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PROCEDURE 846.04 Amp. Sealing
STANDARD OPERATING PROCEDURE
FLAME-SEALING OF GLASS AMPOULES USING MANUAL OR
AUTOMATIC SEALER

**Person Responsible for
Operating Procedures**

Group Leader

Health Physicist

This protocol covers flame sealing of glass ampoules containing radioactive solutions using either the Collé-Cavallo manual sealer (NIST, circa 1975) or the Ampulmatic-10 automatic sealer (Bioscience, Inc). Ampoules to be sealed are: (i) the 1976 “NIST 1” standard ampoules; (ii) the new “NIST 2” cryogenic ampoules; and (iii) the newest 2018 “NIST 3” 75 mm standard ampoules. All three are 5 mL borosilicate glass ampoules. The procedures covered here include (a) manual sealing of NIST 1 and NIST 2 ampoules with a natural gas / oxygen flame by removal of excess glass; and (b) automatic tip sealing of NIST 3 ampoules with a propane / oxygen flame. Tip sealing with the manual sealer (using natural gas / oxygen flame) is not allowed. Occasionally smaller and larger sized ampoules (2 mL, 10 mL, and 20 mL) are sealed with the manual sealer with appropriate sized holders, using identical procedures described for sealing 5 mL ampoules.

The ability to flame seal ampoules is a necessary task for many aspects of the work performed by the NIST Radioactivity Group (RG). Flame-sealed ampoules are widely used in the RG (i) for production of Radioactivity SRMs and standard sources distributed for QA proficiency testing; (ii) for quantitative storage of radioactive solutions; and (iii) for the performance of small-scale gravimetric dilutions.

1. General Considerations

- Only users who have completed Compressed Gas Safety Program Training (NIST s 7101.61) can perform flame sealing of ampoules.
- There should be a designated area within a laboratory, set-up specifically for flame sealing. This area should be sufficiently uncluttered and clear of all unnecessary articles which are not needed for the sealing process.

- The working area must be either bare metal (as on the floor of a fume hood) or lined with aluminum foil or some other non-combustible surface. The manual sealer using the in-house natural gas supply can be located on either a laboratory counter top or inside a fume hood. The automatic sealer using compressed propane fuel must be located in a fume hood.
- The automatic sealer is primarily intended for sealing large numbers of ampoules for SRM production. Sealing can generally be performed without shielding.
- Ampoules containing high levels of radioactivity with substantial photonic-emission exposure rate must be sealed with the manual sealer with the ampoule shielded in either an aluminum or lead pig or with the automatic sealer located behind a leaded L-shield or lead brick wall.
- Sealing procedures are performed with safety glasses or goggles (preferably tinted), protective clothing (lab coats) and disposable gloves (suitable for the solutions in the ampoules). Closed shoes and garments fully covering the legs must also be worn (i.e., no sandals or flip-flops, and no shorts or skirts).
- Radiation monitoring is performed with TLD badges, finger rings (when needed), and portable monitors. Other radiological hazard evaluations and mitigation are covered in Section 8 below.

2. Materials

- Ampoules containing non-combustible solutions
- Collé-Cavallo manual sealer.
- Ampulmatic 10 automatic sealer
- Natural gas outlet
- Compressed 1-lb propane gas cylinder, approved DOT-39 non-reusable, non-refillable cylinder (secured to sealer to prevent tipping)¹
- Compressed oxygen gas cylinder with approved regulator (secured to fume hood or counter top with restraints to prevent tipping)
- Long-armed metal forceps for removing excess glass with manual sealer
- Lighter, as ignition source
- Disposable gloves and protective clothing, including safety glasses or goggles.
- “Sharps” container for removed excess glass with manual sealer.
- Smears to do surveys for possible contamination at the end of operations
- Radiation monitoring paraphernalia (as above)

3. Locations

- Manual sealers located in fume hoods are in B46, B156, B157, and C135.
- Manual sealer located on a counter top is in Room E105
- Automatic sealer is located in Room B157 in the same fume hood as manual sealer (hood dedicated for sealing).

¹ Future use may use larger 20-lb refillable propane tanks.

