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FUELS PREPARATION DEPARTMENT

MONTHLY REPORT

FEBRUARY

1962

HANFORD ATOMIC PRODUCTS OPERATION

RICHLAND, WASHINGTON

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FUELS PREPARATION DEPARTMENT

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MONTHLY REPORT - FEBRUARY 1962

RM Iten 8-10-92 Compiled by Fuels Preparation Department

by TL Phillips 8-11-92 March 7, 1962 - Richland, Washington

RM Eick 8-12-92

Work performed under Contract No. AT(45-1) - 1350 between the Atomic Energy Commission and General Electric Company.

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PRODUCTION

Production of fuel elements slightly exceeded the forecast during February. The plant operated ten canning lines per day through February 16, and eight lines per day thereafter.

Malfunction of a UT-2 tester caused a drop in yields; however, the manufacturing yield exceeded the forecast. Improvements in the AlSi sloop reject rate and the weld reject rate were experienced.

The inventory of finished fuels decreased slightly to an equivalent 2.8 month supply at month end.

At month end the inventory of bare cores reflected a 1.9 month supply.

An input of 8.7 tons to the Coextrusion Process resulted in 93 extrusions, of which 33 were special extrusions for engineering process development work, including 13 primary billet extrusions.

ENGINEERING

Present Reactor Fuels

Two production I&E fuel elements failed in reactors during February. This was ten less than last month and four less than experienced during the same period a year ago.

The first rupture of self-supported natural uranium I&E fuel elements, undergoing evaluation in the C Reactor ribless Zircaloy tube facility, occurred during February. Examinations revealed that bridge sections were missing from six of the eight support rails. Recognizing from earlier examinations that this design was subject to charging damage, steps have been taken to increase rail thickness to 45 mils. Further revisions in rail design will be made if charging problems are not alleviated.

A decision has been made to qualify vendor "B" for future competitive bidding on all aluminum component orders and to extend the evaluation of vendor "H" through the procurement of an additional 150,000 OIIN components.

Approximately 370 tons of alloyed dingot uranium are being irradiated in the old reactors and 1090 tons have been discharged at goal. In addition, 166 tons of alloyed dingot are being irradiated in K reactor and 32 tons have been discharged. To date there have been four transverse dingot core failures and three dingot core failures that were split both transversely and longitudinally. Two longitudinal split failures have occurred in enriched I&E ingot fuel elements. Since ingot and alloyed dingot are rolled and heat treated by essentially the same process, the crack sensitivity of dingot uranium appears to be associated with

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differences in the chemistry - carbon, iron and silicon content of the two metals. The following programs for reducing dingot split failures have been initiated: (1) Adjust the chemistry of dingot uranium as close to that of ingot uranium as possible through proper additives, (2) Change to a hollow core blank heat treatment of dingot uranium, using an oil quench; this should reduce the size of any shrinkage cracks and move the location of any of the cracks away from the I.D. surface, (3) Investigate quench methods in the canning process to reduce I.D. residual tensile stresses.

Irradiation of 50 tubes of nickel-plated fuel elements in 105-DR proceeded without incident at an estimated exposure of 1050-1150 MWD/T. Analytical results from the two effluent sampling tubes indicate that the P^{32} content is consistently ten to twenty-fold higher than the reactor bulk effluent. These results substantiate a ten-fold difference observed on a set of samples last December. Techniques for reducing the phosphorous content of chemically deposited nickel-plate are being investigated.

Finishing and testing of 300 HAPO hot-press fuel elements produced during December and January has been completed. The yield was abnormally low (39%) due to non-bonding at the base end of the fuel elements caused by a malfunction of the lower pressing rams. Necessary corrections have been made.

Based on recent test data, HAPO hot-press fuel elements have an average bond strength of 21,000 psi, with a range of 10,000 to 29,000 psi. This compares favorably with an average bond strength of 19,600 psi and a range of 10,500 psi to 27,300 psi for Sylcor hot-press pieces.

Ultrasonic welding of self-supports on about 300 Sylcor hot-press fuel elements for irradiation testing was essentially completed by month end. Destructive examination of fuel element samples indicates the pieces are of good quality.

The preheat furnace for hot die sizing was received. The installation of the hot-die sizing press and hydraulic unit will start in the near future.

A contract is being negotiated with Battelle Memorial Institute to bond approximately 125 HAPO assembled fuel elements in their fluid pressure bonding facility to optimize process parameters, and to prepare additional fuel elements for a preliminary irradiation test.

A series of tests have been run to determine the effect of bismuth additions to the lead in the duplex canning bath on fuel element bonding layer characteristics. The specimens are now ready for polishing and photomicrographing to examine the braze layers.

The effects of the silicon concentration in the AlSi layer, the lead temperature, and lead preheat time in the duplex canning bath on fuel element bonding are also being further investigated. It has been determined that the percentage of UAl_3 -type compound layer formed on the cores is inversely proportional to the silicon concentration of the duplex bath.

Conversion of fuel end closure welders in the AlSi Shop from AC to DC was continued, with a third automatic welder being converted during the month. Adjustments to power supplies and welding torches are being made and 6 percent argon added to the helium shield to overcome arc starting problems.

Four of five UT-4 closure integrity testers have been installed in the AlSi Shop. Evaluation of their production capability and the establishment of necessary standards and reject limits is underway.

N Reactor Fuels

The warp test, comprising five 23 inch enriched inner tubes, was discharged from KER Loop #1 at 1075 MWD/T and another "crud" test was charged. Since this loop was on cold water during part of the irradiation, conclusions for this test may be questionable and another warp charge is being prepared for testing. The prototype N inner tube enriched fuel elements in KER Loop #2 will reach their goal exposure of 3000 MWD/T about April 1, 1962.

The recently modified KER Loop #3 was charged with two prototypic N fuel assemblies (NAE-1) on February 18. These elements are being used for loop shakedown testing and are classed as throw-away material. Similar throw-away elements (2 to 5) will also be charged into Loop #4, which is now empty, when the results of the Loop #3 test are known. Full charges of eleven each prototypic N fuel elements will be charged into Loops #3 and #4 about April 2, 1962.

National Lead of Ohio has completed the revamping of the Plant #9 facility for casting and heat treating of N uranium ingots and machining billets. Their casting cycle has been adjusted to produce ingots which are of satisfactory quality, as determined by step machining of these ingots and inspection of the primary extrusions.

Bridgeport Brass Company, Ashtabula, Ohio, has satisfactorily performed primary extrusions with their recently installed extrusion equipment. Dimensional and machining checks were carried out by National Lead of Ohio on the material produced, and no surface defects attributable to the primary extrusion operation were noted.

The primary extrusion of the first "Brandywine" uranium at the Bridgeport Brass Company was carried out.

A prohibitive reject rate of 35 to 40 percent exists with N outer coextrusions because of inner clad variation. Heat treatment and primary extrusion tests at HAP0 have indicated that the clad variation problem can be alleviated by special heat treatment. Feed Site tests have therefore been planned. These involve various special heat treatments of the uranium ingots and billets to produce uranium structures which will minimize the clad variation during the subsequent coextrusion step. Billets processed during the same period by the "standard" specification practice will serve as test controls for comparison.

All qualified vendors for cladding shells are now producing acceptable products. An adequate supply of acceptable supports and locking clips are on hand.

Forty-one extrusions were made during February using 11.1", 7.5" and 6.0" tooling. These comprised 19 primary extrusions, 18 composites, and three zircaloy billets. The FPD primary extrusion of N outer billets is complete. Machining of billets will be finished by mid-March. Coextrusion of these billets will follow to evaluate the effect of primary extrusion variables on coextrusion quality.

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A statistical analysis of warp which occurs during beta heat treating indicates that the magnitude of this warp is directly related to the temperature of the coextrusion billet and that the other coextrusion variables such as ram speed do not have a significant effect. A coextrusion billet temperature of 1140°F appears to give optimum yield.

As reported last month, cracks have been detected between the Zircaloy cap and the uranium core in a few instances after TIG welding. Tests were run to define the conditions which enhance the formation of a strong intermetallic compound layer between the braze material and the uranium. These tests show that closures made at temperatures between 1050°C (1922°F) and 1075°C (1967°F) with uranium that is thoroughly clean and dry will provide bonding of sufficient strength to resist fractures during processing and subsequent irradiation.

A laboratory experiment successfully demonstrated that a sonic technique could be used to agitate the braze alloy during end closure brazing operation for N fuels.

Autoclaving of NPR fuel element end closures prepared by gas pressure bonding was continued. After 10 days in 350°C (662°F) water and 400°C (752°F) steam there was little evidence of corrosion in the bond region and weld area. An offsite contract is being negotiated to vapor coat the closure ring with copper to promote bonding between the closure ring and the Zircaloy-2. A new approach is being investigated also which uses a massive copper ring in place of the copper coated Zircaloy-2 ring. If feasible this material could overcome the problem of coating the Zircaloy-2 with a tightly adhering coating of copper that will partially diffuse into the closure ring.

The capability of the internal bond test for N fuels was demonstrated in that cracks invisible to normal microscopic examination were ultrasonically detected. The same small cracks were observed in microscopic examination using polarized light. Approximate widths of the cracks are 0.1 to 0.5 micron. Further examination with an electronic microscope is scheduled to more accurately determine the crack dimensions.

Design and fabrication of the 105 KE post-irradiation test equipment is proceeding on schedule. The original station was not expected to include thickness measuring equipment, but experiments with fast pulse-echo circuitry has shown that an oscilloscope read-out system will be feasible by the beneficial results goal date of June, 1962.

Measurement of ultrasound velocity in heat treated and non-heat treated fuels has shown that velocity is four percent greater in the heat treated fuels. Some beta transformation was detected in extruded fuels; if this transformation can be kept out, an ultrasonic velocity test offers a means of differentiating between heat treated and non-heat treated fuels.

Using a two-channel differential eddy current systems, it was found that resistivity of uranium in the as-rolled direction changes considerably more than resistivity in the 90 degree direction as a result of heat treating. Using this system, it was possible to clearly identify those of eight NPR outer tubes which had been heat treated.

Hydrided spots in zirconium process tubes have been detected by noting changes in the envelope of ultrasound passed through the material. Changes were observed in both 2000 ppm and 5000 ppm sections when tested over the frequency range of 1 to 30 megacycles.

GENERAL

No failures of AlSi fuels occurred in the autoclaves during February. None have been experienced to date this calendar year.

PERSONNEL STATISTICS

Number of employees as of January 31, 1962 855
 Number of employees as of February 28, 1962 823

	<u>Exempt</u>	<u>Nonexempt</u>	<u>Total</u>
General	1	1	2
Manufacturing	89	354	443
Engineering	46	28	74
Financial	14	8	22
Plant Facilities	37	244	281
Employee Relations	1	0	1
TOTAL	188	635	823

<u>Employment</u>		<u>February</u>	<u>January</u>
Additions:	Exempt	3	5
	Nonexempt	<u>3</u>	<u>1</u>
		6	6
Reductions:	Exempt	5	4
	Nonexempt	<u>30</u>	<u>2</u>
		35	6

The large number of reductions in personnel was due to the cutback in manpower required for current fuel element production. A total of twenty-six people were made available as excess; however, only four of these were not placed in other jobs at HAPC and were actually terminated in ROF status. Other reductions included the rotation of two MTP Engineers; transfer of an Engineer to Defense Systems, Syracuse, New York; transfer of an excess Supervisor to non-exempt position in IPD; termination of a Civil Engineer due to lack of work; transfer of an Instrument Trainee to a Technologist position with HLO; three transfers through request for transfer procedure; a deactivate due to personal illness; rotation of a Craft Trainee; a Military Deactivate; and two Instrument Craft resignations.

