tested packagings be identical to the packagings used for shipment. No special meaning is provided for the word identical. This leaves it up to the organization to determine how to assure the packagings can be shown to be identical.

The large variety of performance-oriented packaging types that can be built dictate that comments on tolerancing be general. The packaging can vary from a fiber bag to a complex metal and plastic combination packaging. What would be reasonable tolerances for a bag would be useless for the metal box.

Once a packaging type is selected, the capabilities for producing that packaging should be reviewed. The normal industry tolerances for similar packaging types should be determined and evaluated for acceptability. Even when a particular production facility must be used check the industry wide ability. The information provides some idea of the confidence level that can be placed on testing results. If the facility and/or normal tolerances

are not acceptable look for the best that can be accomplished and evaluate the acceptability. If better than normal tolerances are needed consider a design change. In general cost will be lower if looser tolerances can be set. Keep in mind that your goal is to cost effectively produce packagings where even the weakest has no difficulty in meeting the performance requirements.

3.1.5 Material Selection and Performance-Oriented Packaging

Designing a performance-oriented packaging requires the selection of materials. However, the selection is not completely left to the designer. The regulations restrict to some extent the materials that may be used to create a package. For example, standards are presented in 49 CFR 178 for boxes constructed of steel, aluminum, natural or reconstituted wood, plywood, fiberboard, or plastic. No standards are established for use of other materials such as brass or paperfaced expanded polystyrene board. Use of a box constructed from materials other than what is covered in 49 CFR 178 would require permission from the competent authority. Similar restrictions are placed on the construction of other packagings. Always verify that the material selected is permitted by the regulations for the type of packaging being designed.

Always select material compatible with the material to be transported and the other parts of the packaging. When possible select authorized materials that are covered by standard specifications. Use of material described by standard specifications assures that the properties that serve as the basis for safety will be uniform. For materials not described by a standard specification it is necessary to establish some method that assures consistence of the material. For example, testing the batches to verify properties of importance. Some material properties of importance are listed in Table 3-2. The material properties that will impact the safety provided by the packaging need to be controlled within the limits required by their use. For the material selected verify that the properties of importance will not be adversely impacted by the manufacturing process. For example, the fracture toughness of some materials can be reduced by forming or bending. Also verify that the materials will not be adversely impacted by the environments that will be encountered during use and transportation. For example, exposure of stainless steel to chlorides may result in stress cracking failure in some applications.

When selecting materials, keep in mind that you need to be able to show that the materials used in the packages tested is identical to the materials used in the packages transported. Document the materials selected and used to the extent necessary to show the properties of importance to safety are identical.

Table 3-2. Material Properties of Importance When Designing Packaging.

Minimum yield strength
Minimum tensile strength
Percentage elongation
Percentage reduction of area
Youngs modulus
Poisson's ratio
Fatigue curves
Creep threshold temperature corresponding to 1 million years creep rupture life
Fracture toughness
Coefficient of thermal expansion
Chemical composition ranges
Heat treatment
Density
Chemical composition
Heat capacity
Thermal conductivity
Melting temperature
Emissivity

3.2 EXPERIENCE BASED CONSIDERATIONS

The following sections identify potential problem areas that arise when designing a performance-oriented packaging. The areas have been identified through the experience gained in designing and certifying radioactive material packaging and through information exchanges sponsored by the DOT.

3.2.1 Experience Based on Radioactive Material Packaging

In the DOE community most performance-oriented packaging design and development experience results from meeting radioactive material packaging needs. While the experience is valid, it must be applied with caution.

Caution is required because of differences in the certification testing and the quantity of packaging normally constructed. With radioactive material packaging the testing organization is permitted to use a single packaging to conduct certification testing. In fact, with a Type B package one is required to carry out the hypothetical accident test sequence on the same packaging. With performance-oriented packaging the regulations require conducting the test using a prescribed minimum number of packagings. New packages must be used for each test except where reuse is specifically permitted or required. With radioactive material packaging usually only a few packagings are built to the same design. Building a single packaging for use is not unusual, building more than a thousand is unusual. For performance-oriented packaging the reverse of this is true. These differences permit the use of costly production techniques for radioactive material packagings that may not be cost effective when producing performance-oriented packagings.

The following considerations are based on problems identified through experiences with the design and testing of Type A and Type B packagings.

