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February 7, 1961

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**FUELS PREPARATION
DEPARTMENT**

**MONTHLY REPORT
JANUARY
1961**

Approved by: OSTT

OCT 0 4 1992

**HANFORD ATOMIC
PRODUCTS OPERATION**

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FUELS PREPARATION DEPARTMENT
MONTHLY REPORT - JANUARY 1961

Compiled by Fuels Preparation Department
February 7, 1961 - Richland, Washington

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

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**FUELS PREPARATION DEPARTMENT
MONTHLY SUMMARY REPORT
JANUARY - 1961**

PRODUCTION

Finished production for January was 588.6 tons, or 93% of forecast.

At month end the bare uranium inventory was 1,480 tons compared to 1,457 tons for December. Finished inventory was 825 tons at month end compared to 920 tons for the previous month.

ENGINEERING

Present Reactor Fuel Elements

Eleven fuel failures occurred in January. Regular I&E fuel element rupture trends are relatively unchanged from the previous three months - except for an increase of 110 MWD/T in the average exposure at failure and a lower incidence of internal (hole) failures.

More than twenty-one thousand projection fuel elements were processed; yields were quite satisfactory. Most of the fuel made in January was of the OIIE model which is scheduled for irradiation in the D and H reactors. Under routine irradiation in the D reactor at month end were 182 tubes of natural uranium I&E bumper fuel and 53 tubes of enriched uranium counterparts. Current irradiation exposure of approximately 315 tubes of projection fuels under production test conditions was marred by two failures of bumper elements in January. Both failures were caused by gross corrosion unrelated to the bumper feature.

The feasibility of economically producing AlSi bonded, oversize fuels of high quality has been further confirmed. Of the 858 pieces canned the finished yield was 70% to rail welding. Based on this experience, yields of 80 to 85% could reasonably be expected on a production basis. Detailed testing analysis showed these fuels to be superior in quality to regular I&E production. Process innovations contributing to this quality were: Contour base cans and sleeves, lead plugging of cores prior to preheat, cap-spire pulsing and pressurized quench.

Collapsible bridge rail supports were attached to seven premeasured charges of oversize I&E fuel elements. These were shipped to C reactor for initial test loadings. Three columns were charged into

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overbored graphite channels and ribless Zircaloy tubes. Preliminary data indicated the fuel design approaches the theoretical optimum in flow and heat balance and that tube powers of 1200 KW will be achieved. Maximum specific tube power will be about 72 KW/ft. The three columns are scheduled for exposures of 200, 400, and 800 MWD/T.

Surface quality testing equipment is now operational in all UT-2 core testers.

A test to detect surface defects in canned fuel elements was put into operation in the ALSI fuel element plant and is performing satisfactorily.

Erratic performance of the ultrasonic weld monitor has been traced to changes in the operating voltage characteristic of intermittent welder operation. This information is being used to make timely corrections in order to improve weld quality.

Installation of the cap-spire pulse was completed on all production canning lines.

The conversion of production welders to direct current has been started with work on one machine-line 50% complete. Tests have shown that direct current welding is superior to alternating current in the reduction of braze voids and weld cracking.

NPF Fuel Elements

All of the test elements in the KER loops operated satisfactorily during January. Four 1.6% enriched K single tube fuel elements were discharged at 1200 MWD/T. Preliminary examinations in the viewing pits showed one to have a possible cladding split near the weld. Early examinations in Radiometallurgy are scheduled.

Loop 4 was recharged with 24", natural uranium N-inner tube fuel elements. Except for enrichment, these elements are completely prototypical of the N-inner tube and will operate at conditions of power, heat flux, and uranium temperatures almost identical to those calculated for the 0.947 enriched design in N-Reactor. Other test fuels being fabricated include: Nine K natural-uranium single tubes; twenty enriched uranium NPR inner tubes; thirty enriched-uranium NPR inner tubes. Back-up elements are currently available for all KER loops. The completion of the additional fuels being made will provide a full range of models to simulate the operation of NPR fuels.

The following extrusions were made during January: 20 composites to produce I&E fuel elements and N-inner tubes; 6 Zircaloy billet extrusions to produce the associated cladding and caps; 9 uranium billet extrusions to produce N outer tubes, I&E cores and special cores for HLO; one copper billet.

Approximately 200 K reactor sized I&E Zircaloy-2 depleted fuel elements were extruded on a trial basis and are now being brazed. Three enriched and three natural uranium extrusions were also completed to produce 200 fuel elements for out of reactor testing. Rough exterior surfaces have recently been encountered on extruded fuel tubes. This problem developed with the change to purer enriched metal, indicating that the impurity level of the billets has a significant effect on the quality of subsequent extrusions. Ten enriched billets are expected in February and the fuel elements extruded from these will be available for reactor charging.

Tests were carried out to determine whether beta heat treating of as-received enriched and depleted uranium billets would improve the surface and interface characteristics of extruded material. The results, although not complete, indicate significant improvements may be possible. Work on this technique will continue. Ultrasonic testing prior to extrusion was proved successful in the selection of billets which will not extrude properly. This technique is being further developed.

Warp problems have been encountered in the N-inner tube geometry. Tests have shown that warp can be reduced to acceptable limits by double reverse bending in the plane of deformation followed by a second beta heat treatment.

Approximately 75 NPR inner tube natural and enriched and 20 NPR outer tube natural pieces were Zr-Be brazed. A new post-braze cooling technique was developed to lessen the occurrence of shrinkage cavities which earlier had occasionally developed under the brazed caps. Process improvements are being investigated to better assure securing a black oxide film on the braze area of the end caps. Special polishing after etching and/or changes in etchant-cleaning solutions are being evaluated.

A number of zirconium-clad uranium specimens were autoclaved at BMI at 10,000 psi, 600°C for six hours to test solid state diffusion bonding. Results obtained were good and other tests using different temperatures and exposures are scheduled.

Autoradiographic methods were investigated as supplemental methods for the testing of zirconium clad and bond integrity. Preliminary results are encouraging.

GENERAL

Manufacturing yield for eight-inch I&E was 79.0 per cent compared to 84.2 per cent for the previous month.

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Two autoclave failures occurred during January.

The January operating efficiency was 91.5 per cent compared to 94.3 per cent for December.

Both design and construction work on the new fuels facility is on schedule.

PERSONNEL STATISTICS

Number of employees: December 31, 1960 842
Number of employees: January 31, 1961 847

	<u>Exempt</u>	<u>Nonexempt</u>	<u>Total</u>
General	1	1	2
Manufacturing	79	355	434
Engineering	35	27	62
Financial	12	6	18
Plant Facilities	42	280	322
Relations Practices	5	4	9
 TOTAL	 174	 673	 847

STAFF

General Manager, Fuels Preparation Department	R. L. Dickeman
Acting Manager, Manufacturing Operation	H. E. Berg
Manager, Engineering Operation	L. H. McEwen
Manager, Financial Operation	W. S. Roe
Manager, Plant Facilities Operation	E. Hilgeman
Manager, Relations Practices Operation	R. W. McCullugh
Special Studies Assignment	J. W. Talbott

Mr. W. M. Mathis transferred to the Irradiation Processing Department as Manager of the N-Reactor Operation, effective January 1, 1961.

Mr. H. E. Berg continued as Acting Manager, Manufacturing Operation.

PATENT SUMMARY - JANUARY 1961

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 January 1961. Such persons further advise that for the period therein covered by this report, notebook records, if any, in the course of their work have been examined for possible inventions or discoveries.

RL Dickeman

General Manager
Fuels Preparation Department

RL Dickeman:mkm

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MANUFACTURING OPERATION

January, 1961

CURRENT OPERATIONSProduction and ProductivityStatistics

	NORMAL					ENRICHED				Total
	8"	C	K	O		C	K	O		
	Solid			Reg.	Bumper			Reg.	Bumper	
<u>Current Month's Production</u>										
Acceptable Fuel Elements Produced (Tons)	0	63.9	165.9	175.8	31.2	14.2	56.0	49.1	29.5	588.6
As % of Forecast Production	-	94	102	84	89	79	127	76	118	93
Sum. % of Forecast for Current Qtr.	-	94	102	84	89	79	127	76	118	93
As % of Past 3 Month's Average Production	-	139	74	75	164	113	144	123	227	96
As % of Past 12 Month's Average Production	-	128	78	74	624	109	156	189	983	93
% of Forecast Achieved Last Fiscal Quarter	-	86	107	107	49	64	98	36	136	98
% of Forecast Achieved Last 4 Fiscal Quarters	-	104	104	105	49	88	98	76	136	101

Operating Efficiency

Current Month (%)	91.5
Forecast (%)	93.0
Previous Month (%)	94.3

Manufacturing Yield

Current Month (%)	-	78	78	81	-	77	81	77	-	
Forecast (%)	-	87	87	87	78	87	87	87	78	
Previous Month (%)	-	88	84	83	-	-	83	-	-	
Bare Uranium Available for Processing (Tons)	-	185	455	583		50	58	154	-	1485
Finished Products in Storage (Tons)	23	124	173	270	54	18	50	53	60	825
Special Products Finished (Pieces) Boll										2164
Uranium Utilization										97.8

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ACTIVITIESProduction

Finished production for January was 588.6 tons or 93 per cent of forecast. The production losses were due primarily to low yields on all product models. Retesting of approximately 54 tons of canned material was necessary to assure that cracked cores were not supplied to the reactors. A new tester was installed early in the month to permit the retesting of canned material for core cracks.

A total of 2,164 four-inch I & E Li-Al (Boll) elements were fabricated during January. This is a three-fold increase over the amount processed during the previous month. An increased capacity was achieved when the core machining process was converted to live-center, outer-dimension machining. This process has essentially eliminated the core eccentricity problem which has plagued the operation during the past few months.

Four product models were processed on the projection ultrasonic welder this month. Self-support rails were welded on 13 tons of CIVN fuel elements for use in the ribless zirconium tubes in C reactor, and 33 tons of OIIN and 29 tons of OIIE enriched fuel elements were produced. A 68 per cent welding yield was experienced on the CIVN material, due to processing with a weakened soap solution, causing unacceptable welds. Welding yields were 91 per cent for 8-inch bumpers and 83 per cent for 6-inch enriched bumpers. Oversize CIVN fuel elements, which were produced in the Pilot Plant in December, were also processed on the manual projection welder this month. A total of 68 of these pieces had support rails attached.

Canning operations continued through the month at ten canning line shifts per day on a two-shift basis. A total of 220 canning line shifts were operated during the month.

Yield Control

The manufacturing yield for 8-inch I & E fuel elements of 79.0 per cent for January reflects a significant decrease from the yield of 84.2 per cent attained during December. Braze layer contamination, marred surface and surface appearance reject rates were high. An increase in the braze layer contamination rate was due to an excursion in weld impurities early in the month and are attributed to assembly problems on the OIIN and OIIE models. The marred surface rate reflects the backlogging of material as a result of the autoclave incident together with the retesting of 20,000 canned pieces for "cracked" cores. Surface defects pertain primarily to the material returned from the reactor areas due to stains and autoclave "chatter" marks. Connected with this incident was a general "tightening-up" of visual inspection standards and an overly critical attitude which developed. By month end the impact of these various problems has been brought into proper perspective and a yield improvement is expected.

The January manufacturing yield for 6-inch I & E enriched fuel elements was 78.8 per cent compared to 80.6 per cent for December. Considerable assembly difficulty has been experienced with the enriched I & E models. The 6-inch canning process has been adapted from the 8-inch process, but

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heating and void removal conditions appear to be different from those for the 8-inch models, with resultant increases in the assembly, braze layer integrity and thin wall rates. A particular problem has been an increase in internal wrinkles, resulting in a 3.5 per cent rate for internal thin wall rejects as compared to a 1.2 per cent rate for December. Further, control of the 6-inch canning process is considerably more restrictive resulting in a wider yield variation from day-to-day and month-to-month. A study to define the temperature and cycle requirements for 6-inch material is being planned.

Two autoclave failures occurred during January. Water entry to the core in each case was through pinholes, one being the cap end closure and the other in the base wall.

Construction Projects

CAF-847 - New Fuel Cladding Facility

	<u>Scheduled</u>	<u>Actual</u>
Design	98	98
Construction	32	32

Purchase orders have been placed for the billet heating and beta heat treating equipment with delivery promised in May. Requisitions were issued for billet lubrication and extrusion handling equipment. The purchase order for braze vacuum equipment is being processed with delivery promised in April and May. One leak detector (part of billet assembly equipment) is apparently defective and may have to be returned to the factory.

Design has been completed on the recovery facility and tank farm tie-ins.

CAF-897 - Increased Compressed Air Capacity, 300 Area

	<u>Scheduled</u>	<u>Actual</u>
Design	100	100
Construction	-	15

The building foundations and outside underground work are complete. No further activity is expected until vendor information on the compressor is approved for construction and procurement.

CAF-903 - Projection Fuel Element Modification, 313 Building, Phase I

	<u>Scheduled</u>	<u>Actual</u>
Design	78	78
Construction	"	"

Design criteria have been approved by the AEC. A work authority has been issued to J. A. Jones for movement of the etch machines and procurement of long delivery items of electrical equipment.

CAF-915 - Additional Storage Space, 303 Area

	<u>Scheduled</u>	<u>Actual</u>
Design	--	15

Design criteria have been officially transmitted to the Architect Engineer.

Other Activities

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

8" Solid	30
8" I & E	31,520
6" Enriched	11,856
Total	43,406

PLANT CONDITIONS, INCIDENTS, AND IMPROVEMENTS

General

The operating efficiency in the AlSi Shop was 91.5 per cent during January, 1.5 per cent below forecast. Equipment failures were responsible for 66 per cent of the total time loss and operational outages caused the remaining 34 per cent. The cap and can machine, jacks and agitators and bare core testers were responsible for the major portion of the equipment time losses.

Finished inventories at the end of January were reduced to 825 tons, an over-all 1.2 month supply. A substantial amount of this material is not immediately available for use because bumper elements are being pre-produced for the E-N load and several material lots are being held for quality analysis prior to release.

The month end bare uranium inventory of 1,480 tons is on hand, a 2.4 month supply.

One shipment of scrap was made containing 20,755 pounds of normal uranium, 4,639 pounds of enriched uranium, and 7,816 pounds of G-6.

