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Proper Packaging Required to Maintain Traceability

By Val Miller

How many times have you purchased a new piece of equipment, whether for personal or business use, and received it packaged so that you felt like you were unwrapping Fort Knox. Layer after layer of packaging must be removed, and then you find the paper in the container recommending that you "Retain the original packaging for possible future shipment." In all probability, you did not follow that recommendation, whether because of storage space or a lack of understanding of the importance of proper packaging.

Recently, an alarming number of standard artifacts being shipped between laboratories have been damaged because of failure of the packaging to protect the contents. Poor packaging has caused significant damage to the artifacts resulting in loss of data and, in some cases, complete loss of the artifacts. NIST Handbook 44, Appendix A, section 3.3, Accuracy of Standards, discusses the need for having calibrated standards. The second paragraph of this section states: "Accurate and dependable results cannot be obtained with faulty or inadequate standards." Poor packaging can result in faulty standards.

Besides having the standards calibrated for each use, how is this accomplished? Since the majority of the standards used in legal metrology are made of metal, it is so easy to be lax in our care of them. We think, "It's steel; it doesn't need any special care." But keep in mind that though they are made of steel or some other metal, the material is not the property of the device that we utilize in our tests. Instead, it is the shape and size (volume), the total amount of material (mass) or distance between two marks (length), which are of concern. When a weight slides across a truck floor or scale deck, small amounts of material are removed by friction. Since the known amount of material is the property used in the test, we now have lost, or should have lost, confidence in the accuracy of the value.

Steel test measures have been observed being transported in the back of a vehicle without being restrained or protected. The property of the test measure that we use is the shape and volume. If the test measure contacts another object and is deformed from the shape it had when last calibrated, its accuracy is lost. Even dents that are not visible to the eye can cause errors in volume that far exceed the allowable one-third of the applicable tolerance. In both situations the standards are now faulty and inadequate for use in testing.

Laboratory standards are many times shipped to another laboratory for calibration. The value in the calibration is the reported measured result and uncertainty. If damage occurs during shipment, there can no longer be confidence in the reported measurement result, and any funds expended for the calibration are wasted.

Major shipping companies such as Federal Express and United Parcel Service have made packaging recommendations and shipping guidelines available both in paper form and via

their Internet sites. They recommend that the original packaging be maintained and re-used, and that additional layers of packaging may be required to adequately protect the item being shipped.

Some of their other recommendations may seem extreme, i.e., always using a new box for the outer layer of packaging, using at least two inches of plastic bubble packaging or foam material around each inner box or container (four inches for fragile items), ensuring that all edges and sharp corners are taped or rounded, using at least three strips of tape for top and bottom of a carton and using three or even more layers of packaging materials for fragile items. These recommendations may seem excessive, but they help ensure that the item reaches its destination safely.

For legal metrology standards this is very important, whether we are transporting them from one test location to another or shipping them across the country for calibration. It is important even for those large cast iron weights used to check large capacity scales. Any damage, even if not visible to the eye, can change a standard's property of interest. The Fundamental Considerations require that the error in the standard be less than one-third of the tolerance being tested. The only way to ensure that our properly adjusted and calibrated standards continue to meet this requirement is to ensure that proper packaging is used, whether shipping across the country or just being transported across town.

To apply the guidance provided by these experts to precision mass standards, follow these five basic steps:

1. Wrap the item in a fine lint-free paper (do NOT use plastic materials in direct contact with the item's surface);
2. Next, cover the item with several layers of clean, lint-free cheesecloth;
3. Seal the item in a plastic bag, if appropriate;
4. Wrap the entire package in several layers of plastic bubble packaging material; and finally,
5. Place the wrapped mass standard in a container made of material suitable for protecting the standard.

Exterior packaging materials will vary with the mass of the standard. Heavier items will require more durable materials be used. Multiple layers of packing containers are recommended.

Even when the manufacturer's case is available for the mass standards, you should still wrap the weights in fine lint-free paper before inserting them into the case. This protects the weights from contamination that may be in the case and from damage caused by abrasion if the weights move during transit. Very small weights, such as milligram weights, should be individually wrapped in a small piece of fine lint-free paper before placing them in their designated spot in the case. The extra material provides padding to keep the weights from being damaged or folded during transport. And finally, ensure that sufficient material is placed on top of the leaf weight cover so that it is firmly held in place and does not move during transit, but not to the extent that the leaf weights are damaged. Excessive leaf weight covers in small weight kits have caused a number of

small mass standards to be damaged beyond use by causing the weights to be folded so that they break when being straightened out. Weights in manufacturer's cases must be restrained from all movement or damage is likely.