The additions to the rolls were two MTP Rotational Engineers; a Tech Grad Rotational Engineer; an excess Reproduction Operator from CE&UO to fill a vacancy; an excess Instrument Craftsman in HLO to fill an open requisition on request for transfer basis; and a Craft Trainee on rotation.

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STAFF

General Manager, Fuels Preparation Department
Manager, Manufacturing Operation
Acting Manager, Engineering Operation
Manager, Financial Operation
Manager, Plant Facilities Operation
Manager, Employee Relations

R. L. Dickeman
W. N. Mobley
J. T. Stringer
W. S. Roe
E. Hilgeman
C. O. Steinnagel

PATENT SUMMARY - FEBRUARY 1962

All persons engaged in work that might reasonably be expected to result in inventions, or discoveries, advise that, to the best of their knowledge and belief, no inventions or discoveries were made in the course of their work during February except as listed below. Such persons further advise that, for the period therein covered by this report, notebook records, if any, kept in the course of their work have been examined for possible inventions or discoveries.

"A New 'Plate Type' Transducer for Coupling Ultrasonic
Energy into a Liquid."

..... By D. C. Worlton

"The Removal of Autoclaved Films from Zircaloy-2."

..... By I. V. Nelson and
D. E. DeWitt

RL Dickeman

General Manager
Fuels Preparation Department

RL Dickeman:mkm

MANUFACTURING OPERATIONFEBRUARY, 1962RENT OPERATIONSductiontistics

	NORMAL					ENRICHED				
	8"	O				O				Total
	<u>Solid</u>	<u>C</u>	<u>K</u>	<u>Reg.</u>	<u>Bumper</u>	<u>C</u>	<u>K</u>	<u>Reg.</u>	<u>Bumper</u>	
<u>rent Month's Production</u>										
ceptable Fuel Ele-										
nts Produced (Tons)	-	5.2	267.0	70.9	89.9	28.7	60.3	21.3	22.7	566.0
% of Forecast										
duction	-	37	109	1013	55	96	126	107	81	102
% of Forecast										
r Current Quarter	-	6	139	73	80	96	106	84	100	100
% of Past 3 Month's										
erage Production	-	10	82	113	81	239	131	533	78	88
% of Past 12 Month's										
erage Production	-	9	98	43	147	221	140	107	67	85
f Forecast Achieved										
st Fiscal Quarter	-	107	113	97	82	56	105	109	141	103
f Forecast Achieved										
st 4 Fiscal Quarters	-	113	106	103	100	80	100	101	96	104
<u>rating Efficiency</u>										
rent Month (%)										95.5
ecast (%)										95.0
vious Month (%)										95.6
<u>ufacturing Yield</u>										
rent Month (%)	-	-	87	93	84	90	94	94	84	
ecast (%)	-	90	90	90	85	90	90	90	85	
vious Month (%)	-	-	91	90	87	-	94	85	90	
Uranium Available										
r Processing (Tons)										1043
ished Products in										
orage (Tons)										1515
cial Products Finished										
ieces) Boll										178
ium Utilization										98.2

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Production

Plant Operation - AlSi

Output of fuel elements during February slightly exceeded the forecast. This production level was attained while operating ten canning lines per day through February 16 and eight lines per day thereafter.

The first run rail weld reject rate increased 4.8 per cent and 3.2 per cent for eight-inch and six-inch material respectively. This resulted primarily from misaligned rails due to rail feeder problems.

A total of 2300 KIVN pieces were rejected due to a UT-2 malfunction; however, the balance of the first run reject rate decreased 0.7% and 1.7% for six-inch and eight-inch material respectively. The major contributions to the improvements in first run reject rate were a reduction of 2.2 per cent in the AlSi sloop reject rate for eight-inch material and a reduction of 0.9 per cent in the weld reject rate for six-inch material. The reduction in AlSi sloop reject rate resulted from excellent performance obtained during an eight day canning run of OIIIN material. The improved performance is believed to be associated with the internal surface finish of the sleeves which were in use. The reduction in six-inch material weld reject rate is attributed to an improved control of the welding operation.

Output from the bumper welders was as follows:

	<u>February 1962</u>		<u>To-Date</u>	
	<u>Natural</u>	<u>Enriched</u>	<u>Natural</u>	<u>Enriched</u>
FPD Produced	90	23	907	520
IPD Charged	83	24	579	474
Finished Inventory	328	46	328	46
Average Welding Yield	90%	89%		

Processing was completed on all solid lithium-aluminum material, resulting in 2,294 pieces placed in storage during February. The overall yield on the lot processed in the December-February period was 84 per cent.

Canning of "pork" material was also completed in February with 2,195 pieces (96 per cent yield) placed in storage.

There were no autoclave failures of AlSi Process fuels during February. None have occurred this calendar year.

The inventory of finished fuel elements at month end reflected an equivalent 2.8 month supply based upon projected reactor usage.

The month end inventory of bare cores reflected a 1.9 month supply based upon projected fuels process needs.

The following pieces were processed through the Fuel Recovery facilities during February:

8" Normal I&E	19,357
6" Enriched I&E	4,999
Water Mix	184
Total	<u>24,540</u>

Two shipments of uranium scrap totaling 37 tons of natural and enriched scrap including NPR defective billets and tube scrap, were made. One car also contained 390 empty boxes with lids.

Plant Operation - Coextrusion

A total of 93 extrusions were made during the month of February, of which 60 were inner extrusions for production and 33 were special extrusions for engineering process development work, including 13 primary billet extrusions. The 60 production extrusions represents a total input of 8.7 tons.

Following is the total throughput by station for February:

<u>Operation</u>	<u>Inners</u>	<u>Outers</u>	<u>Total</u>
Extrusion	60	0	60
Cutup	1028	61	1089
Chemical Milling	464	381	845
Braze	800 (ends)	173 (ends)	973 (ends)
Heat Treat	561	167	728
Machining	360	276	636
Vacu-Blast	517	265	782
Welding	334	344	678
End Test	722	590	1312
Clad & Bond Test	377	238	615
Support Weld	14	85	99
Autoclave	0	73	73

The non-destructive testers are in full operation following a certification of their reliability by Quality Control. Comparison tests are currently being performed between the autoradiograph and the clad thickness testers.

Manufacturing Engineering

Design and Projects

CAF-847 - New Fuel Cladding Facility

	<u>Scheduled</u>	<u>Actual</u>
Design	100	100
Construction	100	100

All J. A. Jones work has been completed, and all contractor exceptions have been cleared. Some materials such as cabinets and gages which do not require installation are yet to be received.

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CGF-934 UT-4 Testers, 313 Building

	<u>Scheduled</u>	<u>Actual</u>
Design	100	100
Construction	66	78

Four UT-4 Testers have been installed. These provide sufficient capacity to test all production. Back-up testers will be installed shortly.

CGF-903 Projection Fuel Element Modifications, 313 Building

	<u>Scheduled</u>	<u>Actual</u>
Design	100	100
Construction	82	82

Purchase orders have been placed for the third automatic ultrasonic welder.

CGF-954 High Pressure Autoclave Development Facility

The project proposal was transmitted to HOO-AEC late in February.

Miscellaneous Equipment

The purchase order has been placed for a second Gisholt lathe for the 333 Building, with delivery scheduled for June, 1962.

Drafting and DuplicatingDrawings Produced

New	68
Revisions	119
Small Charts	24
Large Charts	20
Miscellaneous	36

Duplicating Production

Xerox Masters Prepared	186
Multilith Impressions	357,929
Offset Copies	11,284
914 Copier Copies	12,524

PLANT CONDITIONS, INCIDENTS, AND IMPROVEMENTSALS1

Operating efficiency for February remained at essentially the same level experienced in January. Time lost for meetings and operational problems was 0.8%, and equipment outages accounted for the remaining 3.7% of the downtime.

Backlogs created because of lathe and tester problems and two malfunctions of the cap and can machine were the major causes of lost time charged to equipment.

The cap and can machine was responsible for downtime on February 14 and February 26. In both cases adjustments to the equipment corrected the difficulty.

The new Acme-Gridley lathe was installed in the Number 1 position on February 17, 1962 and has operated without incident.

The lathe removed from the Number 1 position was relocated in the Number 5 position and has been dismantled for overhaul. A close inspection of all parts is being made. Many of the bearings in the gear box are loose and some wear is evident in the gear train. The degree of wear and damage found after dismantling have been most convincing as to the need for a major overhaul at this time, for it is doubtful that this lathe could have survived the severity of production operation much longer without major complications.

Downtime on the UT-2 Testers for February was 23 tester hours as compared to 36 hours in January - a 36% decrease. This represents a 97% availability and there were no canning line outages chargeable to this equipment for the month.

Downtime for the UE-1 Testers for February was approximately 41 tester hours as compared to 75 tester hours for January. This represents about a 45% reduction. Tester availability based upon 1,520 production hours was approximately 96%. There were no canning line outages chargeable to this equipment for the month.

Routine testing of fuel elements on the UT-4 Testers was started on February 20th. Reject limits have not been established; therefore, the test at this time represents a cycling of material through the equipment.

Ten ingot and ten dingot uranium rod blanks were analyzed during the month for preferred orientation. A longitudinal and transverse section were studied from each piece and a single dingot and ingot sample was prepared for a radial texture gradient study. The results from this study show the ingot and dingot material to have a very similar crystal orientation except that a small amount of (200) texture was noted along the rod axis of the dingot uranium.

The texture gradient study on the ingot material showed preferred orientation on the outside surface and extending in toward the center for about 0.04 inches. The ingot uranium had texture on the outside surface, and it extended toward the center for about 0.10 inches.

Beginning in September, 1961, voltage readings from the UT-2 Testers were incorporated into the Quality Certification Program. The purpose of these measurements is to determine the correlation between grain structure and distortion of the fuel elements during irradiation. In addition to determining the correlation between grain texture and fuel element distortion,

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the measurements will also provide data to determine the variation of grain size within and between ingots.

The first report of UT-2 Tester voltage readings, compiled under the Quality Certification Program was completed in January and has since been reviewed to determine if the procedures used in compiling these data were meeting the criteria for giving valid information. A few minor defects were found in the data logger tapes which have been corrected.

As a result of some 6,000 regular production cores undergoing a three second delay in the AlSi layer of the duplex furnace before immersion in the lead layer, a number of samples were studied in the metallography laboratory to determine the effect of this additional dwell time on quality tests and standards. Ten of the samples studied were from this production material, while other prepared samples were studied for the systematic effect of an additional two, four and eight seconds dwell time in the AlSi before immersion in the lead layer. The examination revealed that while the compound layers were thicker than usual, there was little or no variation in any of the cases with the different times. The investigation revealed that the production pieces processed with an additional dwell time of three to four seconds meet all quality tests and standards.