1. Inability to manufacture packaging that reproduces the tested prototype. Several packages were built. Tests were conducted on some of the units, the rest were used. When additional units were needed, the original packaging could not be reproduced.

To avoid this problem have the design reviewed by personnel knowledgeable in the manufacturing techniques required to produce the packaging before building the test packagings. Assure that the design can be cost effectively produced.

2. Inability to document what was tested. A series of packages were assembled for testing from material in storage area that contained several similar types of material. After testing it could not be verified which of the materials had been used. The materials performance characteristic differed enough that test was invalidated.

To avoid this problem be sure to document the materials and techniques of construction to the extent necessary to reproduce units that are identical to the tested packagings.

3. Inability to document that tested and production were identical packaging. A series of packages were constructed for testing. Later units were built using a slightly modified production technique. Evaluation could not show the tested units and productions to be identical.

To avoid this problem be sure that after testing any changes to manufacturing techniques are evaluated to extent necessary to demonstrate that production units are identical to the tested packagings.

4. Inability to document all design requirements. A series of packages were constructed and tested. Review of the documentation indicated that several design requirements had not been evaluated to the extent required to verify all design requirements were met. Examples of areas requiring additional evaluation or testing are the ability of the packaging to withstand cold temperature and reduced pressure.

To avoid this problem identify the design requirements and document how each requirement is met by the packaging design on a point by point basis. Have an independent check of the documentation by personnel knowledgeable of the requirements.

5. Inability of design documentation to assure identical units are produced. A series of packages were constructed and tested using a design that depended on a component that was a DOT specification packaging. The designer depending on the DOT specification did not identify the component with additional detail. Later packaging built did not meet the performance requirements even though the component was as specified. Review of the components showed that while meeting the required specification they were a not identical to the original unit. The differences resulted from a variation in the construction permitted by the DOT specification.

To avoid this problem identify all components to the extent necessary to produce identical units. Watch closely that permitted variations within purchased items will not invalidate ability of design to meet performance requirements.

6. Inability of design documentation to assure identical units can be assembled from standard components. A series of packages were constructed and tested using a design that depended on standard boxes and bottles. Later packaging built could not be closed because of interference between tops of bottles and box closure. The performance requirements could not be met even though the components were as specified. The problem resulted from a failure to evaluate the variation permitted by the standard design.

To avoid this problem be sure to evaluate the impact of permitted tolerances, including those established by component manufactures, on the design and on the packagings ability to meet the performance requirements.

3.2.2 Experience Based on Performance-Oriented Packaging

The DOT maintains various methods of information exchange aimed at improving the safety associated with the transportation of hazardous materials. Section 2.3 of this document identifies the HMIX database and how to obtain access. The HMIX provides access to information on the various DOT activities used for exchanging information. The information that follows was identified through use of the DOT information exchange activities.

1. At a meeting of third-party certifiers questions were raised asking if a third-party certifier or manufacturer could certify packagings without knowledge of the contents to be placed in the packaging.

The response to the questions indicated that the packagings could be certified to a specific packing group level and for a specified maximum gross weight or specific gravity. The package could then be used for other hazardous materials so long as the packaging test requirements are equal to or less severe than the levels to which the packaging was tested. Additionally, the package must be assembled and closed in the same manner as the tested package.

2. At a meeting of third-party certifiers questions were raised asking if the shipper can change the inner bottles of a combination packaging without having to conduct certification testing.

The response to the questions indicated substitution of a bottle of the same or smaller size and the same or similar design and construction may be made without further testing provided the bottle being substituted is at least as strong as the bottles originally tested and other conditions that were specified in the notice to the shipper are also met.

3. At a meeting of third-party certifiers questions were raised asking what provisions were made for packagings that are not currently covered under the regulations. For example, boxes made of paperfaced expanded polystyrene board.

The response to the questions indicated that packagings that do not meet the specification in the regulations can be used if they are approved by the appropriate competent authority. The United States competent authority is the Director, Office of Hazardous Materials Transportation (OHMT). An approval for such a packaging may be obtained by writing to OHMT requesting a technical review of the proposed packaging. This provision is for packagings that can be shown to be equally effective and able to successfully withstand the performance tests.

4. At a meeting of third-party certifiers a discussion was held about what requirements UN packagings should be certified.

