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FMF-OM-903 Sodium Handling and Sodium and Slug Loading and Settling

November 1986

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Idaho National Laboratory

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EBR–II FUEL MANUFACTURING FACILITY OPERATIONS MANUAL

REVIEW AND APPROVAL

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REVIEW

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CONTENTS

1. INTRODUCTION

This section describes the procedures and equipment used for handling sodium. The procedure pertains to obtaining sodium, melting it, casting it into sodium cylinders extruding it, disposing of scrap sodium, and cleaning of sodium cylinders and equipment.

2. EQUIPMENT INFORMATION

2.1 Glove Box

The glove box, used for the melting and casting of the sodium, provides a high-purity argon-helium atmosphere in which the sodium can be safely handled. It has a transfer lock which is used for moving material into and out of the box without disturbing the inert atmosphere.

2.2 Sodium Cylinders

Cylinders are used to cast the sodium. The assembeled cylinder, plunger, and orifice is used to extrude sodium for fuel element loading.

2.3 Sodium Pots

The sodium is transferred into the glove box in a stainless steel pot which has two Swagelok sealed ports.

2.4 Cylinder Cradle

The cradle is used to stand the sodium cylinders upright when casting the sodium.

2.5 Other Equipment Necessary for Sodium Handling

2.5.1 Band Heater

A 110-V, 750 watt band heater is used in the glove box to melt the sodium.

2.5.2 Stainless Steel Cans

One-quart cans are used to dispose of the unusable sodium. Two-gallon, or larger, cans are used to

store and transfer sodium cylinders, plungers, and orifices.

2.6 Sodium Extruder

The sodium extruder is an ANL-built device used to extrude sodium through an orifice, forming a slender wire. The diameter of the extruded sodium is slightly smaller than the inside diameter of a fuel element jacket. The extruder has a Boston Gear Works drive motor and controller.

The extruder is activated by the SODIUM EXTRUDER CONTROL located on the floor below the glove box. It has two control positions:

FORWARD - The plunger is pushed forward and sodium is extruded.

REVERSE - The plunger is reversed and sodium extrusion stops almost immediately.

2.7 Balance

The balance is used to weigh the pieces of sodium extruded and cut.

2.8 Shear

The shear, an ANL-built device to cut the extruded sodium to length, has a micrometer adjustment to change the distance between two razor blades and provide an accurate cut.

2.9 Other Equipment Necessary to Sodium Loading

2.9.1 Roller

The roller is an ANL-built device used to straighten the extruded and cut sodium and to reduce the diameter so it will fit into the fuel element jacket.

2.9.2 Tweezers

Two pair of tweezers are provided for handling the sodium. The tweezers are covered with Tygon tubing or other suitable substitute.

2.9.3 Spanner Wrench

A spanner wrench is provided for the easy removal of the orifice from a sodium cylinder.

2.9.4 Jacket Holder

The jacket holder is a steel cylinder approximately 12-in. long welded to a flat plate used to hold the jackets while the sodium is being loaded.

2.9.5 Funnel

A funnel is provided to help guide the sodium into the fuel element jacket. Any sodium left at the top of the jacket could cause a defective weld at the plug end.

2.9.6 Weights

Class S weights between 50 mg and 10 g are provided to verify the calibration of the balance.

2.10 Sodium Settling Furnace

The furnace has three heaters, (1) inside top, (2) inside bottom, and (3) outside. The outside heater extends the full length of the furnace. Each heater has its own temperature controller. The furnace is normally operated at 200°C ± 50°C.

2.11 Other Equipment Necessary to Settling

2.11.1 Jacket Holder

The jacket holder is a steel cylinder approximately 12 in. long welded to a flat plate used to hold the fuel jackets.

2.11.2 Element Cooling Racks

Two 50 element capacity Element Cooling Racks are provided to hold the fuel elements after settling. They are numbered for ease of identification of the individual elements.

2.11.3 Settler Cap

The settler cap is a device used to cover the settler when it is not in use.

3. PRECAUTIONS

3.1 Rules for criticality control per EB-CHCS-A09 shall be observed at all times. No liquids are allowed in the glove box while fissionable material is present, and then only when the glove box atmosphere controls are secured and the glove box is open to atmosphere.

3.2 Transfers into and out of the glove box must be done carefully to prevent a rise in impurity levels. The impurity levels shall not exceed the following:

Oxygen:	50 ppm max.
Water Vapor:	50 ppm max.
Nitrogen:	0.5% max.