4. Manual Sealer Procedure

- The manual sealer is used to seal NIST 1 and NIST 2 ampoules by removing excess molten glass.
- The valve on the natural gas supply is opened, and the torch is ignited with a lighter, burning with just a natural gas flame.
- The compressed oxygen cylinder is opened, and the flame is adjusted by the tank's regulator.
- A filled ampoule whether in a block aluminum holder or similarly-sized lead pig is placed on the sealer platform. The switch for the motor is then turned on to slowly rotate the platform, holder, and ampoule.
- For sealing, the sealer handle containing the light torch is rotated forward until the flame reaches a position about 2 cm below the top of the ampoule. Long metal forceps are used to grasp the molten glass stem (just before the stem collapses) and slowly pull away the excess glass. The flame is held to the seal for less than a second to anneal the glass. The excess glass is disposed into a sharps container. Once sealed, the torch head is rotated backwards to its rest position. The sealed ampoule, after cooling, is returned to the ampoule rack or to a cart if the ampoule is shielded by its own lead pig.
- Each ampoule is closely inspected to ensure that the seals are adequate and without defects. Any ampoule with a defective seal is opened and the solution is transferred to a new ampoule with an aspirating pycnometer. The new ampoule is then sealed.
- All sealed ampoules must be tested to ensure the integrity of the seal. This is performed by inverting the cooled ampoule several times over a wad of tissue paper and visually examining the tissue for the presence of any liquid. The tissue is also surveyed with a portable instrument for contamination. If the ampoule is to be opened immediately after sealing (e.g., as in performing a dilution), it is not required that the ampoule be smeared and further surveyed. All other sealed ampoules must be smeared for possible contamination. Smears of SRM production ampoules (excepting 4400 series) must be measured by GSRD.
- On completion of sealing, all gas supplies are closed, and smears for possible contamination of the sealer, forceps, and sealing area are taken for surveys.

5. Automatic Sealer Procedure

- The automatic sealer is used to seal NIST 3 (i.e., ampoules of height 75 mm) by tip sealing. Once the sealer flame and seal dwell time are appropriately adjusted, the sealer will automatically seal up to 20 NIST 3 ampoules in the sealer carousel.
- If NIST 1 and NIST 2 ampoules of greater than 75 mm height are used, the tip-sealed ampoule will have a height of about 90 mm which is too tall for positioning in the ion chamber holders and for SRM packaging. However, such taller, sealed ampoule could be used for solution storage.
- For safety, the propane cylinder is not connected to the sealer until needed. It is not left permanently connected for long periods between uses.

- The carousel that holds up to twenty 5 mL ampoules is loaded with a single test ampoule (or several) for adjustment of torch flame.
- While the sealer's oxygen inlet toggle valve is closed, the compressed oxygen tank is then opened, and the regulator adjusted to an outlet pressure of approximately 20 psi (138 kPa).
- With the propane cylinder connected to the sealer's fuel inlet port, the cylinder valve is opened.
- The torch is then ignited with a lighter, producing a large, wavering propane-only flame.
- The sealers' oxygen inlet toggle valve is then opened. Adjustments to the propane / oxygen flame are made with the oxygen control needle valve and dwell time control.
- The power switch on the sealer is turned on, and the test ampoule(s) advance to the position in front of the flame. The ampoule is sealed with a tip seal before advancing.
- Once the flame and seal time are adjusted to a desired condition, the sealer unit is turned off, and the carousel is loaded with the filled ampoules that are to be sealed.
- On completion of all seals, the sealer unit is turned off and the sealed ampoules are replaced in the ampoule racks.
- Another batch of ampoules is then loaded into the carousel, if needed, and the sealer is turned on again.
- On completion of sealing, all gas supplies are closed, by first shutting off oxygen supply at the inlet toggle valve on the unit, then, at the compressed oxygen tank, and finally the valve to the propane cylinder.
- Each ampoule is closely inspected to ensure that the seals are adequate and without defects. Any ampoule with a defective seal is opened and the solution is transferred to a new ampoule with an aspirating pycnometer. The new ampoule is then sealed.
- All sealed ampoules must be tested to ensure the integrity of the seal. This is performed by inverting the ampoule over a wad of tissue paper and visually examining the tissue for the presence of any liquid. The tissue is surveyed with a portable instrument for contamination. All sealed ampoules must then be smeared for possible contamination. Smears of SRM production ampoules (excepting 4400 series) must be measured by GSRD.
- On completion of sealing, all gas supplies are closed, and smears for possible contamination of the sealer, forceps (if used to remove sealed ampoules from the carousel) and sealing area are taken for surveys.

