Agenda

• What is a Hazardous Material?
• Who Regulates Hazardous Materials?
• 49 CFR - Code of Federal Regulations
• Hazardous Materials Classifications
• How are you Transporting your Hazardous Material?
• Benefits of Early Planning
• Packaging Types
Agenda

• How Much Are You Shipping?
• Requirements to Certify a Non-Bulk UN Package
• How to Reduce False Failures?
• Non-Bulk Testing Sample
Who Regulates Hazardous Materials?

• US (Domestic transport)  49 CFR Parts § 105-180

• International air (International Civil Aviation Organization-ICAO) “Technical Instructions for the Safe Transportation of Dangerous Goods by Air”

Who Regulates Hazardous Materials?

• The International Air Transport Association republishes the ICAO TI annually as Dangerous Goods Regulations and incorporates member airline requirements that exceed the basics required by International law.

• These additional requirements must be met by shippers as a contractual condition of the Air Waybill (bill of lading) agreement.

• The IATA DGR is considered a “working document” for preparing all HM for International Air Transport and does not have the force of law.
A total of 50 titles to the Code of Federal Regulations (CFR)

Title 49 is a 9 volume set with federal regulations of transportation

The second volume contains Parts 100-185
  – How to transport hazardous materials
Hazardous Materials Classifications

• Hazardous Materials are divided by packaging groups
  – A grouping according to the degree of danger presented by hazardous materials; Packing Group I indicates great danger; Packing Group II, medium danger; Packing Group III, minor danger.
  – Packing Group is determined from the Hazardous Material Tables, (49 CFR, ICAO, IATA, IMDG).
  – No Packing Group required: Gases (Class 2), Radioactives (Class 7), and Infectious Substances (6.2).
Hazardous Materials Classifications

- Hazardous Materials classified into divisions
  - 9 Classes
### The Nine Classes of Hazardous Materials (§ 173.2)

<table>
<thead>
<tr>
<th>Class Number</th>
<th>Division No. (if any)</th>
<th>Name of class or division</th>
<th>49 CFR reference for definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>n/a</td>
<td>Forbidden materials</td>
<td>173.21</td>
</tr>
<tr>
<td>None</td>
<td>n/a</td>
<td>Forbidden explosives</td>
<td>173.54</td>
</tr>
<tr>
<td>1</td>
<td>1.1</td>
<td>Explosives (with a mass explosion hazard)</td>
<td>173.50</td>
</tr>
<tr>
<td></td>
<td>1.2</td>
<td>Explosives (with a projection hazard)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.3</td>
<td>Explosives (with predominately a fire hazard)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.4</td>
<td>Explosives (with no significant blast hazard)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.5</td>
<td>Very insensitive explosives; blasting agents)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.6</td>
<td>Extremely insensitive detonating substance</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2.1</td>
<td>Flammable gas</td>
<td>173.115</td>
</tr>
<tr>
<td></td>
<td>2.2</td>
<td>Non-flammable gas compressed gas</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.3</td>
<td>Poisonous gas</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>n/a</td>
<td>Flammable and combustible liquid</td>
<td>173.120</td>
</tr>
</tbody>
</table>
# The Nine Classes of Hazardous Materials (§ 173.2)

<table>
<thead>
<tr>
<th>Class Number</th>
<th>Division No. (if any)</th>
<th>Name of class or division</th>
<th>49 CFR reference for definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>4.1</td>
<td>Flammable solid</td>
<td>173.124</td>
</tr>
<tr>
<td></td>
<td>4.2</td>
<td>Spontaneously combustible material</td>
<td>173.124</td>
</tr>
<tr>
<td></td>
<td>4.3</td>
<td>Dangerous when wet material</td>
<td>173.124</td>
</tr>
<tr>
<td>5</td>
<td>5.1</td>
<td>Oxidizer</td>
<td>173.127</td>
</tr>
<tr>
<td></td>
<td>5.2</td>
<td>Organic peroxide</td>
<td>173.128</td>
</tr>
<tr>
<td>6</td>
<td>6.1</td>
<td>Poisonous material</td>
<td>173.132</td>
</tr>
<tr>
<td></td>
<td>6.2</td>
<td>Infectious substance (Etiologic agent)</td>
<td>173.134</td>
</tr>
<tr>
<td>7</td>
<td>n/a</td>
<td>Radioactive material</td>
<td>173.403</td>
</tr>
<tr>
<td>8</td>
<td>n/a</td>
<td>Corrosive material</td>
<td>173.136</td>
</tr>
<tr>
<td>9</td>
<td>n/a</td>
<td>Miscellaneous hazardous material</td>
<td>173.140</td>
</tr>
<tr>
<td>None</td>
<td>n/a</td>
<td>Other regulated material: ORM-D</td>
<td>173.144</td>
</tr>
</tbody>
</table>
Hazardous Materials Classifications

- Hazardous Materials have compatibility groups assigned to facilitate segregation during transportation
  - Segregation tables exist for all transportation modes
    - No Restrictions applicable
    - May be loaded away from incompatible divisions
    - May not be loaded with incompatible divisions
How Do You Know if Your Product is Hazardous to Ship?

