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Shipping and handling of Natural History Specimens in Dangerous Goods: A US Perspective

- Andy Bentley, University of Kansas

Most collection holding natural history institutions, as part of their day to day operating procedures, deal with the shipping of specimens, through loans and gifts of material to other institutions as well as the accepting of incoming material. A large number of these contain flammable or hazardous solutions e.g. ethanol, isopropanol or formaldehyde in varying concentrations. Dangerous goods regulations, most in place long before September 11th, 2001, were brought sharply into focus after that tragic event.

Most specimen shipments, whether domestic or international, are sent by airmail to minimize the length of time specimens are exposed to the hazards of transport, thereby reducing the chances of damage and dehydration. Shipping dangerous goods by air presents particular problems. International shipments must comply with both the International Civil Aviation Organization (ICAO) technical instructions as well as national regulations. In order to meet commercial standards, shippers are also required to meet the International Air Transport Association (IATA) Dangerous Goods Regulations. Furthermore, some countries have added variations to many of these requirements.

Regulating agencies

The ICAO governs the implementation and adoption of standard aircraft shipping and packaging regulations by both the Department of Transportation (DOT) in the United States and IATA internationally. DOT regulations are unique to the United States. Other countries have similar domestically enforced regulations while a number rely on IATA for both domestic and international regulations. International (IATA) shipping regulations are followed by most countries. Domestic shipments sent through the mail within the United States must also conform to United States Postal Service (USPS) regulations while courier shipments (FedEx, UPS and DHL) must conform to the individual company's specific regulations (which for the most part follow IATA regulations). USPS and private courier regulations must meet or exceed the DOT or IATA regulations respectively; in many instances they are more restrictive.

Training

The first, and most important, requirement stipulated by all regulations is that all those who pack, handle or ship dangerous goods be properly trained. Training can be obtained from any number of commercial companies that specialize in Dangerous Goods or Hazardous Materials Training, and may range in price from \$300-\$500. For quantities above and beyond restricted quantities, more extensive training is required, which involves additional time and cost.

Dangerous goods/Hazardous materials

Dangerous goods/hazardous materials are classified according to Hazard Class and Packing Group. For example, most flammable liquids fall into Hazard Class 3. Within each Hazard Class, materials are classified into three Packing Groups.

Of the four substances most commonly used in wet collections only ethanol, isopropanol and formaldehyde are covered under dangerous goods regulations. Glycerin (glycerol) used for cleared and stained specimens, is not regulated in any concentration.

Ethanol (ethyl alcohol), most commonly used in concentrations of 70% and above, is regulated for transport. Concentrations between 10% and 80% fall into Packing Group III while concentrations above this fall into Packing Group II.

Isopropanol (isopropyl alcohol), most commonly used at concentrations of 50% and above, falls into Packing Group III at concentrations of 10 to 30% while concentrations above this fall into Packing Group II.

Formaldehyde (formalin) in concentrations above 10% is a Class 9, packing group III substance and is regulated for transport. What is called "10% formalin" in natural history collections is, in fact, 3.7% or 4.0% formaldehyde (formaldehyde is a saturated solution of formaldehyde gas in water, measured by weight or volume concentration) and as such is unregulated for transport.

The shipment of infectious substances, natural history specimens not containing dangerous goods (pinned insects, skins, skeletons etc.), biological materials other than natural history specimens and any material on dry ice is covered by a separate set of regulations while there may also be ancillary permitting requirements for the domestic or international transfer of biological specimens (US Fish and Wildlife, APHIS, CITES etc.).

Regulations

Domestic and international shipping and packing guidelines vary slightly in scope and limitations but both include special dispensations for smaller quantities of dangerous goods. The two sets of small quantity regulations are very similar in scope and content but have a number of limitations that must be adhered to. It is important to consult the original texts of both the DOT and IATA regulations before shipping. USPS and DOT regulations are available online^{1,2} while IATA regulations must be purchased³.

