SANDIA REPORT

SAND2005-40594059
Unlimited Release
Printed: June 2005

Transportation of Hazardous Evidentiary Material

D.M. Osborn

Prepared by
Sandia National Laboratories
Albuquerque, New Mexico 87185 and Livermore, California 94550

Sandia is a multiprogram laboratory operated by Sandia Corporation,
a Lockheed Martin Company, for the United States Department of Energy's
National Nuclear Security Administration under Contract DE-AC04-94AL85000.

Issued by Sandia National Laboratories, operated for the United States Department of Energy by Sandia Corporation.

Available to DOE and DOE contractors from
U.S. Department of Energy
Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, TN 37831

Telephone: (865)576-8401
Facsimile: (865)576-5728
E-Mail: reports@adonis.osti.gov
Online ordering: http://www.osti.gov/bridge

Available to the public from
U.S. Department of Commerce
National Technical Information Service
5285 Port Royal Rd
Springfield, VA 22161

Telephone: (800)553-6847
Facsimile: (703)605-6900
E-Mail: orders@ntis.fedworld.gov
Online order: http://www.ntis.gov/help/ordermethods.asp?loc=7-4-0#online

SAND2005-40594059
Unlimited Release
Printed June 2005

Transportation of Hazardous Evidentiary Material

D.M. Osborn
Materials Transportation Security and Risk Assessment Department
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185-0718

ABSTRACT

This document describes the specimen and transportation containers currently available for use with hazardous and infectious materials. A detailed comparison of advantages, disadvantages, and costs of the different technologies is included. Short- and long-term recommendations are also provided.

Executive Summary

The Federal Bureau of Investigation's Hazardous Materials Response Unit currently has hazardous material transport containers for shipping 1-quart paint cans and small amounts of contaminated forensic evidence, but the containers may not be able to maintain their integrity under accident conditions or for some types of hazardous materials. This report provides guidance and recommendations on the availability of packages for the safe and secure transport of evidence consisting of or contaminated with hazardous chemicals or infectious materials. Only non-bulk containers were considered because these are appropriate for transport on small aircraft. This report will addresses packaging and transportation concerns for Hazardous Classes 3, 4, 5, 6, 8, and 9 materials. If the evidence is known or suspected of belonging to one of these Hazardous Classes, it must be packaged in accordance with the provisions of 49 CFR Part 173.

The anthrax scare of several years ago, and less well publicized incidents involving unknown and uncharacterized substances, has required that suspicious substances be sent to appropriate analytical laboratories for analysis and characterization. Transportation of potentially hazardous or infectious material to an appropriate analytical laboratory requires transport containers that maintain both the biological and chemical integrity of the substance in question. As a rule, only relatively small quantities will be available for analysis. Appropriate transportation packaging is needed that will maintain the integrity of the substance, will not allow biological alteration, will not react chemically with the substance being shipped, and will otherwise maintain it as nearly as possible in its original condition.

The recommendations provided are short-term solutions to the problems of shipping evidence, and have considered only currently commercially available containers. These containers may not be appropriate for all cases. Design, testing, and certification of new transportation containers would be necessary to provide a container appropriate for all cases.

Table 1 provides a summary of the recommendations for each class of hazardous material.

Table 1: Summary of Recommendations

	Container	**Cost**
Hazard Class 3, 4, 5, 8, or 9 Small Containers	1-quart paint can with Armlock™ seal ring	LabelMaster® $2.90 each
	TC Hazardous Material Transport Container	Currently in Use

Table 1: Summary of Recommendations (continued)

	Container	**Cost**
Hazard Class 3, 4, 5, 8, or 9 Large Containers	55-gallon open or closed-head steel drums	All-Pak, Inc. $58.28 - $73.62 each
	95-gallon poly overpack	LabelMaster® $194.50 each
Hazard Class 6 Division 6.1 Poisonous by Inhalation (PIH) Small Containers	1-liter glass container with plastic coating	LabelMaster® $3.35 – $3.70 each
	TC Hazardous Material Transport Container	Currently in Use
Hazard Class 6 Division 6.1 Poisonous by Inhalation (PIH) Large Containers	20 to 55-gallon PIH overpacks	LabelMaster® $142.50 - $170.50 each
	65 to 95-gallon poly overpacks	LabelMaster® $163.30 - $194.50 each
Hazard Class 6 Division 6.2 Infectious Material Small Containers	1-liter transparent container	Currently in Use
	Infectious Substance Shipper	Source Packaging of NE, Inc. $336.00 each
Hazard Class 6 Division 6.2 Infectious Material Large Containers	None Commercially Available	N/A
	None Commercially Available	N/A

Table of Contents

List of Figures

List of Figures

List of Tables

Acronyms

CFR	Code of Federal Regulations
CO_2	Carbon Dioxide
DOT	Department of Transportation
DOT-E	Department of Transportation - Exemption
FBI	Federal Bureau of Investigation
Gal.	gallon
kg	kilogram
kPa	kilopascal
L	liter
lbs	Pound
LD_{50}	Lethal Dose - 50
mg	milligram
mL	milliliter
mm	millimeter
^oC	Degree Celsius
PIH	Poisonous by Inhalation
PVC	Poly-Vinyl Chloride
Qt.	quart
UN	United Nations

(This page left intentionally blank.)

1.0 Introduction

The anthrax scare of several years ago, and less well publicized incidents involving unknown and uncharacterized substances, has required that suspicious substances be sent to appropriate analytical laboratories for analysis and characterization. Transportation of potentially hazardous or infectious material to an appropriate analytical laboratory requires transport containers that maintain both the biological and chemical integrity of the substance in question. As a rule, only relatively small quantities will be available for analysis. Appropriate transportation packaging is needed that will maintain the integrity of the substance, will not allow biological alteration, will not react chemically with the substance being shipped, and will otherwise maintain it as nearly as possible in its original condition.

The Federal Bureau of Investigation's (FBI) Hazardous Materials Response Unit currently has hazardous material transport containers for shipping 1-quart paint cans and small amounts of contaminated forensic evidence, but the containers may not be able to maintain their integrity under accident conditions or for some types of hazardous materials. There are various sizes; the TC-8 and TC-13 hazardous material containers purchased from Purified Microenvironments have an 8-inch and 13-inch diameter opening respectively. The TC containers purchased from Air Products and Chemicals, Inc. have a 4, 6, or 12-inch in diameter opening. Figure 1 shows some examples of the TC hazardous materials transport containers. The containers are constructed from all welded stainless steel-304 and rely on a double O-ring seal configuration for complete containment. The needed packaging may be available commercially, may need to be specially constructed, or may involve modification of an existing design. A single packaging material or design is not appropriate for all samples. Some packaging requirements are regulated by the U.S. Department of Transportation (DOT), as described below. This report, which addresses the needs and requests of the FBI's Hazardous Materials Response Unit, is a preliminary examination of available packaging. In preparing this report, a market survey was conducted to identify those commercial products suitable for the safe and secure transportation of hazardous or infectious materials. Only non-bulk containers were considered because these are appropriate for transport on small aircraft.

Figure 1: TC Hazardous Material Transport Containers

2.0 Purpose

This report provides guidance and recommendations on the availability of packages for the safe and secure transport of evidence consisting of or contaminated with hazardous chemicals or infectious materials. Only non-bulk containers were considered because these are appropriate for transport on small aircraft. Table 1 lists the hazardous materials classes and provides an index to the hazard class definition in 49 CFR Part 173. This report will address packaging and transportation concerns for Hazardous Classes 3, 4, 5, 6, 8, and 9 materials. If the evidence is known or suspected of belonging to one of these Hazardous Classes, it must be packaged in accordance with the provisions of 49 CFR Part 173.

3.0 Background

Three different types of packaging are used for the majority of non-bulk transportation. Packing Group I, II, and III packages are defined in 49 CFR Part 172 and 49 CFR Part 178. Packing Groups I, II, and III indicate the degree of danger presented by the material is great, medium, or minor, respectively. If more than one packing group is indicated for an entry, the packing group for the hazardous material is determined using the criteria for assignment of packing groups specified in 49 CFR Part 173.

Table 1: 49 CFR Part 173 Hazardous Material Classes

Class No.	Division Number (if any)	Name of class or division	49 CFR Reference for Definitions
None	.....	Forbidden materials	173.21
None	.....	Forbidden explosives	173.54
1	1.1	Explosives (with a mass explosion hazard)	173.50
1	1.2	Explosives (with a projection hazard)	173.50
1	1.3	Explosives (with predominately a fire hazard)	173.50
1	1.4	Explosives (with no significant blast hazard)	173.50
1	1.5	Very insensitive explosives; blasting agent	173.50
1	1.6	Extremely insensitive detonating substance	173.50
2	2.1	Flammable gas	173.115
2	2.2	Non-flammable compressed gas	173.115
2	2.3	Poisonous gas	173.115
3	.....	Flammable and combustible liquid	173.120
4	4.1	Flammable solid	173.124
4	4.2	Spontaneously combustible material	173.124
4	4.3	Dangerous when wet material	173.124
5	5.1	Oxidizer	173.127
5	5.2	Organic peroxide	173.128

Table 1: 49 CFR Part 173 Hazardous Material Classes (continued)

Class No.	Division Number (if any)	Name of class or division	49 CFR Reference for Definitions
6	6.1	Poisonous materials	173.132
6	6.2	Infectious substance (Etiologic agent)	173.134
7	.....	Radioactive material	173.403
8	.....	Corrosive material	173.136
9	.....	Miscellaneous hazardous materials	173.140
None	.....	Other regulated material: ORM-D	173.144

4.0 Class 3 Hazardous Material Packaging

Hazard Class 3 materials are defined as liquids having a flash point of not more than 60.5 ^{o}C, or any material in a liquid phase with a flash point at or above 37.8 ^{o}C that is intentionally heated and offered for transportation or transported at or above its flash point in a bulk packaging.

Hazard Class 3 material is assigned a packaging group in accordance with 49 CFR Part 172.101 Hazardous Materials Table in column 5. If the package contains more than one Class 3 material then the packaging group will be determined by Table 2.

Table 2: 49 CFR Part 173.121 Class 3 Alternate Packaging

Packaging Group	Flash Point (closed cup)	Initial Boiling Point
I	...……..	$\leq$ 35 ^{o}C
II	< 23 ^{o}C	35 ^{o}C
III	$\geq$ 23 ^{o}C	> 35 ^{o}C, and $\leq$ 60.5 ^{o}C

Two types of commercially available packaging are considered in this report: specimen containers and transportation containers.

4.1 Flammable Liquid Specimen Containers

The following All-Pak, Inc. products could be used as specimen containers.

The 1-liter glass containers can be used with the DOT-E 9168 exemption shipping package to ship flammable liquids. They are clear or amber glass specimen containers with Teflon-lined caps. The glass containers have a plastic outer liner to prevent the shattering of the container. Some containers have a large mouth opening for the

placement of limited amounts of forensic evidence contaminated with Class 3 materials. Figure 2 shows the various glass specimen containers (Models GLA-00956, GLA-00947, and GLA00968).

Figure 2: Glass Specimen Containers with Plastic Coating

The 1-gallon, closed-head steel drums have a capability to hold larger amounts of liquid, but the 2-inch bung cap limits the amount of forensic evidence. The United Nations (UN) number for this specimen container is UN-1A1/X1.5/250. 1A1 designates a closed head drum, X stands for a Packing Group I container, 1.5 is the maximum specific gravity of the contents, and 250 is the hydrostatic test pressure in kilo-pascals (kPa) to which the package has been subjected. Figure 3 shows a 1-gallon, closed-head steel drum specimen container (Model HMS-60400).