Routine transport of mass field standards may not require protection to the degree provided by the items in the list above, but they should still be protected from damage by restraining them within the transport vehicle and keeping them covered to prevent debris, such as mud, dust and water, from accumulating on the surface.

Volume standards must be protected in a manner suitable for the size of the standard and the material from which they are made.

Small metal volume standards should be:

1. Packaged in a metal container provided by the manufacturer, or placed in a snugly fitting double- or triple-walled cardboard box, if the original container is unavailable, ensuring that the standard is restrained from movement within the container; and
2. Placed the container inside a double- or triple-walled cardboard container, or one made of metal or wood, for added protection.

Large truck- or trailer-mounted volumetric standards must also be protected from damage. Though quite large and made of metal, the size and shape of these standards must be protected. Protection methods for these items can cover a range of possibilities too voluminous for this article and may include procedural, as well as physical, methods. However, sight gauges, levels, and level mounts, which are critical to obtaining good measurement results, must always be protected from damage.

Glassware should be packaged as follows:

1. Wrap in multiple layers of plastic bubble packaging material;
2. Place inside a cardboard box or tube that fits snugly around the wrapping material;
3. Place this box in a much larger box (at least six inches larger on each side) that is filled with energy-absorbing materials to a level that will position the smaller box at the center. The larger box is then filled with more energy-absorbing materials so that the smaller box is fully restrained from movement when the outer box is taped closed.
4. As recommended in a Federal Express brochure for fragile items, use a third layer of box and energy-absorbing materials.

Liquid-in-glass thermometers are another type of standard that is difficult to safely package. Experience shows they should be packaged in a manner similar to glassware, though additional stiffening provided by a piece of wood or a case stiffened with wood should be used.

1. Place the thermometer in the manufacturer's case;
2. Attach the case to a piece of wood having a minimum thickness of 0.25 inch using tape or elastic bands;
3. Place this assembly in a sturdy plastic bag (this will capture the contents if breakage occurs);
4. Wrap the plastic bag-encased item in multiple layers of energy-absorbing materials;

5. Place this box in a much larger box (at least six inches larger on each side) that is filled with energy-absorbing materials to a level that will position the smaller box at the center. The larger box is then filled with more energy-absorbing materials so that the smaller box is fully restrained from movement when the outer box is taped closed;
6. Use a third layer of box and energy-absorbing materials (recommended).

Length standards should be packaged in a manner determined by the design of the standard. Steel tape measures that have a case can be wrapped in energy-absorbing materials and transported in a single layer box.

Tape measures on an open reel should follow these guidelines:

1. Wrap item in protective film;
2. Next, wrap several layers of energy-absorbing materials around item;
3. Place in a box that snugly fits the wrapped item;
4. Place the box in a larger box filled with energy-absorbing materials so the inner box is approximately centered in the outer box.

Steel rulers, on the other hand, should be:

1. Wrapped in protective film;
2. Taped to a stiff piece of wood or other rigid material to prevent bending; and
3. Placed in a large box or mailing tube that provides adequate protection.

To ensure that the artifact arrives safely, one additional precaution should be taken. If shipping the artifact in a wooden crate or box, be sure that the sides, bottom and lid of the container are secured using a suitable banding material. Banding should be added whether or not the box is an inner layer of protection or the outermost layer. The addition of banding material serves to strengthen the container by restricting movement of the container walls and also prevent damage to the artifact by making it difficult for unauthorized personnel to open the container.

If a hardened container such as those manufactured by a number of companies, i.e., Anvil, is used, banding may not be required, but a tamper resistant seal or locking mechanism is strongly recommended to restrict access. Ensure that items or boxes inside the hardened container are held rigidly in place or damage to the artifact is likely.

Shipping artifacts so that the traceability of the associated calibration value is not lost because of damage to the artifact is possible. It just requires proper planning and packaging. And, when possible, use the recommendations of the packaging and shipping experts.