During the period December 12, 1961, through January 12, 1962, all rejects from the UE-1 Testers were analyzed to (a) spot check tester efficiency and (b) to test feasibility of putting some tests on a sampling basis. From these data, it appears that the internal penetration test could be taken off the line. From the grouping of the rejects, the only test which could be put on a sampling basis at this time is the external penetration test.

In the past, ultrasonic weld tensile strength has been monitored by a sampling plan which consisted of testing samples, one element from each welder, twice each shift. The results of each test were then averaged to obtain an average tensile peel strength for each welder. However, it has been shown that the individual welding heads are, to some extent, independent as to their average weld strength and variability.

A new method has been placed into operation which adopts control chart techniques to the control of each welder head. The samples are taken from two elements from each welder every half shift. These are tensile tested to determine the average weld strength of each welder head, thus providing a method of controlling product quality relative to an individual head. By using two elements per sample, six welds from the same welder head, the risk of accepting defective (tensile peel strength below 20 pounds) welds is reduced. This approach should provide a much better control of rail weld tensile strength as variations in quality will be observed in the individual head much before being noticed in the whole slug average of weld strength.

Coextrusion

A check on the longitudinal play between the inner support and the locking clips on the NPR fuel elements has shown that the play is excessive. Most of this play is caused by the locking clip design. This information has

been discussed with Coextruded Product Engineering and they are working on a modified locking clip design. Locking clips will not be welded on production material until an improvement is made in the design of the locking clip.

Following the completion of the primary extrusions, the area surrounding the press and runout table was thoroughly decontaminated. This will eliminate the SWP requirements in this area during regular processing.

The degreaser and aqua-dag tank adjacent to the new billet furnace was charged and tested during the month. Tests indicate satisfactory degging by the dip method. Solvent vapor exposure tests were made by the Industrial Hygiene group while the degreaser was in operation, the results of which are not yet available.

Downtime on the braze stations hampered production continually throughout the month. "A" station was down twenty-one and a half operating hours while evaluating and making changes to the instrumentation. It is still being operated by manual control. "C" station was down 132 hours for recalibration. Although the recalibration of "C" station was complete at month end, considerable maintenance was still required to keep it on automatic operation. "B" station was out of service the entire month awaiting recalibration.

The extrusion press was down 16 hours to align pump couplings. This was accomplished without incident and did not interfere with the production schedule.

Multiple feeds for the east and west 480 volt bus ducts were completed in the press room. Connections were made in the press room on February 21, 1962, which required a power outage of all press room equipment for four hours. The final tie-in was made on Saturday, February 24, 1962, to avoid a four hour power outage which would disrupt the balance of the building.

Preliminary tests of the new billet furnace disclosed warped rails. New rails were obtained and are in the process of being installed.

Braze temperature recording-controlling equipment has been modified to improve the control. Problems still exist with this equipment and frequent calibrations are necessary. The principal problem is in the temperature sensing radiometer. Work is in process to eliminate the problem.

Plans for expansion of the change facilities into the building corridor (Dwg. H-3-17598) were developed and approved. This was done to relieve present overcrowded conditions.

The first group of 50 inner pieces to be reworked has been cut to rework length and started through the process. Outer pieces being reworked will require a different cap size because of dimensional changes during heat treating. Caps for the outer pieces have been ordered and reworking of outers will be delayed until the caps are received.

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The installation of the autoradiograph facility in the 333 Building has been completed. The use of the new darkroom has eliminated the problem of film and time losses caused by light leaks during exposure in the 306 Building.

OPERATING PLANS

Increased usage of KIVE and CIIIW fuel elements resulted in the conversion of scheduled natural eight-inch production to the six-inch size enriched and water mix models. An adjustment of metal receipts within the enriched models was also made in order to gain increased deliveries of the KIVE fuel cores.

Complete responsibility has been assumed from the Engineering Section for processing and inventories for the CIVN self-support model. Processing will continue in the 306 Pilot Plant.

A comprehensive storage space study was issued to establish present and future needs through FY 1965. This will be used as a basis for utilization of present space and planning for new facilities.

FPD HEALTH AND SAFETY

	<u>February</u>	<u>January</u>
Disabling Injuries	0	0
Serious Accidents	0	0
Medical Treatment Injuries	41	60

The Department was awarded the National Safety Council Award of Merit for working without a Disabling Injury from June 16, 1961 to January 23, 1962. This is the fourth Award of Merit achieved since September, 1956. During this period FPD was also presented one Award of Honor.

First quarter safety audits are being conducted by all sections as part of the regular quarterly safety review established during 1961.

Review of Medical Treatment Injury cases reported since announcement of a force reduction in Manufacturing has shown no significant change from normal experience. None of the employees directly involved reported injuries, and performance for production personnel showed no change.

FPD SUGGESTION PLAN

A report released by the General Electric Company acknowledged FPD as one of eleven departments to win the "400 Club" award for 1961. This report placed FPD 5th in the Company for accepted suggestions per thousand employees.

A total of 40 suggestions were received, 33 adopted, 30 rejected, and one reopened during February. With credit given to adopted suggestions received too late for payment in February, the backlog was reduced from 181 to 145.

	<u>February</u>	<u>January</u>
Number of eligible employees	635	663
FPD suggestions received	40	67
Annualized rate per 1,000 eligible employees	756	1,213
Number of suggestions adopted	33	14
Net annual savings	\$5,199	\$1,093
Amount of awards	680	210
Percent of total awards to savings	13.0	19.2
Average amount of awards	\$ 23.60	\$ 15.00

SIGNIFICANT REPORTS ISSUED

HW 72700	Materials Sub-Section Storage Space in the 303 Area	2/9/62	R.E. Estes
HW 72571	Monthly Report, Quality Control Operation, Fuels Preparation Department, January, 1962	2/1/62	A.G. Blasewitz
HW 72695	Report of Uranium Isotopic Analysis	2/15/62	G.B. Hansen
HW 72711	Uranium Quality Control Analytical Results	2/16/62	G.B. Hansen

MANUFACTURING EMPLOYEE RELATIONSSafety

Members of the Manufacturing Operation sustained twenty-seven medical treatment injuries during February.

Security

There were no security violations incurred during February in the Manufacturing Operation.

Radiation and Beryllium Control

A total of the exposures in excess of 100 mrad for Manufacturing personnel for the four week badge period ending January 26, 1962, is 6,245 mrad compared with an average of 7,500 mrad per four week badge period during 1961. There were no legitimate individual exposures in excess of 300 mrad during the badge period. One employee accidentally exposed his badge to 455 mrad by carrying his badge in his pocket during two dental x-rays.

Responsibility for the operation of the oxide burner located east of the 333 Building is expected to be transferred from HLO to FPD. FPD Radiation Monitoring has been covering operation of this facility. Stack gas samples taken during startup of the burner contained as high as 1.6×10^{-10} uc of uranium per cc of air. This was caused by failure to install a gasket around the filter during assembly. The burner has not been used since a new gasket was installed, but no further high uranium air samples are

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anticipated.

A total of nine air samples and 36 smear samples were taken and submitted for beryllium analysis during the period from January 19 through February 18, 1962. Beryllium was detected in two of the air samples, but the beryllium concentration in these samples was less than one per cent of the applicable limit. The eleven smear samples in which beryllium was detected were all taken in beryllium zones and do not represent out-of-control conditions.

Training

Four classes for a total of 50 instruction hours were presented to the instrument technicians and trainees on the UT-4 electronic chassis and control circuitry.

Individual instruction on set-up procedures and trouble shooting techniques on the UT-2 and UE-1 Testers was presented to thirteen instrument men during the month.

Visitors - Visits

Visitors

<u>Name</u>	<u>Company</u>	<u>Contact</u>	<u>Date</u>	<u>Reason</u>
Doolie Pierce	Picker X-Ray Co.	T. W. Gore	2/7,8, 9,24, 25/62	Check operational problems with X-ray film developer
J. P. H. Kelley Arthur Schoen Alex Perge	Washington Office AEC Division Operational Safety	W. O. Goslin	2/6/62	Plant tour
Dr. Wm. Doran	Washington Office AEC Division Operational Safety	W. O. Goslin	2/7/62	Plant tour
V. R. Holmquist	Local Office AEC Division Operational Safety	W. O. Goslin	2/7/62	Plant tour
W. R. Ebling	Specialty Alloys Section	H. E. Berg	2/13/62	Zircaloy II items

<u>Name</u>	<u>Company</u>	<u>Contact</u>	<u>Date</u>	<u>Reason</u>
W. H. Coleman	MTP Field Representative Fort Wayne, Ind.	H. F. Tew	2/20/62	Visit with MTP trainees
<u>Visits</u>				
H. P. Kraemer	Stoker Engineering Tacoma, Wash.	E. Gress	2/14/62	Discuss water mix spools & bumper supports
	Cliff Mfg. Co. Wickliff, Ohio	A. Katz	2/15,16, 17/62	Develop order of aluminum caps & cans
	Aluminum Co. of America Edgewater, New Jersey	M. Ziegler	2/19, 20/62	Discuss aluminum caps & cans
	Savanah River Aiken, South Carolina	C. Paetschke	2/21/62	Discuss specifica- tions and procurement practices
D. W. Darsow	B&W Precision Products Warren, Mich.	Mr. Whitzel	2/20/62	Discuss co- extrusion quality & inspection
	Moczik Tool & Die Wks. Detroit, Mich.	M. Stuck	2/20/62	'Same as above
	Bridgeport Brass Ashtabula, Ohio	J. Puterbaugh	2/21/62	Primary uranium ex- trusions
	Reactive Metal Incorp. Ashtabula, Ohio	F. Fahnoe	2/22/62	Zirconium problems
	Reactive Metal Incorp. Niles, Ohio	C. Sperry	2/23/62	Zirconium cladding
	Nuclear Metals Incorp. Concord, Mass.	R. Krom	2/26/62	Be-Zr braze inserts
	J. B. M. Tool & Die Bryan, Ohio	Mr. Bany Mr. Mayer	2/27/62	Coextrusion tooling

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Patent Summary

All persons engaged in work that might reasonably be expected to result in inventions or discoveries advise that, to the best of their knowledge and belief, no inventions or discoveries were made in the course of their work during February.

Acting Manager - Manufacturing

AGB:HFT:mrh

FUELS ATTRIBUTE DATA

6" NORMAL

DEC	JAN	FEB	MAR	APR	MAY
92.7	90.6	87.7			
90.5	91.6	90.5			
88.3	90.6	89.3			
90.0	90.1	89.9			

8" NORMAL

DEC	JAN	FEB	MAR	APR	MAY
91.1	87.0	83.6			
87.6	87.7	87.2			
	87.0	85.6			
85.3	85.3	85.5			

6" ENRICHED

DEC	JAN	FEB	MAR	APR	MAY
92.2	92.2	92.9			
92.6	92.9	92.6			
88.1	92.2	92.7			
91.7	91.7	92.0			

8" DUMPER

DEC	JAN	FEB	MAR	APR	MAY
88.6	89.8	83.7			
87.2	88.2	87.6			
	89.8	87.1			
84.6	85.5	85.3			

FUELS ATTRIBUTE DATA

0"

6"

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ENGINEERING OPERATION

February, 1962

VISITORS

<u>Name</u>	<u>Company</u>	<u>Contact</u>	<u>Date</u>	<u>Reason</u>
TF Graf	Bridgeport Brass Co., Ashtabula, Ohio	CH Shaw	2-6/7	Extrusion tooling and uranium billet fabrication.
S Cooper	GE Industrial X-Ray Department	JD Schaffer	2-28	Talk about X-ray emission and element analysis.
O Judd	Drake Company Seattle, Wn.	DO Hunter	2-15	Discuss nondestructive testing equipment.
FK Frost	Tektronix Inc. Seattle, Wn.	DO Hunter	2-8	Discuss nondestructive testing equipment.