Figure 3: 1-Gallon, Closed-Head Steel Drum with 2-Inch Bung Cap

The 5-gallon, closed-head steel drum can hold a large amount of liquid, but, like the 1-gallon counterpart, the 2-inch bung cap limits the amount of forensic evidence that can be placed within it. The UN number for this specimen container is UN-1A1/Y1.8/300. The "Y" in the UN number designates this container as a Packing Group II container. Thus, it can be used to transport flammable liquids but only Packing Group II and III materials. Figure 4 shows a 5-gallon, closed-head steel drum specimen container (Model MET-03058).

Figure 4: 5-Gallon, Closed-Head Steel Drum with 2-Inch Bung Cap

The 55-gallon, closed-head steel drums can hold large amounts of liquid but, like the previous two containers, the 2-inch bung cap limits the amount of forensic evidence. The UN number for this specimen container is UN-1A1/X1.2/300 (Model MET-05210). The 55-gallon, removable-head steel drums have the capability to hold large amount of forensic evidence. The UN number for this specimen container is UN-1A2/X400/S (Model MET-03034). 1A2 designates a removable head drum, X stands for Packing Group I container, 423 is the maximum gross mass in kilograms (kg) of the contents, and S stands for solids or inner packaging that does not contain standing liquids. 30-gallon open head steel drums are also available. The UN number for the 30-gallon specimen container is UN-1A2/X300/S (Model MET-03033). Removable-head drums can be used for forensic evidence that has been contaminated with a flammable liquid so long as there are no standing liquids inside the container. Figure 5 shows a 55-gallon, closed-head steel drum specimen container.

Figure 5: 55-Gallon, Closed-Head Steel Drum with a 2-Inch Bung Cap

LabelMaster ® has several products that could be used as specimen containers.

The 1-liter PVC coated glass bottles can be used to ship flammable liquids. They are clear glass specimen containers with Teflon lined caps. The glass containers have a PVC plastic outer liner to prevent the shattering of the container. Some containers have a large mouth opening for the placement of limited amounts of forensic evidence contaminated with Class 3 materials. Figure 6 shows an example of the various types of glass specimen containers (Model KG3280R).

Figure 6: Glass Specimen Container with PVC Plastic Coating

1-gallon and 1-quart sealed paint cans are suitable for shipping flammable liquids but only for Packing Group II and III materials (Models KM28PN and KM32P). The seal is an Armlock™ ring (Models KRL1PC and KRL32UN). The containers have a large mouth opening for the placement of limited amounts of forensic evidence contaminated with Class 3 materials. Figure 7 shows a 1-quart specimen container.

Figure 7: 1-Quart Sealed Paint Can with Armlock™ Seal Ring

The 1-gallon, closed-head steel drums can hold larger amounts of liquid but the 2-inch bung cap limits the amount of forensic evidence. The UN number for this specimen container is UN-1A1/X1.5/250. Figure 3 shows a 1-gallon, closed-head steel drum specimen container (Model KM1020PD).

The 5-gallon, closed-head steel drum can hold a large amount of liquid, but the 2-inch bung cap limits the amount of forensic evidence that can be placed within it. The UN number for this specimen container is UN-1A1/X1.5/275. Figure 4 shows a 5-gallon, closed-head steel drum specimen container (Model KM5020DF).

The 55-gallon, closed-head steel drums have a capability to hold large amounts of liquid but the 2-inch bung cap limits the amount of forensic evidence. The UN number for this specimen container is UN-1A1/X1.8/300 (Model KM5516R). 20-gallon and 30-gallon closed-head steel drums are also available. The UN numbers for the 20-gallon and 30-gallon specimen containers are the same, UN-1A1/X1.2/300 (Models KM2017E1 and KM3017E2). The 55-gallon, removable-head steel drums have the capability to hold large amount of forensic evidence. The UN number for this specimen container is UN-

1A2/X430/S (Model KM5517CO). 20-gallon and 30-gallon open-head steel drums are also available. The UN numbers for the 20-gallon and 30-gallon specimen containers are UN-1A2/X175/S (Model KM2017CO) and UN-1A2/X225/S (Model KM3017CO) respectively. Removable-head drums can be used for forensic evidence that has been contaminated with a flammable liquid so long as there are no standing liquids inside the container. Figure 8 shows a 20-gallon, open-head steel drum specimen container.

Figure 8: 20-Gallon, Open-Head Steel Drum

The 55-gallon, closed-head stainless steel drums have a capability to hold large amounts of liquid but the 2-inch bung cap limits the amount of forensic evidence. The stainless steel drum is corrosion resistant and has the same capabilities as a steel drum. The UN number for this specimen container is UN-1A1/X1.8/300 (Model KM55SSTH). 20-gallon and 30-gallon closed-head steel drums are also available. The UN numbers for the 20-gallon and 30-gallon specimen containers are the same, UN-1A1/X1.5/150 (Models KM20SSDO and KM30SSDO). The 55-gallon, open-head stainless drum is corrosion resistant and has the same capabilities of the 55-gallon, removable-head steel drum. The UN number for this specimen container is UN-1A2/X430/S (Model KM55SSDO). 20-gallon and 30-gallon open-head stainless steel drums are also available. The UN numbers for the 20-gallon and 30-gallon specimen containers are UN-1A2/X160/S (Model KM20SSDO) and UN-1A2/X225/S (Model KM30SSDO) respectively. Figure 9 shows the 55-gallon, 30-gallon, and 20-gallon open- and closed-head stainless steel drum specimen containers.

Figure 9: 55-Gallon, 30-Gallon, and 20-Gallon Open- and Closed-Head Steel Drums

Table 3 lists the flammable liquids specimen containers advantages, disadvantages, and costs.

Table 3: Flammable Liquid Specimen Container Matrix

Specimen Container	Cost		
1-Liter Glass Containers	All-Pak, Inc. $40.26/case – 12/case LabelMaster® $99.00/case – 30/case	**Advantages**	• Small • Light-weight • Low cost • Can see inside container • Inert for most materials • Can be used for Packing Group I materials
		Disadvantages	• Cannot be used for large samples • Not reusable
1-Gallon Steel Drums	All-Pack, Inc. $12.15 each LabelMaster® $13.50 each	**Advantages**	• Small • Light-weight • Low cost • Can be reused • Can be used for Packing Group I materials
		Disadvantages	• Can only hold liquids • Cannot be used for large samples • Cannot see inside container
1-Gallon Paint Can 1-Quart Paint Can	LabelMaster® $3.55 each – 1Gal. $2.90 each – 1 Qt. Both prices include Armlock™ ring seal	**Advantages**	• Small • Light-weight • Low cost • Can be reused
		Disadvantages	• Cannot be used for Packing Group I materials • Cannot be used for large samples • Cannot see inside container
5-Gallon Steel Drums	All-Pak, Inc. $10.65 each LabelMaster® $17.45 each	**Advantages**	• Small • Light-weight • Low cost • Can be reused • Can be used for Packing Group I materials
		Disadvantages	• Can only hold liquids • Cannot be used for large samples • Cannot see inside container

Table 3: Flammable Liquid Specimen Container Matrix (continued)

Specimen Container	Cost		
20-Gallon, Closed-Head Steel Drums	LabelMaster® $81.70 each	**Advantages**	• Small • Light-weight when empty • Low cost • Can be reused • Can be used for Packing Group I materials
		Disadvantages	• Can only hold liquids • Cannot be used for large samples • Cannot see inside container
20-Gallon, Open-Head Steel Drums	LabelMaster® $95.85 each	**Advantages**	• Small • Light-weight when empty • Low cost • Can be reused • Can be used for Packing Group I materials • Can hold large samples
		Disadvantages	• Can only hold solids • Cannot see inside container
20-Gallon, Closed-Head Stainless Steel Drums	LabelMaster® $530.00 each	**Advantages**	• Small • Light-weight when empty • Can be reused • Can be used for Packing Group I materials • Corrosion resistant
		Disadvantages	• High Cost • Can only hold liquids • Cannot be used for large samples • Cannot see inside container
20-Gallon, Open-Head Stainless Steel Drums	LabelMaster® $530.00 each	**Advantages**	• Small • Light-weight when empty • Can be reused • Can be used for Packing Group I materials • Can hold large samples • Corrosion resistant
		Disadvantages	• High cost • Can only hold solids • Cannot see inside container

Table 3: Flammable Liquid Specimen Container Matrix (continued)

Specimen Container	Cost		
30-Gallon, Closed-Head Steel Drums	LabelMaster® $95.85 each	**Advantages**	• Small • Light-weight when empty • Low cost • Can be reused • Can be used for Packing Group I materials
		Disadvantages	• Can only hold liquids • Cannot be used for large samples • Cannot see inside container
30-Gallon, Open-Head Steel Drums	All-Pak, Inc. $37.67 each LabelMaster® $114.50 each	**Advantages**	• Small • Light-weight when empty • Can be reused • Can be used for Packing Group I materials • Can hold large samples
		Disadvantages	• Can only hold solids • High Cost • Cannot see inside container
30-Gallon, Closed-Head Stainless Steel Drums	LabelMaster® $558.00 each	**Advantages**	• Small • Light-weight when empty • Can be reused • Can be used for Packing Group I materials • Corrosion resistant
		Disadvantages	• High cost • Can only hold liquids • Cannot be used for large samples • Cannot see inside container
30-Gallon, Open-Head Stainless Steel Drums	LabelMaster® $558.00 each	**Advantages**	• Small • Light-weight when empty • Can be reused • Can be used for Packing Group I materials • Can hold large samples • Corrosion resistant
		Disadvantages	• High Cost • Can only hold solids • Cannot see inside container

Table 3: Flammable Liquid Specimen Container Matrix (continued)

Specimen Container	Cost		
55-Gallon, Closed-Head Steel Drums	All-Pak, Inc. $58.28 each LabelMaster® $108.50 each	**Advantages**	• Light-weight when empty • Can be reused • Can be used for Packing Group I materials
		Disadvantages	• Can only hold liquids • Cannot be used for large samples • High Cost • Cannot see inside container
55-Gallon, Open-Head Steel Drums	All-Pak, Inc. $73.62 each LabelMaster® $95.85 each	**Advantages**	• Light-weight when empty • Can be reused • Can be used for Packing Group I materials • Can hold large samples
		Disadvantages	• Can only hold solids • High Cost • Cannot see inside container
55-Gallon, Closed-Head Stainless Steel Drums	LabelMaster® $692.00 each	**Advantages**	• Light-weight when empty • Can be reused • Can be used for Packing Group I materials • Corrosion resistant
		Disadvantages	• Can only hold liquids • Cannot be used for large samples • High Cost • Cannot see inside container
55-Gallon, Open-Head Stainless Steel Drums	LabelMaster® $786.00 each	**Advantages**	• Light-weight when empty • Can be reused • Can be used for Packing Group I materials • Can hold large samples • Corrosion resistant
		Disadvantages	• Can only hold solids • High Cost • Cannot see inside container

4.2 Flammable Liquid Transportation Containers

The following All-Pak, Inc. products could be used as transportation containers.

DOT-E 9168 exemption shipping package can ship up to one liter of flammable liquid. It uses either clear or amber glass specimen containers with Teflon-lined caps and a pressure-tested, tall paint can. Absorbent material is placed between the glass container and the paint can. A fiberboard box is used as the outer container. Figure 10 shows the DOT-E 9186 exemption shipping package (Model HMS-66420).

Figure 10: DOT-E 9168 Exemption Shipping Package

The 1-gallon paint can shipping packages are tested and authorized for all modes of transport, but can only be used for transporting Packing Group II and III materials. The specific gravity of the material is not to exceed 1.7. The entire package is a 1-gallon metal paint can specimen container, poly bag, EPS foam end caps, and fiberboard carton. This shipping package can also transport two 1-gallon paint cans (Model HMS-67020) and four 1-gallon paint cans (Model HMS-67020). The package can be backfilled with an absorbent material such as Vermiculite. Figure 11 shows the 1-gallon paint can shipping package (Model HMS-67030).