Domestic Regulations

In the United States, the shipment of dangerous goods (referred to as hazardous materials) are covered in DOT Title 49 CFR¹ (Parts 100 to 185) and USPS Publication 52². An exception to the regulations is made for dangerous goods in restricted quantities termed “small quantity regulations” outlined in DOT 173.4 and USPS Publication 52 (334). These small quantities are considered exempt from regular DOT and USPS hazardous goods requirements. Most fluid preserved natural history specimens can be packed and shipped utilizing these small quantity regulations.

1. Small quantities may be sent through the United States Postal Service via air transportation (Express, Priority and First-Class mail) or surface transportation as Standard or Parcel Post, or by any of the three major courier companies (FedEx, UPS and DHL) that follow DOT 49 CFR 173.4 small quantity regulations.
 2. Class 3 dangerous goods (all packing groups) are acceptable (ethanol and isopropanol).
 3. The maximum quantity of dangerous goods per inner receptacle cannot exceed 30 mL for acceptable liquids (as above). This inner receptacle cannot be liquid full at 55°C (131°F) and is to be constructed of plastic (having a minimum thickness of 0.2mm) earthenware, glass, or metal. A removable closure on an inner receptacle must be held securely in place using wire, tape or other positive means.
 4. Each inner receptacle must be placed within a securely sealed secondary package.
 5. Sufficient cushioning and absorbent material (that will not react chemically with the dangerous goods) must surround each inner receptacle and be capable of absorbing the entire contents of the receptacle.
 6. The secondary packages must be securely packed in a strong outer package (box) which complies with DOT mandated drop and compressive load tests without breakage or leakage from any internal receptacle:
 - a. Drop tests – free drop on top, bottom, long and short side and the junction of three sides of the package from 1.8m (5.9 feet) onto a solid unyielding surface.
 - b. Compressive load test – stack packages of similar size and weight to a height of no less than 3m (10 feet) for 24 hours.
 7. The gross mass of the package must not exceed 29 kg (64 pounds).
- Labeling - The address side of each package must be clearly marked with “This package conforms to 49 CFR 173.4” and complete return address and delivery address must be furnished. There are no other labeling requirements.

International Regulations

International shipments of dangerous goods are covered in Section 2.7³ of the IATA regulations. As above, restricted quantity regulations exist for international shipping, contained in IATA Section 2.7.1 and referred to as “Dangerous Goods in Excepted Quantities”. Dangerous goods in excepted quantities, in contrast to DOT and USPS regulations, are considered dangerous goods under IATA regulations but are exempt from

large portions of the dangerous goods regulations applicable to larger quantities.

1. The United States Postal Service may not be used for international shipping of dangerous goods. All international shipments must be sent using a private courier service (FedEx, UPS or DHL) that follows IATA regulations.
2. Class 3 dangerous goods (all packing groups) are acceptable.
3. As above, each inner receptacle may not contain more than 30 mL while the same construction, liquid full and closure security regulations apply.
4. Each inner receptacle must be placed within a securely sealed secondary package.
5. Sufficient cushioning and absorbent material (that will not react chemically with the dangerous goods) must surround each inner receptacle and be capable of absorbing the entire contents of the receptacle.
6. The same package drop and compressive load test regulations as above apply.
7. IATA regulations state that each inner receptacle must be placed within a securely sealed secondary packaging the total contents of which may not exceed 500 mL for Packing Group II liquids and 1 liter for Packing Group III liquids.
8. Labeling – each package must be labeled with the label below, having minimum dimensions of 100mm x 100mm (4” x 4”). This label must be filled in and signed by the packer. The “Nature and Quantity of Goods” section of the air waybill must be completed with the words “Dangerous Goods in Excepted Quantities”.

Figure 1: Dangerous goods in excepted quantities label for international shipments.