3.3 Care must be taken when handling the cylinder, plungers, and orifices so that they are not damaged.

3.4 Element bond sodium shall have the following maximum impurity levels as established by periodic and historical sodium analysis.

Element	Limit Maximum
Ca	10 ppm
Li	5 ppm
K	1000 ppm

A log is to be maintained of sodium analysis.

3.5 The fuel element jackets to be used in the sodium loading operation shall have been inspected for cleanliness and surface defects per FMF-OM-909. Jacket classification and material traceability shall be identified in the process package.

3.6 Care must be taken in handling the fuel element jackets to prevent damage to the cladding surface. Nylon, rubber or vinyl gloves must be worn at all times when handling the jackets or elements.

3.7 Check the sodium funnel to make certain it is clean. If necessary, remove it from the glove box and clean with alcohol.

4. SODIUM HANDLING

4.1 Obtaining Sodium

4.1.1 When a sodium pot is empty, transfer the pot out of the glove box per FMF-OM-431 or FMF-OM-902.

4.1.2 Before removing the sodium pot from the transfer port, have the Radiation Safety Technician survey the sodium pot for contamination.

4.1.3 Transfer the empty sodium pot to EBR-II Operations (Bldg. 768B) to be filled from the EBR-II secondary system.

4.1.4 Transfer the filled sodium pot back to FASB or FMF. Use extreme care to prevent damage to the pot. Log the pot number, the date the pot was filled, and the sequential batch number.

4.2 Cleaning Sodium Cylinder, Orifices and Plungers

4.2.1 The ethyl alcohol cleaning of the cylinders, orifices, and plungers shall be done by the Analytical Chemistry Laboratory or in the hood by qualified personnel.

4.2.2 When a number of cylinders, orifices, and plungers need to be cleaned, transfer them out of the glove box per FMF-OM-431 or FMF-OM-902. Call the Radiation Safety Technician to survey them for contamination before removing them from the transfer port.

4.2.3 If the cylinders, orifices and plungers are to be cleaned by FMF personnel, transfer them directly to the hood.

4.2.4 If the cylinders, orifices and plungers are to be cleaned by the Analytical Chemistry Laboratory, seal them in a two-gallon or larger can. Label the can to indicate the contents, and transfer it to the Analytical Chemistry Laboratory.

4.2.5 Store the cleaned cylinders, orifices, and plunger in a sealed two-gallon or larger can.

4.3 Filling Sodium Cylinders

4.3.1 Transfer the cylinders, orifices, and plungers into the glove box per FMF-OM-431 or FMF-OM-902.

4.3.2 If there is not a full and/or partially full sodium pot in the glove box, transfer a full sodium pot into the glove box per FMF-OM-431 or FMF-OM-902.

4.3.3 Remove the fill and vent plugs from the sodium pot.

4.3.4 Place the band heater around the sodium pot.

4.3.5 Put a pair of asbestos gloves over the glove box gloves.

4.3.6 Place a splash guard over the top of the sodium pot.

4.3.7 Energize the band heater.

4.3.8 Position the porcelain pan so that it can be used for filling the cylinders.

4.3.9 Place the cradle in the porcelain pan.

4.3.10 Insert the flat end of the plunger (first) into the bottom end of the cylinder.

4.3.11 Place the cylinder in the cradle and turn the cylinder 90°. This will lock the cylinder in position.

4.3.12 When the sodium in the pot has melted, carefully fill the cylinder. It is not necessary to remove the band heater but do not allow a rubber glove to contact a hot surface during these operations.

4.3.13 Remove the filled cylinder from the cradle.

4.3.14 Complete Steps 4.3.10 through 4.3.13 until the cylinders are filled or until the sodium pot is empty.

4.3.15 Unplug the band heater and place the sodium pot where it can safely cool.

4.3.16 Remove the asbestos gloves from the glove box gloves.

4.4 Disposal of Scrap Sodium

4.4.1 When the sodium scrap can(s) are full, transfer the can(s) out of the glove box per FMF-OM-431 or FMF-OM-902.

NOTE: DO NOT SEAL THE CAN UNTIL IT HAS BEEN TRANSFERRED OUT OF THE GLOVE BOX.

4.4.2 Before removing the can(s) from the transfer port, call the Radiation Safety Technician to check the can(s) for contamination.