Figure 11: 1-Gallon Paint Can Shipping Package

Fiberboard overpacks can be used with absorbent materials when shipping 1-gallon, 5-gallon, and 20-gallon drums or paint cans. Some fiberboard overpacks have a lock ring to prevent opening during transport. The overpacks can be backfilled with an absorbent material like Vermiculite. Figure 12 shows a fiberboard overpack. Table 4 shows the model numbers for each type of specimen container.

Figure 12: Fiberboard Overpack

Table 4: Fiberboard Models

Capacity / Total Weight	Model Number
5.5 gallon / 150 lbs.	PAP-05081
26 gallon / 400 lbs.	PAP-05085*
35 gallon / 300 lbs.	PAP-05096*

* Locking Ring

The following LabelMaster® products could be used as transportation containers.

DOT-E 9168 exemption shipping package can ship up to 1-liter of flammable liquid. It uses either clear or amber glass specimen containers with Teflon lined caps and a pressure tested tall paint can. Absorbent material is placed between the glass container and the paint can. A fiberboard box is used as the outer container. Figure 10 shows the DOT-E 9186 exemption shipping package (Model HMS-33).

The 1-liter shipping package is tested and authorized for all modes of transport. The specific gravity of the material is not to exceed 2.4. The entire package with the glass specimen container has been hydrostatically tested to 250 kPa. This package has a XEBEC™ pouch in which the specimen bottle is placed. The absorbent material is an integral part of the pouch. This type of pouch prevents the addition of loose absorbent material. Figure 13 shows the 1-liter shipping package (Model UA950GPT).

Figure 13: 1-Liter Shipping Package

The 1-quart shipping package is tested and authorized for all modes of transport. The specific gravity of the material is not to exceed 1.8. The entire package with the 1-quart metal paint can specimen container and Armlock™ ring has been hydrostatically tested to 95 kPa. This shipping package can also transport four 1-quart paint cans (Model KMP32UN4). The package can be backfilled with an absorbent material such as Vermiculite. Figure 14 shows the 1-quart shipping package (Model KTMP32UN).

Figure 14: 1-Quart Shipping Package

The 1-gallon paint can shipping packages are tested and authorized for all modes of transport. The specific gravity of the material is not to exceed 1.7. The entire package is a 1-gallon metal paint can specimen container with Armlock™ ring, 2 polystyrene end caps, poly bag, tie tape, and fiberboard carton. This shipping package can also transport two 1-gallon paint cans (Model UNIP2PC2R). The package can be backfilled with an absorbent material such as Vermiculite. Figure 15 shows the 1-gallon paint can shipping package (Model UNIP1PC1R).

Figure 15: 1-Gallon Paint Can Shipping Package

The 1-gallon steel drum shipping packages are tested and authorized for all modes of transport. The specific gravity of the material is not to exceed 2.0. The entire package is a 1-gallon, closed-head steel drum specimen container with 2-inch bung cap, poly bag, tape, and fiberboard box. This shipping package is specifically designed for the transport of gasoline. The package can be backfilled with an absorbent material such as Vermiculite. Figure 16 shows a 1-gallon steel drum shipping package (Model KTMGASUN).

Figure 16: 1-Gallon Steel Drum Shipping Package

The 5-gallon steel drum shipping packages are tested and authorized for all modes of transport (Model UNIP5MR). The specific gravity of the material is not to exceed 1.5. The entire package is a 5-gallon, closed-head steel drum specimen container with 2-inch bung cap, pads, tie, tape, and fiberboard box. The package can be backfilled with an absorbent material such as Vermiculite. Figure 16, showing the 1-gallon steel drum shipping package, looks exactly the same for the 5-gallons steel drum shipping package.

The 65-gallon, poly-overpack shipping package is 100% polyethylene. The twist-on lid provides a solid seal with no tools or bolts required. It can accept specimen containers up to 30 gallons. It has a maximum capacity of 440 lbs. The package can be backfilled with an absorbent material such as Vermiculite. Figure 17 shows a 65-gallon, poly-overpack shipping package (Model KM6500P).

Figure 17: 65-Gallon Poly-Overpack Shipping Package

The 95-gallon, poly-overpack shipping package is 100% polyethylene (Model KM8500P). The twist-on lid provides a solid seal with no tools or bolts required. It can accept specimen containers up to 55 gallons. It has a maximum capacity of 650 lbs. The package can be backfilled with an absorbent material such as Vermiculite. Figure 17 shows a 65-gallon, poly-overpack shipping package that is very similar to the 95-gallon, poly-overpack shipping package.

The new Wheeled Overpack™ is the first mobile one-piece overpack on wheels that can handle 55-gallon drums. The integral dolly eliminates the need for a separate dolly for transportation. It's made of 100% polyethylene. This 95-gallon container has built-in handles, but only has a maximum capacity of 250 lbs. Figure 17, showing the 65-gallon poly-overpack, is similar to the Wheeled Overpack™, but there would be integral wheels and handles.

Table 5 lists the flammable liquid transportation containers advantages, disadvantages, and costs.

Table 5: Flammable Liquid Transportation Container Matrix

Transportation Container	Cost		
DOT-E 9168 Exemption Shipping Package	All-Pak, Inc. $20.13 each LabelMaster® $27.05 each	**Advantages**	• Small • Light weight • Low Cost • Can be reused • Can be used for Packing Group I materials
		Disadvantage	• Cannot hold large samples
1-Liter Shipping Package	LabelMaster® $9.90 each	**Advantages**	• Small • Light weight • Low Cost • Can be reused • Can be used for Packing Group I materials
		Disadvantage	• Cannot hold large samples
1-Quart Shipping Package	LabelMaster® $6.80 each – 1 x 1 Qt. $19.80 each – 4 x 1 Qt.	**Advantages**	• Small • Light weight • Low Cost • Can be reused • Can be used for Packing Group I materials
		Disadvantage	• Cannot hold large samples
1-Gallon Paint Can Shipping Package	All-Pak, Inc. $6.64 each – 1 x 1 Gal. $11.64 each – 2 x 1 Gal. $20.80 each – 4 x 1 Gal. LabelMaster® $8.80 each – 1 x 1 Gal. $12.65 each – 2 x 1 Gal.	**Advantages**	• Small • Light weight • Low Cost • Can be reused • Can be used for Packing Group I materials
		Disadvantage	• Cannot hold large samples

Table 5: Flammable Liquid Transportation Container Matrix (continued)

Transportation Container	Cost		
1-Gallon Steel Drum Shipping Package	LabelMaster® $19.65 each	**Advantages**	• Small • Light weight • Low Cost • Can be reused • Can be used for Packing Group I materials
		Disadvantage	Cannot hold large samples
5-Gallon Steel Drum Shipping Package	LabelMaster® $8.75 each	**Advantages**	• Small • Light weight • Low Cost • Can be reused • Can be used for Packing Group I materials
		Disadvantage	• Cannot hold large samples
Fiberboard Overpack	All-Pak, Inc. $8.18 each – 5.5 Gal. $28.55 each – 26 Gal. $30.78 each – 35 Gal.	**Advantages**	• Light weight when empty • Low Cost • Can be reused • Can hold large samples
		Disadvantages	• Not approved to transport Packing Group I materials • Not approved as overpacks
Poly-Overpack	LabelMaster® $163.30 each – 65 Gal. $194.50 each – 95 Gal.	**Advantages**	• Light weight when empty • Can be reused • Can be used for Packing Group I materials • Can hold large samples
		Disadvantages	• High Cost • Requires a dolly to move when loaded

Table 5: Flammable Liquid Transportation Container Matrix (continued)

Transportation Container	Cost		
Wheeled Overpack	LabelMaster® $227.00 each – 95 Gal.	**Advantages**	• Light weight when empty • Can be reused • Can be used for Packing Group I materials • Can hold large samples • Does not require dolly to move when loaded
		Disadvantages	• High Cost • Can only hold 38% of the weight for the same sized poly-overpack

5.0 Class 4 Hazardous Material Packaging

Hazard Class 4 materials are flammable solids. The materials are divided into three divisions. Division 4.1 materials are flammable solids, Division 4.2 materials are spontaneously combustible solids, and Division 4.3 materials are solids that are dangerous when wet. Some Hazard Class 4 materials could be in paste form but are considered solids.

Hazard Class 4 material is assigned a packaging group per 49 CFR Part 172.101 Hazardous Materials Table in column 5. If the package contains more than one Class 4 material then the packing group will be determined on the basis of test results following test methods given in the *UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria Third Revised Edition* (1999) and applying the appropriate criteria given in 49 CFR Part 173.125.

Two types of commercially available packaging are considered in this report: specimen containers and transportation containers.

5.1 Flammable Solid Specimen Containers

The following All-Pak, Inc. products could be used as specimen containers.

The 1-liter glass containers can be used with the DOT-E 9168 exemption shipping package to ship flammable solids. They are clear and amber glass specimen containers with Teflon-lined caps. The glass containers have a plastic outer liner to prevent shattering. The containers can have a large mouth opening for the placement of limited amounts of forensic evidence contaminated with Class 4 materials. Figure 18 shows the clear and amber glass specimen containers (Models GLA-00947 and GLA-00968).

Figure 18: Clear and Amber Glass Specimen Containers with Plastic Coating

The 2-liter and 4-liter glass containers can be used to ship flammable solids (Models GLA-00949 and GLA-00950). They are clear glass specimen containers with Teflon-lined caps. The glass containers have a plastic outer liner to prevent shattering. The containers can have a large mouth opening for the placement of limited amounts of forensic evidence contaminated with Class 4 materials. Figure 18 shows an example of a clear glass specimen container.

The 1-gallon, sealed paint cans are suitable for shipping flammable solids but only for Packing Group II and III materials. The UN number of this specimen container is UN-4G/Y16.6/S (Model MET-3100). 4G designates that the can will be placed in a fiberboard box, Y stands for Packing Group II, 16.6 is the maximum gross mass in kilograms (kg), and S stands for solids or inner packaging that does not contain standing liquids. The containers have a large mouth opening for the placement of limited amounts of forensic evidence contaminated with Class 4 materials. Figure 19 shows a 1-gallon paint can specimen container.

Figure 19: 1-Gallon Paint Can

The 5-gallon, open-head steel drum can hold a large amount of solids, but only for Packing Group II and III materials. The UN number for this specimen container is UN-1A2/Y36/S. 1A2 designates that the drum is an open-head steel drum. Removable-head drums can be used for forensic evidence that has been contaminated with a flammable solid so long as there are no standing liquids inside the container. Figure 20 shows a 5-gallon, open-head steel drum specimen container (Model MET-03076).

Figure 20: 5-Gallon Open Head Steel Drum

The 55-gallon, removable-head steel drums have the capability to hold large amounts of forensic evidence. The UN number for this specimen container is UN-1A2/X400/S (Model MET-03034). 1A2 designates a removable-head drum, X stands for Packing Group I container, 400 is the maximum gross mass in kilograms (kg) of the contents, and S stands for solids or inner packaging that does not contain standing liquids. 30-gallon open-head steel drums are also available. The UN number for the 30-gallon specimen container is UN-1A2/X300/S (Model MET-03033). Removable-head drums can be used for forensic evidence that has been contaminated with a flammable solid so long as there are no standing liquids inside the container. Figure 21 shows a 55-gallon, open-head steel drum specimen container.

Figure 21: 55-Gallon, Open-Head Steel Drum

LabelMaster ® has several products that could be used as specimen containers.

The 1-liter, PVC-coated glass bottles can be used to ship flammable solids. They are clear glass specimen containers with Teflon-lined caps. The glass containers have a PVC plastic outer liner to prevent shattering. The container has a large mouth opening for the placement of limited amounts of forensic evidence contaminated with Class 4 materials. Figure 22shows the various glass specimen containers (Model KG3280R).