In the past three months, there have been several instances in which uranium cores exhibiting severe surface cracking have been found at pickle inspection. This cracking has been associated with an iron content of up to 630 ppm, which is several times that allowed in the specifications. Upon investigation, it was found that on at least three separate occasions, the uranium vendor had inadvertently fabricated cores from ingots which should have been rejected for their high iron content.

The first core cracking was detected at HAP0 in October on a KIIIN recovered core. The two virgin lots known to contain other cores from the ingot involved had been processed earlier and were being irradiated at the time the

first cracked piece was found. Each of these lots sustained a rupture, a hole failure in each case. Both of these pieces are scheduled for examination to determine the cause of failure.

Additional cracked cores were found in OIIIN and KIIIE material in November and December. Because of the difficulty in seeing this defect on virgin cores, a decision was made to utilize a modified surface crack tester and test all canned fuel elements suspected of containing this defect, which involved about 10,000 enriched uranium and 6,000 natural uranium fuel elements.

Spire pulsers were installed stepwise on all canning lines during the period of November 30, 1960 to January 4, 1961. Production data was collected for the period of November 30, 1960 to January 6, 1961 to compare the quality effects of the spire pulse preheating technique with the former spire preheating technique on a production basis. The results of the data that has been analyzed shows the spire pulse preheating technique has affected production during this period as follows:

1. A reduction in assembly rejects by a factor of 1.3.
2. A reduction in bond layer contamination rejects by a factor of 1.3.
3. A reduction of internal bond rejects by a factor of 1.7.
4. No significant effect on internal thin wall rejects.

This production test was not designed to evaluate wetting of the spire and cap wafer or braze porosity. A previous production test showed a significant reduction in cap wafer nonwetting, cap wafer braze porosity, and cap braze line porosity. Periodic observation of the cap and spire wetting indicated that good wetting was being obtained during the period of November 30, 1960 to January 6, 1961.

It has been discovered that certain noise interference affects the external bond test and makes the total count of the internal bond test unusable. The noise has been traced to the high frequency oscillations of the arc welders. The function of the oscillator on each welder is to provide a high frequency, high voltage to start the arc from the electrode to the work. These oscillators have a nominal natural frequency of one megacycle, however, they cause interference of nearly equal amplitude from 1/2 to 220 mc. The problem is currently under investigation.

A coil failure on 1D furnace during the month resulted in the freezing of metal in the channels before the metal could be completely removed from the furnace. After the coil was replaced the power was turned on and the furnace came back into operation satisfactorily.

Six depleted uranium billets were coextruded to produce stock for I & E fabrication training. Due to improper uranium structure, the coextruded tubes have wrinkles in the outer clad. The material can

probably be used for training purposes. From this, and similar recent experiences with the fabrication of uranium cores, it is possible that the material currently in process for the enriched I & E program will not yield acceptable fuel material.

Two separate development efforts are required. The first must deal directly with the uranium fabrication process proposed for NPR fuels to determine the causes of this problem. The second must evaluate the possibilities of altering the final fabrication process for I & E billets currently in production.

Both of these programs are under way. Arrangements are being made to evaluate the use of larger ingot castings (14 inch diameter) and the use of small alloy additions to the enriched metal. This work is to be done by NLO.

Locally, tests have been initiated to: (1) determine the efforts, if any, of extrusion speed and extrusion temperature on the structure of the uranium billet and, (2) to determine the effect of an additional heat treatment of the final billet shape before coextrusion. The latter test is aimed at "reclaiming" billet material already in process.

306 Pilot Plant

Six development tests in the 306 Pilot Plant were conducted during January in addition to projection fuel element welding activities. A new model KVN was produced (500 pieces) for subsequent self-support attachments and charging in one of the K reactors. Pressure quench techniques, an evaluation of nickel plated components, determination of the effects of vacuum outgassing of dingot uranium after heat treating and development of the process for assembly of CWIN fuel elements were among the Pilot Plant activities.

305 Test Reactor

Routine production testing remained on a current status in the 305 Test Reactor during January. Several days downtime caused by staffing changes did not affect the testing schedule.

OPERATING PLANS

Production Forecast

The regular five-year production forecast was completed during January, which showed significant reductions in reactor requirements as compared with previous reviews. For FY 1962, an over-all nine per cent reduction in requirements were shown. These reductions have necessitated a cut back in scheduled uranium receipts beginning February, 1961.

Based upon scheduled fuel element requirements, the AlSi Shop will be able to remain on a ten canning lines per day basis throughout the five year period. The Coextrusion Shop is scheduled to begin its production

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activities during the third quarter FY 1961, producing some zircalloy clad I & E fuel elements for irradiation testing prior to fabrication of NPR fuels. NPR fuel production will begin during the first quarter FY 1962.

Also, significant in the current forecast is the accelerated schedule for bumper fuel element production. All reactors are scheduled to be converted for use of this improved fuel element model during the coming 21-month period. Use of regular I & E fuel elements in the fringe zones of the reactors limits the use of bumpers to approximately 80 per cent of the total requirements. FPD pre-production of enriched fuel elements for use in the E-N demonstration load in May is also scheduled.

SS Accountability

During the past several months, an increasing number of uranium lots processed through the production lines have had imbalances in the piece count. The major problem concerns the large amount of segregation required. In addition, much material is temporarily removed from the production stream for purposes of examination, special testing or special processing. That we are maintaining excellent over-all control is evident in that during the last six months period month-end inventories have balanced within two (2) pieces.

It has been proposed an accountability system be adopted which balances beginning inventories, receipts, shipments and ending inventories. The proposal is presently under consideration.

NPR Planning

Staffing continues to be a major concern in the Coextrusion Shop. A nucleus of key exempt personnel has been assigned, and plans reflect the assignment of the necessary exempt personnel by May, 1961. Contractual obligations centering around the ratio agreement and transfer procedures complicate our planning for assignment of nonexempt personnel. Early in March definite staffing plans are expected to be completed.

EMPLOYEE RELATIONS

Safety Performance

Members of the Manufacturing Operation were treated for 30 medical treatment injuries during January, a frequency rate of 4.02.

Radiation Control

There were no badge readings above 300 mrad this month. However, for the four week period ending December 30, 1960, Manufacturing personnel received a combined total of 6,823 mrad of radiation exposure.

Security Violations

A security violation involving an open file occurred on December 20, 1960 that was not reported in the December report.

Training

Craft and Maintenance Engineering personnel received some valuable training while witnessing the assembly and debugging of leak detector equipment to be used in the NPR fuel production facility. The actual assembly and tests were made by a representative of Carl Herrmann & Associates, Palo Alto, California.

Twelve - two-hour class sessions were held by Maintenance Engineering for instrument technicians on the various parts of the UI-2 testers.

Reports of Invention

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 January.

HE Berg

Acting Manager - Manufacturing

HE Berg:HFT:gl

STATISTICS

1960 - 61

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ENGINEERING OPERATION

January, 1961

VISITORS

<u>Name</u>	<u>Company</u>	<u>Contact</u>	<u>Date</u>	<u>Reason</u>
JW Dickinson	Linde Co.	GR Hanson	1/10 & 1/11/61	Discuss welding torches.
Kunio Ono	Atash Ltd. Japan	DC Worlton	1/30/61	Discuss nondestructive testing.
JK Mohondro	Hallidie Machinery Co.	JL Guthrie	1/12/61	Equipment consultation.

TRIPS

CH Allen	Stoker Engrg.	R Jamyson	1/4 & 1/5/61	Discuss quality control problems on production of bumper supports & inspect vendor's production facility.
	Western Gear	---	1/25/61	Discuss production welders.
TB Correy	Sciaky Bros.	WJ Farrell	1/16/61	Discussed electron beam welding of nickel plated aluminum clad fuel elements, development of current welding power supply that delivers a constant pre-set current, and development of spike welding.
	Canadian G.E., Ltd.	PD Schofield	1/17 & 1/18	Discussed development of spike welding of Zr-2.
	G.E., Johnson City, N.Y.	AE Sweet	1/19/61	Discuss high vacuum. Attend High Vacuum Forum.
	G.E., Schenectady	RL Maul	1/20/61	Discuss development of pulsed wave welder.
		RW Clark	1/20/61	Discuss development of spike welding.
AE Guay	Ajax Magnethermic	NV Ross	1/9 - 1/13/61	Final lab tests on induction heat treating of NPR fuels.

Trips (Continued)

<u>Name</u>	<u>Company</u>	<u>Contact</u>	<u>Date</u>	<u>Reason</u>
SM Gill	National Lead	J Schiltz	1/16	Conf. on U billet fabrication & specifications.
GW Riedeman	of Ohio			
	Allegheny Ludlum	R Paul	1/17	Technical liaison - N reactor fuels component procurement.
	Bridgeport Brass	DR Jefferson	1/18	Technical liaison - uranium extrusion.
	Reactive Metals	RA Quadt	1/19	Technical conference, Zr-2 creep recovery.
SJ Ostrom	Union Machine Works	B Renke	1/11	Collaborate on equipment being build for us.
	Bektal	---	1/23	Inspect nondestructive testing tanks for N reactor fuel in vendor's plant.
JT Stringer	Hotpoint	Mr. Fraley	1/14 -	Interview candidates.
	NLO	FL Cuthbert	1/22	FEDC Working Committee Meeting.
	DuPont, SRP	TC Evans		Discuss U problems at feed sites.
	MCW	JA Fellows		
EA Weakley	NLO	CE Polson	1/18 -	Discuss uranium technology.
	MCW	JA Fellows	1/24	

PERSONNEL

<u>Name</u>	<u>Title</u>	<u>Nature of Change</u>	<u>Date</u>
CJ Fitch, Jr.	Engr., Proc. & Dev.	Transfer to HLO	1/1/61
FH Sherwood	Engr., Proc. & Dev.	Transfer to C&AO	1/1/61

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 January, 1961, except as listed below. Such persons further advise that for the period therein covered by this report, notebook records, if any, in the course of their work have been examined for possible inventions or discoveries.

NONE

ALSI PRODUCT ENGINEERING

Fuel Performance and Requirements

Nine natural uranium and two enriched I & E fuel element ruptures occurred in the reactors during January. A summary of these ruptures is as follows:

<u>Fuel Element Type</u>	<u>Reactor</u>	<u>Exposure (MWD/T)</u>	<u>Rupture Classification</u>	<u>Canning Date</u>	<u>Cladding Alloy</u>
I & E Natural	D	475	Side Hot Spot	10/31/60	X-8001
*	D	957	Side Other	7/5/60	X-8001
*	D	966	Side Other	7/5/60	X-8001
	F	614	Unknown	8/30/60	X-8001
**	H	648	Unclassified	9/29/60	X-8001
***	H	682	Side Other	11/2/60	C-64
	H	757	Internal	9/28/60	C-64
	KE	607	Unknown	9/23/60	X-8001
	KW	621	Internal	10/26/60	X-8001
I & E Enriched	DR	775	Side Other	9/15/60	X-8001
	KW	841	Side Hot Spot	8/17/60	X-8001

* Solid three-rail bumper fuel.

** Clad in new vendor (H) components.

*** Six-inch natural water mixer.

Regular I & E fuel element rupture trends are relatively unchanged from the previous period, except for an increase of about 110 MWD/T in average exposure at failure and a lower incidence of internal (hole) failures.

The first two ruptures (side-other) of solid three-rail bumper natural I & E fuels were experienced in D Reactor. These pieces were being irradiated in a six-column temperature and corrosion monitoring test to high goal exposure at high power factors in low corrosion index process tubes and with decreased water-flow through the process tubes. Three of the columns were provided with water mixers. Based on visual examination, the downstream pieces in the columns without water mixers operated at abnormal top-of-annulus temperatures, causing accelerated uniform corrosion and penetration of the ruptured fuel jackets. Both ruptures are scheduled for examination in Radiometallurgy. In addition, the irradiation conditions under which the columns operated are being analyzed.

A second natural I & E rupture (unclassified) occurred in H Reactor involving fuel clad in new vendor (H) aluminum components undergoing production transition testing. Visually this rupture appears to be a typical longitudinal split core

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failure; however, the average specific power was in the order of 45 KW/ft., and the relative thermal stress in the core was approximately one-third of the stress value (100,000 psi) at which a high incidence of solid fuel ruptures was experienced. The rupture is scheduled for thorough examination in Radiometallurgy to determine cause of failure.

Radiometallurgical examination of an I & E natural internal rupture sustained in tube 4585-KW during October shows the failure was caused by a small hole in the base weld connected to an underlying channel of voids in the braze layer. Examination of an additional natural I & E internal rupture sustained in tube 1471-KE during November is in progress. This rupture was from production lot KR-279-D, suspected of containing cores with a high iron content (approximately 550 ppm). Although the point of coolant entry has not been located, the core has quench cracks in the surface typical of cores with a high iron content and shows up to 50 mils ellipticity in OD at center point. There is no evidence that the quench cracks observed on the surface contributed to failure.

Post-irradiation data on 13 columns of thin (20-mil) collapsible four-rail bumper I & E fuel elements and 14 columns of control elements, recently exposed to about 1160 MWD/T in D Reactor, shows no significant difference in dimensional stability and a lower incidence of hot spots and/or hot areas for the bumper columns. Dimensional instability resulting from an observed average and maximum warp of 13.4 mils and 62 mils, respectively, and ellipticity up to 69 mils contributed to a high incidence of hot spots. The bumper elements in five columns were nearly five fold more effective than the controls, which sustained 34.4% hot spots and/or hot areas. Effectiveness of the bumper columns was presumably influenced by the low compression strength and susceptibility of the rails to damage. Average weight losses for the bumper fuel, which were about twice that for the control pieces (6.1 grams), are attributed to uniform, rather than normal, localized corrosion.

Breaking test data from C Basin confirms previous data indicating that the transverse breaking strength of OIIN I & E fuel elements irradiated in high flux regions of the reactors decreases with exposure. Minimum breaking strength was 2.5 tons for pieces exposed to 1210 MWD/T at a specific power of 65 KW/ft., as compared to 19 tons for an upstream piece exposed to 162 MWD/T at 56 KW/ft. These data compare favorably with that previously obtained for solid fuels, which were cracked during discharge or had essentially no breaking strength after exposure to 800 MWD/T at 40-45 KW/ft.