All three major courier services (FedEx, UPS and DHL) accept dangerous goods in excepted quantities for international delivery^{4,5,6} and waive their normal dangerous goods surcharges for packages containing excepted quantities. All three couriers do, however:

- only accept dangerous goods on a contract or pre-approval basis
- only accept dangerous goods in boxes (no envelopes). FedEx has the added stipulation that the box must measure at least 7” x 4” x 4”.
- only ship dangerous goods to approved countries (there are various countries within which they are prohibited from shipping due in part to these countries not adopting IATA dangerous goods regulations for domestic transport). Packages can only be delivered to the designated international airport and no further.. The list of countries to which this applies changes constantly therefore the courier should be contacted for an up-to-date list^{4,5,6}. In some countries, additional customs, veterinary, or fish and wildlife fees may be incurred.

It has recently been noted that FedEx has regulations in place against the carrying of “dead animals” and that museum specimens fall into this category and are therefore prohibited in FedEx mail. There are various groups working with FedEx to institute exempt status for museum specimens and resolve this impasse.

Transport in personal baggage as carry-on or checked luggage

Due to the fact that DOT defines small quantities as non-hazardous, these quantities are allowed in hand and checked baggage on domestic flights but must be declared to the airline staff before boarding. The final decision as to whether or not to accept these packages is made by the pilot of the aircraft being boarded, thus you may be denied permission to carry the package on board at the last minute

With the present heightened security measures in force at airports and the policy of no liquids or gels (or limited to 3 oz bottles in a clear quart zip-lock bag depending on which airport you fly through) no specimens in fluid would be allowed as carry-on baggage at all.

Internationally, dangerous goods in any quantity are prohibited as carry-on or checked baggage and cannot be carried on your person or checked onto any international flight (IATA Section 2.7.3).

Natural history specimens

In real world collection scenarios, the common practice of wrapping specimens in cheese cloth or gauze moistened with alcohol and sealed in plastic would keep the material from being a dangerous good as long as no more than 30 mL of 70% ethanol was used in each individual package and the heat sealed plastic bags are at least 0.2mm thick. Specimens preserved in 3.7% formaldehyde can be shipped in regular mail both domestically and internationally without any dangerous goods requirements.

Tissues can be placed in cryovials or glass vials in less than 30 mL of 99% ethanol if the caps are secured with tape or Parafilm, and the vials placed in a secondary heat sealed plastic bag with absorbent material and packed similar to the above.

It has also been suggested that fluid preserved specimens may be placed in water (or reduced concentrations of alcohol) for shipment. Although this may put specimens outside of the scope of dangerous goods regulations, the possibility of damage to specimens from swelling (and subsequent shrinkage upon reinsertion into alcohol), cell wall rupture, mold, and bacterial growth will severely endanger the specimens, particularly if the shipment is delayed.

It is important to remember that dangerous goods regulations are not written to specifically address the shipment of natural history specimens. There are various groups that are in the process of working with the various organizations to have regulations put in place that will address certain shortcomings of the existing regulations for natural history specimen shipments.

References:

- 1 Title 49 CFR, Subtitle B, Chapter 1, Subchapter C: Hazardous materials regulations. US Department of Transportation (DOT). http://www.access.gpo.gov/nara/cfr/waisidx_99/49cfrv2_99.html
- 2 USPS Publication 52: Hazardous, Restricted, and Perishable Mail. Part 3: Hazardous Materials. Pgs 15-60. July 1999. <http://www.usps.com/cpim/ftp/pubs/pub52.pdf>
- 3 IATA Dangerous Goods Regulations, 48th Edition. 2007. Section 2 - Limitations pgs 9-80. International Air Transport Association. Not online.
- 4 FedEx Dangerous goods shipping website: <http://www.FedEx.com/us/services/options/express/dangerousgoods/hidden.html>
FedEx Dangerous Goods/Hazardous Materials Hotline: 1-800-463-3339.
- 5 UPS dangerous goods shipping website: <http://www.ups.com/content/us/en/resources/prepare/idg/information/definition.html>
UPS Hazardous Materials Support Center: 1-800-554-9964.
- 6 DHL dangerous goods shipping website: <http://www.dhl-usa.com/usgov/servopt>
DHL Hazardous Materials Hotline: 1-866-588-2002.