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## LEAD CASTING /POURING PROCEDURE

NUCLEAR Lead Fills

### 1) Scope

This instruction covers the material to be used and the procedure to be followed when casting lead into containers for use as biological shielding of gamma radiation in nuclear energy application. Section 6 covers a typical repair procedure.

### 2) Purpose

This instruction is to ensure that blows (gas holes, porosity, pin holes) and shrinkage cavities which reduce the effectiveness of shielding are minimized in the cast lead.

Blows or gas holes are rounded cavities, either spherical, flattened, or elongated, which are caused by the generation and/or accumulation of gas or entrapped air.

A shrinkage cavity or depression, large or small, results from the difference in specific volume of the liquid and solid lead, i.e., the volume of material becomes smaller when it changes from liquid to solid.

### 3) Material

Unless otherwise stated in the application specifications, drawings, instructions, etc., the lead used shall conform to **ASTM B29/92 (Re-approved 1997), Pure lead.**

### 4) Container Preparation

4.1 The internal surfaces shall be clean, free of scale, grease or other contamination.

4.2 The internal surfaces shall be dried immediately after any required leak testing.

4.3 The container shall be positioned so that any projections or obstructions inside the container are located to permit a natural flow of lead into all spaces. (In most cases this will be predetermined by design of the container and the location of the lead pouring openings.)

## 5) Casting Procedure

### 5.1 Containers that are No Larger than 22" Wide x 14" High x 17" Deep

Carbon Steel and stainless steel containers shall be pre-heated to 300°F - 400°F prior to pouring the lead and must be maintained during pouring of the lead.

The container shall be heated using gas torch, oven or furnace.

Inner parts must be pre-heated to 300°F - 400°F and soak time must be sufficient so that all parts are heated to within the required temperature range.

Temperature indicating crayons such as "Tempil-stiks" or contact pyrometers may be used on carbon steel surfaces. Contact pyrometers or other non-contaminating measuring devices must be used on other materials such as Stainless Steel, Inconels, and Aluminum.

The Melting Furnace Temperature of the Lead shall be heated to 800°F - 900°F.

### 5.1.1 Containers that are Larger than 22" Wide x 14" High x 17" Deep

Carbon Steel and stainless steel containers shall be pre-heated to 600°F - 700°F prior to pouring the lead and must be maintained during pouring of the lead.

The container shall be heated using a Multi Zone Heat System utilizing Thermo-couples, insulated with Ceramic Fiber Heat Blankets which are pin welded to the outer shell. All of which are hooked up to a temperature control system. Time/Temperature readouts are standard with this option.

**Special instructions must be written if material other than Ferrous materials are involved.**

The Melting Furnace Temperature of the Lead shall be heated to 700°F - 800°F.

**5.2** Castings, when possible, shall be made in one continuous pour using a melting pot(s) with a bottom draw-off.

When practicable, and as determined by design configuration, splashing shall be avoided by use of an extension pipe angled from the perpendicular and with outlet located within 3 inches of the molten lead.

For larger pours the extension pipe must be withdrawn as the fill progresses to maintain 3 inches between the surface of the molten lead and the outlet of the extension pipe.

Small castings may be cast using a melting pot with a lip pour or cast with a ladle. When pouring is not continuous, the surface of the poured lead shall be kept molten between successive pours to prevent cold shots or voids.

**5.3** Care shall be taken to exclude dross and contaminate from the poured lead. Dross and other contamination must be skimmed from the surface of the molten lead if the pot does not have a bottom draw-off or when pouring using a ladle.

- 5.4 "Puddling" (stirring) of the molten lead shall be done during the pouring operation to reduce entrapped air.
- 5.5 Molten lead shall be added during solidification of the casting to top up to the required level.
- 5.6 Heat may be applied to the container or to the surface of the molten lead so that solidification occurs progressively upward or from the extremities of the cavity to the pouring hole.

A water spray may be applied to the underside of the container or other locations to insure that solidification occurs from the extremities of the cavity to the pouring hole. This will insure that molten lead is available to fill up shrinkage which occurs during solidification.

## Alternate Procedure

The lead shall be allowed to cool gradually from the bottom up by turning off heater banks from the bottom up.

## 6) Lead Repair

- 6.1 Any readings of a radiation scanning test done on the container walls which fall outside of the specified acceptable readings may be cause for rejection, rework or modifications at the discretion of the purchaser, depending on purchaser's evaluation of the test result.
- 6.2 A general repair procedure would be as follows but may not be limited to only these.  
External plates of a thickness indicated by the purchaser shall be welded to the flask's outer body at each location which is suspected of being faulty.  
For larger voids it will be required to bore through the outer shell and into the lead fill cavity to remove the suspected faulty section of lead. New lead would be introduced into the cavity which would be then sealed on the outer shell with a steel cover or plug.