DOCKET NO. 70-139
File Cy.
(Trans. w/ltr. of
9/25/59

ENGELHARD INDUSTRIES, INC.

D. E. MAKEPEACE DIVISION

NUCLEAR MATERIALS DEPARTMENT

REVISION A

FEASIBILITY REPORT DEM-5

Fabrication of Core Subassemblies of the Enrico Fermi Fast Breeder Reactor

Written by: _____
Norton Weiss
Criticality Officer

January 30, 1959
Revised September 4, 1959

Approved by: _____
G. H. Barney
Plant Manager

6/3

- DISTRIBUTION -

USAEC	Licensing Branch, Washington, D. C.
USAEC	Chicago Operations Office
USAEC	New York Operations Office
Mr. Richard Rateick	Power Reactor Development Corporation
Mr. W. C. Arnold	Power Reactor Development Corporation
Mr. Philip Thompson	Nuclear Metals, Inc.
Mr. John Siergiej	Nuclear Metals, Inc.
Mr. W. F. Mittendorf	Engelhard Industries, Inc. D. E. Makepeace Division
Mr. G. H. Barney	Engelhard Industries, Inc. D. E. Makepeace Division
Mr. C. A. Canham	Engelhard Industries, Inc. D. E. Makepeace Division
Mr. Norton Weiss	Engelhard Industries, Inc. D. E. Makepeace Division

PRDC FEASIBILITY REPORT DEM-5

* Section I - "Receipt and Storage of Raw Material"

1. Work to be Performed

DEM in conjunction with Nuclear Metals, Incorporated, intends to fabricate, test, inspect, and deliver 100 core subassemblies to the Power Reactor Development Corporation, Detroit, Michigan. These are to be used in the Enrico Fermi Fast Breeder Power Reactor.

Each core subassembly will consist of a core section composed of pin-type fuel elements and an axial blanket section on either end of the core containing depleted uranium - moly elements. Core sections will contain 144 - 30½" long pins ~~each.~~ These fuel pins will be fabricated from a 10% Mo, 90% U (25.6% enr.) alloy and clad with .005" of zirconium. Each pin will have a zirconium end cap on either end.

In addition to the core subassemblies, DEM proposes to fabricate 300 outer radial blanket subassemblies. These will be fabricated from a 2.75% Mo, 97.25% depleted uranium alloy which will be sodium bonded to stainless steel tubing.

Drawings of the fuel pins and core and blanket subassemblies are attached to facilitate a better understanding. **

The schedule of shipments to PRDC will be as follows:

Core Subassemblies	Blanket Subassemblies	Date
4	12	6/1/59
5	15	7/1/59
6	18	8/1/59

Core Subassemblies	Blanket Subassemblies	Date
7	21	9/1/59
8	24	10/1/59
8	24	11/1/59
8	24	12/1/59
8	24	1/1/60
8	24	2/1/60
8	24	3/1/60
8	24	4/1/60
8	24	5/1/60
7	21	6/1/60
7	21	7/1/60

** 6XN-1723 - ADPA Radial Blanket Assembly.

6XN-1716 - Core Subassembly

5XN-1722 - Fuel Pin Detail

2. Material to be Supplied

PRDC will supply 4,835 pounds of 25.6 enriched uranium in the form of pickled derbies approximately 5" in diameter and weighing approximately 11 pounds (5Kg.) each. The material will be shipped from Davison Chemical Company, Erwin, Tennessee, in birdcages containing 55 lbs. each of uranium (6.4 Kg U-235). A maximum of 390 lbs. (45.4 Kg. U-235) will be sent in any one shipment according to the following schedule:

Date	Pounds Uranium	Kg. U-235 (25.6% Enriched)
3/1/59	240	28.0
4/1/59	240	28.0
5/1/59	245	28.6
6/1/59	340	39.6
7/1/59	390	45.4
8/1/59	390	45.4
9/1/59	390	45.4
10/1/59	385	44.8
11/1/59	385	44.8
12/1/59	385	44.8
1/1/60	385	44.8
2/1/60	385	44.8
3/1/60	340	39.6
4/1/60	335	39.0

We estimate that the maximum amount of U-235 on hand at any one time at DEM will be approximately 170 Kg.