Figure 22 Glass Specimen Container with PVC Plastic Coating

The 1-gallon and 1-quart sealed paint cans are suitable for shipping flammable solids but only for Packing Group II and III materials (Models KM28PN and KM32P). The seal is an Armlock™ ring (Models KRL1PC and KRL32UN). The containers have a large mouth opening for the placement of limited amounts of forensic evidence contaminated with Class 4 materials. Figure 23 shows a 1-quart specimen container.

Figure 23: 1-Quart Sealed Paint Can with Armlock™ Seal Ring

The 5-gallon, open-head steel drum can hold a large amount of forensic evidence. The UN number for this specimen container is UN-1A2/Y36/S. Figure 20 shows a 5-gallon, open-head steel drum specimen container (Model KM5000).

The 55-gallon, removable-head steel drums have the capability to hold large amount of forensic evidence. The UN number for this specimen container is UN-1A2/X430/S (Model KM5517CO). 20-gallon and 30-gallon open-head steel drums are also available. The UN numbers for the 20-gallon and 30-gallon specimen containers are UN-1A2/X175/S (Model KM2017CO) and UN-1A2/X225/S (Model KM3017CO) respectively. Removable-head drums can be used for forensic evidence that has been contaminated with a flammable liquid so long as there are no standing liquids inside the container. Figure 24 shows a 20-gallon, open-head steel drum specimen container.

Figure 24: 20-Gallon, Open-Head Steel Drum

The 55-gallon, open-head stainless drum is corrosion resistant and has the same capabilities of the 55-gallon removable-head steel drum. The UN number for this specimen container is UN-1A2/X430/S (Model KM55SSDO). 20-gallon and 30-gallon open-head stainless steel drums are also available. The UN numbers for the 20-gallon and 30-gallon specimen containers are UN-1A2/X160/S (Model KM20SSDO) and UN-1A2/X225/S (Model KM30SSDO) respectively. Figure 25 shows the 55-gallon, 30-gallon, and 20-gallon open-head stainless steel drum specimen containers.

Figure 25: 55-Gallon, 30-Gallon, and 20-Gallon Open-Head Steel Drums

Table 16 in Appendix A provides a table listing the flammable solids specimen containers advantages, disadvantages, and costs.

5.2 Flammable Solid Transportation Containers

The following All-Pak, Inc. products could be used as transportation containers.

DOT-E 9168 exemption shipping package can ship up to one-liter of flammable liquid. It uses either clear or amber glass specimen containers with Teflon-lined caps and a pressure-tested tall paint can. Absorbent material is placed between the glass container and the paint can. A fiberboard box is used as the outer container. Figure 26 shows the DOT-E 9186 exemption shipping package (Model HMS-66420).

Figure 26: DOT-E 9168 Exemption Shipping Package

The single bottle, all-corrugated package can transport a 2-liter bottle. It uses either clear or amber glass specimen containers with Teflon-lined caps and fiberboard boxes. Absorbent material can be placed between the glass container and the fiberboard. The fiberboard box is used as the outer container. Figure 27 shows the single bottle, all-corrugated package (Model HMS-63060).

Figure 27: Single Bottle, All-Corrugated Package

Fiberboard overpacks can be used with absorbent materials when shipping 1-gallon, 5-gallon, and 20-gallon drums or paint cans. Some fiberboard overpacks have a lock ring to prevent opening during transport. The overpacks can be backfilled with an absorbent material like Vermiculite. Figure 28 shows a fiberboard overpack. Table 6 shows the model numbers for each type of specimen container.

Figure 28: Fiberboard Overpack

Table 6: Fiberboard Models

Capacity / Total Weight	Model Number
5.5 gallon / 150 lbs.	PAP-05081
26 gallon / 400 lbs.	PAP-05085*
35 gallon / 300 lbs.	PAP-05096*

* Locking Ring

The following LabelMaster® products could be used as transportation containers.

DOT-E 9168 exemption shipping package can ship up to one-liter of flammable liquid. It uses either clear or amber glass specimen containers with Teflon-lined caps and a pressure-tested tall paint can. Absorbent material is placed between the glass container and the paint can. A fiberboard box is used as the outer container. Figure 26 shows the DOT-E 9186 exemption shipping package (Model HMS-33).

The 1-liter shipping packages are tested and authorized for all modes of transport. The specific gravity of the material is not to exceed 2.4. The entire package, with the glass specimen container, has been hydrostatically tested to 250 kPa. This package has a XEBEC™ pouch in which the specimen bottle is placed. The absorbent material is an integral part of the pouch. This type of pouch does not require the addition of loose absorbent material. Figure 29 shows the 1-liter shipping package (Model UA950GPT).

Figure 29: 1-Liter Shipping Package

The 1-quart shipping packages are tested and authorized for all modes of transport. The specific gravity of the material is not to exceed 1.8. The entire package, with the 1-quart metal paint can specimen container and Armlock™ ring, has been hydrostatically tested to 95 kPa. This shipping package can also transport four 1-quart paint cans (Model KMP32UN4). The package can be backfilled with an absorbent material such as Vermiculite. Figure 30 shows the 1-quart shipping package (Model KTMP32UN).

Figure 30: 1-Quart Shipping Package

The 1-gallon paint can shipping packages are tested and authorized for all modes of transport. The specific gravity of the material is not to exceed 1.7. The entire package is a 1-gallon metal paint can specimen container with Armlock™ ring, 2 polystyrene end caps, poly bag, tie tape, and fiberboard carton. This shipping package can also transport two 1-gallon paint cans (Model UNIP2PC2R). The package can be backfilled with an absorbent material such as Vermiculite. Figure 31 shows the 1-gallon paint can shipping package (Model UNIP1PC1R).

Figure 31: 1-Gallon Paint Can Shipping Package

The 1-gallon, steel drum shipping packages are tested and authorized for all modes of transport. The specific gravity of the material is not to exceed 2.0. The entire package is a 1-gallon, closed-head steel drum specimen container with 2-inch bung cap, poly bag, tape, and fiberboard box. This shipping package is specifically designed for the transport of gasoline. The package can be backfilled with an absorbent material such as Vermiculite. Figure 32 shows a 1-gallon, steel drum shipping package (Model KTMGASUN).

Figure 32: 1-Gallon Steel Drum Shipping Package

The 5-gallon, steel drum shipping packages are tested and authorized for all modes of transport (Model UNIP5MR). The specific gravity of the material is not to exceed 1.5. The entire package is a 5-gallon, closed-head steel drum specimen container with 2-inch bung cap, pads, tie, tape, and fiberboard box. The package can be backfilled with an absorbent material such as Vermiculite. Figure 32 showing the 1-gallon, steel drum shipping package looks exactly the same for the 5-gallon steel drum shipping package.

The 65-gallon, poly-overpack shipping package is 100% polyethylene. The twist-on lid provides a solid seal with no tools or bolts required. It can accept specimen containers up to 30-gallons. It has a maximum capacity of 440 lbs. The package can be backfilled with an absorbent material such as Vermiculite. Figure 33 shows a 65-gallon, poly-overpack shipping package (Model KM6500P).

Figure 33: 65-Gallon Poly-Overpack Shipping Package

The 95-gallon, poly-overpack shipping package is 100% polyethylene (Model KM8500P). The twist-on lid provides a solid seal with no tools or bolts required. It can accept specimen containers up to 55-gallons. It has a maximum capacity of 650 lbs. The package can be backfilled with an absorbent material such as Vermiculite. Figure 33 shows a 65-gallon, poly-overpack shipping package that would be similar to the 95-gallon, poly-overpack shipping package.

The new Wheeled Overpack™ is the first mobile one-piece overpack on wheels that can handle 55-gallon drums. The integral dolly eliminates the need for a separate dolly for transportation. It is made of 100% polyethylene. This 95-gallon container has built-in handles, but only has a maximum capacity of 250 lbs. Figure 33 showing the 65-gallon, poly-overpack is similar to the Wheeled Overpack™ but there would be integral wheels and handles.

Table 17 in Appendix A provides a table listing the flammable solid transportation containers advantages, disadvantages, and costs.

6.0 Class 5 Hazardous Material Packaging

Hazard Class 5 materials are oxidizers. The materials are divided into two divisions. Division 5.1 materials are oxidizers, and Division 5.2 materials are organic peroxide. Oxidizers are materials that may, generally by yielding oxygen, cause or enhance the combustion of other materials. Hazard Class 5 materials can be in liquid or solid forms.

Hazard Class 5 material is assigned to Packing Group I, II, or III per 49 CFR Part 172.101 Hazardous Materials Table in column 5. If the package contains more than one Class 5 material then the packing group will be determined on the basis of test results following test methods given in the *UN Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria Third Revised Edition* (1999) and applying the appropriate criteria given in 49 CFR Part 173.127, 49 CFR Part 173.128, and 49 CFR Part 173.129.

Since Hazard Class 5 materials can be in liquid form, the specimen and transportation packages discussed in Section 3.1 and 3.2 of this report are appropriate. Hazard Class 5 materials that are solids can use Section 4.1 and 4.2 of this report for specimen and transportation packages.

7.0 Class 6 Hazardous Material Packaging

Hazard Class 6 materials are poisonous materials. The materials are divided into two divisions. Division 6.1 materials are chemical poisons, and Division 6.2 materials are infectious substances. Division 6.1 chemical poisons are materials other than gases which are known to be so toxic to humans as to afford a hazard to health during transportation. Bulk packaging will not be considered in this report since forensic evidence is not collected in bulk.

Division 6.1 poisonous materials are divided into those substances with an oral toxicity, dermal toxicity, or inhalation toxicity. Lethal Dose 50 (LD_{50}) is the dose of a chemical which kills 50% of a sample population of test animals. The oral toxicity of a liquid is an LD_{50} for acute oral toxicity of not more than 500 mg/kg, and the oral toxicity of a solid is an LD_{50} for acute oral toxicity of not more than 200 mg/kg. LD_{50} for acute oral toxicity

is defined as a dose of the material when administered to both male and female young adult albino rats, causes death within 14 days in half the animals tested. The number of animals tested must be sufficient to give statistically valid results and be in conformity with good pharmacological practices. The result is expressed in mg/kg body mass.

The dermal toxicity of a material is an LD_{50} for acute dermal toxicity of not more than 1000 mg/kg. LD_{50} for acute dermal toxicity means that dose of the material which, administered by continuous contact for 24 hours with the shaved intact skin of an albino rabbit while abrading, causes death within 14 days in half of the animals tested. The number of animals tested must be sufficient to give statistically valid results and be in conformity with good pharmacological practices. The result is expressed in mg/kg body mass.

The inhalation toxicity of a material (dust or mist) is an LD_{50} for acute toxicity on inhalation of not more than 10 mg/liter, or a saturated vapor concentration in air at 20 ^{o}C greater than or equal to one-fifth of the LD_{50} for acute toxicity on inhalation of vapors and with an LD_{50} for acute toxicity on inhalation of vapors of not more than 5000 mL/m^3, or is an irritating material with properties similar to tear gas which causes extreme irritation, especially in confined spaces. LD_{50} for acute toxicity on inhalation means that concentrated vapor, mist, or dust when administered by continuous inhalation for one hour to both male and female young adult albino rats, causes death within 14 days in half of the animals tested. If the material is administered to animals as a dust or mist where more than 90% of the particles available for inhalation in the test must have a diameter of 10-microns or less it is reasonably foreseeable that such concentrations could be encountered by a human during transport. The results are expressed in mg/L of air for dusts and mists or in mL/m^3 of air for vapors. LD_{50} for a mixture is determined by applying the appropriate criteria given in 49 CFR Part 173.132.b.3.