The recommendation to third-party certifier was that the packagings be certified to the DOT (49 CFR, post HM-181), ICAO and IMDG regulations because of the fact that foreign governments do not always recognize 49 CFR. The recommendation was to assure that the packagings could move internationally without difficulty. The recommendation stressed the importance of being familiar with all sets of regulations. The impact of the mode of transportation on requirements and the need to note differences on test reports was identified.

5. At the third party meeting questions were raised about someone conducting retesting and continuing to use the third party certification number.

The response to the questions indicated that this was acceptable so long as the testing was periodic retesting and not recertification testing.

6. At the third party meeting a question was raised about comparing packagings being produced to packagings that were originally tested rather than actually performing all the required tests.

The response to the questions was that 49 CFR 178.601(c)(2) requires that you must do all the tests.

Note the difference between this requirement and that for radioactive material packaging. For performance packaging testing must be conducted, comparison and evaluation are not permitted.

7. At the third party meeting a question was raised if the packagings certification tested were required to come from production.

The response to the questions was that the tester should document exactly what was tested. The manufacturers must insure that the packagings actually produced are identical to those that were tested.

8. At the third party meeting a question was raised if a 1 quart glass bottle could be placed inside of the 1 gal paint can that comprised the inner container of a certified combination packaging and be shipped by air without additional testing. The bottle was noted not to meet the pressure test requirements.

The response to the questions was that the glass bottle constitutes additional packaging not required. The bottle inside of the can would be covered by the original certification providing the bottle will not adversely affect the results of the required testing the packaging had passed.

9. At the third party meeting a question was raised if single tested and approved packages (e.g., steel drums or cans) that people must overpack for passenger aircraft, must be retested as in a corrugated overpack box.

The response to the questions was if a combination packaging with a UN standard packaging as an outer packaging is required, the steel inner packaging must be tested in the outer corrugated box. If the packaging prescribed for air transportation is UN standard combination packaging, the combination must be tested.

Note the response in Item 6. For performance packaging the required testing must be conducted, comparison and evaluation are not permitted.

10. At the third party meeting questions were raised as to what constitutes a different packaging and different packaging manufacturer.

The response to the questions indicated that each packaging design required testing for each manufacturer of that design. It was noted that changes in the design such as a change from one plastic resin to another requires retesting of the packaging. If a single packaging manufacturer is using a number of different material suppliers, packagings manufactured from each suppliers material must be tested separately unless the packaging manufacture can ensure that the materials are virtually identical (e.g., fiberboard, materials have the same burst strength, construction, Cobb Rating, etc.). Each different manufacture is subject to the testing requirements even if using materials and design the same as another manufacture.

11. At the third party meeting a discussion of the information contained in the UN series of markings was held.

During the discussion it was noted that the markings do not tell you everything about the use of the packaging. For example, in 49 CFR 178.601 DOT has authorized a number of variation to packagings that are permitted without further testing of a packaging. When a package is used under one of these variations, the variation will not be indicated in the marking or test certification report. There are also a number of provisions in HM-181, Section 173.24a, for the use of packagings based on their package markings. For instance, a single or composite packaging tested and marked for liquids may be used for certain solids. Also a package tested and marked of Packing Group I liquids may also be used for Packing Group II and III liquids with higher specific gravity. It was noted that these provisions do not extend to combination packagings. A combination packaging must be tested separately when used for solid and liquid contents.

12. At the third party meeting a question was raised about the maximum gross weight marking of a packaging tested with water.

The response to the questions indicated that the maximum gross mass marking would be the mass achieved by filling the packaging 98 percent full with a 1.2 specific gravity material. It was noted that the stacking test would have to be conducted based on the weight of packagings filled with 1.2 specific gravity material.

13. At the third party meeting a questions was raised about conducting vibration testing.

The response to the questions indicated that a package must be capable of meeting the vibration standard in 49 CFR 178.608, but that actual testing was not required. The packaging requirement is that each non-bulk packaging be capable of withstanding the test. Third party laboratories were advised that if they did not conduct the vibration test that the reasons for not testing should be noted on the test and certification report. It was pointed out that the third party laboratories were not absolved of the responsibility for certifying a packaging that does not comply with the vibration standard by such a statement.

4.0 REFERENCES

4.1 U.S. DEPARTMENT OF ENERGY ORDERS

DOE Order 1540.1, *Materials Transportation and Traffic Management*, U.S. Department of Energy, Washington, D.C.