Component drawings were completed and material procurement was initiated as required for the assembly of unbonded solid enriched lithium-aluminum alloy elements (2.130-inch OD and 8.850-inch length) for N Reactor control rods.

Uranium Technology

Approximately 205 tons of dingot uranium (including 82 tons of cores vacuum outgassed prior to beta heat treating) are currently being irradiated and 246

tons (including 51 tons of vacuum-outgassed uranium) had been discharged by mid-January. There were no dingot uranium failures during January; three failures have occurred to date in un-outgassed dingot uranium. Post-irradiation data on five tubes of normal dingot cores and 13 tubes of normal ingot cores have been made under the Quality Certification program with the following results:

	<u>Dingot</u>	<u>Ingot</u>
Average Warp	8.5 mils	10 mils
Maximum Warp	31 mils	46 mils
Average Tube-Filling Capacity	18.2 mils	21.3 mils
Maximum Tube-Filling Capacity	50 mils	61 mils

About 22 and 40 tons of regular virgin and vacuum-outgassed virgin OIIIN dingot cores were canned this month. This is the first dingot uranium to be canned as OIIIN fuel elements. The bond test reject rate for OIIIN dingot cores was only 0.9% as compared to the reject rate in December for OIIN dingot cores of 6.6%. The reject rate for normal ingot cores was also lower in January than in December: 1.1% for OIIIN cores in January and 4.6% for OIIN cores in December. This sudden decrease in bond test reject rates is attributable primarily to changing the bond testers from 20 to 25 megacycles in January. The 25-megacycle testers can detect brittle bonds and non-wet areas better than the 20-megacycle testers, but are presently less sensitive to small scattered braze porosity. Total bond count data of the normal ingot and dingot cores canned in December and January show a slight decrease in porosity level in January which may be due to the small difference in braze thickness.

A small-scale test (about 1000 cores) comparing dingot cores vacuum outgassed after beta heat treating with cores vacuum outgassed before beta heat treating and regular dingot cores revealed that vacuum outgassing cores after beta heat treating reduces braze porosity. There were no apparent differences in grain structure. The material outgassed after heat treating was outgassed in final core form at two different conditions: (1) cores were outgassed to produce only a low surface H_2 (less than 0.4), and (2) cores were outgassed to produce a low total H_2 content of less than 1.0 ppm. Since both of these outgassing methods appeared favorable, 20,000 dingot cores with a low surface H_2 and 20,000 dingot cores with a low total H_2 content have been ordered for large-scale evaluation.

The OD surface test circuit was installed and used on all UT-2 testers starting January 2. The reject limits and standards are currently being established. Reject rates for the OD surface test for normal ingot, enriched ingot, and normal dingot virgin cores were 2.3, 2.4, and 1.2%, respectively.

Fifteen (15) quench-cracked cores (due to high iron contamination) were found when the canned enriched lots suspected of containing quench-cracked cores were examined by a modified OD surface tester. One quench-cracked core was also found at pickle inspection this month in a normal recovered uranium lot. Testing Methods is currently developing equipment for testing a canned bumpered normal uranium lot which is suspected of containing quench-cracked cores.

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All normal ingot cores except for OIIN and KIIIN models which are being phased out) and all normal dingot cores were tested for large grains at a setting of 0.3 minimum voltage and 11.4% of the ingot and 16.2% of the dingot cores were rejected. However, over one-half of the ingot cores rejected were due to false rejects from spurious signals. The large-grained and false reject ingot cores were segregated into lots and retested at a setting of 0.1 minimum voltage. At this lower setting, approximately 0.5% of the virgin normal ingot cores are rejected. The cores passing the UT-2 at this lower setting are lot charged as large-grain lots. The large-grained normal ingot and dingot cores will continue to be lot charged until test data has been taken and analyzed on the effect of grain size and grain variation on core characteristics during irradiation and a large-grain reject limit established.

A test quantity (1741 pieces) of CVIN ingot cores for PIP-1 have been received. These overbored size cores were fabricated from rolled ingot uranium, solid core blanked, beta heat treated, and machined by NLO. Samples are currently being evaluated in the Metallurgical Laboratory.

Process Development

The feasibility of producing AlSi-bonded oversize I & E fuel economically and of high quality in support of the proposed Plant Improvement Program has been further confirmed through the testing of the oversize fuel assembled during December. Of the 858 pieces canned, the finished yield was 70% or about 600 acceptable pieces for rail welding. Based on this experience, yields in the order of 80-85% can be reasonably expected on a production scale.

Quality of the finished oversize fuel elements proved superior to regular I & E production, and is primarily attributed to process revisions and innovations used to improve the uniformity and strength of the AlSi braze. Total bond count data indicated internal and external braze porosity was reduced by a factor of at least four; UT-4 test data indicated a comparable reduction in braze closure voids; and average bond strength was 16,000 psi as compared to 14,000 psi for regular production fuel. Process innovations contributing to improved quality of oversized fuel were contour base cans and sleeves, lead plugging of the cores prior to preheat in duplex bath, cap-spire pulsing, and pressurized quench.

Collapsible bridge rail supports (69 mils high and 40 mils thick) were attached to seven pre-measured charges of oversize I & E fuel elements and shipped to C Reactor for the initial test loadings. Three columns were charged in overbored graphite channels and ribless zircaloy tubes on January 21. Preliminary data indicate the fuel design approaches the theoretical optimum from the standpoint of flow and heat balance, and tube powers of 1200-KW will be achieved. Maximum specific power will be about 72 KW/ft. The three columns are scheduled to be exposed to 200, 400, and 800 MWD/T, respectively.

Investigation of the integrity of nickel-plated fuel elements established fairly conclusively that the deep pitting corrosion of the aluminum observed at discontinuities in the nickel on irradiated fuel elements occurred in the examination basin water after the fuel elements were discharged from the reactor. It had been expected that galvanic corrosion might take place in the examination basin water since a variety of dissolved materials are present, including aluminum de-oxidizing compounds. Metallographic examination of an irradiated and a non-irradiated fuel element which were exposed to examination basin water for about the same length of time revealed 20-30 mil deep pits in both, and the contours of the pits were very similar. In addition, results of reactor process water flow tube tests at 120 and 165 C revealed no evidence of accelerated aluminum corrosion at discontinuities in the nickel; in fact, the aluminum corrosion rates were generally less than would be expected for unplated aluminum.

Exploratory corrosion testing of nickel-plated aluminum in high-temperature water continued to yield encouraging results. Seven out of ten nickel-plated C-64 alloy aluminum cans survived 300 hours exposure to 360 C, pH 10 water in a re-freshed autoclave. All had visible discontinuities in the nickel plate at the beginning of the test. The three failures were evident after 184 hours, with a one to three inch length of the can reduced to oxide, including the entire base end. Corrosion failures appear to be related to plate thickness, and possibly to plate adhesion. These results are particularly significant since the plate was run-of-the-mill product of four commercial vendors, and had no special treatment or quality testing. These autoclave tests will be continued, and flow tube tests in high-temperature, high-pH water are planned.

A test of canning fuel elements in nickel-plated aluminum components was carried out, aimed at defining a process cycle optimized for AlSi-uranium bonding and improved cap wetting. The canning operation demonstrated that assembly can be carried out under a wide variety of conditions; quality testing results are not available at present. Further exploration of closure-welding produced some satisfactory sections of weld bead, but reproducibility has not been established.

Process Technology

Installation of the cap-spire pulsers was completed on all production canning lines January 5. Test data indicate the spire-pulsers have significantly reduced assembly and braze layer contamination rejects and internal braze porosity.

Temporary nuclear specifications were issued for the autoclaving of AlSi-bonded enriched uranium-aluminum alloy elements scheduled for corrosion and crud film tests in 1706-KE single-pass tube.

Drawings for the production model pressurized quench machine are 90% complete. An adjustable basket has been designed to accommodate all size fuel elements. Design is complete and components have been ordered to modify the prototype machine to perform step quenching - that is, partial submerge to within one-half inch of the top of the sleeve until solidifications of the AlSi is assured, followed by complete immersion.

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Changes in tooling and setup for machining E-N material have increased throughput to nearly double that required to meet the present pile-charging schedule, operating on a one-shift basis. Large amounts of material are still being rejected, however, because of voids and striae present in the feed material.

The prototype female-end stamping head, designed for use in the serial stampers to stamp FPD data on the female end of the fuel element, has been tested and proven satisfactory. The main feature of this head is its provision for remotely indexing (by the lathe operator) one of the digits to provide canning line identification. No further action can be taken toward procurement of the stamping machines until IPD decides what information is to be stamped on the male end of the fuel element.

During the month, 5022 CIVN self-supported fuel elements were welded on the automatic ultrasonic welder. The yield through the weld inspection station was 81.7%. During the month, 9717 OIIN bumper fuel elements were processed through the automatic ultrasonic welder. The yield was 91.5%. Major reject category was rail misalignment.

The majority of the production on the ultrasonic welder has been OIIE bumper fuel elements. Twenty-one thousand, three hundred sixty-eight (21,368) elements were welded with a yield of 81.9%. The major reject category has been gage rejects due to misalignment of rails and extreme rail deformation on the welds near the ends of the element. The cause of the extreme deformation is welding near a flexure node of vibration of the element core. The problem has been solved by changing the boundary conditions of the element, thus the location of the nodes at the end of the element. The rubber isolation pads in the welder chucks were replaced with steel pads. Even with this method of support, there are certain locations on the fuel element where it is not advisable to weld.

Offsite procurement of bumper design rails is to begin by mid-February. The rails are presently being fabricated by the Technical Shops.

A test to determine the allowable time delay between fuel element etch and ultrasonic rail welding has been completed. The present limit is four days. This limit can be extended to ten days without a significant reduction in weld strength.

The following special products have been produced on the manual ultrasonic welder:

1. Seven charges of CVIN self-supported elements.
2. CVIN self-supported thermocouple probes.
3. CVIN self-supported downstream dummy patterns.
4. Flow charge of KVN self-supported elements.
5. Flow charge of KIVN bumper elements.

Direct current is superior to alternating current for welding AlSi-bonded fuel elements in that the direct-current process eliminates more braze voids and results in less weld cracking. As a result, all of the AC welding power supplies are scheduled to be replaced with DC power supplies. The detail drawings for the DC conversion are about 90% complete, and parts for the conversion are being ordered. The conversion of the machines has been started with the work on one machine - line one about 50% complete.

306 AlSi Pilot Plant Activities

Approximately 5775 uranium cores were dip-brazed in the pilot plant for process development purposes. Two thousand nine hundred (2900) of the fuel elements are for reactor use. The major items of development were:

1. Aluminum component cleaning and wettability tests in molten AlSi for component vendor evaluation.
2. Cycling thermocouple cores and components to determine heating rates of several fuel element models.
3. Fabrication of KVN model fuel elements for attachment of supports for IPD reactor testing.
4. Evaluation of pressure quench technique and automatic machine.
5. Evaluate effect of vacuum outgassing after beta heat treatment on finished fuel element porosity.
6. Optimization of six-inch I & E enriched fuel fabrication cycle.
7. Canning of elements in nickel-plated components.
8. Fabrication of fuel elements with special braze conditions for weld studies.

COEXTRUDED PRODUCT ENGINEERING

N-Reactor Fuel Development

KER Testing

All of the test fuel elements in the KER loops operated satisfactorily the past month. Four 1.6% enriched K single tube fuel elements were discharged from Loop 4 for examination January 14 at an exposure of 1200 MWD/T. Preliminary examination of the fuel elements in the viewing pit indicates no gross imperfections. Markings on the cap end of one of the fuel elements indicates a possibility of a crack at the weld bead, however, definite confirmation cannot be made until further examination in the Radio Metallurgy facilities this coming month.

Loop 4 was recharged with four 24-inch natural uranium inner tube fuel elements. These elements are prototypal and operating conditions in the test loop are similar to those expected in the N-reactor with 0.947 enrichment.

Fuel elements in process from which additional test charges will be made include - nine K single tube natural uranium, twenty NPR inner tube natural uranium, and thirty NPR inner tube enriched uranium.

Coextruded K I&E² Program

Approximately 200 I&E zircaloy-2 clad depleted uranium fuel elements are in process and are presently at the brazing operation. This practice material will all be scrapped because it is depleted uranium. The surface roughness on these pieces exceeds quality control standards. Six additional extrusions (3 enriched and 3 natural uranium) which will produce approximately 200 fuel elements have been completed and are being processed. The acceptable material will be used for hydraulic flow tests. The next shipment of ten enriched billets is expected the first week of February and fuel elements from these extrusions will be available for reactor charging. Other aspects of the coextruded enriched I&E program are discussed herein together with process discussions on the N fuel.

Materials Development and Procurement

Uranium Billets

NLO has improved their machining capability to the point that almost all of the backlog orders have been cleared. Currently four shipments of billets are enroute to HAP0. It appears that deliveries of enriched I&E billets will be on schedule by sometime early in March.

Recent coextrusion results have shown a problem in OD surface smoothness. It appears that variations, perhaps small, in the triple beta heat treating process for the cast ingots may have a rather pronounced effect upon billet structure. There is work under way to resolve this problem, and basically three avenues of approach are being evaluated. First, of course, is variations in the heat treating technique itself. Second is additional study on the effects of colder mechanical working to produce the structures needed for coextrusion. The last area of evaluation is that of impurity content in the metal, since it appears that this problem developed simultaneously with a switch from natural to purer enriched metal. Billets are already in the stream containing significantly larger quantities of briquette and scrap in the makeup charges which will tend to result in higher impurity concentrations and may do some grain refining.

Zircaloy-2 Cladding Shells - Vendor Development

Bridgeport Brass Company has just started work on their contract and has not fabricated any parts yet. Their work is approximately 30 days behind schedule. Redetermination of their contract is now planned about March 1.

Harvey Aluminum Company has ingot cast and is canning for extrusion. Drawing technology for the large tubes is being developed on another contract, consequently these will not be drawn until the technology is known. The smaller tubes offer little problem and will be produced first. The overall program is delayed approximately 30 days bringing redetermination to about March 1.

Allegheny Ludlum Steel Corporation has produced tubes for N outer, both clads. So far, no acceptable pieces have passed their internal inspection for submission to our inspector, but some material should be delivered on these items during February.