Division 6.1 material is assigned a packaging group per 49 CFR Part 172.101 Hazardous Materials Table in column 5. If the package contains more than one Division 6.1 material then the packing group will be determined by Table 7 for all pathways except inhalation by vapors for liquids or solids. If the package contains more than one Division 6.1 material then the packing group will be determined by Figure 34 for a liquid based on inhalation of vapors and is taken from 49 CFR Part 173.33. If a package contains more than one Division 6.1 material with a combination of oral, dermal, and inhalation toxic limits then use the equations in 49 CFR Part 173.133.

Table 7: Packing Group Determination for Oral, Dermal, and Inhalation Dust and Mist Concentrations

Packing Group	Oral Toxicity LD_{50} (mg/kg)	Dermal Toxicity LD_{50} (mg/kg)	Inhalation Toxicity by Dusts and Mists LD_{50} (mg/L)
I	≤ 5	≤ 40	≤ 0.5
II	> 5, ≤ 50	> 40, ≤ 200	> 0.5, ≤ 2
III	Solids: > 50, ≤ 200 Liquids: > 50, ≤ 500	> 200, ≤ 1000	> 2, ≤ 10

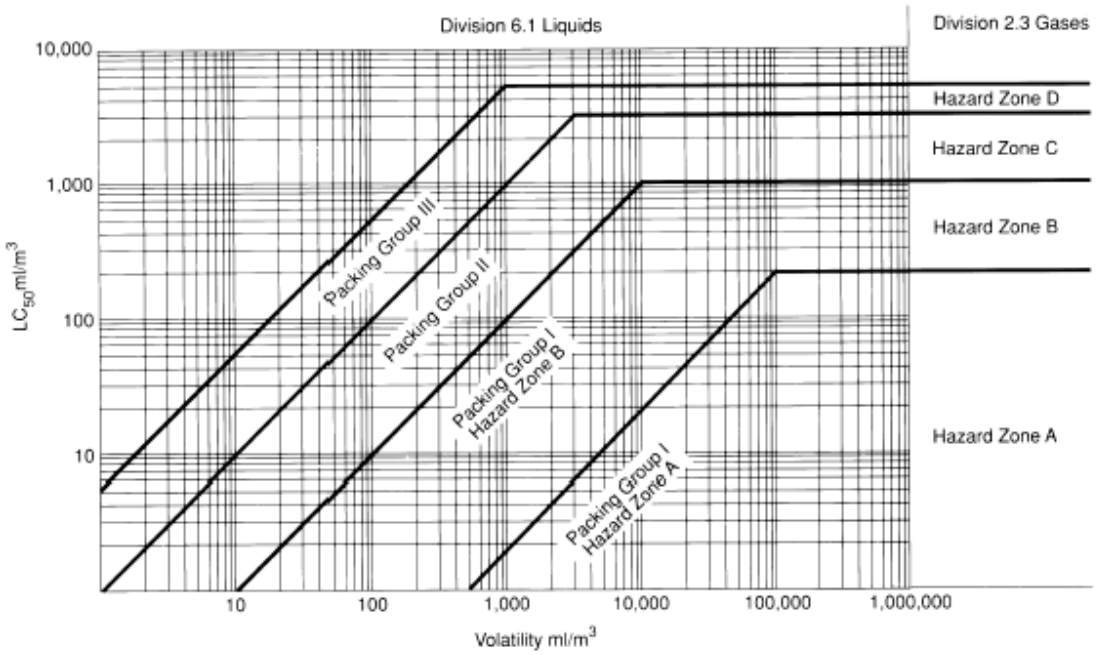

Figure 34: Inhalation Toxicity Packing Group and Hazard Zone Borderlines

Since Division 6.1 materials can be in liquid or solid form, the specimen and transportation packages discussed in Section 3.1 and 3.2 of this report are appropriate with the exception of those chemicals that are poisonous by inhalation.

Division 6.2 infectious materials are known to contain or suspected of containing a pathogen, virus or micro-organism or a proteinaceous infectious particle (prion) that has the potential to cause disease in humans or animals. Table 8 lists four risk groups as defined by DOT regulations (49 CFR Part 173). If the evidence is known or suspected of belonging to Risk Group II or III, it must be packaged in accordance with the provisions of 49 CFR Part 173.24; if the evidence belongs to Risk Group IV, or if it is a substance listed in 42 CFR Part 72, it must be packaged to meet the test requirements of 49 CFR Part 178.609, and the secondary packaging must be marked with a BIOHAZARD symbol conforming to the specifications in 29 CFR Part 1910.1030.g.1.i with an itemized list of

its contents that must be enclosed between the secondary packaging and the outer container. Forensic evidence may be exempt from packaging requirements per 49 CFR Part 173.134.b.12 if the material falls into Risk Group I defined by 49 CFR Part 173.134.b.6. If evidence contains or is suspected of containing any substance listed in 42 CFR 72, the package must also adhere to the requirements listed in 42 CFR 72. Tables 9, 10, and 11 list the substances in 42 CFR Part 72.3.

Table 8: 49 CFR Part 173.134 Risk Groups

Risk Group	Pathogen	Risk to Individuals	Risk to the Community
I	A micro-organism unlikely to cause human or animal disease.	None or Very Low	None or Very Low
II	A pathogen likely to cause human or animal disease but is unlikely to be a serious hazard, and capable of causing serious infection on exposure for which there are effective treatments and preventive measures available and the risk of infection is limited.	Moderate	Low
III	A pathogen usually causing serious human or animal disease but does not ordinarily spread from one infected individual to another and effective treatments are preventive and measures are available.	High	Low
IV	A pathogen usually causing serious human or animal disease and that can be readily transmitted from one individual to another directly or indirectly and effective treatments and preventive measures are not usually available.	High	High

Table 9: 42 CFR Part 72.3 Fungal Agents*

Blastomyces dermatitidis.
Coccidioides immitis.
Cryptococcus neoformans.
Histoplasma capsulatum.
Paracoccidioides brasiliensis.

* This list may be revised from time to time by Notice published in the Federal Register to identify additional agents which must be packaged in accordance with the requirements contained in this part.

Table 10: 42 CFR Part 72.3 Viral and Rickettsial Agents*

Adenoviruses – human – all types.
Arboviruses – all types.
Coxiella burnetii.
Coxsackie A and B viruses – all types.
Creutzfeldt – Jacob agent
Cytomegaloviruses.
Dengue viruses – all types.
Ebola virus.
Echoviruses – all types.
Encephalomyocarditis virus.
Hemorrhagic fever agents including, but not limited to, Crimean hemorrhagic fever (Congo), Junin, Machupo viruses, and Korean hemorrhagic fever viruses.
Hepatitis associated materials (hepatitis A, hepatitis B, and hepatitis nonA - nonB).
Herpesvirus – all members.
Infectious bronchitis – like virus.
Influenza viruses – all types.
Kuru agent.
Lassa virus.
Lymphocytic choriomeningitis virus.
Marburg virus.
Measles virus.
Mumps virus.
Parainfluenza viruses – all types.
Polioviruses – all types.
Poxviruses – all members.
Rabies virus – all strains.
Reoviruses – all types.
Respiratory syncytial virus.
Rhinoviruses – all types.
Rickettsia – all species.
Rochalimaea quintana.
Rotaviruses – all types.
Rubella virus.
Simian virus 40.
Tick-borne encephalitis virus complex, including Russian spring-summer encephalitis, Kyasanur forest disease, Omsk hemorrhagic fever, and Central European encephalitis viruses.
Vaccinia virus.
Varicella virus.

Table 10: 42 CFR Part 72.3 Viral and Rickettsial Agents (continued)*

Variola major and Variola minor viruses.
Vesicular stomatis viruses – all types.
White pox viruses.
Yellow fever virus.

* This list may be revised from time to time by Notice published in the Federal Register to identify additional agents which must be packaged in accordance with the requirements contained in this part.

Table 11: 42 CFR Part 72.3 Bacterial Agents*

Acinetobacter calcoaceticus.
Actinobacillus – all species.
Actinomycetaceae – all members.
Aeromonas hydrophila.
Arachnia propionica.
Arizona hinshawii – all serotypes.
Bacillus anthracis.
Bacteroides spp.
Bartonella – all species.
Bordetella – all species.
Borrelia recurrentis, B. vincenti.
Brucella – all species.
Campylobacter (Vibrio) foetus, C. (Vibrio) jejuni.
Chlamydia psittaci, C. trachomatis.
Clostridium botulinum, Cl. Chauvoei, Cl. Haemolyticum, Cl.
Histolyticum, Cl. Novyi, Cl. Septicum, Cl. Tetani.
Corynebacterium diphtheriae, C. equi, C. haemolyticum, C.
pseudotuberculosis, C. pyogenes, C. renale.
Edwarsiella tarda.
Erysipelothrix insidiosa.
Escherichia coli, all enteropathogenic serotypes.
Francisella (Pasteurella) Tularensis.
Haemophilus ducreyi, H. influenzae.
Klebsiella–all species and all serotypes.
Legionella–all species and all Legionella-like organisms.
Leptospira interrogans – all serovars.
Listeria – all species.
Mimae polymorpha.

Table 11: 42 CFR Part 72.3 Bacterial Agents (continued)*

Moraxella – all species.
Mycobacterium – all species.
Mycoplasma – all species.
Neisseria gonorrhoeae, N. meningitides.
Nocardia asteroids.
Pasteurella–all species.
Plesiomonas shigelloides.
Proteus – all species.
Pseudomonas mallei.
Pseudomonas pseudomallei.
Salmonella – all species and all serotypes.
Shigella – all species and all serotypes.
Sphaerophorus necrophorus.
Staphylococcus aureus.
Streptobacillus moniliformis.
Streptococcus pneumoniae.
Streptococcus pyogenes.
Treponema careteum, T. pallidum, and T. pertenue.
Vibrio cholerae, V. parahemolyticus.
Yersinia (Pasteurella) pestis, Y. Enterocolitica.

* This list may be revised from time to time by Notice published in the Federal Register to identify additional agents which must be packaged in accordance with the requirements contained in this part.

Two types of commercially available packaging are considered in this report for chemicals that are poisonous by inhalation and infectious materials: specimen containers and transportation containers.

7.1 Poisonous by Inhalation Specimen Containers

The following All-Pak, Inc. product could be used as specimen container.

The 1-liter Boston round glass containers can be used with the DOT-E 9168 exemption shipping package to ship poisonous by inhalation liquids. They are clear and amber glass specimen containers with Teflon-lined caps. The glass containers have a plastic outer liner to prevent shattering. The containers have a small mouth opening, limiting the

amount of forensic evidence that can be placed within it. Figure 35 shows the clear and amber glass specimen containers (Models GLA-00939 and GLA-00958).

Figure 35: Clear and Amber Boston Round Glass Specimen Containers with Plastic Coating

LabelMaster ® has the following products that could be used as specimen containers.

The 1-liter Boston round glass containers can be used with the DOT-E 9168 exemption shipping package to ship poisonous by inhalation liquids. They are clear and amber glass specimen containers with Teflon-lined caps. The glass containers have a plastic outer liner to prevent shattering. The containers have a small mouth opening, limiting the amount of forensic evidence that can be placed within it. Figure 35 shows the clear and amber glass specimen containers (Models KG3250 and KG3200).

The 55-gallon poisonous by inhalation (PIH) overpack has the capability to hold large amounts of forensic evidence. The UN number for this specimen container is UN-1A2/X430/S (Model KM55PIH). 20-gallon and 30-gallon PIH overpacks are also available. The UN numbers for the 20-gallon and 30-gallon specimen containers are UN-1A2/X175/S (Model KM20PIH) and UN-1A2/X235/S (Model KM30PIH), respectively. The removable head allows for forensic evidence that has been contaminated with a poisonous by inhalation liquid so long as there are no standing liquids inside the container. Figure 36 shows the 20-gallon, 30-gallon, 55-gallon, and 85-gallon PIH overpacks.