DOE Order 1540.2, *Hazardous Materials Packaging for Transport - Administrative Procedures*, U.S. Department of Energy, Washington, D.C.

DOE Order 5480.3, *Safety Requirements for the Packaging and Transportation of Hazardous Materials, Hazardous Substances, and Hazardous Wastes*, U.S. Department of Energy, Washington, D.C.

4.2 CODE OF FEDERAL REGULATIONS

49 CFR Subchapter C, "Hazardous Materials Regulations" Title 49, *Code of Federal Regulations*, Parts 171-180, as amended, U.S. Department of Transportation, Washington, D.C.

DOT Docket HM-181, 1991, "Performance-Oriented Packaging Standard Revision and Response to Petition for Reconsideration-Final Rule," 49 CFR, Part 106, Research and Special Programs Administration, Washington, D.C.

4.3 INTERNATIONAL REGULATIONS

International Maritime Dangerous Goods (IMDG) Code, current edition, International Maritime Organization, London, United Kingdom.

Technical Instructions for the Safe Transport of Dangerous Goods by Air, current edition, International Civil Aviation Organization, Montreal, Quebec, Canada.

Recommendations on the Transport of Dangerous Goods, current edition, United Nations.

Dangerous Goods Regulations, current edition, International Air Transport Association, Montreal, Canada.

4.4 U.S. DEPARTMENT OF TRANSPORTATION PUBLICATIONS

Hazardous Materials Information Exchange (HMIX): User's Guide, Federal Emergency Management Agency and the U.S. Department of Transportation, November 1987, Washington, D.C.

APPENDIX A
MATERIAL CHARACTERIZATION CHECK LIST

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APPENDIX A

MATERIAL CHARACTERIZATION CHECK LIST

This check list is intended as a guide to and documentation for the information needed to classify a hazardous material for transport, in accordance with Department of Transportation (DOT) regulations.

The following discusses the information to be entered in the various sections of the form.

CHECK LIST IDENTIFICATION

The following instructions are for Section A of the check list.

- Write in today's date.
- Write in the check list identification (ID) number. The check list ID number should be a number or combination of numbers and letters unique to the specific material being characterized.
- Write in the name of the cognizant person. The cognizant person should be someone who can answer questions about the material characterization.
- Write in the phone number and the organization of the cognizant person.

MATERIAL DESCRIPTION

The DOT requires identification of the proper shipping name. An accurate material description is required to assure selection of the proper shipping name. Identification of the chemical name of the material is an important and often difficult part of the description. The following provides some guidance for selecting the chemical name of the material to be shipped.

Examples of specific chemical (or technical) names are hydrochloric acid and dichlorodifluoromethane. Examples of generic chemical names are acid and refrigerant gas. Examples of industrial or commercial names are cleaner and Freon².

²A trademark of E. I. duPont de Nemours and Company.

When the material being shipped is described by a chemical-like name, it is often a challenge to know how to comply with all transport regulations. Primarily, this is because there are many synonyms for most chemicals. If the material is described by a synonym that is not listed in the DOT HMT (49 CFR 172)¹, the chemical could be shipped as a nonhazardous material even though it actually is listed by DOT under some other name as a hazardous material.

For example, the following are listed as synonyms in a database of hazardous substances:

1. Azide	9. Nci-co6462
2. Azium	10. Nsc 3072
3. Azoture de sodium	11. Smite
4. Hydrazoic acid, sodium salt	12. Sodium azide
5. Kazoe	13. Sodium, azoture de
6. Natriumazid	14. Sodium di azoturo
7. Natriummazide	15. U-3886.
8. Nemazyd	

Only one of these names is listed in the HMT; "sodium azide" is listed with Hazard Class 6.1, packing group II, UN-1687, and labeled poison. None of the other names even reference sodium azide. A material described as "smite" would be shipped as a nonhazardous material unless the toxic nature of the material was recognized, and it was shipped as "Poisonous solids, n.o.s." Hazard Class 6.1, and UN-2811. Its toxic nature would have to be adequately known to assign it the correct packing group.

Even if "smite" were shipped as a hazardous material, the emergency responders would have to use a synonym cross-reference in their database to determine what precautions they needed to take in handling any emergency. Thus, the material description should include as many names and synonyms as are known so the material can be identified as precisely as possible.