4.4.3 The sodium filled quart can(s) shall be prepared for storage as follows:

4.4.3.1 The quart cans of sodium shall be stored in sealable tin can containers. The sealable storage container must have a minimum of 1-in. of sand surrounding the quart cans of sodium.

4.4.3.2 Notify the Radiation Safety Technician for tagging of the storage container.

4.4.3.3 Notify Materials Handling and the ANL-W Safety Engineer who will arrange for storage in the Sodium Storage Building.

4.5 Emergency Operation and Shutdown

4.5.1 In case of a fire within the glove box, both the Fire Department and Radiation Safety should be notified immediately. Secure the power to the band heater. Assist fighting the fire and/or evacuate as required.

CAUTION: USE ONLY YELLOW FIRE EXTINGUISHERS TO COMBAT SODIUM FIRES.

4.5.2 In case of any accident, notify the Responsible Engineer.

4.5.3 In case of a criticality alarm, EVACUATE IMMEDIATELY.

5. SODIUM LOADING

5.1 Startup Procedure

5.1.1 Transfer the bundle of fuel element jackets, which are bound together with rubber bands and placed in a plastic bag, into the glove box per FMF-OM-431 or FMF-OM-902.

5.1.2 Turn on the breaker for the sodium extruder.

5.1.3 Turn the Boston Gear Works drive control unit ON. Make sure the directional switch is in the forward position.

5.1.4 Set the Variac speed to approximately 25. The exact setting depends upon the ability of the operator to control the extrusion of the sodium.

5.1.5 Place a new sodium cylinder on the extruder when needed per the following sequence:

5.1.5.1 Run the extruder ram in the reverse direction to remove pressure from the orifice cap of the old cylinder.

5.1.5.2 Using the spanner wrench, remove the orifice cap.

5.1.5.3 Raise the latch to release the sodium cylinder, turn the cylinder 90° and remove. Set the cylinder and orifice aside.

5.1.5.4 Run the extruder ram back as far as possible, by depressing the REVERSE switch on the SODIUM EXTRUDER CONTROL. This facilitates inserting the new plunger and cylinder.

5.1.5.5 Insert a new cylinder and turn it 90°. Lower the latch to lock the cylinder. Install a new orifice.

5.1.5.6 Run the extruder ram out to extrude sodium by depressing the FORWARD switch on the SODIUM EXTRUDER CONTROL. The extruder is now ready for operation.

5.1.6 Verify the accuracy of the balance by checking with each of the certified weight standards. The indicated weight shall be ± 2 mg of the standards for acceptance. Do <u>not</u> proceed until balance calibration is verified.

5.1.7 Using the jacket diameter class per the process package and the average fuel pin volume per the computer summary, calculate the required sodium weight. Record calculated sodium weight on the Process Work Sheet. The Fuel Element Manufacturing Supervisor will verify the calculations before loading begins.

5.1.8 Calibrate the shear as follows:

5.1.8.1 Press the FORWARD switch on the SODIUM EXTRUDER CONTROL to extrude a length of sodium and cut it with a knife.

5.1.8.2 Shear the sodium over-length and weight.

5.1.8.3 Adjust the shear, reshear, and reweigh until the desired weight of sodium is obtained.

5.1.8.4 The shear is calibrated and ready for use.

5.2 Sodium Loading Procedure

5.2.1 Place a table under the extruded so the sodium will extrude fairly straight.

5.2.2 Press the FORWARD switch on the SODIUM EXTRUDER CONTROL.

5.2.3 Extrude sodium to a length slightly longer than the distance between blades of the shear.

5.2.4 Cut the sodium off with the pocket knife.

5.2.5 Transfer the sodium to the shear and cut to the predetermined length. Use the Tygon-covered tweezers (or other suitable substitute) to handle the sodium.

5.2.6 Weigh the sheared piece of sodium. It must be within ± 10 mg of the required sodium weight.

5.2.7 If the piece of sodium is too light, add additional small pieces of sodium to achieve the correct weight.

5.2.8 If the piece of sodium is too heavy, trim it to achieve the correct weight.

5.2.9 Transfer the piece of sodium to the other side of the glove box. Use the Tygon-covered tweezers (or suitable substitute).

5.2.10 Lay the piece of sodium on the rolling table, and with the sodium roller, straighten and reduce the diameter of the sodium until it will fit inside the fuel element jacket.