In addition to the enriched material, we will receive 58,540 lbs. depleted uranium from Davison Chemical Company, in the form of 12" dia. derbies cut into 3 slices each. This depleted material will be shipped at a maximum rate of 15,000 lbs. per month and will be used for blanket material.

3. Receiving and Storage

Birdcages, containing enriched uranium derbies will be received at DEM plant, Plainville, Mass. A maximum of 7 birdcages will be

received at any one time. Each birdcage will contain 5 derbies weighing 5 Kg. each. The maximum amount of U-235 per birdcage will be 6.4 Kg. The total amount of U-235 for 7 birdcages will be approximately 45 Kg.

Birdcages will be stored in our enriched vault until ready for for production. This vault is constructed of 12" thick concrete and is 7' 11" wide x 13' 0" long x 7' 11" high with a Mosler combination safe door.

The birdcages will be unbolted one at a time, under the direction of the Criticality Officer, and the derbies weighed to verify the accuracy of the shipper's weights. The five derbies will be replaced in the original birdcage if they are to be melted within a month after receipt. This is necessary due to the fact that birdcages must be returned to Davison Chemical Company one month after delivery.

Those derbies which are to remain in storage for a period longer than one month will be placed in metal cubicles in the vault. We anticipate building 10 such cubicles, each capable of holding 5 derbies (6.4 Kg. total contained U-235). If more space is necessary, we can add additional cubicles to hold in excess of 300 Kg. U-235 in a safe configuration at this enrichment level.

Cubicles will be of all welded construction using 1/8" steel plate as material. They will be 6½" x 6½" x 6" deep with a hinged door containing a rubber gasket and a latch. The cubicle will be lagged to the concrete wall with two steel bolts each. There will be a 2 foot spacing in all directions between cubicles.

Additional cubicles may be added as required by extending the wall sections upward and by building additional center sections in angle iron framework maintaining the same spacing requirements. A drawing (#1033-1) of 10 such wall cubicles is enclosed for reference.

In addition to vault storage for enriched derbies, we intend to store enriched scrap (Chips, cropped ends, etc.,) in the locked caged area surrounding the vault. Containers to be used will be covered steel 1 gal. and 5 gal. containers. They will be stored in vertical and horizontal arrays on unistrut sections with bucket clamps to fasten the containers in position, thus assuring the maintenance of spacing requirements. The individual containers and types of scrap will be discussed in the body of the report under fabrication procedure.

Another concrete vault 8 ft. wide x 12' 3" long x 8 ft. high on the opposite side of the mfg. area will be used for storage of finished pins prior to assembly. In addition, it will be used to store analytical and metallographic samples.

Other enriched material which may be processed concurrently with the PRDC material will be stored in this vault also. We estimate that this will amount to approximately 15 Kg. U-235 in the form of a 26% U-Al alloy to be used for making tubular fuel elements for the Argonne CP-5 reactor. A copy of our feasibility report DEM-4 will serve to describe this fabrication and storage procedure.

In-process PRDC material will be stored in a locked cage of dimensions 19½ ft. long x 15 ft. wide adjoining the aforementioned vault. A third cage surrounds the vault and at this time is being held in reserve for such storage as may be necessary.

Section II - Fabrication

The enriched fuel pins will be fabricated from a 90% Uranium (25.6% enriched) - 10% moly. alloy which will be coextruded with zirconium tubing to provide the clad layer. A complete flow chart of the fabrication procedures is attached for reference.

All material movement will be cleared through the Criticality Officer or his representative at all times. No enriched material will be moved without specific approval being granted. Enriched derby and scrap storage areas will be under the direct supervision of Criticality representatives. No one will be permitted in the locked storage areas unless accompanied by the Criticality Officer or his designate.

The project engineers working on the different phases of manufacturing will be responsible for carrying out the provisions of this feasibility report with the assistance of criticality, health-safety, and accountability representatives. Fabrication will proceed through the following stages:

1. Charge Preparation and Melting of U-Mo Ingot

   The uranium to be used for melting will be removed from the birdcage or vault cubicle and issued to production by the criticality representative in a tared, covered, 5 gallon steel bucket in the vault. The bucket will be moved to the furnace area on a dolly. One half of the charge will be issued at a time. A

melting charge will consist of 10 derbies weighing approximately 5 Kg. each.