6. General Hazards and General Hazards Mitigation

- Flame sealing of glass ampoules containing radioactive solutions can only be performed in the presence of two persons, one of whom is designated as the person actually doing the sealing. The presence of the other individual ensures safety.
- Sealing is to be done only by persons having been adequately trained and who have demonstrated their competence to the SRM Coordinator or Radioactivity Group Leader.
- All persons doing the sealing must wear protective clothing, which includes but is not limited to a lab coat, gloves (resistant to the solutions in the ampoules), and safety eyeglasses or goggles.
- The main general hazard associated with sealing is the potential for contamination from a broken glass ampoule dropped when transferring the sources from an ampoule rack to the sealer or transferring the ampoule back to the rack. Ampoules are to be transferred from carts to the sealing locations in ampoule racks or in pigs designed for the purpose.
- The specific risks and methods of mitigation are accidental spillage of unsealed ampoule contents or accidental breakage of sealed ampoules by dropping them. Great care must be taken when handling the filled ampoules, particularly when transferring the ampoules in racks or pigs from a cart to the sealer and back to a cart.
- Most personnel exposure during sealing operations occurs when the radiations are shielded by glass containers (in worst case) or by aluminum or lead pigs. Typical handling time is less than 15 minutes to seal 50 ampoules, including transfers to the sealer.
- The procedures covered here incorporate handling of sharps during manual sealing by removal of excess glass, possibly contaminated with radioactive material (but very low probability). The excess glass is only removed and handled with long-armed metal forceps and disposed directly into sharps containers.
- Natural gas / oxygen torches are used for the manual sealers. A propane / oxygen torch is used for the automatic sealer. The torch heads are secured in fixed positions on both sealer types, and the flames are never near combustible materials. The compressed-oxygen tanks use approved regulators and are secured to fume hoods or bench tops with approved gas cylinder restraints. The compressed propane cylinder is DOT-39 approved and is stationary, standing with flat bottom on surface of fume hood and fixed to the sealer with rigid copper tubing..

7. Emergency Procedures

- All laboratory procedures involving the use of radioactive materials will be done in the presence of two qualified persons.
- All laboratories are equipped with suitable portable instruments for surveying exposures and detecting possible contaminations. Refer to Section 8 below

- In the event of a non-radiological accident involving facilities or personal injury, the severity of the accident must be assessed and addressed accordingly. For emergency situations, all personnel are trained to call (x2222) the appropriate authorities. Depending on the situation, either the location should be immediately controlled and evacuated or first aid action should be administered to anyone injured (x2222), e.g., turning off dangerous equipment (torches, electrical sparking), use of fire extinguishers, use of emergency showers and eye wash stations, or stopping of bleeding, or CPR.
- When unplanned exposures are discovered, laboratory workers must immediately remove themselves from the radiation source and must immediately contact the Radiation Safety (GRSD) office.
- In case of source breakage or leakage during sealing, the spill must be isolated and GRSD immediately notified (call extension x5800 or x2222 after hours). The laboratory should be posted as having potential contamination and secured until cleared by GSRD. If any individuals are contaminated measure the contamination, note the level and begin immediate washing in a stopped sink or basin (collecting the wash water for later analysis). Cleanup of the spill is to follow normal GRSD practices. If the radiation level is not a hazard to the individual involved in the incident, the individual shall remain in the facility until he/she is cleared by GSRD.

8. Radiological Hazard Evaluation and Mitigation.

- All laboratories are equipped with suitable portable instruments (appropriate for the radiation type) for surveying exposures and detecting possible contaminations, including photon emission detectors for exposure rate measurements during sealing operations.
- Dosimetry (TLD) badges and finger rings (when applicable) shall be worn by users.
- The sealer and sealing area will be smeared for possible contamination at the conclusion of sealing operations.
- The personal contamination monitor (PCM) nearest to the sealer locations shall be used to check for possible contamination upon exiting the sealing locations. Generally, a half-body monitor is preferable for surveying larger portions of the body. An alpha-sensitive meter to check for contamination or an alpha-sensitive hand and foot monitor must be used when sealing alpha-emitting solutions.,
- A telephone is available inside the sealing location rooms to notify GSRD in case of emergency: x5800 or x2222 after hours.