Harvey Aluminums' order for 100 feet of 7-1/2 inch nominal OD zircaloy-2 tubing has been temporarily delayed because of draw tooling failure. An initial draw was attempted during which the draw bench stalled. New tools are scheduled for completion February 1 and drawing will proceed shortly thereafter. If all goes well, this order should be delivered during February.

Copper Cans

A series of tests have been conducted on cleaning copper in preparation for welding. The tests indicate that the process being used is not satisfactory. About 70% of the copper will clean successfully with the present method. (1 min, 45% HNO₃, 25°C). The main difficulty is transfer time from the nitric etchant to the water rinse. The copper must be transferred immediately to the rinse, which requires handling each piece individually. Transferring the copper components with a hoist is not rapid enough. The difficulty is apparently due to the surface temperature of the copper as it emerges from

the bath. This surface temperature, due to the heat of reaction of the copper dissolution promotes air oxidation immediately. Reducing the nitric acid concentration reduces the oxidation problem but is not sufficient.

Two copper brightening solutions have been tested and they work very satisfactorily. The two solutions, Zinctone, Brass Dip, are propriety compounds from Turco Products. The brightening solutions produce bright oxide-free copper consistently. The surface remains oxide free for several hours. One sample welded satisfactorily after sitting for 16 hours exposed to the atmosphere. Further information such as solution life and cost (\$3/gal) has been requested from the vendor.

A series of tests have been conducted using Everdur (97% Cu - 3% Si) as a material for billet canning rather than pure copper. This material looks very promising for the coextrusion process. The advantages are:

1. Easily cleaned and welded. Everdur can be cleaned with nitric acid consistently. The component can be welded with 1/2 the current. This is desirable since only one-half the heat is applied to the billet during welding. This will minimize the amount of oxidation of uranium core and zircaloy clad during assembly.
2. Minimize the problems of copper removal from the fuel tubes. Two tubes have been stripped to date. On pure copper clad tubes there is a visual copper film on the zircaloy cladding. With Everdur the cladding is stripped clean with no visual evidence of a copper film.

A series of tests have been conducted on the dissolution of Everdur in nitric acid (45% by weight). The tests indicate that this solution works very well. The solution life is reduced slightly by the presence of silica in the solution, present as a colloid, which gradually builds up to an appreciable amount when the copper reaches about 5% by weight. However, even with a high silica content in the solution the Everdur dissolves rapidly. The only objection to a high silica content is the difficulty of draining the solution from the tank as it would be thick. Reducing the maximum copper content to 5% by weight would remove this difficulty.

It has been demonstrated that high quality welds can be produced on the regular copper cans using the heliarc process and argon shielding gas rather than helium. The training of all personnel for production welding of copper jacket components is being done with argon.

Billet Preheating

Although current plans are to preheat billets in a pit type furnace for the coextrusion process, the use of induction looks attractive and some development tests are being performed.

During the month, four different tests were carried out using the same billet but using different cycling on the power to determine the best means of heating the billet. For run #1, the power was on until the surface temperature (Cu) reached 1400°F, which took 18 seconds. At this temperature the power was cycled on and off in such a manner as to bring the uranium, zircaloy and copper up to 1100°-1200°F, which was reached in 12 minutes. The pulsing was done manually. The second run was handled somewhat like the first but instead of pulsing manually, the pulsing was done with a Flex-o-pulse timer. The surface temperature of 1200°F was obtained before pulsing was started. Again the pulsing was done in such a manner to bring the uranium, zirconium, and copper to 1000°-1050°F, which took 12 minutes. On both runs, the outer Zr remained 75° to 100°F higher. For run #3, the power was on until the surface temperature reached 650°F, which took 8 seconds. The power was then pulsed in such a manner as to bring the uranium, zirconium and copper to 1125°-1150°F, which took 24 minutes. The outer Zr remained 100°F higher.

The power on these three runs was 560 KW using the 130 volt taps on the secondary of the transformer.

For run #4, the power was on until the surface temperature reached 300°F, in 10 seconds. The secondary voltage was reduced from 130 volts to 63 volts which reduced power to 120 KW. After the surface temperature reached 300°F, the pulsing of power was started. Operating with a reduced voltage on the coil and starting at a low temperature to pulse made the operation much easier to control. However, this operation increased the time to 22 minutes to bring the uranium, zirconium and copper to 1125°-1200°F.

It was also necessary to establish a standard location for a thermocouple to heat regular billets by.

On the four runs, a thermocouple was placed in the billet core with the sensing end of the thermocouple against the inner Cu. This temperature reading followed the uranium and zircaloy temperatures within 20°F. With this thermocouple location and an established cycling period, it is probable that a satisfactory heating process could be set up for billet heating. The next step is to extrude induction heated billets.

Coextrusion

The following extrusions were made during the month:

1. 6.0 Inch Tooling

20 Composites - T-98 through T-117

T-98, 99, 104, 109 & 110	NIT Normal
T-105 & 106	NIT .94 Enriched
T-100, 101, 102, 103, 107 & 108	I&E Depleted
T-111, 112, & 114	I&E .94 Enriched
T-113, 115, 116 & 117	I&E Normal

6 Zircaloy Billets - Zr-38 through Zr-43

Zr-38, 41 & 42	I&E Inner Clad
Zr-39	I&E End Caps
Zr-40	NIT Inner Clad
Zr-43	NIT Shroud Tube

3 Copper Billets

2. 11.1 Inch Tooling

9 Uranium Billets - U-30 through U-38

U-30, 31, 32 & 33	NOT Cores
U-34, 35, 36 & 37	I&E Cores
U-38	4-in. x 1-in. Core for HLO

1 Copper Billet

Extreme surface and interface roughness was encountered on ten coextrusions (3 NIT and 7 I&E) made during the month.

The roughness on all of the above extrusions was caused by uranium billet core history. Die or mandrel pickup did not occur on any of these extrusions, and zircaloy components have proven satisfactory on other coextrusions. The billet integrity test indicated in each case that unusual grain size and variation existed as compared to billets which produced high quality coextrusions.

On the suspicion that 11-inch castings were not adequately beta treated prior to extrusion and using the billet tester to measure as-received billet quality, a series of tests have been made on both normal and enriched material by single and triple beta heat treating the as-received billet cores. The grounds for the above tests go back to original NIT coextrusions where the same condition existed and was improved considerably by heat treating of as-received billets.

The results, in general, of the above tests, although incomplete, are as follows:

1. The billet core tester has predicated on a 100% basis the billet cores which would produce rough surfaces.
2. Single beta heat treating of as-received cores that are rejected by the tester will reduce OD surface roughness to a point which will permit use of clad thickness and bond tester. The interface roughness, however, is increased, but clad variation still meets required specifications.
3. Triple beta heat treating does not produce any better outside surface finish and could produce greater interface roughness.

4. In one case, triple beta treating of an "A" billet from the primary extrusion did not improve the OD surface at the rear of the coextrusion which would be the front most part of the primary extrusion. This part of the primary extrusion receives very little work and this is probably the reason for the overall lower quality of all "A" billets which have been received in the past two months.

Copper Removal

The copper removal problem has been characterized by residual copper being carried over to the zircaloy-2 strip etch and not being removed completely during the stripping process. This resulted in preferential attack at the copper contaminated areas and pitting of the zircaloy-2 clad. Process techniques applied to overcome this problem were:

1. Immediate transfer of fuel elements from the copper removal bath to the zircaloy-2 strip. The freshly exposed clad surfaces resulted in rapid removal of the copper-zirconium layer. Temperature is also a factor since the copper stripping solution is maintained at about 60-70°C.
2. Point contact baskets are used for the first 30 seconds of the zircaloy-2 strip. Elements are then transferred to roller baskets for the remainder of the etch period.

Preliminary tests have been run on stripping Everdur and it appears to be removed more completely than the regular copper.

Chemical Milling

The past month efforts have been concentrated upon improving the surface smoothness of the end recess. The smoothness is dependent upon the chemical composition of the uranium metal and the composition of the etchant.

The pitting that occurs appears to be due to metal impurities in the uranium. Certain impurities, e.g. Fe, Ni, Cr, are dissolved more rapidly than the uranium. Small vacancies appear where the impurities were and these vacancies become larger. The pits grow to a depth of about 5 mils in some cases. Uranium metal with about 50 ppm Fe, 20 ppm Ni and 20 ppm Cr does not pit. This pitting effect is minimized when the sulfate concentrate is increased to about 4800 #/M gal. Increasing the sulfate anion concentration however suppresses the depolarizing action of the copper. Therefore, the copper level must be increased from 160 #/M gal. to somewhere around 260 #/M gal. Very smooth surfaces can be obtained but this introduces a small increase in the contour variation. It is possible that some sacrifice must be made between smoothness and contour variation.

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End Closure DevelopmentZr-Be Brazing

Approximately 75 inner natural and enriched and 20 outer natural pieces were closed. A new cooling technique has been developed which seems to eliminate the shrinkage cavities which were giving trouble before. This technique consists of retracting the coil so as to keep the braze metal molten on the surface until after it has solidified below the cap. This provides a pool of molten metal to feed into the cap-clad service. Initial brazing trials with the first I&E pieces indicated that it would not be practical to use the N inner braze rings as had been planned. Our outstanding orders with NMI for braze rings were modified to provide a different size for the I&E pieces. The first material sized expressly for I&E should be here February 1.

A Brown regulating control device was installed in the field of the braze induction heating unit. This regulator releases the need of one man to operate the equipment manually.

The temperature recording instrument used with the radiation pyrometer has two pens and only one in use. Another range (slide wire) was provided for the second pen and calibrated to the range on the first pen. This second range provides the signal to drive the magnetic amp (regulator) according to the temperature on the radiation pyrometer.

Brazed Closure TIG Welding

Continued work on the problem of braze segregation zones indicates that they are present in both the inner and outer welds. There appears to be a relationship between the width of the braze and the formation of these zones. Tests partially completed indicate that as the braze widens these disappear. Outer braze widths greater than 0.016 inch and inner braze widths greater than 0.026 inch show very few such regions.

Solid State Diffusion Bonding

Specimens autoclaved by BMI at 10,000 PSI, 600°C, and 6 hours at temperature have been received and the following checks performed:

1. Visual inspection for pressurization,
 - a. one piece leaked,
 - b. all pieces had a slight circumferential cladding indent at the interface between the cap and the uranium.

- [REDACTED]
2. Metallographic examination of the bond lines between the cladding and caps indicated approximately 70% of the joint was bonded. The unbonded areas were of varying short lengths.
 3. Caps on the ends of the 14 pieces autoclaved showed no evidence of unbonded areas with ultrasonic testing.
 4. One cap was removed from an N inner tube with a cold chisel and hammer without removing the cladding. It was found that there was a very strong uniform bond between the uranium and the cap. After 12 days exposure of the fractured surface to the air, the uranium showed only slight areas of discoloration indicating that it was protected with a film of zircaloy-2, or non oxidizing compound layer.
 5. The outer and inner cladding were removed to below the cap of an N inner tube. A Zygo test failed to show any discontinuity between the cap and uranium. An attempt was made to remove the cap with a hammer and cold chisel. The cap was deformed but no evidence of fracture was found between the uranium and zircaloy-2 cap.

Half of the second set which is to be autoclaved at 10,000 PSI, 640°C and one hour at temperature, has been prepared. It is anticipated that the others will be prepared by 2/10/61.

At the Vacuum Technology Conference at General Electric Co., Johnson City, New York, it was learned that General Electric is using cathodic etching at the Ithaca, New York plant as a production process. The technique they use was obtained and should produce better bonding as the localized action is not severe, producing less surface pitting.

Beta Heat Treating

Warp Studies

During the past month, the heat treating program was redirected to evaluate the effect of the tube cooling method after coextrusion on heat treated warp. Tubes 98N* and 99N were cooled in a V-trough while tubes 104N, 105E and 106E were cooled by rolling for 15 minutes on the run-out table.

On the basis of previous data from KER inner tube stock, one would predict that the V-trough cooled material would exhibit the more warp after beta heat treating and the rolled tubes would have less warp.

Although an alpha anneal prior to beta heat treating would have served as measure of difference in residual stress, the fuel lengths from these tubes were not annealed prior to heat treating because of the needs of other parts of the program. A summary of finished materials is shown in Table 1.

* N=natural uranium; E=0.947 enriched.

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TABLE 1
WARP IN BETA HEAT TREATING

<u>Tube No.</u>	<u>Cooling Method</u>	<u>No. of Lengths Processed</u>	<u>Length of Fuels</u>	<u>No. Having Acceptable Warp*</u>
98N	V-trough	11	24-in.	5
99N	"	10	"	3
104N	Rolling	7	"	5**
106E	"	18	18-in.	18

* The goal for warp is not more than 30 mils double throw.

** The two rejects exceeded specification by only 0.5 and 1.5 mils.

The yield from tubes 98 and 99 is the poorest yet encountered. This yield prompted further work in methods of recovering warped lengths. Previously, it was shown that warp could be reduced by reverse bending followed by a second beta heat treating. Although that work reduced the magnitude of the warp in every piece, there was not a large recovery of fuel lengths.

To improve the yield from straightening, the amount of reverse bending in the same plane was increased from 1X (i.e. + 18 mils to -18 mils bow) to 2X (i.e. + 18 mils to -36 mils bow). Again after a second beta heat treatment, warp was reduced in every piece and 10 out of 12 pieces met specification. This yield is promising and indicates the need for more work on this method of recovery.

Study has indicated that a careful vector analysis of warp in a process of beta heat treating, reverse bending and re-beta heat treating must show minimum angular dispersion of the warp vector (i.e. force:distance) of the second heat treatment if the process is to be practical in production. It became apparent that the wall thickness variation might provide a variable stress whose strain could not be predicted if other variable stresses were present. To examine this point, three lengths of fuel were given additional heat treatments after the beta:reverse bend:re-beta. One piece given three more beta heat treatments and two pieces given two more beta heat treatments did not incur further warp. From these data one concludes:

1. The primary driving force of warp is that of preferred orientation. Thus, the largest change in warp will occur during a first beta heat treatment,
2. Wall thickness variation is a lesser driving force than preferred orientation.

At this time, one cannot conclude if the cooling method is an important variable. All other things being equal, the starting warp represents a condition (magnitude, position) from which a warp vector is added during beta heat treating. If the vector cannot be minimized, the initial condition is important. If the vector can be minimized, the initial condition is not as important.