The moly. which is to be melted will be in the form of rods ½" in dia. x approx. 3/8" high. The maximum charge to be melted will be as follows:

Weight Uranium (25.6%)	-	52.0 Kg. (13.3 Kg. U-235)
Weight Moly.	-	5.8 Kg.
TOTAL CHARGE		57.8 Kg.

The crucible to be used for melting will be ½" thick graphite, 8" in dia. and 12½" high. The mold will be 1" thick graphite, 3.95" in diamter and 16" high. Ingots will be melted in a Kinney vacuum induction furnace and bottom poured into the mold. We expect to melt approximately 50 ingots. Hoses which maintain the flow of cooling water through the coils will be uncoupled while charging the crucible and replaced when charging has been completed, to prevent accidental flooding.

The crucible will be charged with one-half of the uranium on the bottom, the moly. in the middle, and the balance of the uranium on top. All work which isdone inside the furnace will be done while wearing respirators. Crucibles and molds will be weighed prior to charging for accountability purposes.

When the charge has been melted, it will be bottom-poured into the mold and allowed to cool for at least 2 hours.

Whenever sufficient scrap has been generated in the course of fabrication, a certain amount will be recycled into each melt along

with the derbies. The maximum amounts of cleaned scrap to be used per melting charge will be as follows:

a.	Lathe turnings (compacted)	1.0 Kg. U-235
b.	Primary extrusion croppings (1.5" dia.)	0.75 Kg. U-235
c.	Incomplete slugs (1.445" dia.)	0.70 Kg. U-235
d.	Secondary extrusion croppings (.310" dia.)	0.85 Kg. U-235
e.	Rejected pins (.158" dia.)	0.35 Kg. U-235

These figures represent maximum quantities which may be used and in most instances will be cut down considerably. The scrap to be used for remelting will be prepared in the following manner:

a. Turnings - degreasing, max. 350 gm. U-235 per batch. - Compacted on a hydraulic press.

b. Cropped Ends - pickled in nitric acid, a max. of 350 gm. U-235 per batch - pieces to be weighed before and after pickling to determine amount of U-235 in solution-solution to be transferred to 13 gal. polyethylene containers whenever 350 gm. U-235 has gone into solution.

c. Rejected pins - detergent cleaning - max. 350 gm. U-235 per batch.

2. <u>Removal of Ingot from Mold and Crucible from Furnace</u>

After the ingot has cooled sufficiently, the mold container will be dropped and the mold removed. A tared cover will be placed over the top of the mold to prevent oxide from escaping. The covered mold will then be weighed and sent to a hood for ingot removal. The ingot will be removed in the hood and vacuumed to remove loose oxide. It will then be steel stamped for identification

and placed in a tared covered bucket to be weighed to .05% accuracy. After weighing, the ingot will be inserted into a bird-cage container to be used for both transportation and storage. The birdcage will be of angle iron construction supporting a 5" dia. pipe which is capped at both ends and cut in the middle to support the ingot in a vertical position. The two halves of the pipe will be threaded in order that they may be sealed after the ingot has been inserted. The ingot will be fixed in position such that there is a 12" spacing between it and the outer edge allowing it to adjoin a similar container and still maintain a 2 ft. separation between the two ingots. The birdcage will be provided with casters for ease of movement. * A drawing of the container is enclosed for reference.

The crucible will be covered and removed from the furnace via a hoist. It will then be weighed to determine the weight of oxide and skull. After weighing, it will be transported to a hood where both crucible and mold will have the dross mechanically removed. Large pieces of skull will beplaced in 5 gal. covered steel buckets for storage, a max. of 1.5 Kg. (.35 Kg. U-235) per bucket. Scrap buckets will be removed to the enriched scrap storage area where they will be stored in arrays with a 12" edge-edge separation between adjacent containers.

The hood will then be vacuumed to remove small particles of oxide, and the mold and crucible wiped thoroughly with damp cloths before being removed from the hood. Vacuum cleaner filters will be removed and placed in covered metal containers for reclamation.