Another example of synonyms involves Freon, a commercial name for refrigerant gas, not listed in the HMT (49 CFR 172). Refrigerant gas, n.o.s. is listed as nonflammable gas with UN-1078. There are 16 different refrigerant gases listed in the HMT. Each is listed with a different UN number for identification by emergency responders. There is no way for an emergency responder to use a cross reference in a database to determine the precise material being shipped. This is one reason DOT requires the proper shipping name to be as specific as possible. Thus, the material "dichlorodifluoromethane" should be shipped with

¹49 CFR 172, "Hazardous Materials Tables and Hazardous Materials Communications Requirements and Emergency Response Information Requirements," Title 49, *Code of Federal Regulations*, Part 172, as amended, U.S. Department of Transportation, Washington, D.C.

that as the proper shipping name instead the more generic "Refrigerant gas, n.o.s." Choosing the correct proper shipping name is more likely if the material description includes as many names and synonyms as possible.

The following are instructions for completing Section B of the check list.

- Write in the name that the material custodian normally uses when referring to this material in the space provided for package contents.
- Check the proper blank to indicate what physical form the material will have when it is being transported (e.g., solid, liquid, gas, or other).
- List the specific gravity and vapor pressure if the material will be shipped as a liquid.
- Write in the specific chemical (i.e., technical) name of the material. The specific chemical name is the recognized identification currently used in scientific or technical handbooks, journals and texts (49 CFR 171.8).
- Write in the generic chemical name.
- Write in the industrial or commercial name.
- Write in all known synonyms.
- Write in "yes" or "no" to the question about whether or not the material is a waste.

MATERIAL CHARACTERISTICS

This information is used to determine how the material is to be transported. These characteristics determine the following:

1. Correct packaging for the material
2. What performance tests the packaging must withstand
3. How the packaging is labeled
4. How the packaging should be marked.

Thus, some time and effort are warranted to have this information correct and complete. Additional sheets of paper should be used, if appropriate.

The following instructions are for Section C of the check list.

- Check the characteristics that apply to the material (e.g., flammability, toxicity, chemical instability, corrosivity, or explosivity).
- If the material is flammable or combustible, write the flashpoint of the material.
- If the material is toxic, write the LD-50 value (if known).
- If the material would melt, sublime, solidify, or otherwise change phase because of temperature or pressure changes that might occur during transport (i.e., chemical instability), include that information. If any potential phase change is accompanied by a sudden release of heat or energy, inform the transportation specialist of this explosivity characteristic.
- If the material is corrosive toward skin, metal, plastic, or other material, include the degree of corrosivity and the materials that are attacked.
- If the material has any other properties that might make it unpleasant or dangerous for the workers during transport, provide that information.
- Contact the transportation specialist about any unusual circumstances or questions about describing the materials characteristics. Contact the transportation specialist if the material has any tendencies toward flammability, toxicity, chemical instability, corrosivity, explosivity, or any other unpleasant or unusual characteristic.

CHEMICAL COMPATIBILITY

The following are common packaging components:

- Steel
- Other metals
- Plywood
- Polyvinyl chloride and other plastics
- Polyethylene
- Aluminum
- Wood
- Fiberboard
- Glass
- Stoneware
- Porcelain.

Elastomers, rubber, and various gasket materials are used for seals and gaskets. Thus, these and other less common materials may come into contact with hazardous materials during transport. The material custodian may need to discuss this with the packaging engineer or transportation specialist before completing Section D of the check list.

The chemical compatibility of materials is sometimes sensitive to low concentrations of impurities. In these instances, the custodian of these materials will generally be better informed about chemical compatibilities than any one else. Therefore, this information must be conveyed to the packaging engineer or transportation specialist.

In Section D of the check list, describe any chemical incompatibilities that are known, suspected, or questionable. If experience has shown specific materials are definitely compatible, include that information.

If uncertain about how to complete Section D of this check list, communicate directly with a packaging engineer or transportation specialist.