Salt Bath Heat Treating

Previous criteria for beta heat treating incorporated the use of a T-bar to support the fuel. It was shown that the chloride salt froze in the bore of the N inner tube geometry and uniform heating was possibly not achieved. To improve both the handling and the uniformity of heating, a top support was developed by brazing a loop of zircaloy wire to one end cap closure at the time it is brazed. This wire allows the piece to hang vertically and has eliminated the concern that warp could result from buckling of the fuel on the T-bar.

Monitoring of the drag out losses of both chloride and nitrate salts has been started. This work is aimed at determining:

1. the dependence of quench rate in the nitrate salt as a function of chloride contamination,
2. the dependence of cooling rate in the water bath as a function of brine concentration,
3. the economics of the drag outs.

Induction Heat Treating

The last phase of the existing contract with Ajax Magnethermic Corp. was completed during the week of January 9, 1961. The only outstanding data yet to be received are the calculations on coil designs.

Ten N inner tubes were induction heated and air-blast quenched. In the initial set-up, uniformity of temperature was indicated by both thermocouples (6 per piece) and a radiometer (Minneapolis Honeywell Miniature). Visually, the pieces showed a cold spot over a distance from 1/2 to 3-in. at the bottom of the fuels but neither technique substantiated the observation. However, a radiometer (solar cell) built by the Optical Shop, HLO, showed the cold spot.

In work at HAP0, the Optical Shop have completed a radiation-ratio pyrometer (essentially a 2-color pyrometer) and this has been calibrated against the solar-cell radiometer and thermocouples using a static technique on the scanner. Tests are scheduled for further calibration during scanning tests.

Etching and Autoclaving

There has been a serious problem in the pilot plant operations with respect to the formation of white oxide on brazed weld beads after autoclaving ever since the braze operation was started. The problem has been a hit or miss proposition but has affected the major quantity of material processed in the pilot plant.

A series of tests are under way, or planned, to investigate and establish cause factors for white weld oxide.

1. Uranium Contamination

Uranium analyses are being performed on weld bead surfaces showing white oxide to determine the presence of uranium.

Special test pieces are being fabricated in which the braze base will be zircaloy-2 instead of uranium. These will be brazed, welded, etched and autoclaved with uranium base companion pieces.

2. Etch Bath Contamination

Four N inner elements which had corroded white were reprocessed through vapor blast and etch and were autoclaved. Two elements were etched in uranium and copper contaminated etchant and two other elements were etched in freshly prepared etchant. This test was designed to determine if these contaminants contributed to white weld oxide formation. In all four elements, one end of each had good black films. Varying amounts of white oxide were present on the other ends. Since one of the I&E elements had failed during autoclaving, it is believed that the ends which had been in contact with the uranium sludge had been contaminated during the autoclave cycle.

A series of Be-Zr braze rings were etched and autoclaved using various etchants. In all cases where etching was the final step prior to autoclaving, varying degrees of white oxide were present.

One piece of solid Be-Zr braze material was prepared by running weld beads on the surface. The weld bead was black as contrasted to the whiter background of braze material.

3. Mechanical Polishing Prior to Autoclave

A test now in the autoclave is designed to determine if a black weld bead can be obtained by eliminating the etch as the last treatment of the weld bead prior to autoclave. Test elements were etched, followed by polishing of the weld bead with fine emery cloth.

Side Support Welding

The tool design for resistance welding supports on the NPR inner and outer tubes has been completed, and fabrication on the tooling will be started January 30.

The tools for each fuel element size will have a steel ring mounted in the block to be used as a gage to expand each support against before spot welding. The tooling is designed in such a manner that each support can be spot welded on one end, the fuel element moved back 7/8 inch, the support expanded against the ring and then the other end of the support can be spot welded. The fuel element can be indexed in the ring, moved forward and the second support spot welded in place. Same operation is repeated for the third support.

Canadian General Electric Company has developed a method of resistance welding known as "spike" welding which may have application for support welding. It is accomplished by generating a very narrow, high peaked current pulse at the midpoint of each alternating current half cycle and using a low electrode force. The time-amplitude relationship is such that the heat is generated virtually at the surfaces to be joined and no metal is melted or indent formed by the electrodes. The weld has the appearance of a diffusion bond with grain refinement. A contract is being negotiated with Canadian General Electric for the test welding of supports on KER single tube to see if side supports and locking devices can be attached without alteration of the structure of the uranium. In welding 0.065 inch zircaloy-2 to 0.065 inch zircaloy-2, the heat affected zone extends approximately 0.010 inch from the interface of the two pieces.

TESTING METHODS

Process Fuel Element Inspection

Bare Core Station

Surface quality inspection equipment is now operational in all UT-2 testers. Equipment performance during the past month's operation has been good, although some problems remain in fully integrating this test into the production line. As optimum performance is rather critically dependent upon ultrasonic beam alignment, special techniques need to be developed to insure equivalent test results between testers. This problem should be helped considerably by improved test head fixtures which are scheduled for installation within the next two weeks.

New Methods Development

Detection of Core Defects in Canned Fuel Elements

A test hastily developed and put into operation in the 313 Building for the purpose of detecting surface defects in canned fuel elements has given good results. This test utilizes a 2 MC ultrasonic beam, carefully aimed to penetrate the core through the aluminum jacket. Operating two shifts per day for approximately ten days, the test inspected some 20,000 fuel elements. Destructive examination of the rejects revealed fifteen cores whose surface were cracked with the "mud-flat" pattern characteristic of high iron cores.

UT-4 Project

Approximately 500 overbore pieces were tested in the prototype UT-4 equipment. Results indicated that these elements contained significantly less cap-can braze porosity than is normally encountered in process fuel elements. Evidence of porosity adjacent to the end of the core, however, was comparable with process fuel.

Special emphasis is being given the design of simple, reliable, mechanical systems for the production line UT-4 equipment. Shop drawings are nearing completion. Work is also rapidly progressing on the electronic designs. Shop work on one unit, being built for the 306 Pilot plant under an Appropriation Request, will begin during the month. Work on the five units scheduled for 313 Building will be delayed pending approval of a project proposal.

Ultrasonic Weld Monitor

The considerable data gathered to evaluate the ultrasonic welder monitor continues to look favorable. A recent incident which at first appeared

to be an exception was traced to an intermittent fault in two channels of the automatic welder. In this case the 15 KC oscillator voltage dropped from a normal sixty volts to four volts. Although the quality of welds produced at the lower operating level was better than might be expected, the harmonic content of the output voltage became immeasurable. It thus appears that the technique may be useful for quickly revealing abnormal operating conditions that may not be readily apparent from an examination of the finished weld.

Further evaluating data will be obtained with a four channel instrument now nearing shop completion.

N Reactor Fuel Testing

Billet Testing

Ultrasonic inspection of uranium billets prior to extrusion has been particularly successful in selecting those billets which do not extrude properly. This test is based upon the experimental observation that as-received billets which have high ultrasonic attenuation, and hence are of large grain structure, produce fuel elements whose surfaces are unacceptably rough. Positive correlation came with a billet which had only a few inches of large grain material near the end of the billet. Fuel elements corresponding to this region were unacceptable because of surface roughness, while the rest of the extrusion was indeed satisfactory.

More recent studies in which beta heat treated billets produce good extrusions suggest, however, that the ultrasonic test may be influenced to a degree by grain orientation. Studies are under way to explore this possibility.

Cladding Tests

Autoradiograph techniques are being investigated as a supplemental method of assuring the integrity of fuel cladding. Films exposed for approximately six hours clearly show two mil variations in a nominal twenty-five mil wall. An artificial defect 0.015 inches in diameter drilled about half-way through the cladding is much more clearly resolved by this test than it is by the present eddy-current test.

Another test in which a fuel tube was set on and directly on an X-ray film clearly showed braze porosity at the weld closure. This test appears attractive in that it provides a convenient method of inspecting the zirconium closure ring as well as the braze layer.

Zirconium Orientation

Efforts are being made to develop methods of detecting regions of preferred crystal orientation in pre-extruded zirconium components. One approach of promise uses a "Libby" coil to look for variations in electrical

conductivity around the circumference of the piece. Samples tested so far show definite variations at roughly ninety degree intervals along the circumference. Plans are to correlate these data with warp measurements.

Lamb Wave Testing

A method of converting frequency to amplitude for use in the Lamb wave thickness test has promise for a limited range of thickness. In most applications a small range at high sensitivity is needed rather than a large range, low sensitivity test. To reduce interference from other modes operation is restricted to the lowest mode, giving less sensitivity. A range of less than one megacycle would be sufficient for the tubing test. In order to get the required accuracy, instead of using frequency analyzer techniques a frequency to amplitude conversion method was tried. The amplitude limited signal is amplified on the skirt of an amplifier frequency response curve. Over a range of 300 KC the system gave good results but obtaining a larger range is being investigated. If this method proves satisfactory it will be used in the tubing test. Use of a contour corrected lens over the transducers in the thickness test resulted in about 5 db signal increase per transducer. This would result in averaging the thickness over about 1/4 inch instead of about 1/16 inch without the lens.

Comparison of response of Lamb wave mode reflection from defects in flat plate with reflections in tubing show a very similar response. It appears that the large variations in signal amplitude obtained from rotation of the tubing is an interference phenomena caused by the many angles of incidence to the curve wall. In flat plates such interference can be obtained by adjusting the crystal angle or defect orientation.

ENGINEERING GENERAL

Power Asymmetry Measurements

A column of metal, which had neutron flux perturbation caused by two control rods, was selected for power asymmetry studies. The metal exposure time was typical, and highest fuel element powers in the column were about 60 KW/ft. The control rods were directly above this column during about 90% of the exposure time. One control rod was at the upstream position and one was at the midstream position of the column. Neutron flux gradients, caused by these rods, were most severe in the vicinity of piece numbers 17, 18, 24, and 25. These fuel elements were carefully measured for power differences at diametrically opposite points along a number of axial positions. The maximum measured power asymmetry for pieces 17 and 18 was about $3\% \pm 3\%$. The higher readings were obtained in the neighborhood of the rib marks and the lower diametrically opposite. Based on front to rear weasel data, piece number 24 appeared to have been exposed to the greatest flux gradient therefore, was expected to have greater power asymmetry. The maximum measured power difference for this piece was $7.5\% \pm 3\%$. Here again this difference occurred at points near and opposite to, the rib marks with the higher reading near the ribs. Piece number 25 had a hot spot near the male end at a circumferential position almost opposite to the rib marks leading to the assumption that this area was cocked toward the control rod. Front to rear

weasel data showed less axial neutron flux gradient than piece number 24. However, the radial gradient could have been more severe since this hot spot area would have been nearer to the control rod if cocking did occur. Measurements at this hot spot and diametrically opposite showed $12\% \pm 3\%$. Again the higher readings were on the rib side which was opposite the hot spot area. Less detailed measurements were made on most of the remaining pieces in the column and no more than 5% asymmetry was detected. A few other "hot spots" were also examined and little asymmetry was observed.

Before firm conclusions are made more information is needed. Following a quality certification analysis on this column, the fuel elements which show the greatest warp, jacket corrosion, ellipticity, etc. will be carefully examined for power asymmetries. Power asymmetries associated with predicted rib heights for this column will also be established. More hot spots will be examined. Asymmetry caused by poison splines will also be measured. More columns which are effected with flux perturbations will also be examined. An attempt will be made to evaluate the probable damage to the fuel elements caused by these measured asymmetries.

Plant Improvement Program

Fuels Preparation Department Plant Improvement Program, HW-68140, was completed and distributed.

Manager, Engineering

LH McEwen:dl

FINANCIAL OPERATION

JANUARY, 1961

Meetings between representatives of the Manufacturing and Financial Sections were continued for the purpose of establishing accounting procedures for the Coextrusion Shop operations. Segregation of the process steps into logical cost centers which will provide the bases for cost accumulation, reporting, interpreting and measuring performance is now underway.

Information regarding Fuels Preparation Department's On-site-Off-site Fixed and Variable Cost to HAPO was updated January 5, 1961. Plans are to revise this information every six months unless analyses by the Department or receipt of more current off-site data necessitate interim revision. (Reference document - HW65811 - Rev. 2).

Cost studies were made regarding conversion and unit cost of new fuel models, including normal and enriched projection and overbore elements. In addition, cost information was updated for NPR Startup and the fuel cost for the initial N-Reactor Load. N-Reactor fuel cost estimates were revised as a result of design changes in the fuel element.

Preparations are currently underway for establishment of a spare parts inventory and cost standards for process material and operating labor for the manufacture of N-Reactor fuel elements.

Cost data were prepared for presentation at the meeting with AEC Washington officials. Included were charts comparing production and unit cost performance at HAPO with Savannah River, along with cost estimates covering FPD's conversion cost for both the old and new fuel element models.

The weekly work order cost-to-date report was revised to include additional information which will assist operating foremen in more clearly defining the cost status of work orders.

The weekly Overrun Report, summarizing all work order overruns by foreman, has been completely mechanized. Mechanization of this report has resulted in clerical savings of approximately nine hours per week in C&AO. The new report will be issued during the first week in February.

Reconciliation of January's quarterly physical inventory of precious metals indicated no discrepancies between quantities held by Department custodians and reconciled book balances.

Recommendations were made that physical inventories of rare and precious metals be taken semi-annually rather than quarterly, as currently required by HAPO OPG 8.14. Since the AEC Manual requires only semi-annual physical inventories of rare and precious metals, a considerable HAPO-wide cost savings would be effected by eliminating two of the quarterly inventories currently being taken.

Expenditure estimates for equipment for the third and fourth quarters of FY 1961 have been developed and submitted to Contract Accounting. The

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**FUELS PREPARATION
DEPARTMENT**

**MONTHLY REPORT
JANUARY
1961**

Approved by: OSTT

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FUELS PREPARATION DEPARTMENT
MONTHLY REPORT - JANUARY 1961

Compiled by Fuels Preparation Department
February 7, 1961 - Richland, Washington

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

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**FUELS PREPARATION DEPARTMENT
MONTHLY SUMMARY REPORT
JANUARY - 1961**

PRODUCTION

Finished production for January was 588.6 tons, or 93% of forecast.

At month end the bare uranium inventory was 1,480 tons compared to 1,457 tons for December. Finished inventory was 825 tons at month end compared to 920 tons for the previous month.