* 1033-2

3. Pickling Enriched U-Mo Ingot

The ingot in the birdcage will be moved to the enriched pickling area. The ingot will be removed from the birdcage and placed in a plastic tray. Concentrated hydrochloric acid will be poured over the ingot to remove oxide. Water will be added to dilute the acid, and the ingot scrubbed with a steel brush while in the acid solution. The ingot will then be removed from the tray and dried. After drying, the ingot will be reweighed and replaced in the birdcage. The difference in ingot weight before and after pickling will show the amount of U-235 which has gone into solution. Whenever the amount of U-235 in solution reaches 50 grams, the solution will be transferred to a polyethylene container and sent to the scrap storage area.

The pickled ingot will be transported to the canning area.

4. Canning, Welding, and Evacuation of Enriched Billets

Each ingot (11.8 Kg. U-235) will be removed from the birdcage and inserted into a clean steel can on a roller table. Copper-nickel extrusion components (nose plug, cut-off slug, end caps, and evacuation tube) will be inserted into the copper can and heliarc welded together. After welding, the canned billet will be evacuated to one micron and leak tested. If leaks are found, the canned billet will be returned to the welder for reworking. If no leaks are apparent, the evacuation tube will be sealed and the billet placed in the birdcage for shipment to NMI.

5. Shipment of Canned Billets to NMI for Primary Extrusion

The canned billets will be shipped to NMI in sealed birdcages via DEM truck. A maximum of 2 billets (23.6 Kg. U-235) will be shipped at any time. Birdcages will be fastened in position on the truck to avoid accidental movement in transit. All shipments will be inspected by the criticality officer before being allowed to proceed. The driver will be briefed on possible hazards to be avoided.

6. Receipt of Steel Clad Secondary Billets from NMI

The extruded steel clad rods, 1.525" dia. will be received from NMI in max. lots of 4. The rods will be approx. 9 ft. long and weigh approx. 51 Kg. (11.8 Kg. U-235) each. They will be shipped in individual containers. Each container will be constructed of welded angle iron with a channel fixed in position to hold a rod in a covered tray and an outer cover which will be bolted in place for shipping. The birdcage type construction will assure a 15" spacing between adjacent containers. *A drawing of the container is enclosed for reference.

Containers will be transported to the in-process cage for storage. When needed for production, the material will be issued by the criticality representative in lots of one rod (11.8 Kg. U-235).

* 1033-3 & 4

7. Removal of Steel 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 backsaw when authorized by the criticality representative.

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. pdyethylene lined drum as long as the total U-235 content per drum is less than 100 grams.

8. Sawing Extruded Secondary Billets

Each rod will be cut into slugs 4.187" long on a mechanical hacksaw. Approx. 25 slugs will be cut from the two rods combined. A maximum lot for processing will consist of 15 slugs (6.6 Kg. U-235). Each lot of slugs will be placed in its own tote tray for transportation and storage. The tote tray will hold 15 slugs in two metal channels which cannot possibly contain any more than that number. The channels are positioned in the tray to maintain a minimum 12" edge-edge spacing between adjacent units.

After sawing has been completed, one tote tray will be moved to the machining area and the other to the in-process storage area. Saw chips will be stored in one gal. steel pails, a max. of 1.5 Kg. alloy (.35 Kg. U-235) per pail. Pails will be stored in arrays at 12" edge-edge separation in the enriched scrap storage area.

9. Machining Slugs

The cut slugs will be machined on a lathe to 4.163" in length and 1.443" in diameter. Slug ends will also be shaped to a convex at the rear end and a concave at the front end. A carbide cutting tool will be used and a water soluble wax as lubricant. The lathe will be hooded to prevent vapors from escaping.

Turnings will not be allowed to accumulate in the lathe bed but will be scooped up and placed in tared, one gal. steel pails. A max. of 1.5 Kg. chips (.35 Kg. U-235) will be allowed in any one pail. The turnings will then be degreased and sent to the press to be compacted. The maximum amount of chips to be compacted will be 4.5 Kg. (1.0 Kg. U-235). Compacted chips will be placed in one gal. steel pails and stored at 12" edge-edge spacing in the enriched scrap area prior to remelting.

