

DUCKET NO.

20-139

Insp.

ENGELHARD INDUSTRIES, INC.
D. E. MAKE'EAGE DIVISION
NUCLEAR MATERIALS DEPARTMENT

REVISION A

FEASIBILITY REPORT DEM-6

FABRICATION OF 164 ENRICHED (10%)
FUEL PINS FOR THE SRE TEST PROGRAM
(E. F. F. B. R.)

Written by:

Norton Weiss
Criticality Officer

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Approved by:

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Work to be Performed:

DEM in conjunction with Nuclear Metals, Inc. intends to fabricate and ship 164 prototype enriched fuel pins for the Sodium Reactor Experiment test program to Atomics International Inc., Canoga Park, California. These pins will be of the same type as those mentioned in our feasibility report DEM-5 previously submitted except that the U-235 enrichment will be 10% instead of 25%. Dimensions and alloy composition will be the same.

Material to be Supplied:

Uranium to be used for fabrication will be supplied by Mallinckrodt Chemical Co., St. Louis, Mo., in the form of biscuits $4\frac{1}{2}$ " in dia. x $\frac{1}{4}$ " - $3/4$ " thick. Each biscuit will weigh approx. 2.5 Kg. We estimate that a total of 55 Kg. 10% enriched uranium (5.5 Kg. U-235) will be required for the project.

Mallinckrodt will ship in 30" circular aluminum birdcages, a maximum of 4 biscuits (1 Kg. U-235) to a cage. Depending on the actual number of biscuits to be packed in a cage, we should receive from 5 to 7 birdcages of enriched material. It is anticipated that three shipments will be made by Mallinckrodt commencing on March 20.

Receiving and Storage:

Birdcages containing enriched material will be received at the DEM plant in Plainville, Mass. After removal from the truck, they will be transported to our enriched vault storage area. Our vault is constructed of 12" thick reinforced concrete and is 7' 11" wide x 13' 0" long x 7' 11" high with a Mosler combination safe door. The uranium will be stored in the original birdcages until ready for melting. Birdcages

are of such design that they may be stacked and still maintain a safe configuration to insure against the achievement of accidental criticality.

Each birdcage will be unbolted and the biscuits removed and weighed to verify the accuracy of the shipper's weights. The weighed biscuits will be replaced in the birdcage and sealed before the next one is opened. Storage and weighing will be under the supervision of the criticality officer or his representative. No one will be allowed in the storage area unless accompanied by one or the other.

Fabrication Procedures:

The fabrication of the 164 enriched pins is similar to that of the core assembly pins as discussed in our previously submitted feasibility report DEM-5. The following is an outline of the procedures to be followed:

A. Charge Preparation and Melting of U-Mo Ingot:

Enriched uranium biscuits will be issued for melting by the criticality officer. It is anticipated at this time that only one ingot will be melted. The ingot will be 4" in dia. x approx. 16" long. Total charge to be melted will be as follows:

Wt. Uranium (10% enr.)	- 54 Kg. (5.4 Kg. U-235)
Wt. Moly.	- 6 Kg.
Total	- 60 Kg.

Uranium will be moved to the melting area under the supervision of the criticality officer in lots of 10 biscuits (2.5 Kg. U-235) on

a rolling cart and charged into the crucible. The moly. in the form of $\frac{1}{2}$ " dia. rods, $\frac{3}{8}$ " long will be charged into the crucible at the same time.

The melting crucible will be $\frac{1}{2}$ " thick graphite, 8" in dia. and $12\frac{1}{2}$ " high. The mold will be 1" thick graphite, 4" in dia. and 16" high. Melting will be done in a hooded Kinney vacuum induction furnace. The rubber hoses which control the flow of water through the cooling coils of the furnace will be uncoupled before charging to prevent accidental flooding of the crucible. After charging has been completed, they will be re-fastened.

When the charge has been melted, it will be bottom poured into the mold and allowed to cool for a minimum of two hours.