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MATERIAL CHARACTERIZATION CHECK LIST

Date: March 12, 1992

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A. Material Characterization Check List Identification

Date _____ Check List ID Number _____

Cognizant Person _____ Phone _____

Cognizant Organization _____

B. Materials Description

Package Contents _____

Physical Form (check one) Solid ☐ Liquid ☐ Gas ☐ Other ☐If the material is a liquid list its specific gravity, _____
and its vapor pressure at 131°F (55°C), _____

Specific chemical name (technical name) _____

Generic chemical name, _____

Industrial or Commercial name, _____

All known synonyms. _____

Is this waste material? _____

C. Material Characteristics

Does the material have any characteristics of:

Flammability ☐, Toxicity ☐, Chemical Instability ☐,Corrosivity ☐, Explosivity ☐, or other characteristicwhich may make it hazardous during transport or accident? _____
(Check all applicable)Provide details about any characteristics checked. Identify additional sheets
with ID number above.

(continued on next page)

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[illegible][illegible]

List all common packaging component materials incompatible with the material to be shipped. _____

APPENDIX B
PACKAGING SELECTION CHECK LIST

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APPENDIX B

PACKAGING SELECTION CHECK LIST

This check list is a guide to and documentation of the information needed to select a package for a hazardous material in compliance with the U.S. Department of Transportation (DOT) regulations. A package engineer or a transportation specialist should fill out this check list. Information from the Material Characterization Check List is used during the completion of this check list to identify all applicable hazard classes for the material to be shipped. Thus, the Packaging Selection Check List ensures subsidiary hazard classes are considered in selecting the packaging. Finally, the Packaging Selection Check List requires consideration of any special packaging provisions identified in Column 7 of the Hazardous Materials Table (HMT).

The following discusses the information to be entered in various sections of the form.

CHECK LIST IDENTIFICATION

The following are instructions for filling out Section A of the check list.

- Write in today's date.
- Write in the check list identification (ID) number. The check list ID number should be a number or combination of numbers and letters unique to the specific material being characterized.
- Write in the name of the cognizant person. The cognizant person should be someone who can answer questions about the package selection.
- Write in the phone number and the organization of the cognizant person.

MATERIALS IDENTIFICATION

The following are instructions for filling out Section B of the check list.

- Fill in the common name of the material being shipped on the line for package contents.
- Put a check in the blank next to the physical form the material will have during transport. This information should be the same as that on the referenced Material Characterization Check List (Section B).
- Write in the date and number of the Material Characterization Check List that describes the material to be transported in the packaging being selected.

HAZARD CLASS

Section C cites the references in 49 CFR 173¹ for the hazard class and packing group definitions. The information from the Materials Characterization Check List is used in conjunction with the references to determine which hazard class definitions are met.

The following are instructions for completing Section C of the check list.

- Use the information on the Material Characterization Check List along with 49 CFR 173 to determine which hazard class definitions the material meets. **NOTE:** The material may meet more than one definition. For example, it could be a flammable solid (Hazard Class 4.1) if it meets the definition in 49 CFR 173.124 and also a poisonous material (Hazard Class 6.1) if it also meets the definition in 49 CFR 173.132. In this example, list both 4.1 and 6.1 as the hazard classes that the material meets. When selecting a packaging, be sure to list all hazard classes whose definitions were met in the spaces provided.
- Determine if the material, or one of its synonyms, is listed in the HMT appendix, 49 CFR 172.101 Appendix². Write down the information listed in the space provided as follows.
 - If the material is listed in this appendix, it is regulated by the U.S. Environmental Protection Agency as a hazardous substance under Section 101(14) of the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)*³.
 - If more than a "regulated quantity" (RQ) is being shipped in a single package, it must be packaged as a hazardous material and comply with the DOT regulations.
- List the appropriate RQ value in the space provided.
- Check on the Material Characterization Check List if the material is to be transported as a hazardous waste.

¹49 CFR 173, "Shippers-General Requirements for Shipments and Packaging," Title 49, *Code of Federal Regulations*, Part 173, as amended, U.S. Department of Transportation, Washington, D.C.

²49 CFR 172, "Hazardous Materials Tables and Hazardous Materials Communications Requirements and Emergency Response Information Requirements," Title 49, *Code of Federal Regulations*, Part 172, as amended, U.S. Department of Transportation, Washington, D.C.

³*Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)*, 42 USC 9601, et seq.

- Write down the correct hazard class for the material to be shipped. The correct hazard class should be determined in accordance with 49 CFR 173.2a and 172.101(c)(12)(iii).