ENGINEERING

Present Reactor Fuel Elements

Eleven fuel failures occurred in January. Regular I&E fuel element rupture trends are relatively unchanged from the previous three months - except for an increase of 110 MWD/T in the average exposure at failure and a lower incidence of internal (hole) failures.

More than twenty-one thousand projection fuel elements were processed; yields were quite satisfactory. Most of the fuel made in January was of the OIIE model which is scheduled for irradiation in the D and H reactors. Under routine irradiation in the D reactor at month end were 182 tubes of natural uranium I&E bumper fuel and 53 tubes of enriched uranium counterparts. Current irradiation exposure of approximately 315 tubes of projection fuels under production test conditions was marred by two failures of bumper elements in January. Both failures were caused by gross corrosion unrelated to the bumper feature.

The feasibility of economically producing AlSi bonded, oversize fuels of high quality has been further confirmed. Of the 858 pieces canned the finished yield was 70% to rail welding. Based on this experience, yields of 80 to 85% could reasonably be expected on a production basis. Detailed testing analysis showed these fuels to be superior in quality to regular I&E production. Process innovations contributing to this quality were: Contour base cans and sleeves, lead plugging of cores prior to preheat, cap-spire pulsing and pressurized quench.

Collapsible bridge rail supports were attached to seven premeasured charges of oversize I&E fuel elements. These were shipped to C reactor for initial test loadings. Three columns were charged into

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overbored graphite channels and ribless Zircaloy tubes. Preliminary data indicated the fuel design approaches the theoretical optimum in flow and heat balance and that tube powers of 1200 KW will be achieved. Maximum specific tube power will be about 72 KW/ft. The three columns are scheduled for exposures of 200, 400, and 800 MWD/T.

Surface quality testing equipment is now operational in all UT-2 core testers.

A test to detect surface defects in canned fuel elements was put into operation in the ALSI fuel element plant and is performing satisfactorily.

Erratic performance of the ultrasonic weld monitor has been traced to changes in the operating voltage characteristic of intermittent welder operation. This information is being used to make timely corrections in order to improve weld quality.

Installation of the cap-spire pulse was completed on all production canning lines.

The conversion of production welders to direct current has been started with work on one machine-line 50% complete. Tests have shown that direct current welding is superior to alternating current in the reduction of braze voids and weld cracking.

NPF Fuel Elements

All of the test elements in the KER loops operated satisfactorily during January. Four 1.6% enriched K single tube fuel elements were discharged at 1200 MWD/T. Preliminary examinations in the viewing pits showed one to have a possible cladding split near the weld. Early examinations in Radiometallurgy are scheduled.

Loop 4 was recharged with 24", natural uranium N-inner tube fuel elements. Except for enrichment, these elements are completely prototypical of the N-inner tube and will operate at conditions of power, heat flux, and uranium temperatures almost identical to those calculated for the 0.947 enriched design in N-Reactor. Other test fuels being fabricated include: Nine K natural-uranium single tubes; twenty enriched uranium NPR inner tubes; thirty enriched-uranium NPR inner tubes. Back-up elements are currently available for all KER loops. The completion of the additional fuels being made will provide a full range of models to simulate the operation of NPR fuels.

The following extrusions were made during January: 20 composites to produce I&E fuel elements and N-inner tubes; 6 Zircaloy billet extrusions to produce the associated cladding and caps; 9 uranium billet extrusions to produce N outer tubes, I&E cores and special cores for HLO; one copper billet.

Approximately 200 K reactor sized I&E Zircaloy-2 depleted fuel elements were extruded on a trial basis and are now being brazed. Three enriched and three natural uranium extrusions were also completed to produce 200 fuel elements for out of reactor testing. Rough exterior surfaces have recently been encountered on extruded fuel tubes. This problem developed with the change to purer enriched metal, indicating that the impurity level of the billets has a significant effect on the quality of subsequent extrusions. Ten enriched billets are expected in February and the fuel elements extruded from these will be available for reactor charging.

Tests were carried out to determine whether beta heat treating of as-received enriched and depleted uranium billets would improve the surface and interface characteristics of extruded material. The results, although not complete, indicate significant improvements may be possible. Work on this technique will continue. Ultrasonic testing prior to extrusion was proved successful in the selection of billets which will not extrude properly. This technique is being further developed.

Warp problems have been encountered in the N-inner tube geometry. Tests have shown that warp can be reduced to acceptable limits by double reverse bending in the plane of deformation followed by a second beta heat treatment.

Approximately 75 NPR inner tube natural and enriched and 20 NPR outer tube natural pieces were Zr-Be brazed. A new post-braze cooling technique was developed to lessen the occurrence of shrinkage cavities which earlier had occasionally developed under the brazed caps. Process improvements are being investigated to better assure securing a black oxide film on the braze area of the end caps. Special polishing after etching and/or changes in etchant-cleaning solutions are being evaluated.

A number of zirconium-clad uranium specimens were autoclaved at BMI at 10,000 psi, 600°C for six hours to test solid state diffusion bonding. Results obtained were good and other tests using different temperatures and exposures are scheduled.

Autoradiographic methods were investigated as supplemental methods for the testing of zirconium clad and bond integrity. Preliminary results are encouraging.

GENERAL

Manufacturing yield for eight-inch I&E was 79.0 per cent compared to 84.2 per cent for the previous month.

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Two autoclave failures occurred during January.

The January operating efficiency was 91.5 per cent compared to 94.3 per cent for December.

Both design and construction work on the new fuels facility is on schedule.

PERSONNEL STATISTICS

Number of employees: December 31, 1960 842
Number of employees: January 31, 1961 847

	<u>Exempt</u>	<u>Nonexempt</u>	<u>Total</u>
General	1	1	2
Manufacturing	79	355	434
Engineering	35	27	62
Financial	12	6	18
Plant Facilities	42	280	322
Relations Practices	5	4	9
 TOTAL	 174	 673	 847

STAFF

General Manager, Fuels Preparation Department	R. L. Dickeman
Acting Manager, Manufacturing Operation	H. E. Berg
Manager, Engineering Operation	L. H. McEwen
Manager, Financial Operation	W. S. Roe
Manager, Plant Facilities Operation	E. Hilgeman
Manager, Relations Practices Operation	R. W. McCullugh
Special Studies Assignment	J. W. Talbott

Mr. W. M. Mathis transferred to the Irradiation Processing Department as Manager of the N-Reactor Operation, effective January 1, 1961.

Mr. H. E. Berg continued as Acting Manager, Manufacturing Operation.

PATENT SUMMARY - JANUARY 1961

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 January 1961. Such persons further advise that for the period therein covered by this report, notebook records, if any, in the course of their work have been examined for possible inventions or discoveries.

RL Dickeman

General Manager
Fuels Preparation Department

RL Dickeman:mkm

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MANUFACTURING OPERATION

January, 1961

CURRENT OPERATIONSProduction and ProductivityStatistics

	NORMAL					ENRICHED				Total
	8"	C	K	O		C	K	O		
	Solid			Reg.	Bumper			Reg.	Bumper	
<u>Current Month's Production</u>										
Acceptable Fuel Elements Produced (Tons)	0	63.9	165.9	175.8	31.2	14.2	56.0	49.1	29.5	588.6
As % of Forecast Production	-	94	102	84	89	79	127	76	118	93
Sum. % of Forecast for Current Qtr.	-	94	102	84	89	79	127	76	118	93
As % of Past 3 Month's Average Production	-	139	74	75	164	113	144	123	227	96
As % of Past 12 Month's Average Production	-	128	78	74	624	109	156	189	983	93
% of Forecast Achieved Last Fiscal Quarter	-	86	107	107	49	64	98	36	136	98
% of Forecast Achieved Last 4 Fiscal Quarters	-	104	104	105	49	88	98	76	136	101

Operating Efficiency

Current Month (%)	91.5
Forecast (%)	93.0
Previous Month (%)	94.3

Manufacturing Yield

Current Month (%)	-	78	78	81	-	77	81	77	-	
Forecast (%)	-	87	87	87	78	87	87	87	78	
Previous Month (%)	-	88	84	83	-	-	83	-	-	
Bare Uranium Available for Processing (Tons)	-	185	455	583		50	58	154	-	1485
Finished Products in Storage (Tons)	23	124	173	270	54	18	50	53	60	825
Special Products Finished (Pieces) Boll										2164
Uranium Utilization										97.8

B-1

ACTIVITIESProduction

Finished production for January was 588.6 tons or 93 per cent of forecast. The production losses were due primarily to low yields on all product models. Retesting of approximately 54 tons of canned material was necessary to assure that cracked cores were not supplied to the reactors. A new tester was installed early in the month to permit the retesting of canned material for core cracks.

A total of 2,164 four-inch I & E Li-Al (Boll) elements were fabricated during January. This is a three-fold increase over the amount processed during the previous month. An increased capacity was achieved when the core machining process was converted to live-center, outer-dimension machining. This process has essentially eliminated the core eccentricity problem which has plagued the operation during the past few months.

Four product models were processed on the projection ultrasonic welder this month. Self-support rails were welded on 13 tons of CIVN fuel elements for use in the ribless zirconium tubes in C reactor, and 33 tons of OIIN and 29 tons of OIIE enriched fuel elements were produced. A 68 per cent welding yield was experienced on the CIVN material, due to processing with a weakened soap solution, causing unacceptable welds. Welding yields were 91 per cent for 8-inch bumpers and 83 per cent for 6-inch enriched bumpers. Oversize CIVN fuel elements, which were produced in the Pilot Plant in December, were also processed on the manual projection welder this month. A total of 68 of these pieces had support rails attached.

Canning operations continued through the month at ten canning line shifts per day on a two-shift basis. A total of 220 canning line shifts were operated during the month.

Yield Control

The manufacturing yield for 8-inch I & E fuel elements of 79.0 per cent for January reflects a significant decrease from the yield of 84.2 per cent attained during December. Braze layer contamination, marred surface and surface appearance reject rates were high. An increase in the braze layer contamination rate was due to an excursion in weld impurities early in the month and are attributed to assembly problems on the OIIN and OIIE models. The marred surface rate reflects the backlogging of material as a result of the autoclave incident together with the retesting of 20,000 canned pieces for "cracked" cores. Surface defects pertain primarily to the material returned from the reactor areas due to stains and autoclave "chatter" marks. Connected with this incident was a general "tightening-up" of visual inspection standards and an overly critical attitude which developed. By month end the impact of these various problems has been brought into proper perspective and a yield improvement is expected.

The January manufacturing yield for 6-inch I & E enriched fuel elements was 78.8 per cent compared to 80.6 per cent for December. Considerable assembly difficulty has been experienced with the enriched I & E models. The 6-inch canning process has been adapted from the 8-inch process, but

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heating and void removal conditions appear to be different from those for the 8-inch models, with resultant increases in the assembly, braze layer integrity and thin wall rates. A particular problem has been an increase in internal wrinkles, resulting in a 3.5 per cent rate for internal thin wall rejects as compared to a 1.2 per cent rate for December. Further, control of the 6-inch canning process is considerably more restrictive resulting in a wider yield variation from day-to-day and month-to-month. A study to define the temperature and cycle requirements for 6-inch material is being planned.

Two autoclave failures occurred during January. Water entry to the core in each case was through pinholes, one being the cap end closure and the other in the base wall.

Construction Projects

CAF-847 - New Fuel Cladding Facility

	<u>Scheduled</u>	<u>Actual</u>
Design	98	98
Construction	32	32

Purchase orders have been placed for the billet heating and beta heat treating equipment with delivery promised in May. Requisitions were issued for billet lubrication and extrusion handling equipment. The purchase order for braze vacuum equipment is being processed with delivery promised in April and May. One leak detector (part of billet assembly equipment) is apparently defective and may have to be returned to the factory.

Design has been completed on the recovery facility and tank farm tie-ins.

CAF-897 - Increased Compressed Air Capacity, 300 Area

	<u>Scheduled</u>	<u>Actual</u>
Design	100	100
Construction	-	15

The building foundations and outside underground work are complete. No further activity is expected until vendor information on the compressor is approved for construction and procurement.

CGF-903 - Projection Fuel Element Modification, 313 Building, Phase I

	<u>Scheduled</u>	<u>Actual</u>
Design	78	78
Construction	"	"

Design criteria have been approved by the AEC. A work authority has been issued to J. A. Jones for movement of the etch machines and procurement of long delivery items of electrical equipment.

CAF-915 - Additional Storage Space, 303 Area

	<u>Scheduled</u>	<u>Actual</u>
Design	--	15

Design criteria have been officially transmitted to the Architect Engineer.

Other Activities

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

8" Solid	30
8" I & E	31,520
6" Enriched	11,856
Total	43,406

PLANT CONDITIONS, INCIDENTS, AND IMPROVEMENTS

General

The operating efficiency in the ALSi Shop was 91.5 per cent during January, 1.5 per cent below forecast. Equipment failures were responsible for 66 per cent of the total time loss and operational outages caused the remaining 34 per cent. The cap and can machine, jacks and agitators and bare core testers were responsible for the major portion of the equipment time losses.

Finished inventories at the end of January were reduced to 825 tons, an over-all 1.2 month supply. A substantial amount of this material is not immediately available for use because bumper elements are being pre-produced for the E-N load and several material lots are being held for quality analysis prior to release.

The month end bare uranium inventory of 1,480 tons is on hand, a 2.4 month supply.

One shipment of scrap was made containing 20,755 pounds of normal uranium, 4,639 pounds of enriched uranium, and 7,816 pounds of G-6.

In the past three months, there have been several instances in which uranium cores exhibiting severe surface cracking have been found at pickle inspection. This cracking has been associated with an iron content of up to 630 ppm, which is several times that allowed in the specifications. Upon investigation, it was found that on at least three separate occasions, the uranium vendor had inadvertently fabricated cores from ingots which should have been rejected for their high iron content.

The first core cracking was detected at HAP0 in October on a KIIIN recovered core. The two virgin lots known to contain other cores from the ingot involved had been processed earlier and were being irradiated at the time the

first cracked piece was found. Each of these lots sustained a rupture, a hole failure in each case. Both of these pieces are scheduled for examination to determine the cause of failure.

Additional cracked cores were found in OIIIN and KIIIE material in November and December. Because of the difficulty in seeing this defect on virgin cores, a decision was made to utilize a modified surface crack tester and test all canned fuel elements suspected of containing this defect, which involved about 10,000 enriched uranium and 6,000 natural uranium fuel elements.