Figure 36: PIH Overpacks

Table 18 in Appendix A provides a table listing the poisonous by inhalation specimen containers advantages, disadvantages, and costs.

7.2 Infectious Material Specimen Containers

The following ThermoSafe ® products could be used as specimen containers.

Aluminum cans accommodate most laboratory collection tubes, vials and bottles. They are completely autoclavable (i.e., can be heated to very high temperatures without deforming) and Expanded polystyrene (EPS) foam mailers and mailing sleeves are available for these containers. Figure 37 shows the aluminum can specimen containers with their mailing sleeves (Models 435 and 436).

Figure 37: Aluminum Can Specimen Containers with Mailing Sleeves

Figure 38 shows an aluminum can with a foam insert and a mailing sleeve (Model 630). This model can hold four 16 x 100 mm tubes.

Figure 38: Aluminum Can with Test Tubes and Foam Insert

The company's 0.5- and 1-liter transparent containers are liquid-tight polypropylene containers that can withstand 95 kPa of pressure. The 0.5-liter containers (INF-2000) can hold up to 6 vials. The larger 1-liter containers are autoclavable. Figure 39 shows a 1-liter container with labeling (INF-3000).

Figure 39: 1-Liter Container with Labeling

Source Packaging of New England, Inc. has several products that could be used as specimen containers.

The company's 0.5- and 1-liter transparent containers are liquid-tight polypropylene containers that can withstand 95 kPa of pressure and are autoclavable. They are designed with a quarter-turn, stop-lock lid. Figure 39 shows a 1-liter container with labeling (INF-3004).

Table 19 in Appendix A provides a table listing the specimen containers advantages, disadvantages, and costs.

7.3 Poisonous by Inhalation Transportation Containers

The following All-Pak, Inc. product could be used as transportation container.

The Poisonous by Inhalation (PIH) shipping package is a modified DOT-E 9168 exemption shipping package that can ship up to one-liter of PIH material. It uses either clear or amber glass specimen containers with Teflon lined caps and a pressure tested tall paint can to meet the 49 CFR testing requirements to ship a Division 6.1 PIH material. Absorbent material is placed between the glass container and the paint can. A fiberboard box is used as the outer container. Figure 40 shows the PIH shipping package (Model HMS-66580).

Figure 40: Poisonous by Inhalation Shipping Package

Fiberboard overpacks can be used with absorbent materials when shipping 20-gallon PIH overpacks. The fiberboard overpack has a lock ring to prevent opening during transport. The overpack can be backfilled with an absorbent material like Vermiculite. Figure 41 shows a fiberboard overpack (Model PAP-05096).

Figure 41: Fiberboard Overpack

The following LabelMaster® products could be used as transportation containers.

The Poisonous by Inhalation (PIH) shipping package is a modified DOT-E 9168 exemption shipping package that can ship up to one-liter of PIH material. It uses either clear or amber glass specimen containers with Teflon lined caps and a pressure tested tall paint can to meet the 49 CFR testing requirements to ship a Division 6.1 PIH material. Absorbent material is placed between the glass container and the paint can. A fiberboard box is used as the outer container. Figure 40 shows the PIH shipping package (Model HMS-950PIH).

The 65-gallon, poly-overpack shipping package is 100% polyethylene. The twist-on lid provides a solid seal with no tools or bolts required. It can accept specimen containers up to 30-gallons. It has a maximum capacity of 440 lbs. The package can be backfilled with an absorbent material such as Vermiculite. Figure 42 shows a 65-gallon, poly-overpack shipping package (Model KM6500P).

Figure 42: 65-Gallon, Poly-Overpack Shipping Package

The 95-gallon, poly-overpack shipping package is 100% polyethylene (Model KM8500P). The twist-on lid provides a solid seal with no tools or bolts required. It can accept specimen containers up to 55-gallons. It has a maximum capacity of 650 lbs. The package can be backfilled with an absorbent material such as Vermiculite. Figure 41 shows a 65-gallon, poly-overpack shipping package that would be similar to the 95-gallon, poly-overpack shipping package.

The new Wheeled Overpack™ is the first mobile one-piece overpack on wheels that can handle 55-gallon drums. The integral dolly eliminates the need for a separate dolly for transportation. It's made of 100% polyethylene. This 95-gallon container has built-in handles, but only has a maximum capacity of 250 lbs. Figure 42 showing the 65-gallon poly-overpack is similar to the Wheeled Overpack™, but there would be integral wheels and handles.

Table 20 in Appendix A provides a table listing the flammable solid transportation containers advantages, disadvantages, and costs.

7.4 Infectious Material Transportation Containers

The following ThermoSafe ® products could be used as transportation containers.

The Cryogenic Shipper is specifically engineered to transport infectious substances safely and efficiently, and can hold 15 vial canes or 75 test tubes. It is made of high density polyethylene and can be used for both a storage or transportation container. This model has a liquid nitrogen capacity to maintain a temperature at or below -150 ^{o}C for up to 16 days. Using liquid nitrogen provides the most effective means of preserving biological materials and can stop the biological clock while carbon dioxide cannot. The tip-tolerant design and patented screw cap prevent leaks and vents excessive pressure. Figure 43 shows the Cryogenic Shipper (Model LN2DG).

Figure 43: Cryogenic Shipper

The large capacity transport container is constructed with a double wall made of polyethylene and filled with urethane foam insulation. It can hold up to 570 pounds of dry ice pellets and has a capacity of 8 – 11 cubic feet. The tight-fitting FLEX-SEAL® lid and container seal maintain temperatures and maximize transport efficiency. However, the seal cannot be used as a secondary boundary for infectious substances. Figure 44 shows the 11 cubic foot capacity transport container (Model 864).

Figure 44: Large Capacity Transport Container

The mid-size transportation container is constructed with a double wall made of polyethylene and filled with urethane foam insulation. It can hold up to 235 pounds of dry ice pellets and has a capacity of 1.8 – 4 cubic feet. The lid and container seal maintain temperature and maximize transport efficiency. However, the seal cannot be used as a secondary boundary for infectious substances. Figure 45 shows the 3.75 cubic foot capacity transport container (Model 301) with the optional dolly (Model 376).

Figure 45: Mid-Size Capacity Transport Container with Optional Dolly

The following Source Packaging of New England, Inc. product could be used as a transportation container.

The Infectious Substance Shipper (INF- 3500) is a U.N. certified 6.2 infectious substance shipper designed for temperature controlled bulk shipping. It can accommodate five 1-liter transparent specimen containers. This durable transport container is constructed with a double wall made of polyethylene and filled with urethane foam insulation. Figure 46 shows the infectious substance transport container model with five 1-liter transparent specimen containers which are sold separately.

Figure 46: Infectious Substance Shipper

Table 21 in Appendix A provides a table listing the transportation containers advantages, disadvantages, and costs.

8.0 Class 8 Hazardous Material Packaging

Hazard Class 8 materials are corrosive. Corrosive materials are defined as a liquid or solid that causes full thickness destruction of human skin at the site of contact within a specified period of time, or a liquid that has a severe corrosion rate on steel or aluminum based on the criteria in 49 CFR Part 173.137.C.2.

Hazard Class 8 material is assigned a packaging group per 49 CFR Part 172.101 Hazardous Materials Table in column 5. If the package contains more than one Class 8 material then the packing group will be determined using data obtained from tests conducted in accordance with *OECD Guideline for Testing of Chemicals, Number 404, Acute Dermal Irritation/Corrosion*, (1992) and applying the appropriate criteria given in 49 CFR Part 173.137.

Since Hazard Class 8 materials can be in liquid form, the specimen and transportation packages discussed in Section 3.1 and 3.2 of this report are appropriate. Hazard Class 8 materials that are solids can use Section 4.1 and 4.2 of this report for specimen and transportation packages.

9.0 Class 9 Hazardous Material Packaging

Hazard Class 9 materials are miscellaneous hazardous materials. Miscellaneous hazardous materials are materials which present a hazard during transportation, but which do not meet the definition of any other hazard class. This class includes any material which has an anesthetic, noxious or other similar property, which could cause extreme annoyance or discomfort to a flight crew member so as to prevent the correct performance of assigned duties, or any material that meets the definition of 49 CFR Part 171.8.

Hazard Class 9 material is assigned a packaging group per 49 CFR Part 172.101 Hazardous Materials Table in column 5.

Since Hazard Class 9 materials can be in liquid form, the specimen and transportation packages discussed in Section 3.1 and 3.2 of this report are appropriate. Hazard Class 9 materials that are solids can use Section 4.1 and 4.2 of this report for specimen and transportation packages.

10.0 Adhesive and Spill Remover

The FBI's Hazardous Materials Response Unit requested information pertaining to the removal of adhesive residue and organic material. The following Case Solutions® products could be used for adhesive and organic spill removal.

The Adhesive Remover (Product CSR01) can remove medical ink and adhesive residue from tamper stickers on stainless steel and aluminum. It comes in 2 oz. and 8 oz. bottles and is sold by the case.

The Spill Remover (Product CSRE01), BioGone®, is a multi-enzymatic organic odor and spill remover. It can be used manually to break down bio-burden, and rapidly penetrates and removes organic matter. It comes in 2 oz., 8 oz., 1 gal., 15 gal., and 30 gal. sizes.

Table 12 lists the adhesive and spill remover costs and product number for each size.

Table 12: Adhesive and Spill Remover Matrix

Adhesive/Spill Remover	Cost	Product Number
Adhesive Remover 2 oz. bottle	Case Solutions® $62.00/case – 12/ case	CSR011
Adhesive Remover 8 oz. bottle	Case Solutions® $104.00/case – 12/case	CSR012
Spill Remover 2 oz. bottle	Case Solutions® $25.80/case – 12/case	CRSE015
Spill Remover 8 oz. bottle	Case Solutions® $43.00/case – 12/case	CSRE011
Spill Remover 1 gallon container	Case Solutions® $75.00/case – 4/case	CSRE012
Spill Remover 5 gallon container	Case Solutions® $ 247.00 each	CSRE013
Spill Remover 15 gallon container	Case Solutions® $ 494.00 each	CSRE014

11.0 Recommendations

The recommendations provided are short-term solutions to the problems of shipping evidence, and have considered only currently commercially available containers. These containers may not be appropriate for all cases. Design, testing, and certification of new transportation containers would be necessary to provide a container appropriate for all cases.

11.1 Short Term Recommendations for Hazardous Material not in Class 6

This section will address packaging and transportation concerns for Hazardous Classes 3, 4, 5, 8, and 9 materials. Current commercially available containers have limited usefulness. The specimen containers currently used by the FBI's Hazardous Materials Division are the same as the 1-quart paint can specimen containers available from LabelMaster® and All-Pak, Inc. These containers provide a sufficient primary boundary for hazardous materials. The limited volume available for forensic evidence is the only limit to the use of this product. It is therefore recommended that the use of these specimen containers be continued, but the use of an Armlock™ seal ring from LabelMaster® should be incorporated.

The FBI's Hazardous Materials Division currently has hazardous material transport containers for shipping 1-quart paint cans and small amounts of contaminated forensic evidence, but the containers may not be able to maintain their integrity under accident conditions or for some types of hazardous materials. Containers were purchased from Purified Microenvironments, and Air Products and Chemicals, Inc. There are various sizes; the TC-8 and TC-13 hazardous material containers purchased from Purified Microenvironments have an 8-inch and 13-inch diameter opening respectively. The TC containers purchased from Air Products and Chemicals, Inc. have a 4, 6, or 12-inch in diameter opening. The containers are constructed from all welded stainless steel-304 and rely on a double O-ring seal configuration for complete containment. The top flange has two-machined grooves for two standard size O-rings. Figure 47 provides an example of the TC containers. The TC containers from Purified Microenvironments have a bolted top and the TC containers from Air Products and Chemicals, Inc. have a ring binder for a lid closure. In the short-term, it is recommended to continue the use of these containers. The use of a gold O-ring instead of the current rubber O-rings should be investigated due to that fact that gold is chemically inert, ductile, and can be reused. The only limiting factor is the initial cost of purchasing gold O-rings. Gold foil and gasket material can be purchased from Scientific Instruments Services, Inc. However, the inability to transport large volumes of forensic evidence limits the use of TC containers.