After each lot of slugs has been machined, they will be replaced in the tote tray and moved to the cleaning area under the direction of the criticality representative.

10. Cleaning Machined Slugs

Slugs will be detergent cleaned. The slugs will be inserted into the tank in batches of three slugs (1.20 Kg. U-235) each.

The cleaned slugs will be weighed on a metrogram balance to the nearest 0.1 gm. After weighing, the slugs will be replaced in the birdcage and moved to the canning area.

11. Canning, Welding, and Evacuation of Slugs

Each slug will be canned according to the following procedure: Copper-nickel extrusion components will be placed on either end of the slug and a zirconium sleeve fitted over the assembly. A steel can with an end cap will then be placed over the entire assembly and welded in a fixture. The canned billet is then connected to a leak tester and checked for leaks. If a leak is found, the billet will be marked and re-welded. If no leak is found, the billet will be attached to a vacuum pump and pumped down for 30 - 45 min. Near the end of the period the billet will be heated to 900°F with a torch. The evacuation tube will also be heated and then welded shut to seal off the billet. Excess evacuation tubing will be cut off with a torch, and the sealed billet placed in a metal container for shipment to NMI. A maximum of 15 canned billets (6.0 Kg. U-235) will be placed in one shipping container.

12. Shipment of Canned Slugs to NMI

Shipping containers for canned slugs will be of angle iron construction and hold 15 slugs at an 18" distance from a similar container. The slugs will be placed in a steel tray end to end to form a rod approx. 7½ ft. long. The tray will be covered and bolted in place to assure that the slugs will not be disturbed in transit. *A drawing of the tray in which the slugs are to be inserted is enclosed. A maximum of 30 slugs (12.0 Kg. U-235) in

* 1033-4

two separate containers will be shipped to NMI via DEM truck. Containers will be fastened in the truck to prevent accidental movement. All shipments will be inspected by the criticality officer or his representative before departure. In addition to the slugs, two primary billets in birdcages may be transported at the same time.

13. Receipt of Coextruded Rods from NMI

Coextruded rods .310" in dia. x approx. 10 ft. long will be received from NMI in maximum lots of 30 (12.0 Kg. U-235). The rods will be packed in shipping containers each containing 15 rods. The 15 rods will be placed in a metal tray 10 ft. long. The tray will have a cover which is bolted in place and have holes in the bottom for drainage. The covered tray will then be set in the steel channel which will then be covered and bolted. The channel will also have holes for drainage. The entire unit will be suspended in an angle iron framework assuring a minimum spacing of 18" between adjacent containers. *A drawing of the tray which will be used in conjunction with the basic unit is enclosed.

Upon receipt of the rods at DEM, the shipping containers will be moved to the in-process storage area. When ready for processing, a lot of 15 rods (6.6 Kg. U-235) will be issued by the criticality representative and sent to the pickling area in the shipping container.

* 1033-4

14. Cropping and Pickling of Coextruded Rods

A lot of 15 coextruded rods will have the ends cropped on an alligator shear. The cropped ends will then be painted with two coats of Unichrome #324 stop off laquer to prevent the exposed uranium from being attacked by acid. The rods will then be weighed and rough pickled to remove the majority of the steel cladding. End croppings will be cut into 1½" lengths and sorted into four categories:

a. Pieces containing U-Mo only.

b. Pieces containing U-Mo with Zr cladding.

c. Pieces having some Cu-Ni on the surface.

d. Pieces containing primarily Cu-Ni.

Categories a. and b. will be placed in one gal. steel pails (max. .35 Kg U-235 each) and sent to the scrap storage area. Category c. will be pickled to remove Cu-Ni and then sent to the scrap storage area for storage prior to recycle melting. A max. quantity of .35 Kg. U-235 will be adhered to in pickling cropped ends. Category d. material will be placed in metal containers for storage.

A maximum of 3 rods (1.1 Kg. U-235 will be placed in a pickle tank which contains a 1" overflow leading into a 5" ID polyethylene container to assure an "always safe" solution height. The rough pickle solution is 1:2 nitric acid. The rods will be pickled for 15 minutes, rinsed in cold water, and wiped dry. They will be weighed prior to finish pickling. Rough pickle solutions will be sampled and changed after every 25 rods. The solutions will be placed in polyethylene carboys for temporary storage.