TRIPS

	<u>Company Visited</u>			
TB Correy	National Research Corp., Cambridge, Mass.	JVE Hansen	2-5	Contract negotiation.
	Nuclear Metals, Inc., Concord, Mass.	H Sawyer	2-6	Discuss metal coating.
	Union Carbide Development Co., NY, NY	N. Davis	2-8	Discuss gas vapor coating.
	Elgeet Optical Rochester, NY	R Lohwater	2-9	Microscope demonstration.
AE Guay	Battelle Memorial Institute, Columbus, Ohio	RF Dickerson CL Angerman HP Roth DT Peterson	2-22	Steering Committee, Metallographic Group
TR Groupman	Linde Company Seattle, Wash.	J Dickinson	2-22/23	Explore feasibility of using SIGMA welding process on copper evacuation cans.
CH Shaw	JBM Tool & Die Byron, Ohio	E Johnson	2-23	Extrusion tooling.

TRIPS (cont'd.)

<u>Name</u>	<u>Company Visited</u>	<u>Contact</u>	<u>Date</u>	<u>Reason</u>
FW Knight CH Shaw	Meezik Tool & Die, Detroit, Michigan	D Struck	2-20	Extrusion tool design and procurement.
	B&W Precision Prod., Detroit, Michigan	V Whitzel	2-20	" " " "
	Bridgeport Brass Co., Ashtabula, Ohio	J Puterbaugh	2-21	Observe "500" extrusion and see new facility.
	National Lead of Ohio, Fernald, Cincinnati, Ohio	J Schiltz	2-23	N uranium program
JT Stringer	Savannah River Plant, Aiken, South Carolina	TC Evans	2-28/ 3-3	Attend FEDC meeting.
DC Worlton	Boeing Aircraft, Seattle, Wash.		2-13	Discuss nondestructive testing.
	Sperry Products, Seattle, Wash.	H Hovland	2-14	" " "

PERSONNEL

<u>Name</u>	<u>Title</u>	<u>Reason</u>	<u>Date</u>
RK Robinson	Engineer	Permanently assigned from Tech. Grad. Program	2-1-62

INVENTIONS

All Engineering Operation personnel engaged in work that might reasonably be expected to result in inventions or discoveries advised that to the best of their knowledge and belief, no inventions or discoveries were made in the course of their work during February, 1962, except as listed below. Such persons further advise that, for the period therein covered by this report, notebook records, if any kept in the course of their work have been examined for possible inventions or discoveries.

"A New 'Plate Type' Transducer for Coupling Ultrasonic Energy into a Liquid," DC Worlton

"The Removal of Autoclaved Films from Zircaloy-2," IV Nelson and DE DeWitt.

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SIGNIFICANT REPORTS ISSUED

- HW-72417, "Fluid Pressure Bonding Test," SA Burgess, 1-23-62.
- HW-72291, "Development and Evaluation of Spire Pulse for ALSi Lead-Dip Canning," GR Hanson, 1-17-62.
- HW-72589, "Special Uranium Isotopic Analysis from the Feed Sites," JT Stringer, 2-2-62.
- HW-72614, "CY 1962 Program, Coextruded Product Engineering," SM Gill, 2-7-62.
- HW-72352, ADD., "A Plan for Metallographic and X-Ray Diffraction Data Summary of Historical Samples," AE Guay, et.al., 2-15-62.
- HW-72526, "Chemical and Grain Size Segregation in ALSi Process Ingots," GL Hammons, 1-30-62.
- HW-72644, "Nondestructive Thickness Measurement of End Caps on Hanford Fuel Elements," RL Brown, Jr., 2-8-62.

SECURITY

There were no security violations in Engineering during February, 1962. Total CYTD - 0.

ALSI PRODUCT ENGINEERING

Fuel Performance and Requirements

Two (2) regular production I&E fuel elements (1 natural, 1 enriched) failed in the reactors during February. A summary of these ruptures is as follows:

<u>Fuel Element Type</u>	<u>Tube and Reactor</u>	<u>Exposure MWD/T</u>	<u>Rupture Classification</u>	<u>Failure Date</u>	<u>Canning Date</u>
Natural Bumper	3775D	1158	Core Split	2/18/62	8/6/61
Enriched Non-Bumper	2463B	270	Side Hot Spot	2/26/62	7/12/61

A more favorable fuel performance trend was indicated this period. The number of regular production fuel ruptures in February was ten (10) less than sustained last month and four (4) less than experienced during the same period a year ago.

The natural "bumper" rupture sustained this month was split transversely at the center and diagonally from the center to the base end. Since the fuel element was from a recovered lot that may have contained both ingot and dingot cores, identification of the core is awaiting a more detailed examination in the Radiometallurgy Laboratory.

Radiometallurgy examination of two alloyed dingot transverse core ruptures, which occurred in F-Reactor during October, 1961, is essentially complete. Results thus far have shown 1) the end closures are sound and free of defects that might have permitted coolant entry, 2) "mud-flat" cracks are present on the inner surface of the cores near the points of complete cleavage, and 3) X-ray diffraction of a core sample indicates a slight amount of preferred grain orientation. Three additional X-ray diffraction samples, including samples for chemical analysis of iron and silicon content, are currently being processed from sections of the cores having internal cracks. The actual cause of the dingot core failures is unknown, and it is unlikely that further examination of these ruptures will establish the cause. Examination of an incipient dingot core failure from B-Reactor having "worm tracks" on the surface, is underway. No defects are visually evident in the end closures.

The first rupture of self-supported natural uranium I&E fuel element undergoing evaluation in the C-Reactor ribless zircaloy tube facility occurred on February 3. This rupture had been exposed to about 1003 MWD/T, and was classified as a "side other" corrosion failure. Examination of the piece revealed that the bridge-sections were missing from six of the eight self-support rails, leaving only the 40 mil thick rail tabs to support the fuel element in the process tube. Severe groove corrosion and penetration of the fuel cladding, adjacent to a rail at the cap end with the bridge section missing, caused the rupture. Recognizing self-support rails of the initial

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design were subject to charging damage based on earlier examinations of discharged material, rail thickness has been increased to 45 mils to improve rail strength. Further revision in rail design may be necessary if charging problems cannot be alleviated.

Based on the current status of the alternate aluminum component vendor evaluation program, a decision has been reached to qualify vendor "B" for future competitive bidding on all component orders, and to extend the evaluation of vendor "H" through the procurement of an additional 150,000 OIIN components. As of February 1, about 114,000 vendor "B" components of a nominal 150,000 scheduled had been irradiated to goal exposure in the old reactors to compare rupture performance with control material. Seven (7) ruptures have occurred to date in the test and six (6) in the control material. Considering both the ex-reactor evaluation and in-reactor performance of vendor "B" components, a marked change in performance would be necessary under the present irradiation test to demonstrate the performance of vendor "B" components is equivalent or two-fold worse than the control material with a 10 percent chance of error in judgment. Future potential risks in production or inventory losses associated with the use of this vendor's components will be minimized through rigorous quality control, close scrutiny of irradiation performance, expeditious handling and evaluation of small orders negotiated for other fuel component models, and a "back-up" inventory of control material will be maintained in the immediate future. As of February 1, about 66,500 vendor "H" components had been irradiated to goal exposure, incurring ten (10) ruptures as compared with six (6) control ruptures. Experience thus far indicates the performance of this vendor's components is about two-fold worse than the control material. However, process modifications made by vendor "H" at mid-term of the present program to improve an obviously inferior product has resulted in improved quality, which is expected to yield a correspondingly better performance. Increasing the sample size through an extension of the evaluation of vendor "H" components should facilitate statistical conclusions relative to the qualification of this vendor.

Uranium Technology

Approximately 370 tons of alloyed dingot uranium are being irradiated in the old reactors and 1090 tons have been discharged at goal. In addition, 166 tons of alloyed dingot are being irradiated in the K-Reactors and 32 tons have been discharged. Only 16 tons of dingot cores were canned this month.

To date, there have been four (4) transverse dingot core failures and three (3) dingot core failures that were split both transversely and longitudinally. A transverse split failure occurred this month in a recovered OIIN bumper fuel lot at 1158 MWD/T, but it is not presently known whether it is an ingot or dingot core. In ingot fuel elements, two longitudinal split failures have occurred to date in enriched I&E cores (in July, 1958 and in December, 1961). Since ingot and alloyed dingot uranium are rolled and heat treated by essentially the same process, the crack sensitivity of dingot uranium appears to be associated with chemistry. The primary chemical differences between ingot and alloyed dingot uranium are in the carbon, iron and silicon contents as follows:

	<u>Alloyed Dingot</u>	<u>Ingot</u>
Average Carbon	< 30 ppm	445
" Iron	155	100
Silicon	102	33

During the quench after heat treatment, beta-alpha transformation results in a volume decrease that produces small randomly oriented shrinkage cracks in the center portion of solid dingot uranium core blanks. In ingot uranium, this volume change occurs primarily at inclusion stringers (mainly carbides), which are oriented in the longitudinal direction near the center of the solid core blank. The majority of the shrinkage cracks are removed during core drilling operation, but some of the randomly oriented cracks remain on the I.D. surface of dingot cores. Mallinckrodt Chemical Works has determined that as the iron content is increased (35 to 180 ppm) in dingot uranium the more brittle the uranium becomes at temperatures up to 350°F. Similar measurements have not been made for ingot uranium. In brittle materials, less stress is required to propagate cracks. The stresses needed to propagate the shrinkage cracks on the I.D. surface of dingot cores may result from:

- (1) Water reaction in the cracks forcing the cracks apart by buildup of voluminous uranium oxide. This mechanism requires water entry to the core I.D., but no source of water entry through a weld or spire defect has been found to date in dingot split failures. However, on the three split failures examined with cladding attached, water had reacted with the uranium completely around the spire for the entire length of the core suggesting extensive reaction occurred either before or after the failure was detected.
- (2) High tensile residual stresses resulting from the Al-Si canning process. Joseph* has measured longitudinal and circumferential tensile residual stresses on the I.D. surfaces of Al-Si canned cores (triple-dip process) in the order of 100,000 psi. These high stresses are the result of the cold water quench after canning which quickly cools the outer surface and allows the inner surface to cool slowly. This mechanism of crack propagation could result in a transverse split failure in a dingot fuel element. If an ingot core were to split due to these residual stresses, one would expect that the split would be longitudinal since the shrinkage voids are associated with longitudinal impurity stringers.

Considering the above, the following programs for reducing dingot split failures have been proposed and will be investigated:

* DP-630, "Residual Stresses in Natural Uranium Fuel", J. W. Joseph, Jr., October, 1961.