- All substances listed in 49 CFR Appendix A to Table § 172.101
  - Code of Federal Regulations for Transportation of Hazardous Materials

- Google search:
  - 49 CFR Hazardous Substances Appendix A
    [Link](http://www.phmsa.dot.gov/pv_obj_cache/pv_obj_id_1F837D26327CA9D66466119CF0D3C49390110100/filename/172_101_appa.pdf)
Questions Break
How Are You Transporting Your Hazardous Material?

• Modes of Transportation
  – Ground Transportation
    • Truck
    • Rail
  – Air
    • Additional requirements (§173.27)
      – pressure testing required for transport of liquids
      – Packaging Group III material with a primary or subsidiary risk of Division 4.1, 4.2, 4.3, 5.1, or Class 8 must meet the Packaging Group II performance level
  – Vessel (Sea)
Where Are You Shipping To?

• Geography
  – Domestically
    • Uses 49 CFR for package certification
    • Ground (truck)
    • Rail
    • Air
Where Are You Shipping To?

– Internationally (truck, sea and air)
  • Can use 49 CFR for package certification from the U.S. only
    – Must also meet the Country of Destination requirements
  • See IATA regulations for assistance
Benefits of Early Planning

• Can save money and time of product launch
• Early discussions with the following:
  – Internal Hazmat Expert
  – 3rd Party Test Laboratory
  – Packaging Supplier
• Discuss with your Hazmat Expert:
  – Meeting the regulations requirements with the pertinent authority
    • Defining packaging type
    • Special Permits
    • Specific Country of Destination requirements
    • Training your staff
Benefits of Early Planning

• Discuss with your testing laboratory:
  – Test inputs
  – Number of samples and supplies for testing
  – Documentation requirements
  – Ballast weights

• Discuss with your packaging supplier:
  – Design the most suitable and robust package system for your product
Packaging Types

• Non-Bulk Packages
  – Combination Packages
  – Single Packages
  – Composite Packages

• Bulk Packages
  – Semi-bulk packages
    • Large Packages
Packaging Types

• Exceptions (Not part of this webinar)
  – Limited Quantity
  – Consumer Commodities
  – Excepted Quantities
How Much Are You Shipping?

- Non-bulk packaging

<table>
<thead>
<tr>
<th>Hazardous Material Type</th>
<th>Maximum Net Weight</th>
<th>Maximum Volumetric Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solids</td>
<td>400 kg (882 pounds)</td>
<td>450 liters (119 gallons)</td>
</tr>
<tr>
<td>Liquids</td>
<td>n/a</td>
<td>450 liters (119 gallons)</td>
</tr>
<tr>
<td>Gases</td>
<td>n/a</td>
<td>454 kg (1,000 pounds)</td>
</tr>
</tbody>
</table>

(For gases, the capacity is given as water capacity due to the nature of the container used.)
How Much Are You Shipping?

- Large packaging
  - Exceeds 400 kg net mass or 450 liters (118.9 gallons) capacity
  - Has a volume of not more than 3,000 liters (792.5 gallons) capacity (see § 178.801(i) of this subchapter)
How Much Are You Shipping?

- Bulk packaging

<table>
<thead>
<tr>
<th>Hazardous Material Type</th>
<th>Minimum Weight</th>
<th>Minimum Volumetric Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solids</td>
<td>&gt; 400 kg (882 pounds)</td>
<td>&gt; 450 liters (119 gallons)</td>
</tr>
<tr>
<td>Liquids</td>
<td>n/a</td>
<td>&gt; 450 liters (119 gallons)</td>
</tr>
<tr>
<td>Gases</td>
<td>n/a</td>
<td>&gt; 454 kg (1,000 pounds) (water capacity)</td>
</tr>
</tbody>
</table>
Requirements to Certify a Non-Bulk UN Package

• Hazardous Material Information
• Packaging Material Information
  – Drawings
  – Specifications
• Packaging Methods/Process
• Packaging supplies
Hazardous Material Information

- Name of the Hazardous Material Product
- Part Number
- UN Proper Name
- UN Number
Requirements for Solids

- Grain
- Size
- Weight
- Dimensions
- Ballast
  - Similar characteristics to the actual dangerous goods product
  - Package system with ballast must weight the total intended rated weight
Requirements for Liquids

- Specific Gravity
- Viscosity
- Ballast
  - For non-plastic inner containers
  - For plastic inner containers
Questions Break!
Process of Packaging the Dangerous Goods Component

• Very detailed packaging instructions
• Document equipment utilized
  – Make
  – Model #
  – Equipment settings
Example – Just Taping the Box!!