The rods will undergo a finish pickle to remove small spots of steel which may remain after the rough pickle. The finish pickle solution is dilute (1:9) sulfuric acid. A maximum of 3 rods (1.1 Kg. U-235) will be allowed in the tank at any one time. After the steel is completely removed, the rods will be rinsed and wiped dry. The pickled rods will then be weighed before proceeding to the next operation.

Finish pickle solutions will be sampled and changed whenever a quantity of 25 grams of U-235 has gone into solution as computed from weight loss data. Solutions will be transferred to polyethylene carboys for temporary storage. When analytical results are received, solutions may be combined in 30 or 55 gal. polyethylene lined drums as long as the maximum quantity per drum does not exceed 100 gms. U-235.

15. <u>Swaging, Cutting, and Pointing Pickled Rods</u>

A maximum of 15 - 6½ ft. rods (5.5 Kg. U-235) will be allowed in the swaging area. Each rod will be swaged to .158" dia. x approx. 26 ft. long. Swaged rods will then be placed on a rolling table and moved to cut off wheel shear. Each rod will be inserted into a stop and cut to 30½" lengths. Approx. 10 of these pins will be cut from each rod. Test specimens ½" long will be cut from each end and the middle of every other rod for metallographic examination.

After being inspected for proper length, the pins will be placed in trays in a metal cabinet for internal transportation and storage. Each cabinet will hold 150 pins (5.25 Kg. U-235) in 15 trays of 10 pins each. The pins will be fastened in position to maintain identity. *A drawing of the metal cabinet is enclosed. The three test specimens from every sampled rod will also be placed in the proper tray. Subsequently, three specimens, each properly identified, will be placed in a glass, screw cap bottle and sent to the quality control section for examination in max. lots of 100 samples (64 gm. U-235).

Scrap ends generated will be placed in one gal. covered steel pails (max. 350 gm. U-235/pail) and sent to the enriched scrap area for storage in arrays.

When cutting has been completed, each lot of pins will be moved to a two die swaging mach. within the area for pointing. The ends of each pin will be pointed to a 30° angle and inspected. When all points have been swaged, the pins will be replaced in the cabinet and moved to the cleaning area.

16. Cleaning Pointed Pins After Swaging

The swaged pins will be removed from the cabinet in lots of 20 pins (700 gm. U-235). This will be the maximum quantity to be allowed in the cleaning tank at any time. The 20 pins will be placed in a stainless steel rack and inserted into the tank for cleaning. Cleaning time will be approx. 5 min. per batch. After

* 1033-5

cleaning, the pins will be removed from the rack and inserted into a graphite vacuum annealing fixture which may hold a max. of 165 pins (5.8 Kg. U-235). A drawing of the annealing fixture is enclosed. When the fixture has been loaded with the cleaned pins, it will be moved to the vacuum annealing area on a dolly.

17. Vacuum Annealing Finished Pins

The fixture containing a max. of 165 pins will be loaded into the retort of the vacuum annealing furnace. Two such fixtures (11.6 Kg. U-235) separated by a minimum of 2 ft. will be the maximum permissible loading of the furnace. A graphite spacer ring between the two fixtures will assure that the spacing will be maintained in case holding wire give away.

After the retort has been loaded, the furnace will be pumped down to less than 1 micron and then heated to 800°C where it will be held at temp. for one hour. The furnace will then be cooled to 375°C in less than four hours, and then from 375° to 150°C.

The retort will be removed from the furnace and the two fixtures removed from the retort. The pins will then be removed from the fixtures and replaced in the storage cabinet. One cabinet will be sent to the testing area and the other to the in-process storage area. The entire annealing cycle will take approx. 13 hours.