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- (1) Change to a hollow core blank heat treatment of dingot uranium, using an oil quench. This should reduce the size of any shrinkage cracks and move the location of any of the cracks away from the I.D. surface.
- (2) Adjust the chemistry of dingot uranium as close to that of ingot uranium as possible through proper additives.
- (3) Investigate quench methods in the canning process to reduce I.D. residual tensile stresses. Suggested methods for reducing these stresses are to air quench both the external and internal surfaces or to simultaneously water quench the inside and outside surfaces.

One normal ingot core was found by the chemical analysis audit of one core per incoming lot that exceeded the maximum specified carbon content (750 ppm). This core analyzed 952 ppm carbon and is the only out-of-specification core for chemistry that has been found at HAPU for the last four months. National Lead was advised of this incident and requested to take corrective action to insure future shipments conform with specifications.

Approximately 5 tons of OIIIIN cores fabricated from alpha extruded dingot rods have been prepared for reactor charging under a production test.

National Lead has completed an ingot charge make-up test consisting of 6 different charge compositions with about 30 tons of OIIIIN cores produced from each type of charge. Each charge has a different combination of virgin metal (derbies and dingot uranium), briquettes, and massive remelt metal such as reject cores and, in one case, pigots. Approximately one half the cores from each type of charge make-up were canned this month with three Quality Certification charges being taken to measure any gross dimensional differences after irradiation between the six types of charges.

Process Development

Irradiation of fifty (50) tubes of nickel-plated fuel elements in 105-DR proceeded without incident at an estimated exposure of 1050 - 1150 MWD/T. Analytical results from the two effluent sampling tubes are not encouraging in that the P³² content is consistently ten to twenty-fold higher than the reactor bulk effluent. These results are from three sets of samples in late January and early February, and substantiate a ten-fold difference observed on a set of samples last December. Techniques for reducing the phosphorous content of chemically deposited nickel-plate are being investigated.

Over a 70 percent yield was achieved in a recent test to evaluate 400 fuel elements canned in nickel-plated components under the best process conditions developed to date. Rejects include 6 percent for unsatisfactory assembly, 4 percent from external bond, and 12 percent for closure braze, employing an arbitrary UT-4 tester reject standard. Although the above figures do not include rejects for can wall penetration, welding, and radiograph inspection, it is felt that these categories will be small. Penetration testing with existing equipment is not completely reliable because of the reduced can-wall thickness (30 mils), and the presence of the nickel plate. Caustic

stripping of four (4) rejects indicated the as-received can-wall thickness (27 - 30 mils) was unchanged, but metallographic examination revealed up to 8 mils penetration. Further destructive and non-destructive testing is planned. Possibly, the nickel plate thickness may have to be increased from the present 0.2 - 0.3 mils to assure no penetration.

Further progress has been made toward improving the quality of the weld closures of fuel elements canned in nickel-plated components. It appears that the AlSi and nickel spike of the weld bead can be eliminated employing conventional DC welding. Improved mixing was achieved by machining a V-groove on the cylindrical surface of the fuel element approximately 50 mils from the end and approximately 50 mils in depth, thus extending through the can-wall and braze layer into the cap. The weld bead is largely formed from metal between this groove and the end of the fuel element.

Further laboratory effort toward the development of a corrosion resistant autoclave film on X-8001 alloy aluminum consisted of investigating a range of autoclaving times and temperatures, and the preparation of coupons for accelerated corrosion testing. The autoclave treatment is carried out in two steps, water autoclaving followed by autoclaving in a potassium-dichromate-chromate solution at pH 6.7. This process appears to be more amenable for production use than autoclaving in approximate pH 1 chromic acid, since no undesirable electrolytic effects have been observed, "worm track" corrosion of the X-8001 aluminum does not occur, and both aluminum and stainless steel appear to be adequate for containment of the solution.

Alternate Process

HAPO Hot Press

Finishing and testing of 300 hot-press fuel elements produced during December and January has been completed. The yield was abnormally low (39%) due to non-bonding at the base end of the fuel elements caused by a malfunction of the lower pressing rams. This malfunction resulted in a large portion of the pressing pressure being carried by the ejection rams instead of the pressing rams. Necessary corrections have been made, and 150 additional fuel elements are being hot-pressed to provide the quantity of acceptable pieces required for a preliminary irradiation test next month.

Based on recent test data, HAPO hot-press fuel elements have an average bond strength of 21,000 psi, with a range of 10,000 to 29,000 psi. This compares favorably with an average bond strength of 19,600 psi and a range of 10,500 psi to 27,300 psi for Sylcor hot-press pieces.

Sylcor Hot Press

Ultrasonic welding of self-supports on about 300 Sylcor hot-press fuel elements for irradiation testing was started on February 9, and will be essentially completed by month end. Destructive examination of fuel element samples for diffusion, thickness, and continuity of the nickel, indicates the pieces are of good quality.

Hot Die Sizing

The preheat furnace for hot die sizing was received. Details have been worked out to start the installation of the hot-die sizing press and hydraulic unit. Electrical service to the 3716 Building in which this equipment is to be installed is about 75 percent complete.

Fluid Pressure Bonding

A contract is being negotiated with Battelle Memorial Institute to bond approximately 125 HAPU assembled fuel elements in their fluid pressure bonding facility to optimize process parameters, and to prepare additional fuel elements for a preliminary irradiation test.

Process Technology

A series of tests have been run to determine the effect of bismuth additions to the lead in the duplex canning bath on fuel element bonding layer characteristics. Uranium wafers were preheated in alloys ranging from 100% lead to 100% bismuth. Four different AlSi layer silicon concentrations were tested for each lead alloy, and the AlSi contact time was controlled at a specified minimum. The specimens are now ready for polishing and photomicrographing to examine the braze layers.

The effects of the silicon concentration in the AlSi layer, the lead temperature, and lead preheat time in the duplex canning bath on fuel element bonding are also being further investigated. It has been determined that the percentage of UAl_2 -type compound layer formed on the cores is inversely proportional to the silicon concentration. The silicon concentration in the AlSi layer of the duplex bath has little effect on the total thickness of the fuel element bond, but greatly suppresses the growth of the compound layer during fuel assembly and quenching.

Fuel elements fabricated for production tests during the month included 664 overbore (CVIN) fuel elements for replacement charges, 110 KVN fuel elements to evaluate self-supported fuel in K-Reactor ribless zircaloy process tubes, and 125 CIID fuel elements to evaluate the use of depleted uranium for front face shielding in C-Reactor.

Conversion of fuel end closure welders in the AlSi Shop from AC to DC was continued, with a third automatic welder being converted during the month. Arc starting problems have become evident since installation of the new DC power supplies, and are attributed to the inductance added to the welding circuit to achieve a low current ripple. Adjustments of the power supplies and welding torches improved arc starting, but did not completely eliminate the problem. A current sensing circuit was added to the welders to assure unwelded fuel closures for lack of arc starting would not pass through the machines undetected. Further experimental work showed that arc starting could be substantially improved by adding six percent argon to the helium shielding gas.

Experience with the prototype ultrasonic projection rail welder has indicated a deterioration of welding efficiency with the number of welds produced. After approximately 700,000 welds per welding head, the time required to make a weld has gradually increased from 0.6 second to 1.2 seconds. In an attempt to determine the cause of this loss of efficiency, one of the welding heads was returned to the vendor for examination. It was found that the nickel laminations which make up the transducer had become distorted and bent out of shape. Whether this was due to mechanical damage or to progressive distortion during operation is unknown. At month end, a second welding head was returned to the vendor to further investigate the extent and cause of the problem.

In order to standardize the method of gaging projection fuels, full-length slotted tube gages were designed and a drawing prepared showing the dimensions and tolerances required for each projection fuel model. Attempts to fabricate the gages on site within the desired tolerances have thus far proven unsuccessful. Five potential vendors have failed to bid on the gages for the same reason. Minor relaxation of the tolerances have been made in order to obtain these gages.

Design and procurement of an automatic feed system for the ultrasonic welders to handle elliptical bumper rails is being expedited in anticipation of full conversion to this bumper rail design. A vendor is supplying a vibratory feeder which will orient elliptical rails. The feasibility of automatically loading magazines from this feeder is being investigated, but the results thus far are not promising.

Four of five UT-4 braze closure integrity testers have been installed in the AlSi Shop. Initially, it is planned to evaluate the capability of these testers, followed by the establishment of necessary standards and reject limits for the acceptance of production material.

AlSi Pilot Plant

During February, a total of 3488 pieces was canned in the 306 AlSi Pilot Plant. Of these pieces, 3,343 were for reactor use and 145 for destructive or other tests.

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COEXTRUDED PRODUCT ENGINEERING

N-Reactor Fuel Development

KER Loop Testing

The warp test (five 23-inch enriched inner tubes; two negligible warp; and three excessive warp) was discharged from Loop 1 on February 16, 1962, and another "crud" test was charged. The warp test exposure was approximately 1075 MWD/T. Since the loop was on cold water during part of the irradiation, conclusions may be questionable. Therefore, another warp test is being prepared and may be irradiated if space is available.

The prototype NIE (23-inch) elements in Loop 2 are operating satisfactorily and should reach goal exposure (3000 MWD/T) about April 1, 1962.

Fuel pieces for the tapered end closure test are ready for charging.

On about April 1, 1962, Loops 1 and 2 will be shut down approximately three months for pump modifications.

The recently modified Loop 3 was charged with two prototypic N-fuels (NAE-1: inner and outer assemblies) on February 18, 1962. These fuels are being used as heater elements for loop shakedown testing, and they are termed "throw-away" material. Loop 4 is now empty. It was originally planned to charge two prototypic N-fuels in Loop 4. Later, it was decided to leave Loop 4 empty pending the results of Loop 3 testing. Two prototypic N-fuels are ready for charging in Loop 4.

Listed below is the revised schedule for Loops 3 and 4:

March 23, 1962 (Throw-away Charge - Startup use)

Loop 3: Charge 5 N-prototypic fuels.

Loop 4: Charge either 2 or 5 N-prototypic fuels.

Material Status: Eleven N-prototypic fuels fabricated and ready for shipment.

April 2, 1962 (Full-loop Charge)

Loop 3: Charge 11 N-prototypic fuels.

Loop 4: Charge 11 N-prototypic fuels.

Material Status: Outers - 27 at autoclaving and 65 at autoradiograph testing.

Inners - 14 at support welding and 60 at autoradiograph testing.

Production Test and Development Fabrication - Pilot Plant

The schedule on page 13 represents the status of work in the Coextrusion Pilot Plant. This constitutes the bulk of the work performed in the pilot plant. Additional work performed, not covered by process work requests, included a drop test charge of approximately 50 NPR assemblies. This charge was processed through support welding, locking clip attachment and sizing. The assemblies were returned to the pilot plant after testing and were rebuilt for further testing.

Materials Development and Procurement

Uranium Billets

Feed Site Operations

National Lead Company of Ohio has completed the revamping of their Plant No. 9 facility for casting and heat treating N-uranium ingots and machining billets. Their shakedown operations in the casting area began in late January. Plant No. 9 now produces ingots up to 28-inches in length in comparison to the 22-inch ingots previously produced in Pilot Plant and Plant 5 facilities. After some preliminary surface quality problems, NLO has now adjusted their casting cycle to produce ingots of satisfactory quality as determined by step machining of the ingots and inspection of the primary extrusions.