• First, the die cut RSC will be erected by hand. The bottom of the shipper is then sealed by hand on the closing faces with four (4) strips of 76.20 mm (3.00 in) wide 3M nominal translucent pressure sensitive fiberglass reinforced tape. The first strip of tape is applied parallel to the length-wise closing flap with a minimum length of 523.73 mm (20.62 in) factoring the minimum overhang of 76.20 mm (3.00 in) per side. The second and third additional strips of tape is applied parallel to the width-wise closing flap with a minimum length of 305.40 mm (12.02 in) factoring the minimum overhang of 76.20 mm (3.00 in) per side. The fourth piece of tape is applied perpendicular to the center of the length of the closing flap with a minimum length of 152.40 mm (6.00 in) equally divided between the two sides. The tape is cut with a Wiss Scissor - Model Number 428N, Part Number 186-428N.
Packaging Components

• Minimum Requirements
  – Component Name
  – Manufacturer’s Name and Address
  – Part Number
  – Material Makeup
Packaging Components

• Additional Requirements
  – Drawings
    • With Specified Dimensions
  – Weight
  – Quantity
• Also known as Weight Rating

Definition: The weight of a packaging plus the weight of its contents (stated in kilograms)

– The whole package as it would normally ship

– Typically the weight rating is slightly above the whole package weight to have some flexibility for acceptable variances in packaging materials
Testing per 49 CFR Section §178

• Recommended quantities of Packaging and Samples
  – Five fully configured package systems filled with ballast weight to replace the dangerous goods component
  – One complete package system without ballast for material testing
  – Closure supplies such as nails, tape, etc.
Solids - How Do I Prepare My Samples?

• Substitute the dangerous component with ballast weight
• Ballast weight should be similar to the item dangerous goods component being represented in
  – Texture
  – Geometry
  – Density
  – Weight
Liquids - How Do I Prepare My Samples?

• Substitute the dangerous component with ballast weight
  – For non-plastic inner containers
    • +23°C/50% Relative Humidity for a min. of 24 hours
    • Water to 98% volumetric capacity not nominal capacity
  – For plastic inner containers
    • Antifreeze or similar that will remain in liquid form at -18°C for a min. of 24 hours
    • Fill to 98% volumetric capacity not nominal capacity
How to Minimize False Failures?

• Your company should fill and close the test samples with your established closing methods
  – Helps detect faulty process issues
• Issues may arise when testing containers for paste-like material when using liquid similar to water
  – Use ballast similar in texture, geometry, density and weight to the item dangerous goods component
  – Provides better data
Questions Break!
Non-Bulk Testing Sample

- Non-bulk Packaging
  < 450 liters (119 gallons) volumetric capacity and
  < 400 kg (882 pounds)
Conditioning Test per 49 CFR § 178.602

• Quantity: 5 Packages
• Prior to Drop Testing
• Liquids in non-plastics and solids
  – Condition at +23°C / 50% Relative Humidity
  – Duration: Minimum of 24 hours
Conditioning Test per 49 CFR § 178.603

- Quantity: 5 packages
- Prior to Drop Testing
- Liquids in a plastic container
  - Condition at -18°C
    - Container filled with glycol water to prevent from freezing
  - Duration: Minimum of 24 hours
Drop Testing per 49 CFR § 178.603

• Dependent of the geometry of the outer package
  – Six Drops (three for each drop)
    • Wooden barrels
    • Steel jerricans
    • Non-steel jerricans
    • Drums
      – Steel, Aluminum, Metal (other than steel or aluminum), Plywood, Fiber, Plastic and, Composite packaging (in shape of a drum)
Drop Testing per 49 CFR 178.603

• Five Drops (one for each box)
  • Boxes
    – Natural wood, plywood, reconstituted wood, fiberboard, plastic, steel, aluminum or other metal (boxes), composite packagings (in shape of a box)

• Three Drops (three drops per bag)
  • Bags
    – Single-ply with a side seam

• Three Drops (two drops per bag)
  • Bags
    – Single-ply without a side seam or multi-ply
Drop Testing per 49 CFR § 178.603

- Drop Test Orientation for boxes

<table>
<thead>
<tr>
<th>Drop Number</th>
<th>Drop Orientation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Flat on Bottom</td>
</tr>
<tr>
<td>2</td>
<td>Flat on Top</td>
</tr>
<tr>
<td>3</td>
<td>Flat on Long Side</td>
</tr>
<tr>
<td>4</td>
<td>Flat on Short Side</td>
</tr>
<tr>
<td>5</td>
<td>Corner</td>
</tr>
</tbody>
</table>
Drop Testing per 49 CFR § 178.603