5.2.11 Place the funnel on top of a fuel element jacket and carefully drop the piece of sodium into the jacket. Use the Tygon-covered tweezers.

5.2.12 Repeat 5.2.2 through 5.2.11 until all the jackets are loaded with sodium.

5.2.13 Transfer the sodium loaded jackets to the settling operation.

5.3 Shutdown Procedure

5.3.1 In the electrical breaker box for the glove box, open the breaker for the sodium extruder.

5.3.2 Collect all pieces of sodium and place in scrap sodium can.

5.4 Emergency Operation

5.4.1 If any emergency is encountered during operation of the extruder, stop the extruder by pressing the LIMIT switch on the SODIUM EXTRUDER CONTROL or by opening the sodium extruder breaker in the breaker box for the glove box.

5.4.2 If a seal on the glove box is broken, notify Radiation Safety immediately.

5.4.3 In case of a fire within the glove box, notify both the Fire Department and Radiation Safety immediately.

CAUTION: USE ONLY YELLOW FIRE EXTINGUISHERS OR SAND TO COMBAT SODIUM FIRES.

5.4.4 In case of any accident, notify the Responsible Engineer.

5.4.5 In the event of an emergency in any facility, put sodium in any air-tight secondary container within the glove box. Ascertain that containers are sealed before leaving the area.

5.5 Maintenance Schedule and Procedure

5.5.1 Clean used sodium cylinders, orifices, and plungers prior to reuse.

NOTE: THE GLOVE BOX GLOVES SHOULD NOT BE ALLOWED TO CONTACT SURFACES CONTAMINATED WITH SODIUM.

5.5.2 The Class S weights used for balance calibration and the pan and counterweights on the balance shall be recertified on a 2-year schedule.

6. SLUG LOADING AND SETTLING

6.1 Startup Procedures

6.1.1 Transfer the fuel slugs into the glove box per FMF-OM-431 or FMF-OM-902.

6.1.2 Turn on the settling furnace.

6.1.3 Check that controller setpoints are positioned to give an acceptable temperature within the operating range of 200°C ± 50°C.

6.1.4 Remove the cap from the furnace.

6.1.5 Let the furnace control at the operating temperature for 15 minutes before inserting the sodium-filled jackets.

6.2 Slug Loading and Settling Procedure

6.2.1 Take the element record sheet for the fuel slug batch to the desk next to the glove box.

6.2.2 Select a fuel element jacket from the holder and read the jacket serial number to a second technician who will record the jacket identification number on the element record sheet for the first fuel slug in the batch.

6.2.3 Place the jacket into position #1 in the settling furnace.

6.2.4 Repeat 6.2.2 and 6.2.3 for the first 50 jackets in the batch. The jacket number is recorded on the element record sheet for the second fuel slug and the jacket placed in position No. 2 in the settling furnace, and so on until 50 jackets have been placed in the settling furnace.

6.2.5 Place the fuel slugs into the designated jackets. The fuel slugs are in a bandolier with the slug top designated. Any fuel slug with sharp edges should be oriented with the sharp edge to the top. When the fuel slug is inverted because of sharp edges, the element record sheet is to be marked "SLUG INVERTED".

6.2.6 During loading of the fuel slugs check the furnace temperatures several times, to assure that furnace is at 200°C ± 50°C.

6.2.7 Let the elements soak at temperature for 10 minutes.

6.2.8 Using the tweezers, carefully move the elements from the furnace to the element cooling rack. The element position number in the furnace should correspond to the number of the slot it is placed into in the element cooling rack.

6.2.9 Place the locking bar in place to prevent the elements from falling out.

6.2.10 Allow the elements to cool a minimum of 10 minutes before proceeding with the next operation.

6.2.11 Repeat 6.2.2 through 6.2.10 until the remaining fuel slugs in the batch are processed. The second settling process should start with the 51st fuel slug in the batch.

6.3 Shutdown Procedures

6.3.1 Turn off the settling furnace and replace the cap.

6.3.2 Retain the element record sheet with the process package.

6.4 Emergency Operation and Shutdown

6.4.1 If any emergency is encountered, deenergize the settling furnace.

6.4.2 If a seal on the glove box is broken, notify Radiation Safety immediately.

6.4.3 In case of a fire within the glove box, notify both the Fire Department and Radiation Safety immediately.

NOTE: USE YELLOW FIRE EXTINGUISHERS OR SAND TO COMBAT SODIUM FIRES.