Bridgeport Brass Company, Ashtabula, Ohio has performed the primary extrusion of short and long N-inner and N-outer ingots with their newly-installed extrusion facility. The salt bath preheat furnace has been satisfactorily tested using thermocoupled ingots. The first primary extrusions have been satisfactory from an I.D. and O.D. concentricity standpoint based upon dimensional and machining checks performed by National Lead Company of Ohio. No surface defects attributable to the primary extrusion operation have been noted.

The primary extrusion of the first "Brandywine" uranium at Bridgeport Brass Company was carried out on February 21, 1962. Long ingots, each producing three outer billets or four inner billets, were pushed. Only one small problem was recognized. The N-inner primary extrusions bent and probably suffer low yields when machined. The problem can probably be prevented by redesign of the runout fixture to supply better support.

Quality Improvement

A prohibitive reject rate (35 to 40 per cent) exists on N-outer co-extrusions because of inner clad variation. Promising preliminary heat treatment and primary extrusion tests at HAPCO indicate that the clad variation problem can be alleviated. Therefore, a feed site test has been planned in an effort to reduce the inner clad variation on N-outer coextrusions by various special treatments of the uranium ingots and

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IN PROCESS DATE	PWR NO.	EXTRUSION DATE	TUBE NUMBER	WORK DESCRIPTION	TYPE AND QUANTITY REQUIRED	PROCESS LOCATION	EXPECTED COMPLETION DATE	COMMENTS
12/27/61	12			Fabricate NPR prototype fuels for high temperature flow tests.	(20) 24-inch assemblies	Support & locking device welding	3/7/62	
	25			Evaluate cap clad end closure nondestructive test by incremental machining of cap to locate non-fills.	(15) NIE	Complete	2/15/62	
1/25/62	28			Prepare fuel elements for pressure bond end closure tests.	(12) NOT	Complete	2/2/62	
	29			Prepare fuel elements for brazing to evaluate application of ultrasonic vibration		Delayed due to equipment fabrication	Indefinite	
1/25/62	30			Determine amount of interference fit of NIT supports to meet specifications and avoid excessive scratching of NOT (ID).	(5) NAE	Complete		
2/8/62	31		UT-6 UT-7 UT-8 UT-9 UT-10 UT-11 UT-12	Extrude 6 NOT billets and process fuel segments to determine effect of immediate beta heat treatment prior to coextrusion.		In process. Facing to length	Indefinite	
2/22/62	32			Prepare NIT specimens for projection welded end closure. Chemically milling and etching.	(250) 2-inch	Copper stripped.	Indefinite	
I&E program				Fabricate coextruded I&E fuel elements for production reactor testing.		100 at end facing	3/30/62	200 ready for reactor charging.

billets. Billets processed during this same period by the "standard" specification practice will be employed as test controls. The co-extrusion performance of the test and control billets will be compared to determine the degree of quality improvement effected by the special treatments.

Test Parameters

1. All NOE billets scheduled for delivery between March 1 and April 30 (approximately 130 units) will be produced under this controlled test.
2. All NOE billets will be produced from the 28-inch long ingots cast in the new Plant 9 melting facility.
3. The ingots for supplying these billets will be segregated into four equal categories by serial selection (i.e. Category One will include Ingots 1, 5, 9, etc.; Category Two will include Ingots 2, 6, 10, etc.; Category Three will include Ingots 3, 7, 11, etc.; and Category Four will include Ingots 4, 8, 12, etc.) to prevent time dependent casting variables from clouding the test data.
4. The four categories of material will be fabricated as specified below:

Category One:

The as-cast, hollow ingots will be reamed to 3.0 inch I.D. prior to beta heat treating. During primary extrusion, the ingots will be upset onto a 2.650 inch O.D. Mandrel.

Categories Two and Three:

The billet blanks cut from primary extrusions will be single beta heat treated. Category Two billets will be heat treated prior to machining. Category Three billets will be heat treated after rough machining of the I.D. and the O.D. The billet blanks will be vertically oriented during heating and quenching. The heating and quenching media will have free access to the I.D. of the billets. The heat treating and quenching cycles will be as follows:

- Beta Treatment - 25 to 30 minutes in 720 to 740°C (1330 to 1365°F) salt.
- Transfer Time - (salt to brine) - 15 to 30 seconds.
- Quenching Medium - About 0.25 weight per cent brine at 21 to 37°C (70 to 100°F).

Category Four:

This material is for test control and will be processed as prescribed by the specifications applicable to standard production material.

Zircaloy Cladding

All qualified vendors for cladding shells are producing acceptable products. One vendor plans to change to a forging and rolling process to make inner tube-inner clads. This process has proven troublesome in two instances in the past, and several typical test pieces will be evaluated before any quantity is produced.

Zircaloy Supports

A substantial quantity of all supports and locking clips are on hand and are acceptable. Inner tube supports are in shortest supply, but sufficient quantity is available to last about two months. More are due to arrive within a few weeks, and the total ordered quantities of all items should last at least through June.

Extrusion ProcessExtrusions

The following Engineering extrusions were made during the month:

11.1 Inch Tooling

19 Primary Extrusions - PU-47 through PU-65

All extrusions to NOE size.

7.5 Inch Tooling

6 Composites - UT-8 Through UT-12 and X-13

UT-8 - NOE's with heat treated cores to reduce
Through inner clad thickness variation
UT-12

X-13 - NOE thin clad standard.

2 Zircaloy Billets - Z-125 and Z-126

Z-125 & - Tubes for IPD
Z-126

6.0 Inch Tooling

12 Composites - UT-13 Through UT-17, ZT-13 & 14, and X-16 Through X-20

UT-13 - NIE's with heat treated cores to determine effect
Through on clad thickness variation and beta heat treated
UT-17 warp.

ZT-13 & - NIE size with copper cores to evaluate zircaloy
ZT-14 clad components.

X-16 - NIE test billets with various preshape designs for
Through evaluation.
X-20

1 Zircaloy Billet - Z-127

Z-127 - Rod for HLO

NOE Inner Clad Thickness Variation

Six NOE test billets were extruded in which the uranium billets were single beta heat treated in an attempt to reduce inner clad thickness variation. The evaluation of these tubes by both physical measurement and nondestructive testing showed a considerable decrease in inner clad thickness variation, and all pieces met specifications: .019" minimum (on finished fuel), .008" maximum variation per cross section. All measurements were between .026" and .034" and the maximum piece variation was .007".

Based on the improvements obtained on the above six extrusions, the NOE production during March will all be made with heat treated billets. If clad thickness control is satisfactory on the production material, the process specifications will be changed to require heat treatment of NOE billets at the feed sites.

Primary Extrusion

The primary extrusion of NOE size material is complete. Machining of billets will be complete by 3/15/62. Coextrusion of NOE billets fabricated onsite will be scheduled by Process Work Request to evaluate the effects of primary extrusion variables on coextrusion quality.

Billet Preheating

The first set of test runs have been completed on the large continuous production furnace, and the data is being evaluated. Four runs each have been made with both the NOT and NIT billets, and two temperature profiles of the furnace have been made. These tests have indicated that some changes should be made in both the mechanical characteristics of the furnace and the thermal characteristics of billet heating. At present, the mechanical character of the furnace is being revised. When this is finished, an additional set of tests will be made of methods correcting the thermal characteristics. The primary problem is the damping of the billet surface temperature.

Warp Studies, NIE Fuels

A statistical analysis has been made to determine if the warp which occurs during beta heat treating is related to coextrusion process variables. This analysis has related the magnitude of both received warp (R) and the change in

warp during beta heat treating (V_1). The conclusions that have now been statistically qualified are as follows:

1. both R and V_1 vary proportionately in magnitude with the temperature of the coextrusion billet. That is, the R and V_1 have been shown to be statistically significantly different at these billet temperatures: 1170, 1155, 1140 and 1100°F (632, 624, 616, and 593°C).
2. other coextrusion process variables do not have an effect on the magnitude of R and V_1 . These variables are:
 - a. Copper Components: DHP vs Everdur A copper
 - b. Liner Temperature: 800°F vs 600°F (427°C vs 316°C)
 - c. Ram Speed: 15, 14 and 10 ipm.
 - d. Graphite Cut-off Temperature: 1140°F vs 800°F (616°C vs 427°C)
 - e. Billet Position in i.e. A vs B vs C billets. the Ingot

The conclusions of the dependence of R and V_1 on ram speed cannot be clearly separated from the billet temperature effect. The low ram speeds (10 ipm) have been used with low billet temperatures (1140°F) and the higher ram speeds (15 and 14 ipm) with high billet temperatures (1170°F and 1155°F). A separate and well-designed test must be made, if the true effect of ram speed is to be learned.

In the last report, the coextrusion process variables were compared with heat treating yield data. It appeared that coextrusion conditions of the billet at 1140°F and the ram speed at 10 ipm would give optimum yield. The current analysis indicates that the ram speed need not be so specified.

The foregoing conclusions indicate that billet temperature alone determines the magnitude of V_1 . One can, therefore, conclude that the original hypothesis that "temperature gradients that exist in the billet during coextrusion, determine the magnitude of V_1 " is still valid. It follows rather simply that as the temperature of the tools remains constant (i.e. the loader and the liner), the heat flow and the final temperature gradient in the billet will vary proportionately with the temperature of the billet. This reflects again on the need to decrease the heat flow from the billet by both heating the billet loader and decreasing the billet temperature (because the liner temperature cannot be raised).

The statistical analysis shows that R and V_1 are related in magnitude. Thus it appears that if the pieces are straight as they are received at beta heat treating, they will tend to remain straight during beta heat treating. Perhaps,

then, too much attention has been directed at the data on "size" of as-coextruded pieces. It is reasonable to assume that pieces having either large eccentricities and/or clad thickness variation will warp during cooling on the runout table and the lack in "size" will be indicated by the values of R. This could be tested by a hypothesis if the volumes of "size" data could be condensed.

Current statistical analyses indicate that R and V_1 vary in magnitude as a function of the position of the piece in the coextrusion. Exact correlations as a function of (1) billet temperature, (2) ram speed, and (3) billet type (i.e. A, B, and C) are being programmed at Data Processing.

Chemical Processing

Chemical Milling Development

Recent brazing tests indicate that metallurgical bonding between the uranium cap and core can be improved if the chemically milled uranium surface is well populated with small pits. Process solution conditions have been varied in an attempt to produce this surface with some degree of consistency. Conditions appear to favor a rapid rate which can be obtained by a high nitrate content and a reduced sulfate and copper content in the milling acid solution. Some desirable results have been obtained. However, the variation in metallic structure of uranium samples submitted have affected process reproducibility. Further testing will take the approach of using a second chemical milling solution which will pit the smooth surfaces produced by the first solution. This probably would be of short duration, etching to a depth of less than 20 mils.

Cathodic Etching

A test was performed to evaluate the effect of cathodic etching as a means of zircaloy surface preparation prior to autoclaving. Two coextruded I&E fuels were cathodically etched in the described manner.