B. Removal of Ingot from Mold and Crucible from Furnace:

After the ingot has cooled for a sufficient length of time, the mold container will be dropped and the mold removed from the furnace. The mold will be capped with a tared cover and weighed. It will then be sent to a hood for removal of the ingot from the mold. After the ingot has been removed, it will be vacuumed to remove loose oxide and wiped with a damp cloth. The ingot will then be steel stamped for identification and placed in a birdcage container of the type shown in our drawing number 1033-2 previously submitted.

The crucible will be removed from the furnace, covered, and weighed to determine the weight of oxide and skull. All personnel working inside the furnace will be required to wear respirators. After weighing, the crucible will be moved to a hood where the skull

will be mechanically removed and placed in a tared, covered 5 gal. steel bucket.

Both mold and crucible will be wiped thoroughly with damp cloths before being removed from the hood.

C. Pickling Enriched U-Mo Ingot:

The ingot in the birdcage will be moved to the enriched pickling area under the direction of the criticality representative. It will be pickled in hydrochloric acid and scrubbed with a steel brush while in the tank to remove oxide. After pickling and scrubbing, the ingot will be rinsed in water, and dried with clean rags. The ingot will then be reweighed and sent to the canning area in the birdcage. Pickle solutions will be retained in polyethylene screw cap containers for eventual disposition.

D. Canning, Welding, and Evacuation of Ingot:

The ingot will be removed from the birdcage and inserted into a cleaned copper can on a roller table. Extrusion components (nose plug, cut-off slug, end caps, evacuation tube) will be inserted into the can and heli-arc welded. The canned billet will be evacuated to one micron and leak tested. If no leaks are apparent, the evacuation tube will be sealed, and the canned billet placed in the birdcage for shipment to NMI.

E. Shipment of Canned Billet to NMI for Primary Extrusion:

The birdcage will be sealed and inspected by the criticality officer before being released for shipment. Transportation will be via DEM truck. The loading and securing of the birdcage in the truck will be directed by the criticality officer before shipment may be

made. The driver will be briefed on possible hazards before being allowed to proceed with the shipment.

F. Receipt of Copper Clad Secondary Billet from NMI:

The copper clad extruded billet (1.525" dia. x approx. 9 ft. long) will be received from NMI in an angle iron exclusion frame. A drawing of the exclusion frame to be used (#1033-3 and 4) has been previously submitted. It will be moved to the in-process storage area until such time as it may be required for production. When needed, the billet will be released for production by the criticality representative.

G. Removal of Steel Cladding from Extruded Secondary Billets:

One rod will be transported to a hood which has been set aside for the purpose of removing the steel cladding from the extruded rod. The rod will be clamped in a vise and the cladding mechanically stripped with a hammer and chisel. When completely stripped of cladding, the rod will be weighed and then transported to the pickling area.

The rod will be pickled in a 1:2 nitric acid solution to complete the removal of all cladding material. When removal is complete, the rod will be placed in a rinse tank and rinsed thoroughly with cold tap water. After rinsing, the rod will be removed and dried. It will then be weighed and sent to the hacksaw when authorized by the criticality officer.

Pickle solutions will be sampled and transferred to polyethylene containers whenever 50 grams U-235 is in solution as calculated from before and after weighings. Polyethylene containers will be stored in the enriched scrap area until analytical results have been received. The containers may then be combined in a 30 or 55 gal. polyethylene lined drum as long as the total U-235 content per drum is less than 100 grams.

H. Sawing Extruded Secondary Billet:

The pickled billet will be moved to the mechanical hacksaw where it will be sawed into pieces approx. 4" long. Approx. 25 slugs will be cut from one billet. Each slug will be wiped clean with TCE, steel stamped for identification, and placed in a tote tray capable of holding 15 slugs (3.0 Kg. U-235). Two such tote trays will be required per billet.

Saw chips will be stored in one gal. covered steel pails, a max. of 3.9 Kg. alloy (350 gm. U-235) per container. We anticipate generating only approx. 1.5 Kg. alloy (.155 Kg. U-235) in the form of saw chips and thus will require only one pail to hold the total amount of saw chips generated. The pail containing saw chips will be sealed and sent to the enriched scrap storage area at 12" edge-edge distance from similar containers.