• Solids

<table>
<thead>
<tr>
<th>Packaging Group</th>
<th>Drop Height (Meters)</th>
<th>Drop Height (Feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>1.8</td>
<td>5.9</td>
</tr>
<tr>
<td>II</td>
<td>1.2</td>
<td>3.9</td>
</tr>
<tr>
<td>III</td>
<td>0.8</td>
<td>2.6</td>
</tr>
</tbody>
</table>
Drop Testing per 49 CFR § 178.603

• Liquids
  – Materials with specific gravity (SG) < 1.2

<table>
<thead>
<tr>
<th>Packaging Group</th>
<th>Drop Height (Meters)</th>
<th>Drop Height (Feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>1.8</td>
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<td>II</td>
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<td>3.9</td>
</tr>
<tr>
<td>III</td>
<td>0.8</td>
<td>2.6</td>
</tr>
</tbody>
</table>

  – Materials with specific gravity (SG) > 1.2

<table>
<thead>
<tr>
<th>Packaging Group</th>
<th>Drop Height (Meters)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>SG x 1.5 m (4.9 feet)</td>
</tr>
<tr>
<td>II</td>
<td>SG x 1.0 m (3.3 feet)</td>
</tr>
<tr>
<td>III</td>
<td>SG x 0.67 m (2.2 feet)</td>
</tr>
</tbody>
</table>
Stacking Test per 49 CFR § 178.606

• Quantity: 3 Packages
• Duration: Minimum of 24 hours
• Formula:

Top Load = \[ \left( \frac{\text{Minimum stack height}}{\text{height of container}} \right) - 1 \] \times \text{weight of shipper with contents}

• Formula Notes
  – Simulated stack height predefined as a minimum of 3.0 meters (10 feet)
  – Height (outer height)
  – Weight (gross mass)
Stacking Test per 49 CFR § 178.606

• Formula

\[ \text{Top Load} = \left( \frac{\text{Minimum stack height}}{\text{height of container}} \right) - 1 \] \times \text{weight of shipper with contents}

• Example:

Package weight: 5 kg
Package height: 10 inches
10 feet = 120 inches

\[ \text{Top Load} = \left( \frac{120 \text{ inches}}{10 \text{ inches}} \right) - 1 \] \times 5 kg
= 55 kg of minimum load for 24 hours
Vibration Testing per 49 CFR § 178.608

• Quantity: 3 packages
• Duration: 1 hour
• Frequency:
  – Fast enough so it results in the package being raised from the vibration platform to allow a 1.6 mm (0.63 inch) thick flat material such as steel strapping or paperboard to be passed between the bottom of the package and the platform.
Pressure Differential 49 CFR § 173.27

- Quantity: 3 containers
- Air transportation only
- Liquids only
- Duration: 30 Minutes
- Test per the table below

<table>
<thead>
<tr>
<th>Packaging Group</th>
<th>Internal Pressure (kPa)</th>
<th>Internal Pressure (psig)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>95</td>
<td>14</td>
</tr>
<tr>
<td>II</td>
<td>95</td>
<td>14</td>
</tr>
<tr>
<td>III</td>
<td>75</td>
<td>11</td>
</tr>
</tbody>
</table>
Pass / Fail Criteria

• A packaging passes the testing if:
  – There is no rupture or leakage from any of the packages
  – No test sample should show any deterioration which could adversely affect transportation safety or any distortion liable to reduce packaging strength
  – If testing liquids, each individual package should be turned sideways to ensure no leakage is present
Cobb Testing 49 CFR § 178.516(b)(1)
Reference ISO 535

- Quantity: 3 samples
- Fiberboard boxes ability to withstand moisture
- Duration: 30 minutes
- Test Outline
  - Apply 100 ml of water to a test area of 100 cm²
    - This will provide 10 mm of water head to the 100 cm² area
  - Wait 30 minutes and roll the samples using a specified roller and blotting paper
• Passing Criteria
  – The samples do not absorb more than 155 grams per square meter
1. You now have the ability to determine if you are dealing with a hazardous material
2. Steps to get your package UN POP certified
3. Knowing the benefits of early planning
4. Importance of using proper ballast weights during testing to reduce false failures
5. Testing requirements per CFR 49
About WESTPAK, INC.

Two Locations:

San Jose Laboratory
83 Great Oaks Boulevard
San Jose, CA 95119
408-224-1300

San Diego Laboratory
10326 Roselle Street
San Diego, CA 92121
858-623-8100

www.westpak.com

Contact Us
THANK YOU!

Please feel free to Contact Us with any questions or assistance with your testing needs.

Edmund Tang
Laboratory Manager

Jorge Campos
Test Engineer II