PACKING GROUP

Section D of the check list provides for identification of the correct packing group for Hazard Classes 3, 4.1, 4.2, 4.3, 5.1, 5.2, 6.1, 6.2, 8, 9, and for other regulated materials (ORM-D). The definitions cited in Section C of the check list are used to make these determinations. **NOTE:** If the material is a hazardous waste or hazardous substance (determined in Section C), the requirements in 49 CFR 172.101(f) must also be met.

The following instructions are for completing Section D of the check list.

- Write in the assigned packing group.

PROPER SHIPPING NAME

Section E of the check list provides space for identifying the proper shipping name using the requirements in 49 CFR 172.101(b) and 172.101(c).

The following instructions are for completing Section E of the check list.

- Using information from Section C, select the proper shipping name from the HMT.
- List the name in the space provided in the check list. **NOTE:** Proper shipping names are listed in Roman type in the HMT.

Materials that meet the following: (1) are not defined in any hazard class, (2) are listed in the HMT appendix, and (3) are to be shipped in packages containing more than an RQ per package must be categorized as Class 9 and assigned one of the following HMT proper shipping names:

- Environmentally hazardous substances, liquid, n.o.s.
- Environmentally hazardous substances, solid, n.o.s.
- Other regulated substances, liquid, n.o.s.
- Other regulated substances, solid, n.o.s.

Materials that do not meet any definition of hazard class but do qualify as hazardous waste must be categorized as Class 9 and assigned one of the following HMT proper shipping names:

- Waste environmentally hazardous substances, liquid, n.o.s.

- Waste environmentally hazardous substances, solid, n.o.s.
- Hazardous waste, liquid, n.o.s.
- Hazardous waste, solid, n.o.s.

AUTHORIZED PACKAGINGS

Section F provides space for identifying the section number of 49 CFR 173 describing the authorized nonbulk packagings. This information is found in HMT Column 8B associated with the correct proper shipping name, hazard class and division, and packing group.

The following instruction are for completing Section F of the check list.

- Write in the paragraph number from Column 8B of the HMT.

PACKAGING SELECTED

Packaging selection may be an repetitive process. Review the authorized packagings listed in the paragraph of 49 CFR 173 identified in Section F and tentatively select a packaging. A tentative selection from the authorized list would be based upon quantity to be transported, ease of use, packaging cost, packaging availability, and other relevant factors. **NOTE:** If the tentative selection is not disqualified by the special provisions in Column 7 of the HMT, the tentative selection could become the final selection. The selected packaging should be identified using nomenclature specific to 49 CFR.

The following are instructions for completing Section G of the check list.

- List the package type (e.g., steel drum) in the first space.
- List both the inner and outer packaging types in the space provided if combination packaging (e.g., a glass bottle inside a fiberboard box) is selected.
- Identify the packaging identification code (e.g., for a steel drum the code would be 1A1). The code rules are described in 49 CFR 178.502.¹
- Identify the packaging marking required by 49 CFR 178.503 in the space provided (e.g., for a steel drum the marking would be /Y400/S or /X1.4/150). These markings identify packaging performance test requirements and capacity limits.

¹49 CFR 178, "Shipping Container Specification," Title 49, *Code of Federal Regulations*, Part 178, as amended, U.S. Department of Transportation, Washington, D.C.

- Identify any special provisions that start with the letter "N" (for nonbulk packagings) or start with a number (for multimodal). There are no special provisions specifically for the highway transportation mode.

NOTE: Column 7 of the HMT lists special provisions (additional packaging requirements) for certain materials being shipped. Some of these special provisions are applicable only to bulk packagings. Others apply to packages shipped by a specific mode of transportation, such as air. The special provisions in each category are identified by a unique prefix. Because the scope of this document includes nonbulk packagings being transported by highway only, the special provisions applicable to those categories need to be identified on the check list.

- If all of the special provisions identified were met by the package selected, write "yes." If not, write "no," and explain why.
- If the packaging authorized for this material was relatively economical, write "yes." If not, write "no."
- If the packaging was easy to use, write "yes." If not, write "No."

MATERIAL CHARACTERIZATION CHECK LIST

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A. Packaging Selection Check List Identification

Date _____ Check List ID Number _____

Cognizant Person _____ Phone _____

Cognizant Organization _____

B. Materials Characterization Check List

Package Contents _____

Physical Form (check one) Solid _____ Liquid _____ Gas _____ Other _____

What is the date and ID number on the latest Materials Characterization Check List for this material?