The closure area on No. 1 element was cathodically etched, followed by the normal nitric hydrofluoric acid etch. The process was reversed with the No. 2 element, producing an as-cathodic etched surface for autoclaving. The autoclave film on element No. 1 was black. A slight pitted weld area was produced by the cathodic etch process. The cathodically etched surface on element No. 2 was completely white, except for the weld bead area which was black. No explanation is offered, except that cathodic etching apparently removes the white oxide producing materials on the Be-Zr weld and produces it on the zircaloy-2 clad surface. Chemical etching applied subsequent to cathodic etch restores the zircaloy surface to one which can be satisfactorily autoclaved.

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DECLASSIFIEDBrazed End ClosureInvestigation of Closure Bonding

As reported last month, cracks have been detected between the zircaloy cap and the uranium core in a few instances (about 12 out of 5600 closures tested). Indications are that this cracking occurs during the TIG welding process. It is also indicated that this cracking is associated with poor bonds which show no evidence of an intermetallic compound layer between the braze material and the uranium. In some cases, such cracks may also be associated with, or initiated by, the presence of voids or unwet spots in the interface.

A detailed study of the problem has shown that in general two conditions may exist between the cap and core. First, the molten braze may simply wet the uranium without the formation of any discernable intermetallic compound layer. This bond has a tensile strength of approximately 50,000 PSI and a shear strength somewhat greater. In the second case, a very pronounced intermetallic compound layer is formed which is normally about 1/2 mil thick. The strength of this bond is thought to be about 25% greater than the other, although quantitative data on its exact strength are not yet available.

Based on the assumption that the presence of a visible compound layer is desirable, a series of tests has been run in an attempt to define the conditions which enhance its formation. No attempt will be made to cover the results of the study here, except to make the following summary statements.

1. The formation of the compound layer is very temperature sensitive. If the braze is made at 1025°C (1877°F), or below, essentially no intermetallic layer will be formed. If made at 1075°C (1967°F) or above, the compound layer will be essentially complete.
2. Its formation is not time sensitive within the range of 10 to 60 seconds at temperature.
3. Surface condition may have some effect, but it is not yet known what the optimum surface is. Moderate amounts of oxide on the uranium do not seem to have any effect, either good or bad, while some surfaces, such as sand blasted or cathodically etched, seem to prevent formulation of the compound layer.
4. Uranium impurities are believed to have deleterious effects, although insufficient data exist to determine which impurities and at what levels they become significant.

At present, it appears that if the closures are made at a temperature between 1050°C (1922°F) and 1075°C (1967°F), and if the uranium is thoroughly clean and dry, the resulting bond will have sufficient strength to resist fracture during the various processing steps and subsequent reactor irradiation.

End Closure Welding

"Recast" Closure Weld

A modification to the TIG closure weld has been developed where the arc is run on the flat of the faced-off cap instead of directly over the braze line. This results in a "recasting" of the top .050" of the braze line with a minimum of melting of the braze and zircaloy cap.

This technique obviates the need for the "wide braze" now used, as well as the step-cut cap. This should result in substantial savings in the cost of caps, make facing much less critical and give a weld more amenable to inspection. Further study of this technique is necessary and is being carried out.

Brazed Closure Welding

Weld rejects for the brazed closure have been approximately 1/2 per cent for outer tubes and 1-1/2 per cent for inner tubes. The inner tube rejects are equally divided as follows:

1. Braze defects
2. Wall thickness variation
3. operator's errors

Gas Pressure Bonded End Closure

Autoclaving of NPR fuel tube end closures that were gas pressure bonded at 650°C (1202°F) for one hour at 10,000 PSI has continued. After ten days in 350°C (662°F) water and 400°C (752°F) steam, there was no more evidence of corrosion in the bond region and weld than there was after seventy-two hours in the same media. One set of specimens was exposed under each condition. They have been replaced in the autoclaves for continued testing.

An offsite contract (DDR-139) is being negotiated to vapor coat the closure rings with copper to promote bonding between the zircaloy-2 cladding and closure ring. The fuel closure ring has been redesigned to a two-piece ring and the "V" type to a three-piece ring to provide a simpler coating operation. The design change reduces the problem to coating a flat ring. In the case of the flat closure, the ring is coated on all surfaces but that contacting the uranium, while in the case of the "V" closure, the flat ring is coated on all surfaces to produce bonding with the seal ring, cladding and "V" portion of the closure ring.

The problem of electroplating a tightly adhering coating of copper that will partially diffuse into zircaloy-2 is being studied, with the current effort being directed toward the use of a copper-cyanide solution. Cyanide solutions are used where the metal to be plated is positive with respect to the solution. Zircaloy-2 displays the characteristic.

A new approach to the copper-diffusion bonded end closure has been developed to overcome the problem of coating the zircaloy-2 with a tightly adhering coating

of copper that will partially diffuse into the closure ring. The new approach uses a massive copper ring in place of the coated zircaloy-2 ring. Discussions to date have disclosed no serious objection to the massive copper ring. In addition, some believe that there would be no serious objection to bonding the massive copper ring directly to the uranium. The following points remain to be resolved:

1. Geometry of the ring.
2. Thickness of the massive copper ring. It is felt that it should be two to three times the cladding thickness in order to provide adequate corrosion distance as the bond has a higher corrosive rate than the copper.
3. The effect of the copper on the Zirflex decladding process. Specimens are being prepared for Chemical Research for investigation of the effect. There is no known effect of this amount of copper on the process.
4. The increased neutron absorption of copper. Whether this is of primary concern is being investigated.

The sixth test lot of gas pressure bonded end closures, the second with an electroplated film of copper to accelerate bonding between zircaloy-2 cladding and closure ring, has been autoclaved at Battelle Memorial Institute and is scheduled for arrival onsite by June 28, 1962. These contain a "V" type closure in which the "V" has been machined in beta heat treated uranium. No report has been received on the processing.

Inner Tube Supports

A recent test in the 306 Pilot Plant showed that when an inner tube is inserted into an outer tube before autoclaving, white scratches appear after autoclaving at the points where the inner supports made contact with the I.D. surface of the outer tube. The test further showed that these scratches appeared even when the minimum inner support circle diameter was used. The effect of these white scratches on fuel quality is not yet known. Methods for eliminating the white scratches are now being investigated.

Also, a test is being run to determine the effect on the I.D. surface of the outer tube when an inner tube is inserted into an outer tube after autoclaving.

TESTING METHODS ENGINEERING

N Fuels Testing

The capability of the internal bond test was demonstrated in that cracks invisible to normal microscopic examination were ultrasonically detected. The same small cracks were observed in microscopic examination using polarized light. Approximate widths of the cracks are 0.1 to 0.5 micron. Further examination with an electronic microscope is scheduled to more accurately determine the crack dimensions. The fuels examined were not typical of the process, but were rejects from the peel test.

Experiments with ultrasonic examination of zirconium components has indicated that changes in patterns of pulses from a rotating component as well as changes in average amplitude can provide useful information about the components.

New Test Development

Post-Irradiation Test Equipment

Ultrasonic bond test maps were taken of twenty C-VI-N before and after welding of self-supports. No significant change in bonding was noted. The maps, however, did suggest an ultrasonic test for weld integrity as examination of maps will reveal unbonds between rails and cladding. A visual readout would be required.

Design and fabrication of the 105 KE facility is proceeding on schedule. The original station was not expected to include thickness measuring equipment, but experiments with fast pulse-echo circuitry has shown that an oscilloscope readout system will be feasible by the beneficial results goal date of June, 1962.

UT-4 Project

Four units have been debugged and delivered to 313 Building. These units are completely installed and two have been available for operation since the middle of February with beneficial results obtained on February 26. The two operating units are handling the entire production flow. Data logging is taking place to aid in establishing a correct operating point. In the meantime, the worst fuels (ten or fifteen per day) are being saved for retesting under final operating conditions. The second two units are expected to be available for full operation by March 9, 1962.

NPR Fuels

A laboratory experiment successfully demonstrated that a sonic technique could be used to agitate the braze alloy during brazing. About 30 watts of power at 350 cycles per second was coupled into a N.I.T. Agitation of water substituted for braze alloy was observed.

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Experiments were performed to determine if sonic vibrations could cause a break in a weak braze. The thrust force for the vibration transducer was two pounds. No change in bonding was observed and future experiments will utilize a twenty-four pound thrust.

Measurement of ultrasound velocity in heat treated and non-heat treated fuels has shown that velocity is four percent greater in the heat treated fuels. Some Beta transformation was detected in extruded fuels; if this transformation can be kept out, an ultrasonic velocity test offers a means of differentiating between heat treated and non-heat treated fuels.

Hydride Detection in Zirconium

Massive hydrided spots in zirconium process tubes have been detected by noting changes in the envelope of ultrasound passed through the material. Changes were observed in both 2000 ppm and 5000 ppm sections when tested over the frequency range of 1 to 30 megacycles. Small hydrided spots were detected in 5000 ppm samples by noting fifteen to thirty percent reduction in envelope amplitude. In addition to changes in the ultrasound envelope, changes in ultrasound velocity were noted in massive uniform hydrided sections. Velocity increased two percent in the 5000 ppm sections and four percent in the 7000 ppm section as compared to a non-hydrided section.

Flaw Detection in Copper Lubricant End Plates

A need exists for locating flaws in the end plates which enclose N fuels billets before extrusion. If pin holes exist in these plates, the hermetic seal within the billet will be broken and poor bonding will result. A laboratory test was developed which will inspect the plates. Testing of present supplies can be handled using the laboratory setup.

Directional Resistivity Studies

Several directional probes were designed and built for experiments in measuring resistivity of zircaloy-2 and uranium in specific directions. Changes of resistivity of approximately one to five percent were noted in zircaloy-2 between measurement along the direction of rolling to measurement across the direction of rolling. Changes of approximately six to ten percent was noted for as-rolled uranium, and one and one-half to three percent for Beta heat treated uranium. As aspect ratio (ratio of coil length to coil width) is increased, directional sensitivity is also increased. The limits of this relationship, however, have not been defined as yet.

Using a two-channel differential eddy current system, it was found that resistivity of uranium in the as-rolled direction changes considerably more than resistivity in the 90 degree direction as a result of heat treating. Using this system, it was possible to clearly identify from eight NPR outer tubes those which had been heat treated.

ADVANCE FUEL ENGINEERING

Chemical and Grain Size Segregation in AlSi Process Ingots

A report which describes the results of a study aimed at resolving the magnitude of chemical segregation in the ingots from which I&E fuel cores are fabricated was issued in February. The experimental data for this study were supplied by the National Lead Company of Ohio. It is demonstrated that carbon, oxygen and nitrogen show extensive segregation along the ingot length. This segregation is also evident in the finished cores. The ingot top contains the purest uranium, while that material midway between the top and bottom is least pure. No segregation of iron or silicon was evident.

The noted chemical segregation is apparently responsible for a corresponding grain size segregation. A mathematical model is presented in the report which correlates grain size to uranium chemistry in I&E cores fabricated from normal uranium ingots. This model shows that in addition to the effect that iron and silicon has on grain size, the effect of carbon, oxygen and nitrogen is also quite significant.

Alpha-Solid Extrusion of I&E Cores

The economic incentive to alpha-solid extrude HCE-I&E fuel cores has been reviewed. The review was based on data supplied by Mallinckrodt Chemical Works.^(1,2) The total economic incentive, which is made up of process cost reductions and transportation savings, is small enough that expected variations in processing costs cause considerable uncertainty as to whether or not a real saving will occur from MCW alpha-solid extrusion of I&E fuel cores.