Figure 47: TC Hazardous Material Transport Containers

The use of a "PEACE PIPE" could be considered. The PEACE PIPE was developed at the Rocky Flats Environmental Technology Site for the storage and transport of transuranic waste. The PEACE PIPE is not qualified as a Type-B radioactive container, but it has potential to be used for transporting other hazardous materials or contaminated forensic evidence. The PEACE PIPE is a nominally 24-inch long, 6-inch diameter, Schedule 40, or 12-inch diameter, Schedule 20 stainless steel-304 pipe. Figure 48 shows a schematic drawing of the PEACE PIPE and its standard 55-gallon drum packaging container. Selected payload data is shown in Table 13. However, the carbon composite filters used for the PEACE PIPE would not be conducive for transporting hazardous materials that could damage or migrate through the filters.

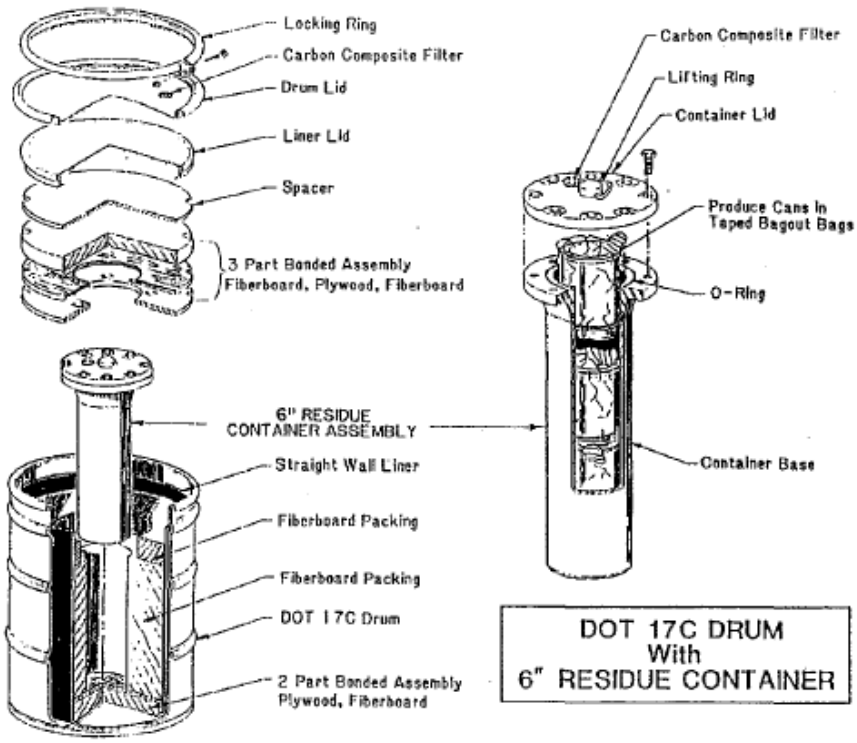

Figure 48: Schematic Drawing of the PEACE PIPE and Its Standard 55-gallon Drum Packaging Container

Table 13: PEACE PIPE Payload Data

Pipe Size Diameter (inches)	6	12
Outside Diameter (inches)	6.5	12.875
Inside Diameter (inches)	6.125	12.333
Wall Thickness (inches)	0.375	0.5
Inside Height (inches)	25.125	25.875
Inside Volume (liters)	~12	48
Pipe Weight Empty (lbs)	88	195
Payload Net Weight (lbs)	66	167
Drum & Liner Weight (lbs)	77	77
Fiberboard Weight (lbs)	97	65
Total Weight (lbs)	328	504

A 55-gallon, open-head drum packaging container could also be used for transporting TC containers. This would provide an added measure of protection in the event of an accident. This could be a 55-gallon drum, a 55-gallon stainless steel drum, or a 55-gallon PIH Overpack. Also, the use of the Wheeled Overpack™ if the total weight is less than 250 lbs. or the 95-gallon Poly-Overpack if the total weight is less than 650 lbs. could also be considered for additional protection.

It is recommended a 55-gallon open or closed-head drum could be used for transporting large volumes of forensic evidence. These drums could then be loaded into the Wheeled Overpack™ if the total weight is less than 250 lbs. or the 95-gallon Poly-Overpack if the total weight is less than 650 lbs. for additional protection.

The Plutonium Air Transportable Model 2 (PAT-2) package could be considered to transport small amounts of hazardous materials or forensic evidence. The PAT-2 was designed for transporting small quantities of plutonium or uranium by air. According to the PAT-2 Safety Analysis Report (SAR), "The PAT-2 package is resistant to severe accidents, including that of a high-speed jet aircraft crash, and is designed to withstand such environments as extreme impact, crushing, puncturing, and slashing loads, severe hydrocarbon-fueled fires, and deep underwater immersions, with no escape of contents. The accident environment may be imposed upon the package singly or sequentially." This package is certified as a Type-B radioactive container, and thus meets all the requirements for transporting other hazardous materials. Table 14 shows selected payload data.

Table 14: PAT-2 Payload Data

Payload of fissile material	15 grams
Total Mass (lbs)	72
Outside Height (inches)	14
Outside Diameter (inches)	15
Inside Height (inches)	1.73
Inside Diameter (inches)	2.75

The use of TC containers, PEACE PIPE, or PAT-2 will limit the volume of hazardous materials or contaminated forensic evidence that could be transported. A 55-gallon, open-head stainless steel drum or a 55-gallon PIH Overpack can transport large volumes of hazardous materials or contaminated forensic evidence, but their thin walls and open head lids provide little protection in the event of an accident. Also, none of these containers are chemically inert from all hazardous chemicals.

Table 15 provides a summary of the recommendations for each class of hazardous material.

11.2 Short Term Recommendations for Poisonous by Inhalation Materials

This section will address the packaging and transportation concerns for Hazardous Materials Class 6 Division 6.1 poisonous by inhalation (PIH) materials. Current commercially available containers can be useful. There are no specimen containers currently used by the FBI's Hazardous Materials Division that could be specifically applied to PIH materials. It is therefore recommended that for small amounts of evidentiary material, 1-liter plastic coated glass containers should be used as specimen containers. If large amounts of evidentiary material are to be transported, the 20 to 55-gallon PIH overpack should be used.

The TC containers described in Section 10.1 of this report should be used for transporting the 1-liter plastic coated glass containers. If the 20 to 55-gallon PIH overpacks are to be transported, then the 65 to 95-gallon poly overpack transport containers should be used.

Table 15 provides a summary of the recommendations for each class of hazardous material.

11.3 Short Term Recommendations for Infectious Material

This section will address packaging and transportation concerns for Hazardous Materials Class 6 Division 6.2 infectious materials. Current commercially available containers have limited usefulness. The specimen containers currently used by the FBI's Hazardous Materials Division are the same as the 1-liter transparent specimen containers currently

available from ThermoSafe® and Source Packaging of New England Inc. These containers provide a sufficient primary boundary for infectious materials or secondary boundary if test tubes are placed inside. Cost and limited volume available for forensic evidence are the only limits to the use of this product. It is therefore recommended that the use of these specimen containers be continued.

The FBI's Hazardous Materials Division currently has an infectious material transportation container for shipping 1-liter transparent specimen containers by air, but it does not allow the sublimated CO_2 from dry ice to be vented. The container must be left unlocked to allow the carbon dioxide to escape and does not suffice as a containment boundary. In the short-term, the purchase of the Infectious Substance Shipper from Source Packaging of New England, Inc. (Model INF-3500) is recommended. However, the inability to transport large volumes of forensic evidence could limit its use.

The use of liquid nitrogen as a refrigerant may provide a better solution. Liquid nitrogen will provide temperatures low enough to limit or stop biological activity during transport. Ultimate stability of frozen cells cannot be assured unless the material is maintained at temperatures below -130 ^{o}C, which dry ice cannot achieve. The use of liquid nitrogen can allow the package to tolerate a shipping delay.

If liquid nitrogen is to be used then the recommendation would be to use the Cryogenic Shipper from ThermoSafe® (Model LN2DG). However, the use of this transportation container could result in a potential costly overhaul of the shipping containers currently used by the Hazardous Materials Division. The vial canes that would be used can hold test tubes, but will not hold anything other than test tubes. This limiting factor will not allow any forensic evidence larger than what can be placed in a test tube.

Table 15 provides a summary of the recommendations for each class of hazardous material.

Table 15: Summary of Recommendations

	Container	**Cost**
Hazard Class 3, 4, 5, 8, or 9 Small Containers	1-quart paint can with Armlock™ seal ring	LabelMaster® $2.90 each
	TC Hazardous Material Transport Container	Currently in Use

Table 15: Summary of Recommendations (continued)

	Container	Cost
Hazard Class 3, 4, 5, 8, or 9 Large Containers	55-gallon open or closed-head steel drums	All-Pak, Inc. $58.28 - $73.62 each
	95-gallon poly overpack	LabelMaster® $194.50 each
Hazard Class 6 Division 6.1 Poisonous by Inhalation (PIH) Small Containers	1-liter glass container with plastic coating	LabelMaster® $3.35 – $3.70 each
	TC Hazardous Material Transport Container	Currently in Use
Hazard Class 6 Division 6.1 Poisonous by Inhalation (PIH) Large Containers	20 to 55-gallon PIH overpacks	LabelMaster® $142.50 - $170.50 each
	65 to 95-gallon poly overpacks	LabelMaster® $163.30 - $194.50 each
Hazard Class 6 Division 6.2 Infectious Material Small Containers	1-liter transparent container	Currently in Use
	Infectious Substance Shipper	Source Packaging of NE, Inc. $336.00 each
Hazard Class 6 Division 6.2 Infectious Material Large Containers	None Commercially Available	N/A
	None Commercially Available	N/A

11.4 Long Term Recommendations for Noninfectious Materials

This section will address packaging and transportation concerns for Hazardous Classes 3, 4, 5, Division 6.1, 8, and 9 materials. Since current specimen and transportation containers limit the size of forensic evidence to 1-quart specimen containers, and transportation containers that can hold a limited number of specimen containers or contaminated forensic evidence, a new and larger shipping container should be investigated. A larger container may be needed when there is a large volume of slightly contaminated evidentiary material. A larger container would maintain integrity during air transport, yet be light enough to be transported by small aircraft or helicopters. While the probability of an accident is low, the package must be able to survive severe accident environments.

A transportation design appropriate for this purpose could have a stainless steel outer shell and internal lining of glass or gold. This container would be able to maintain dry ice temperatures for about two days. It would have the capacity to transport large volumes of evidence, or large specimens. This primary container could then be placed into a secondary container for added safety while in transport. Both containers would be autoclavable. The combined primary and secondary containers would be able to withstand the impact of a light aircraft crash. The secondary container will be stamped with the symbol for hazardous chemical materials and the FBI Hazardous Materials Response Unit's contact information so first responders would know that precautions must be made for dealing with an unknown hazardous chemical material.

11.5 Long Term Recommendations for Infectious Materials

This section will address packaging and transportation concerns for Division 6.2 infectious materials. Since current specimen and transportation containers limit the size of forensic evidence to 1-liter specimen containers and transportation containers that can hold up to six 1-liter specimen containers, a new shipping container should be investigated. Such a container would maintain integrity during air transport yet be light enough to be transported by small aircraft or helicopters. While the probability of an accident is low, the package must be able to survive severe accident environments.