Spire pulsers were installed stepwise on all canning lines during the period of November 30, 1960 to January 4, 1961. Production data was collected for the period of November 30, 1960 to January 6, 1961 to compare the quality effects of the spire pulse preheating technique with the former spire preheating technique on a production basis. The results of the data that has been analyzed shows the spire pulse preheating technique has affected production during this period as follows:

1. A reduction in assembly rejects by a factor of 1.3.
2. A reduction in bond layer contamination rejects by a factor of 1.3.
3. A reduction of internal bond rejects by a factor of 1.7.
4. No significant effect on internal thin wall rejects.

This production test was not designed to evaluate wetting of the spire and cap wafer or braze porosity. A previous production test showed a significant reduction in cap wafer nonwetting, cap wafer braze porosity, and cap braze line porosity. Periodic observation of the cap and spire wetting indicated that good wetting was being obtained during the period of November 30, 1960 to January 6, 1961.

It has been discovered that certain noise interference affects the external bond test and makes the total count of the internal bond test unusable. The noise has been traced to the high frequency oscillations of the arc welders. The function of the oscillator on each welder is to provide a high frequency, high voltage to start the arc from the electrode to the work. These oscillators have a nominal natural frequency of one megacycle, however, they cause interference of nearly equal amplitude from 1/2 to 220 mc. The problem is currently under investigation.

A coil failure on 1D furnace during the month resulted in the freezing of metal in the channels before the metal could be completely removed from the furnace. After the coil was replaced the power was turned on and the furnace came back into operation satisfactorily.

Six depleted uranium billets were coextruded to produce stock for I & E fabrication training. Due to improper uranium structure, the coextruded tubes have wrinkles in the outer clad. The material can

probably be used for training purposes. From this, and similar recent experiences with the fabrication of uranium cores, it is possible that the material currently in process for the enriched I & E program will not yield acceptable fuel material.

Two separate development efforts are required. The first must deal directly with the uranium fabrication process proposed for NPR fuels to determine the causes of this problem. The second must evaluate the possibilities of altering the final fabrication process for I & E billets currently in production.

Both of these programs are under way. Arrangements are being made to evaluate the use of larger ingot castings (14 inch diameter) and the use of small alloy additions to the enriched metal. This work is to be done by NLO.

Locally, tests have been initiated to: (1) determine the efforts, if any, of extrusion speed and extrusion temperature on the structure of the uranium billet and, (2) to determine the effect of an additional heat treatment of the final billet shape before coextrusion. The latter test is aimed at "reclaiming" billet material already in process.

306 Pilot Plant

Six development tests in the 306 Pilot Plant were conducted during January in addition to projection fuel element welding activities. A new model KVN was produced (500 pieces) for subsequent self-support attachments and charging in one of the K reactors. Pressure quench techniques, an evaluation of nickel plated components, determination of the effects of vacuum outgassing of dingot uranium after heat treating and development of the process for assembly of CWIN fuel elements were among the Pilot Plant activities.

305 Test Reactor

Routine production testing remained on a current status in the 305 Test Reactor during January. Several days downtime caused by staffing changes did not affect the testing schedule.

OPERATING PLANS

Production Forecast

The regular five-year production forecast was completed during January, which showed significant reductions in reactor requirements as compared with previous reviews. For FY 1962, an over-all nine per cent reduction in requirements were shown. These reductions have necessitated a cut back in scheduled uranium receipts beginning February, 1961.

Based upon scheduled fuel element requirements, the AlSi Shop will be able to remain on a ten canning lines per day basis throughout the five year period. The Coextrusion Shop is scheduled to begin its production

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activities during the third quarter FY 1961, producing some zircalloy clad I & E fuel elements for irradiation testing prior to fabrication of NPR fuels. NPR fuel production will begin during the first quarter FY 1962.

Also, significant in the current forecast is the accelerated schedule for bumper fuel element production. All reactors are scheduled to be converted for use of this improved fuel element model during the coming 21-month period. Use of regular I & E fuel elements in the fringe zones of the reactors limits the use of bumpers to approximately 80 per cent of the total requirements. FPD pre-production of enriched fuel elements for use in the E-N demonstration load in May is also scheduled.

SS Accountability

During the past several months, an increasing number of uranium lots processed through the production lines have had imbalances in the piece count. The major problem concerns the large amount of segregation required. In addition, much material is temporarily removed from the production stream for purposes of examination, special testing or special processing. That we are maintaining excellent over-all control is evident in that during the last six months period month-end inventories have balanced within two (2) pieces.

It has been proposed an accountability system be adopted which balances beginning inventories, receipts, shipments and ending inventories. The proposal is presently under consideration.

NPR Planning

Staffing continues to be a major concern in the Coextrusion Shop. A nucleus of key exempt personnel has been assigned, and plans reflect the assignment of the necessary exempt personnel by May, 1961. Contractual obligations centering around the ratio agreement and transfer procedures complicate our planning for assignment of nonexempt personnel. Early in March definite staffing plans are expected to be completed.

EMPLOYEE RELATIONS

Safety Performance

Members of the Manufacturing Operation were treated for 30 medical treatment injuries during January, a frequency rate of 4.02.

Radiation Control

There were no badge readings above 300 mrad this month. However, for the four week period ending December 30, 1960, Manufacturing personnel received a combined total of 6,823 mrad of radiation exposure.

Security Violations

A security violation involving an open file occurred on December 20, 1960 that was not reported in the December report.

Training

Craft and Maintenance Engineering personnel received some valuable training while witnessing the assembly and debugging of leak detector equipment to be used in the NPR fuel production facility. The actual assembly and tests were made by a representative of Carl Herrmann & Associates, Palo Alto, California.

Twelve - two-hour class sessions were held by Maintenance Engineering for instrument technicians on the various parts of the UI-2 testers.

Reports of Invention

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 January.

H. E. Berg

Acting Manager - Manufacturing

HE Berg:HFT:gl

STATISTICS

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ENGINEERING OPERATION

January, 1961

VISITORS

<u>Name</u>	<u>Company</u>	<u>Contact</u>	<u>Date</u>	<u>Reason</u>
JW Dickinson	Linde Co.	GR Hanson	1/10 & 1/11/61	Discuss welding torches.
Kunio Ono	Atash Ltd. Japan	DC Worlton	1/30/61	Discuss nondestructive testing.
JK Mohondro	Hallidie Machinery Co.	JL Guthrie	1/12/61	Equipment consultation.

TRIPS

CH Allen	Stoker Engrg.	R Jamyson	1/4 & 1/5/61	Discuss quality control problems on production of bumper supports & inspect vendor's production facility.
	Western Gear	---	1/25/61	Discuss production welders.
TB Correy	Sciaky Bros.	WJ Farrell	1/16/61	Discussed electron beam welding of nickel plated aluminum clad fuel elements, development of current welding power supply that delivers a constant pre-set current, and development of spike welding.
	Canadian G.E., Ltd.	PD Schofield	1/17 & 1/18	Discussed development of spike welding of Zr-2.
	G.E., Johnson City, N.Y.	AE Sweet	1/19/61	Discuss high vacuum. Attend High Vacuum Forum.
	G.E., Schenectady	RL Maul	1/20/61	Discuss development of pulsed wave welder.
		RW Clark	1/20/61	Discuss development of spike welding.
AE Guay	Ajax Magnethermic	NV Ross	1/9 - 1/13/61	Final lab tests on induction heat treating of NPR fuels.

Trips (Continued)

<u>Name</u>	<u>Company</u>	<u>Contact</u>	<u>Date</u>	<u>Reason</u>
SM Gill	National Lead	J Schiltz	1/16	Conf. on U billet fabrication & specifications.
GW Riedeman	of Ohio			
	Allegheny Ludlum	R Paul	1/17	Technical liaison - N reactor fuels component procurement.
	Bridgeport Brass	DR Jefferson	1/18	Technical liaison - uranium extrusion.
	Reactive Metals	RA Quadt	1/19	Technical conference, Zr-2 creep recovery.
SJ Ostrom	Union Machine Works	B Renke	1/11	Collaborate on equipment being build for us.
	Bektal	---	1/23	Inspect nondestructive testing tanks for N reactor fuel in vendor's plant.
JT Stringer	Hotpoint	Mr. Fraley	1/14 -	Interview candidates.
	NLO	FL Cuthbert	1/22	FEDC Working Committee Meeting.
	DuPont, SRP	TC Evans		Discuss U problems at feed sites.
	MCW	JA Fellows		
EA Weakley	NLO	CE Polson	1/18 -	Discuss uranium technology.
	MCW	JA Fellows	1/24	

PERSONNEL

<u>Name</u>	<u>Title</u>	<u>Nature of Change</u>	<u>Date</u>
CJ Fitch, Jr.	Engr., Proc. & Dev.	Transfer to HLO	1/1/61
FH Sherwood	Engr., Proc. & Dev.	Transfer to C&AO	1/1/61

INVENTIONS

All Engineering Operation personnel engaged in work that might reasonably be expected to result in inventions or discoveries advised that to the best to their knowledge and belief no inventions or discoveries were made in the course of their work during January, 1961, except as listed below. Such persons further advise that for the period therein covered by this report, notebook records, if any, in the course of their work have been examined for possible inventions or discoveries.

NONE

ALSI PRODUCT ENGINEERING

Fuel Performance and Requirements

Nine natural uranium and two enriched I & E fuel element ruptures occurred in the reactors during January. A summary of these ruptures is as follows:

<u>Fuel Element Type</u>	<u>Reactor</u>	<u>Exposure (MWD/T)</u>	<u>Rupture Classification</u>	<u>Canning Date</u>	<u>Cladding Alloy</u>
I & E Natural	D	475	Side Hot Spot	10/31/60	X-8001
*	D	957	Side Other	7/5/60	X-8001
*	D	966	Side Other	7/5/60	X-8001
	F	614	Unknown	8/30/60	X-8001
**	H	648	Unclassified	9/29/60	X-8001
***	H	682	Side Other	11/2/60	C-64
	H	757	Internal	9/28/60	C-64
	KE	607	Unknown	9/23/60	X-8001
	KW	621	Internal	10/26/60	X-8001
I & E Enriched	DR	775	Side Other	9/15/60	X-8001
	KW	841	Side Hot Spot	8/17/60	X-8001

* Solid three-rail bumper fuel.

** Clad in new vendor (H) components.

*** Six-inch natural water mixer.

Regular I & E fuel element rupture trends are relatively unchanged from the previous period, except for an increase of about 110 MWD/T in average exposure at failure and a lower incidence of internal (hole) failures.

The first two ruptures (side-other) of solid three-rail bumper natural I & E fuels were experienced in D Reactor. These pieces were being irradiated in a six-column temperature and corrosion monitoring test to high goal exposure at high power factors in low corrosion index process tubes and with decreased water-flow through the process tubes. Three of the columns were provided with water mixers. Based on visual examination, the downstream pieces in the columns without water mixers operated at abnormal top-of-annulus temperatures, causing accelerated uniform corrosion and penetration of the ruptured fuel jackets. Both ruptures are scheduled for examination in Radiometallurgy. In addition, the irradiation conditions under which the columns operated are being analyzed.

A second natural I & E rupture (unclassified) occurred in H Reactor involving fuel clad in new vendor (H) aluminum components undergoing production transition testing. Visually this rupture appears to be a typical longitudinal split core

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failure; however, the average specific power was in the order of 45 KW/ft., and the relative thermal stress in the core was approximately one-third of the stress value (100,000 psi) at which a high incidence of solid fuel ruptures was experienced. The rupture is scheduled for thorough examination in Radiometallurgy to determine cause of failure.

Radiometallurgical examination of an I & E natural internal rupture sustained in tube 4585-KW during October shows the failure was caused by a small hole in the base weld connected to an underlying channel of voids in the braze layer. Examination of an additional natural I & E internal rupture sustained in tube 1471-KE during November is in progress. This rupture was from production lot KR-279-D, suspected of containing cores with a high iron content (approximately 550 ppm). Although the point of coolant entry has not been located, the core has quench cracks in the surface typical of cores with a high iron content and shows up to 50 mils ellipticity in OD at center point. There is no evidence that the quench cracks observed on the surface contributed to failure.

Post-irradiation data on 13 columns of thin (20-mil) collapsible four-rail bumper I & E fuel elements and 14 columns of control elements, recently exposed to about 1160 MWD/T in D Reactor, shows no significant difference in dimensional stability and a lower incidence of hot spots and/or hot areas for the bumper columns. Dimensional instability resulting from an observed average and maximum warp of 13.4 mils and 62 mils, respectively, and ellipticity up to 69 mils contributed to a high incidence of hot spots. The bumper elements in five columns were nearly five fold more effective than the controls, which sustained 34.4% hot spots and/or hot areas. Effectiveness of the bumper columns was presumably influenced by the low compression strength and susceptibility of the rails to damage. Average weight losses for the bumper fuel, which were about twice that for the control pieces (6.1 grams), are attributed to uniform, rather than normal, localized corrosion.

Breaking test data from C Basin confirms previous data indicating that the transverse breaking strength of OIIN I & E fuel elements irradiated in high flux regions of the reactors decreases with exposure. Minimum breaking strength was 2.5 tons for pieces exposed to 1210 MWD/T at a specific power of 65 KW/ft., as compared to 19 tons for an upstream piece exposed to 162 MWD/T at 56 KW/ft. These data compare favorably with that previously obtained for solid fuels, which were cracked during discharge or had essentially no breaking strength after exposure to 800 MWD/T at 40-45 KW/ft.

Component drawings were completed and material procurement was initiated as required for the assembly of unbonded solid enriched lithium-aluminum alloy elements (2.130-inch OD and 8.850-inch length) for N Reactor control rods.