Date _____ ID Number _____

C. Hazard Class (172.101(d))

Citation for Hazard Class and Packing Group definitions:

Hazard 49 CFR Reference for:

Class Hazard Packing

and Class Group

<u>Div.</u>	<u>Name of Hazard Class or Division</u>	<u>Definition</u>	<u>Assignment</u>
None	Forbidden Materials	173.21	None
None	Forbidden Explosives	173.53	None
2.1	Flammable Gas	173.115	None
2.2	Non-flammable Compressed Gas	173.115	None
2.3	Poisonous Gas	173.115	None
3	Flammable and Combustible Liquid	173.120	173.121
4.1	Flammable Solid	173.124	173.125(b)
4.2	Spontaneously Combustible Mtl	173.124	173.125(c)
4.3	Dangerous When Wet Material	173.124	173.125(d)
5.1	Oxidizer	173.128	173.127
5.2	Organic Peroxide	173.128	173.129
6.1	Poisonous Material	173.132	173.133
6.2	Infectious Substance	173.134	173.134(c)
7	Radioactive Material	173.403	None
8	Corrosive Materials	173.136	173.137
9	Miscellaneous Hazardous Material	173.140	173.141
None	Other Regulated Material, ORM-D	173.144	173.145

MATERIAL CHARACTERIZATION CHECK LIST

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Which Hazard Class definitions, cited above, does the material meet

a. _____ b. _____ c. _____

How is this material, or one of its synonyms,

- a. listed in the HMT Appendix (172.101(a)(8)) _____
 - b. listed in the Hazardous Material Table (HMT) in Roman Type (49 CFR 172.101) _____
 - c. qualified as Hazardous Waste (40 CFR 261.3) _____
- What is the RQ amount _____

The assignment of the Hazard Class, and Division, must be consistent with definitions cited above. Materials which do not meet any definition cited above but are listed in the Appendix to the HMT or qualify as Hazardous Waste are assigned Hazard Class 9.

For materials with multiple hazards the Hazard Class assignment must be in accordance with 49 CFR 173.2a and 172.101(c)(12)(iii).

What is the correct Hazard Class for the material to be shipped?

D. Packing Group (172.101(f) and 173.2)

For Hazard Classes 3 through 9 the Packing Group is assigned in accordance with the Packing Group definitions cited in the above tabulation (and requirements of 49 CFR 172.101(f) for hazardous wastes and hazardous substances).

What is the assigned Packing Group? _____

E. Proper Shipping Name (172.101(c)(12)(i))

The Proper Shipping Name must be the most specific name appearing in the Hazardous Materials Table which occurs on the same line with the appropriate Hazardous Class and the Packing Group.

What is the Proper Shipping Name? _____

F. Authorized Packagings (172.101(i))

The package used must be authorized in the Hazardous Materials Table on a line having the correct entries for the Proper Shipping Name, Hazard Class, Hazard Division, and Packing Group number.

What paragraph number is listed in HMT Column 8B? _____

MATERIAL CHARACTERIZATION CHECK LIST

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G. Packaging Selected

Which of the following packaging types was selected? _____

1. Steel drum
2. Aluminum drum
3. Metal drum other than steel or aluminum
4. Plywood drum
5. Fiber drum
6. Plastic drum and jerry can
7. Wooden barrel
8. Steel jerrican
9. Steel or aluminum box
10. Natural wood box
11. Plywood box
12. Reconstituted wood box
13. Fiberboard box
14. Plastic box
15. Woven plastic bag
16. Plastic film bag
17. Textile bag
18. Paper bag
19. Composite packagings with inner plastic receptacles
20. Composite packaging with inner glass, porcelain, or stoneware receptacles
21. Combination packaging

If this is a combination packaging what is:

Outer Packaging? _____

Inner Packaging? _____

What is the package identification code (178.502)? _____

What marking is on this package to designate the packing group test requirements and capacity limits (178.503)? _____

What special provisions, either "numeric" or starting with the letter "N", are listed in HMT Column 7 on the line with the correct Proper Shipping Name, Hazard Class and Packing Group (172.101(h) and 172.102)?

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**SPECIAL
PROVISION BRIEF DESCRIPTION OF THAT PROVISION**

Were all special provisions identified above met by the package selected?

In comparison with other packaging configurations authorized for this material, is the packaging selected relatively economical? _____
Is it relatively easy to use? _____

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