A transportation design appropriate for this purpose would have a stainless steel outer shell and internal insulation layers. This container would be able to maintain dry ice temperatures for about two days. The container would have an integral filtering system that would allow the dry ice to sublimate while preventing any infectious material from entering the atmosphere. It would have the capacity to transport large volumes of evidence, or large specimens. This primary container could then be placed into a secondary container for added safety while in transport. The secondary container would also have an integral filtering system that would allow dry ice to sublimate while preventing any infectious materials from entering the atmosphere. Both containers would be autoclavable. The combined primary and secondary containers would be able to withstand the impact of a light aircraft crash. The secondary container will be stamped

with the symbol for infectious materials and the FBI Hazardous Materials Response Unit's contact information so first responders would know that precautions must be made for dealing with an unknown infectious material. Figure 49 shows the Class 6 infectious materials placard that is currently used for transporting and the biohazard label.

Figure 49: Class 6 Infectious Material Placard and Biohazard Label

(This page left intentionally blank)

Appendix A
Specimen and Transport Container Cost Matrix

Table 16: Flammable Solid Specimen Container Matrix

Specimen Container	Cost		
Glass Containers	All-Pak, Inc. $3.35 each – 1 liter $3.57 each – 2 liter $6.57 each – 4 liter LabelMaster® $0.11 each – 1 liter	**Advantages**	• Small • Light-weight • Low cost • Can see inside container • Inert for most materials • Can be used for Packing Group I materials
		Disadvantages	• Cannot be used for large samples • Not reusable
1-Gallon Paint Can 1-Quart Paint Can	All-Pak, Inc. $65.26 each – 1 Gal. LabelMaster® $3.55 each* – 1Gal. $2.90 each* – 1 Qt. * Both prices include Armlock™ ring seal	**Advantages**	• Small • Light-weight • Low cost • Can be reused
		Disadvantages	• Cannot be used for Packing Group I materials • Cannot be used for large samples • Cannot see inside container
5-Gallon, Open Head-Steel Drums	All-Pak, Inc. $10.65 each LabelMaster® $12.30 each	**Advantages**	• Small • Light-weight • Low cost • Can be reused • Can be used for Packing Group I materials
		Disadvantages	• Can only hold liquids • Cannot be used for large samples • Cannot see inside container
20-Gallon, Open-Head Steel Drums	LabelMaster® $95.85 each	**Advantages**	• Small • Light-weight when empty • Low cost • Can be reused • Can be used for Packing Group I materials • Can hold large samples
		Disadvantage	• Cannot see inside container

Table 16: Flammable Solid Specimen Container Matrix (continued)

Specimen Container	Cost		
20-Gallon, Open-Head Stainless Steel Drums	LabelMaster® $530.00 each	**Advantages**	• Small • Light-weight when empty • Can be reused • Can be used for Packing Group I materials • Can hold large samples • Corrosion resistant
		Disadvantages	• High cost • Cannot see inside container
30-Gallon, Open-Head Steel Drums	All-Pak, Inc. $37.67 each LabelMaster® $114.50 each	**Advantages**	• Small • Light-weight when empty • Can be reused • Can be used for Packing Group I materials • Can hold large samples
		Disadvantages	• High Cost • Cannot see inside container
30-Gallon, Open-Head Stainless Steel Drums	LabelMaster® $558.00 each	**Advantages**	• Small • Light-weight when empty • Can be reused • Can be used for Packing Group I materials • Can hold large samples • Corrosion resistant
		Disadvantages	• High Cost • Cannot see inside container
55-Gallon, Open-Head Steel Drums	All-Pak, Inc. $73.62 each LabelMaster® $95.85 each	**Advantages**	• Light-weight when empty • Can be reused • Can be used for Packing Group I materials • Can hold large samples
		Disadvantages	• High Cost • Cannot see inside container
55-Gallon, Open-Head Stainless Steel Drums	LabelMaster® $786.00 each	**Advantages**	• Light-weight when empty • Can be reused • Can be used for Packing Group I materials • Can hold large samples • Corrosion resistant
		Disadvantages	• High Cost • Cannot see inside container

Table 17: Flammable Solid Transportation Container Matrix

Transportation Container	Cost		
DOT-E 9168 Exemption Shipping Package	All-Pak, Inc. $20.13 each LabelMaster® $27.05 each	**Advantages**	• Small • Light weight • Low Cost • Can be reused • Can be used for Packing Group I materials
		Disadvantage	• Cannot hold large samples
1-Liter Shipping Package	LabelMaster® $9.90 each	**Advantages**	• Small • Light weight • Low Cost • Can be reused • Can be used for Packing Group I materials
		Disadvantage	• Cannot hold large samples
1-Quart Shipping Package	LabelMaster® $6.80 each – 1 x 1 Qt. $19.80 each – 4 x 1 Qt.	**Advantages**	• Small • Light weight • Low Cost • Can be reused • Can be used for Packing Group I materials
		Disadvantage	• Cannot hold large samples
1-Gallon Paint Can Shipping Package	LabelMaster® $8.80 each – 1 x 1 Gal. $12.65 each – 2 x 1 Gal.	**Advantages**	• Small • Light weight • Low Cost • Can be reused • Can be used for Packing Group I materials
		Disadvantage	• Cannot hold large samples
1-Gallon Steel Drum Shipping Package	LabelMaster® $19.65 each	**Advantages**	• Small • Light weight • Low Cost • Can be reused • Can be used for Packing Group I materials
		Disadvantage	• Cannot hold large samples

Table 17: Flammable Solid Transportation Container Matrix (continued)

Transportation Container	Cost		
5-Gallon Steel Drum Shipping Package	LabelMaster® $8.75 each	**Advantages**	• Small • Light weight • Low Cost • Can be reused • Can be used for Packing Group I materials
		Disadvantage	• Cannot hold large samples
Fiberboard Overpack	All-Pak, Inc. $8.18 each – 5.5 Gal. $28.55 each – 26 Gal. $30.78 each – 35 Gal.	**Advantages**	• Light weight when empty • Low Cost • Can be reused • Can hold large samples
		Disadvantages	• Not approved to transport Packing Group I materials • Not approved as overpacks
Poly-Overpack	LabelMaster® $163.30 each – 65 Gal. $194.50 each – 95 Gal.	**Advantages**	• Light weight when empty • Can be reused • Can be used for Packing Group I materials • Can hold large samples
		Disadvantages	• High Cost • Requires a dolly to move when loaded
Wheeled Overpack	LabelMaster® $227.00 each – 95 Gal.	**Advantages**	• Light weight when empty • Can be reused • Can be used for Packing Group I materials • Can hold large samples • Does not require dolly to move when loaded
		Disadvantages	• High Cost • Can only hold 38% of the weight for the same sized poly-overpack

Table 18: Poisonous by Inhalation Specimen Container Matrix

Specimen Container	Cost		
1-Liter Glass Containers	All-Pak, Inc. $3.41 each – Clear $3.56 each – Amber LabelMaster® $3.35 each – Clear $3.70 each – Amber	**Advantages**	• Small • Light-weight • Low cost • Can see inside container • Inert for most materials • Can be used for Packing Group I PIH materials
		Disadvantages	• Cannot be used for large samples • Not reusable
20-Gallon PIH Overpack	LabelMaster® $142.50 each	**Advantages**	• Small • Light-weight when empty • Can be reused • Can be used for Packing Group I PIH materials • Can hold large samples • Corrosion resistant
		Disadvantages	• High cost • Can only hold solids • Cannot see inside container
30-Gallon PIH Overpacks	LabelMaster® $149.50 each	**Advantages**	• Small • Light-weight when empty • Can be reused • Can be used for Packing Group I materials • Can hold large samples
		Disadvantages	• High Cost • Can only hold solids • Cannot see inside container
55-Gallon PIH Overpacks	LabelMaster® $170.50 each	**Advantages**	• Small • Light-weight when empty • Can be reused • Can be used for Packing Group I materials • Can hold large samples
		Disadvantages	• High Cost • Can only hold solids • Cannot see inside container

Table 19: Infectious Material Specimen Container Matrix

Specimen Container	Cost		
Aluminum Cans	ThermoSafe® Model 630 - $180.75/case – 10/case Model 435 - $96.90/case – 48/case Model 436 - $84.95/case – 25/case	**Advantages**	• Small • Light-weight • Low cost • Autoclavable
		Disadvantages	• Can hold only a limited number of vials • Cannot see inside container • Cannot be used for large samples
0.5-Liter Transparent Containers	Source Packaging of NE, Inc. $100.40/case – 20/case ThermoSafe® $55.65/case – 6/case	**Advantages**	• Small • Light-weight • Low Cost • Can see inside container
		Disadvantages	• Can hold only a limited number of vials or small samples • Cannot be used for large samples • Not autoclavable
1.0-Liter Transparent Containers	Source Packaging of NE, Inc. $111.37/case – 6/case ThermoSafe® $243.10/case – 12/case	**Advantages**	• Small • Light-weight • Can see inside container • Can hold a large number of vials • Autoclavable
		Disadvantages	• Can only hold a limited number of small samples • Cannot be used for large samples • Expensive to replace

Table 20: Poisonous by Inhalation Transportation Container Matrix

Transportation Container	Cost		
PIH Shipping Package	All-Pak, Inc. $20.35 each LabelMaster® $27.05 each	**Advantages**	• Small • Light weight • Low Cost • Can be reused • Can be used for Packing Group I PIH materials
		Disadvantage	• Cannot hold large samples
Fiberboard Overpack	All-Pak, Inc. $30.78 each – 35 Gal.	**Advantages**	• Light weight when empty • Low Cost • Can be reused • Can hold large samples
		Disadvantages	• Not approved to transport Packing Group I PIH materials • Not approved as overpacks
Poly-Overpack	LabelMaster® $163.30 each – 65 Gal. $194.50 each – 95 Gal.	**Advantages**	• Light weight when empty • Can be reused • Can be used for Packing Group I PIH materials • Can hold large samples
		Disadvantages	• High Cost • Requires a dolly to move when loaded
Wheeled Overpack	LabelMaster® $227.00 each – 95 Gal.	**Advantages**	• Light weight when empty • Can be reused • Can be used for Packing Group I PIH materials • Can hold large samples • Does not require dolly to move when loaded
		Disadvantages	• High Cost • Can only hold 38% of the weight for the same sized poly-overpack

Table 21: Infectious Material Transportation Container Matrix

Transportation Container	Cost		
Cryogenic Shipper	ThermoSafe® $1,027.95 each	**Advantages**	• Maintains samples below -150 °C for up to 16 days • International Civil Aviation Organization certified • Safe venting of gases • Large capacity for sample vials • Light weight
		Disadvantages	• Cannot hold large samples • Cannot use dry ice
Large Capacity Transport Container	ThermoSafe® $716.00 each	**Advantages**	• Maintains samples below -70 °C for up to 7 days • Can hold large samples • Very large capacity for sample vials
		Disadvantages	• Does not allow for venting of gases • Not certified for air travel • Heavy weight
Mid-Size Transportation Containers	ThermoSafe® $675.70 each	**Advantages**	• Maintains samples below -70 °C for up to 15 days • Can hold large samples • Large capacity for sample vials
		Disadvantages	• Does not allow for venting of gases • Not certified for air travel • Heavy weight
Infectious Substance Shipper	Source Packaging of NE, Inc. $336.00 each	**Advantages**	• Maintains samples below -70 °C for up to 2 days • International Civil Aviation Organization certified • Safe venting of gases • Large capacity for sample vials • Light weight
		Disadvantage	• Cannot hold large samples
Optional Dolly	ThermoSafe® $150.15 each		