18. Fluorescent Penetrant Inspection of Pins and Cleaning

The pins will be tested using a fluorescent penetrant dye for surface defects. Maximum lot size for testing will be 20 pins (700 gm. U-235). When testing has been completed, acceptable pins will be detergent cleaned, again in lots of 20. The cleaned pins will then be replaced in the cabinet. Rejected pins will be cut into approx. 5" - 6" lengths and placed in one gal. steel pails for recycling. A max. of 1.5 Kg. (350 gm. U-235) will be placed in any pail which will then be stored in arrays in the enriched scrap area. When the entire lot of 150 pins has been tested and cleaned, it will be sent to the weighing area in the metal cabinet. Pins will be weighed individually to 0.1 gm., replaced in the cabinet, and sent to the swaging area.

19. Swaging End Caps on Finished Pins Straightening and Cleaning

Zirconium end caps will be swaged onto both ends of the pins. They will then be straightened in a two die swaging machine. After straightening, each pin will be replaced in its tray. When the entire lot of pins has been swaged, it will be moved to the cleaning area and cleaned ultrasonically in batches of 20 pins (700 gm. U-235). After cleaning, the pins will be replaced in the cabinet and sent to the inspection area for final inspection.

20. Inspection of Finished Pins

Finished pins will be removed from the cabinet and inspected for straightness, length, and diameter, in addition to a complete visual examination. Acceptable pins will be replaced in the cabinet while rejects will be cut into 5" - 6" long pieces and placed in one gal. steel pails in the enriched scrap area (max.

350 gm. U-235/pail). A maximum of 10 pins (350 gm. U-235) will be on any inspection bench at any time. When inspection has been completed, the metal cabinet containing the acceptable pins will be sent to the vault for storage prior to assembly.

21. Insertion of Pins into Stainless Steel Birdcages

When ready for assembly, a lot of 144 pins (5.0 Kg. U-235) will be issued in the metal cabinet to the primary assembly area. The pins will be individually inserted into a stainless steel birdcage (*print enclosed) which will be sent to the final assembly area located in a clean area separated from the fabrication area by a wall. Only one lot of 144 pins will be in the assembly area at any time.

22. Final Assembly of Pins into Core Subassembly

The birdcage containing the enriched fuel pins will have the locking plates and anchor bars inserted and welded. The birdcage will then be inserted into a stainless steel tube 2.464 x 2.464 x 73" long, with only the locking end being exposed. The lower blanket grid assembly containing 16 depleted U-Mo axial blanket rods will be welded to the birdcage in a welding fixture. The entire unit will then be slipped further into the tube until only the blanket rod end caps are exposed. A grid will be placed over the end caps and welded to the lowe orientation cam. The lower subassembly will then be joined to the upper subassembly in a fixture, the concentricity checked, and the two welded together to button up the complete assembly. Localized cleaning will be

* 6XN-1718

done where necessary with acetone. The entire finished subassembly will be inserted into a polyethylene liner containing an indicating desiccant and heat sealed prior to insertion into the shipping container.

Finished core subassemblies will be stored in the assembly area on wall racks maintaining a 2 ft. separation between each unit while awaiting shipment.

23. Shipment of Core Subassemblies to PRDC

At this time the design of the shipping containers and the method of transportation to be used have not been firmly established We are presently working on these problems and expect to finalize our plans shortly. It is our intention to provide this additional information in the form of a supplement to our license application when ready.

Section III - Accountability and Health-Safety

An Outline of our program with respect to Health-Safety procedures has been previously submitted with our original license application docket No. 70-139 and will be adhered to in the performance of this contract. Copies of our accountability manual are enclosed.

The accountability representative will maintain and control all records pertaining to the issuance and storage of special nuclear materials. He will issue a material control card with each lot of material which will remain with that lot through all stages of fabrication. In addition, he will keep a master control records containing weights of all material in-process and in storage.

All weighings of enriched material will be performed to a .05% accuracy.

The main features of our health-safety program have already been described in our manual which has been previously submitted. All operations involving the possibility of loose oxide escaping into the air will be performed in adequately ventilated hoods. Audible monitoring equipment capable of detecting gamma radiation has been purchased and is expected to be installed by April. All enriched fabrication will take place in our exclusion or "hot" area. Final assembly and cleaning will take place in a 65 x 95 ft. area separated by a glazed tile wall from the "hot" area. This assembly area will be maintained as a clean area since precautions and checks will be maintained by means of air sampling and smear testing to assure that contamination does not spread from the "hot" area into the clean area.