Although MCW and the OROO-AEC apparently still are interested in alpha-hollow extrusion, the economic incentive to develop this process is not apparent from cost figures supplied thus far to HAPC. The fact is that even admittedly optimistic cost estimates predicted for alpha-hollow extrusion result in total costs that are approximately \$0.03 higher than costs estimated for solid extrusion.

Acting Manager, Engineering

JT Stringer:msw

- (1) GEH-25500, "The Dingo Process, A Status Report as of May 10, 1961," Mallinckrodt Chemical Works, (Secret).
- (2) GEH-25641, "Economic Advantages of Solid Alpha Extrusion," D. E. Stephens, Mallinckrodt Chemical Works, October 25, 1961 (Secret).

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FINANCIAL OPERATION

FEBRUARY, 1962

Preparation of the FY 1964 budget and the revision of the FY 1963 budget began with the receipt of departmental personnel estimates on February 2. By month end the budget was basically complete with all interim due dates met.

Reports have been developed to provide details of operating cost by product model for the AlSi Process and by station in the Coextrusion Process. First formal issuance of these reports will be made during March.

The revised production cost report which includes incremental costing for projection, the use of equivalent production for calculation of unit cost, and additional details as to the sources of production cost was issued for the first time in February. Comments received to date have been favorable. Preparation time for this important report has been reduced by one full day, with a corresponding improvement in the issuance date.

Meetings were held with managers and foremen of all maintenance subsections to explain the procedures for mechanized recycling of work orders. The improved system eliminates the use of cross orders and provides secondary servicing units with additional information and controls.

A meeting was held with C&AO representatives to outline plans for mechanization of Research and Engineering cost distribution. Present scheduling calls for completion of preliminary data processing programs by April 1, 1962, with implementation by June. Future plans indicate that machine reporting of Engineering end function cost can be accomplished by October or November.

The Equipment Not Included in Construction Projects Budget for FY 1964 and Revision of Budget for FY 1963 was prepared. FY 1963 requirements are estimated at \$2.3 million. Included in this figure are funds for a 1500 KVA emergency power generator, additional ultrasonic welders, replacement of semi-automatic welders with automatic welders, equipment for controlled process plating development as well as routine equipment replacement and upgrading. The FY 1964 estimate totals \$1.7 million.

The Plant Acquisition and Construction Budget for fiscal years 1963 and 1964 is currently under preparation. The budget including detailed data sheets and cost estimates will be submitted in March.

Project Proposal CAF 954, Hi-Pressure Autoclave Facility has received Company approvals and was transmitted to the Commission on 2-27-62. The project, if approved, will provide \$485,000 for the construction of an autoclave facility for development of alternate end closure processes. The facility will consist of a relatively small building equipped with two autoclaves and necessary control and supporting equipment.

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The proposal for the controlled Process Plating Development Facility was reviewed and cost data checked during the month. The facility will be used for development of plating techniques to improve fuel element quality. The cost of the facility including \$10,000 of expense work is estimated as \$187,000.

Travel for February amounted to \$4,000 with 56 days in travel status. Attendance at a meeting of a professional and trade society by one employee involved costs of \$419 with 4 days in travel status. Participation by two persons in offsite courses accounted for 7 days in travel status at a cost of \$353.

There were no charges against Assistance to Hanford programs in February. Activity has been very nominal during the current year with FY cost to date totaling \$1,900.

Two cost improvement proposals were received in February with total estimated savings of \$6,922. This brings the number received this year to four with estimated savings of \$18,102. Additional savings of \$6,292 have been realized from the suggestion plan.

Auditors of the General Accounting Office contacted certain department personnel relative to purchases of Tektronix oscilloscopes. Points in question were the basis for specifying this particular make and where the responsibility rested for determining whether other brands would be satisfactory when the term, "or equal", was used. All questions were answered to the auditors satisfaction.

Review is underway of material purchased or withdrawn from stores during January, 1962.

FPD records management practices were reviewed February 27 and 28, 1962, by representatives of HOC-AEC and CAO Records Management. Findings indicate (1) some better utilization of existing file space can be realized; and (2) managers need to be better informed of the workings of the records management program.

No reports of unusual significance were issued during the month.

The Financial Section had no security violations during January.

Manager - Finance

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PLANT FACILITIES OPERATIONFEBRUARY 1962I. RESPONSIBILITY CHANGES

None.

II. ACHIEVEMENTSA. Statistics1. Utilities

	<u>Feb.</u>	<u>Jan.</u>
Average steam generated (M lbs/hr)	94	111
Maximum steam generated (M lbs/hr)	144	168
Total steam generated (M lbs)	63,085	82,785
Coal consumed (tons)	3,105.08	4,044.15
Evaporation rate (steam/#coal)	10.16	10.23
Efficiency - Actual	72.3	69.2
Efficiency - Theoretical	75.0	76.4
No. of Boilers on: 3 2 3		
Date of change : 9 20		
Sanitary water from 3000 Area (M Gals.)	154.05	171.36
Total water from 3000 Area (Avg. Rate GPM)	3,829	3,839
Total water from #3 and #4 wells (M Gals.)	11.69	12.40
Total water from #2 well (M Gals.)	.30	.30
Peak water consumption for 24 hours (M Gals.)	5.9	6.1

B. Operating Experience

Intermittent failure of the ash sluice pump with subsequent loss of suction was experienced during the month. Inspection of the suction pump revealed that the cast iron wear plate had been penetrated and the 12 inches of concrete under the plate had been eroded to a depth of about 7 inches. The wear was caused by impingement of the water stream from the agitator jet in the sump. The concrete was grouted and a new wear plate fabricated of four alternate layers of steel plate and dense rubber, with the rubber on top to absorb the eroding effects of the agitator jet. Inquiry has been made to the manufacturer of the ash handling equipment to get his recommendations.

A new procedure is being developed for the routine weekly shutdown of the import water from Richland, which will reduce surges caused by this operation. This procedure will be applied during any shutdown of sanitary water from Richland.

Two unscheduled power outages were experienced this month in the 384 Building due to the opening of a main electrical breaker. This tripping occurred while under the additional load of ash sluicing,

which also required the use of all the 480 volt pump motors in the 382 Building. Both outages only affected normal service and appeared to be the result of starting too many pieces of equipment simultaneously. As a temporary corrective measure, the instantaneous trip settings were adjusted from 800 amp to 1,000 amps. A more precise adjustment will be made during a future scheduled breaker inspection.

Coal deliveries were poor during the month, requiring the use of a bulldozer to obtain coal from the stockpile.

The modification and cleaning of the north process pond was completed on schedule and process water was diverted from the south pond. Process water flow appears to be heavy but the new pond is performing well.

The calibration and measurement of all calibrating resistors and capacitors in the EASE computer located in 3707-C Building was completed this month.

The field requirements of the "Cutie Pie" radiation instrument appear to be increasing. Whereas six months ago approximately fifty of the CPs were used for exchange purposes, now all instruments are in use.

The fire alarm panel in the Plutonium Fabrication Pilot Plant was completely rewired and tested. Causes of previous malfunctions were all corrected or eliminated.

Conversion of the 3716 Building to provide space for the nickel plating facility has created additional storage problems in the Engineering Section.

A new Polyvinyl Chloride filter box was built and installed in the 325 Building. The filter box was built at a cost savings of approximately \$200 over that required for a stainless steel one.

C. Equipment Experience

Steam coils on the distilled water still in the 329 Building were removed and cleaned. The accumulation of scale was heavy and the capacity of the still had been greatly reduced.

Hanford Laboratories Operation has requested most of the filter changes in their buildings be performed on overtime to prevent undue interruptions of these units during the normal working hours.

The manufacturer's representative visited the powerhouse to inspect the trip-open steam valve on the emergency turbo-generator. This valve has persistently failed to open when tripped, although it could be opened manually by rotating the valve handwheel about a

half turn after tripping. A simple adjustment of an orifice screw provided the necessary correction and the valve now opens satisfactorily when tripped.

The Area evacuation siren failed to function during the "wailing" test after proper functioning when the "steady" signal was tested. The complete system was inspected and no cause of malfunction could be detected. It is speculated that dirt particles in a relay contact may have caused the malfunction; however, electrical personnel will be present during the next scheduled test.

Considerable trouble was experienced with the closed circuit television in the 305-B Building. Additional training in the maintenance of this system is needed and such arrangements are being planned.

The condensate sump pump motor at the 308 Building grounded out again due to excessive moisture. A totally enclosed motor was modified to fit the pump and the sump vent was extended outside the sump to reduce the steam and condensate accumulation adjacent to the motor. It is expected that these corrective measures will eliminate future motor failures.

D. Inventions and Improved Methods

All personnel in the Operation engaged in work which might lead to inventions and/or discoveries advised that, to the best of their knowledge, none were made in the course of their work during the month of February 1962.

E. Cost and Savings

Two Cost Improvement items, totalling \$3,893, and suggestions of \$1,930, were approved to bring the Section to 15 per cent of CY-1962 goal.

F. Status of Projects and Major Jobs

Modification of No. 1 I.D. Fan - J. A. Jones has been authorized to proceed with the installation of an auxiliary oil pump.

384 Building Maintenance Shop - The moving of maintenance material and equipment is continuing at the shop.

Monumenting Burial Grounds, 300 Area - The construction contract was awarded February 27, 1962 in the amount of \$3,985. This bid was considerably under both the engineering estimate and the fair cost estimate.

Air Dryer Installation, 38 Building - Equipment is scheduled for delivery March 16, 1962 with installation work to start as soon as the equipment is received.

Modification of No. 6 Sanitary Water Pump - All components are now in place and the pump is in service. Painting and minor modification to the gasoline engine remains to be done.

Auxiliary Instrument Panel, 384 Building - The major share of equipment has been delivered on site and the final installation drawings are scheduled for completion on March 9, 1962. Installation will be by Plant Forces.

New Water Distillation Facility, 3706 Building - The bid opening for the demineralizer is scheduled for March 1, 1962, and delivery of the still about mid-March. The recirculating hot water system has been completed and is working satisfactorily.

Refrigerated Air Conditioning, 3717-B Building - Equipment has been delivered and a work order issued to J. A. Jones for installation. Design is complete with operation of the system planned for March 30, 1962.

Modification of No. 5 Sanitary Water Pump - All equipment is on site and installation will proceed as soon as scheduling permits.

Sanitary Water Grid System Extension - Field work by J. A. Jones will be started as soon as milder weather prevails.

Intercommunication System, 384 Building - The primary specifications and design are complete. Further progress awaits approval of the required funds.

Emergency Power System - Procurement and installation of a new 1500 KVA diesel driven generator to increase the emergency power system is awaiting approval of funds in the amount of \$280,000. This will be a packaged unit with installation costs of less than \$5,000.

Major Studies

Work Sampling, CY-1962 - Work Sampling of craft people working the day shift was completed February 23, 1962. Swing shift employees are currently being sampled. Approximately 4200 observations have been made to date with completion of the study scheduled for March 16, 1962.

4th Expansion, Steam Generation Plant - The second rough draft of the budget study was completed and forwarded to Facilities Engineering for use in the preparation of the FY-1963 Budget Data Sheet.

END

**DATE
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12 / 14 / 92