Uranium Technology

Approximately 205 tons of dingot uranium (including 82 tons of cores vacuum outgassed prior to beta heat treating) are currently being irradiated and 246

tons (including 51 tons of vacuum-outgassed uranium) had been discharged by mid-January. There were no dingot uranium failures during January; three failures have occurred to date in un-outgassed dingot uranium. Post-irradiation data on five tubes of normal dingot cores and 13 tubes of normal ingot cores have been made under the Quality Certification program with the following results:

	<u>Dingot</u>	<u>Ingot</u>
Average Warp	8.5 mils	10 mils
Maximum Warp	31 mils	46 mils
Average Tube-Filling Capacity	18.2 mils	21.3 mils
Maximum Tube-Filling Capacity	50 mils	61 mils

About 22 and 40 tons of regular virgin and vacuum-outgassed virgin OIIIN dingot cores were canned this month. This is the first dingot uranium to be canned as OIIIN fuel elements. The bond test reject rate for OIIIN dingot cores was only 0.9% as compared to the reject rate in December for OIIN dingot cores of 6.6%. The reject rate for normal ingot cores was also lower in January than in December: 1.1% for OIIIN cores in January and 4.6% for OIIN cores in December. This sudden decrease in bond test reject rates is attributable primarily to changing the bond testers from 20 to 25 megacycles in January. The 25-megacycle testers can detect brittle bonds and non-wet areas better than the 20-megacycle testers, but are presently less sensitive to small scattered braze porosity. Total bond count data of the normal ingot and dingot cores canned in December and January show a slight decrease in porosity level in January which may be due to the small difference in braze thickness.

A small-scale test (about 1000 cores) comparing dingot cores vacuum outgassed after beta heat treating with cores vacuum outgassed before beta heat treating and regular dingot cores revealed that vacuum outgassing cores after beta heat treating reduces braze porosity. There were no apparent differences in grain structure. The material outgassed after heat treating was outgassed in final core form at two different conditions: (1) cores were outgassed to produce only a low surface H_2 (less than 0.4), and (2) cores were outgassed to produce a low total H_2 content of less than 1.0 ppm. Since both of these outgassing methods appeared favorable, 20,000 dingot cores with a low surface H_2 and 20,000 dingot cores with a low total H_2 content have been ordered for large-scale evaluation.

The OD surface test circuit was installed and used on all UT-2 testers starting January 2. The reject limits and standards are currently being established. Reject rates for the OD surface test for normal ingot, enriched ingot, and normal dingot virgin cores were 2.3, 2.4, and 1.2%, respectively.

Fifteen (15) quench-cracked cores (due to high iron contamination) were found when the canned enriched lots suspected of containing quench-cracked cores were examined by a modified OD surface tester. One quench-cracked core was also found at pickle inspection this month in a normal recovered uranium lot. Testing Methods is currently developing equipment for testing a canned bumpered normal uranium lot which is suspected of containing quench-cracked cores.

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All normal ingot cores except for OIIN and KIIIN models which are being phased out) and all normal dingot cores were tested for large grains at a setting of 0.3 minimum voltage and 11.4% of the ingot and 16.2% of the dingot cores were rejected. However, over one-half of the ingot cores rejected were due to false rejects from spurious signals. The large-grained and false reject ingot cores were segregated into lots and retested at a setting of 0.1 minimum voltage. At this lower setting, approximately 0.5% of the virgin normal ingot cores are rejected. The cores passing the UT-2 at this lower setting are lot charged as large-grain lots. The large-grained normal ingot and dingot cores will continue to be lot charged until test data has been taken and analyzed on the effect of grain size and grain variation on core characteristics during irradiation and a large-grain reject limit established.

A test quantity (1741 pieces) of CVIN ingot cores for PIP-1 have been received. These overbored size cores were fabricated from rolled ingot uranium, solid core blanked, beta heat treated, and machined by NLO. Samples are currently being evaluated in the Metallurgical Laboratory.

Process Development

The feasibility of producing AlSi-bonded oversize I & E fuel economically and of high quality in support of the proposed Plant Improvement Program has been further confirmed through the testing of the oversize fuel assembled during December. Of the 858 pieces canned, the finished yield was 70% or about 600 acceptable pieces for rail welding. Based on this experience, yields in the order of 80-85% can be reasonably expected on a production scale.

Quality of the finished oversize fuel elements proved superior to regular I & E production, and is primarily attributed to process revisions and innovations used to improve the uniformity and strength of the AlSi braze. Total bond count data indicated internal and external braze porosity was reduced by a factor of at least four; UT-4 test data indicated a comparable reduction in braze closure voids; and average bond strength was 16,000 psi as compared to 14,000 psi for regular production fuel. Process innovations contributing to improved quality of oversized fuel were contour base cans and sleeves, lead plugging of the cores prior to preheat in duplex bath, cap-spire pulsing, and pressurized quench.

Collapsible bridge rail supports (69 mils high and 40 mils thick) were attached to seven pre-measured charges of oversize I & E fuel elements and shipped to C Reactor for the initial test loadings. Three columns were charged in overbored graphite channels and ribless zircaloy tubes on January 21. Preliminary data indicate the fuel design approaches the theoretical optimum from the standpoint of flow and heat balance, and tube powers of 1200-KW will be achieved. Maximum specific power will be about 72 KW/ft. The three columns are scheduled to be exposed to 200, 400, and 800 MWD/T, respectively.

Investigation of the integrity of nickel-plated fuel elements established fairly conclusively that the deep pitting corrosion of the aluminum observed at discontinuities in the nickel on irradiated fuel elements occurred in the examination basin water after the fuel elements were discharged from the reactor. It had been expected that galvanic corrosion might take place in the examination basin water since a variety of dissolved materials are present, including aluminum de-oxidizing compounds. Metallographic examination of an irradiated and a non-irradiated fuel element which were exposed to examination basin water for about the same length of time revealed 20-30 mil deep pits in both, and the contours of the pits were very similar. In addition, results of reactor process water flow tube tests at 120 and 165 C revealed no evidence of accelerated aluminum corrosion at discontinuities in the nickel; in fact, the aluminum corrosion rates were generally less than would be expected for unplated aluminum.

Exploratory corrosion testing of nickel-plated aluminum in high-temperature water continued to yield encouraging results. Seven out of ten nickel-plated C-64 alloy aluminum cans survived 300 hours exposure to 360 C, pH 10 water in a re-freshed autoclave. All had visible discontinuities in the nickel plate at the beginning of the test. The three failures were evident after 184 hours, with a one to three inch length of the can reduced to oxide, including the entire base end. Corrosion failures appear to be related to plate thickness, and possibly to plate adhesion. These results are particularly significant since the plate was run-of-the-mill product of four commercial vendors, and had no special treatment or quality testing. These autoclave tests will be continued, and flow tube tests in high-temperature, high-pH water are planned.

A test of canning fuel elements in nickel-plated aluminum components was carried out, aimed at defining a process cycle optimized for AlSi-uranium bonding and improved cap wetting. The canning operation demonstrated that assembly can be carried out under a wide variety of conditions; quality testing results are not available at present. Further exploration of closure-welding produced some satisfactory sections of weld bead, but reproducibility has not been established.

Process Technology

Installation of the cap-spire pulsers was completed on all production canning lines January 5. Test data indicate the spire-pulsers have significantly reduced assembly and braze layer contamination rejects and internal braze porosity.

Temporary nuclear specifications were issued for the autoclaving of AlSi-bonded enriched uranium-aluminum alloy elements scheduled for corrosion and crud film tests in 1706-KE single-pass tube.

Drawings for the production model pressurized quench machine are 90% complete. An adjustable basket has been designed to accommodate all size fuel elements. Design is complete and components have been ordered to modify the prototype machine to perform step quenching - that is, partial submerge to within one-half inch of the top of the sleeve until solidifications of the AlSi is assured, followed by complete immersion.

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Changes in tooling and setup for machining E-N material have increased throughput to nearly double that required to meet the present pile-charging schedule, operating on a one-shift basis. Large amounts of material are still being rejected, however, because of voids and striae present in the feed material.

The prototype female-end stamping head, designed for use in the serial stampers to stamp FPD data on the female end of the fuel element, has been tested and proven satisfactory. The main feature of this head is its provision for remotely indexing (by the lathe operator) one of the digits to provide canning line identification. No further action can be taken toward procurement of the stamping machines until IPD decides what information is to be stamped on the male end of the fuel element.

During the month, 5022 CIVN self-supported fuel elements were welded on the automatic ultrasonic welder. The yield through the weld inspection station was 81.7%. During the month, 9717 OIIN bumper fuel elements were processed through the automatic ultrasonic welder. The yield was 91.5%. Major reject category was rail misalignment.

The majority of the production on the ultrasonic welder has been OIIE bumper fuel elements. Twenty-one thousand, three hundred sixty-eight (21,368) elements were welded with a yield of 81.9%. The major reject category has been gage rejects due to misalignment of rails and extreme rail deformation on the welds near the ends of the element. The cause of the extreme deformation is welding near a flexure node of vibration of the element core. The problem has been solved by changing the boundary conditions of the element, thus the location of the nodes at the end of the element. The rubber isolation pads in the welder chucks were replaced with steel pads. Even with this method of support, there are certain locations on the fuel element where it is not advisable to weld.

Offsite procurement of bumper design rails is to begin by mid-February. The rails are presently being fabricated by the Technical Shops.

A test to determine the allowable time delay between fuel element etch and ultrasonic rail welding has been completed. The present limit is four days. This limit can be extended to ten days without a significant reduction in weld strength.

The following special products have been produced on the manual ultrasonic welder:

1. Seven charges of CVIN self-supported elements.
2. CVIN self-supported thermocouple probes.
3. CVIN self-supported downstream dummy patterns.
4. Flow charge of KVN self-supported elements.
5. Flow charge of KIVN bumper elements.

Direct current is superior to alternating current for welding AlSi-bonded fuel elements in that the direct-current process eliminates more braze voids and results in less weld cracking. As a result, all of the AC welding power supplies are scheduled to be replaced with DC power supplies. The detail drawings for the DC conversion are about 90% complete, and parts for the conversion are being ordered. The conversion of the machines has been started with the work on one machine - line one about 50% complete.

306 AlSi Pilot Plant Activities

Approximately 5775 uranium cores were dip-brazed in the pilot plant for process development purposes. Two thousand nine hundred (2900) of the fuel elements are for reactor use. The major items of development were:

1. Aluminum component cleaning and wettability tests in molten AlSi for component vendor evaluation.
2. Cycling thermocouple cores and components to determine heating rates of several fuel element models.
3. Fabrication of KVN model fuel elements for attachment of supports for IPD reactor testing.
4. Evaluation of pressure quench technique and automatic machine.
5. Evaluate effect of vacuum outgassing after beta heat treatment on finished fuel element porosity.
6. Optimization of six-inch I & E enriched fuel fabrication cycle.
7. Canning of elements in nickel-plated components.
8. Fabrication of fuel elements with special braze conditions for weld studies.

COEXTRUDED PRODUCT ENGINEERING

N-Reactor Fuel Development

KER Testing

All of the test fuel elements in the KER loops operated satisfactorily the past month. Four 1.6% enriched K single tube fuel elements were discharged from Loop 4 for examination January 14 at an exposure of 1200 MWD/T. Preliminary examination of the fuel elements in the viewing pit indicates no gross imperfections. Markings on the cap end of one of the fuel elements indicates a possibility of a crack at the weld bead, however, definite confirmation cannot be made until further examination in the Radio Metallurgy facilities this coming month.

Loop 4 was recharged with four 24-inch natural uranium inner tube fuel elements. These elements are prototypal and operating conditions in the test loop are similar to those expected in the N-reactor with 0.947 enrichment.

Fuel elements in process from which additional test charges will be made include - nine K single tube natural uranium, twenty NPR inner tube natural uranium, and thirty NPR inner tube enriched uranium.

Coextruded K I&E² Program

Approximately 200 I&E zircaloy-2 clad depleted uranium fuel elements are in process and are presently at the brazing operation. This practice material will all be scrapped because it is depleted uranium. The surface roughness on these pieces exceeds quality control standards. Six additional extrusions (3 enriched and 3 natural uranium) which will produce approximately 200 fuel elements have been completed and are being processed. The acceptable material will be used for hydraulic flow tests. The next shipment of ten enriched billets is expected the first week of February and fuel elements from these extrusions will be available for reactor charging. Other aspects of the coextruded enriched I&E program are discussed herein together with process discussions on the N fuel.

Materials Development and Procurement

Uranium Billets

NLO has improved their machining capability to the point that almost all of the backlog orders have been cleared. Currently four shipments of billets are enroute to HAP0. It appears that deliveries of enriched I&E billets will be on schedule by sometime early in March.

Recent coextrusion results have shown a problem in OD surface smoothness. It appears that variations, perhaps small, in the triple beta heat treating process for the cast ingots may have a rather pronounced effect upon billet structure. There is work under way to resolve this problem, and basically three avenues of approach are being evaluated. First, of course, is variations in the heat treating technique itself. Second is additional study on the effects of colder mechanical working to produce the structures needed for coextrusion. The last area of evaluation is that of impurity content in the metal, since it appears that this problem developed simultaneously with a switch from natural to purer enriched metal. Billets are already in the stream containing significantly larger quantities of briquette and scrap in the makeup charges which will tend to result in higher impurity concentrations and may do some grain refining.

Zircaloy-2 Cladding Shells - Vendor Development

Bridgeport Brass Company has just started work on their contract and has not fabricated any parts yet. Their work is approximately 30 days behind schedule. Redetermination of their contract is now planned about March 1.

Harvey Aluminum Company has ingot cast and is canning for extrusion. Drawing technology for the large tubes is being developed on another contract, consequently these will not be drawn until the technology is known. The smaller tubes offer little problem and will be produced first. The overall program is delayed approximately 30 days bringing redetermination to about March 1.

Allegheny Ludlum Steel Corporation has produced tubes for N outer, both clads. So far, no acceptable pieces have passed their internal inspection for submission to our inspector, but some material should be delivered on these items during February.

Harvey Aluminums' order for 100 feet of 7-1/2 inch nominal OD zircaloy-2 tubing has been temporarily delayed because of draw tooling failure. An initial draw was attempted during which the draw bench stalled. New tools are scheduled for completion February 1 and drawing will proceed shortly thereafter. If all goes well, this order should be delivered during February.

Copper Cans

A series of tests have been conducted on cleaning copper in preparation for welding. The tests indicate that the process being used is not satisfactory. About 70% of the copper will clean successfully with the present method. (1 min, 45% HNO₃, 25°C). The main difficulty is transfer time from the nitric etchant to the water rinse. The copper must be transferred immediately to the rinse, which requires handling each piece individually. Transferring the copper components with a hoist is not rapid enough. The difficulty is apparently due to the surface temperature of the copper as it emerges from

the bath. This surface temperature, due to the heat of reaction of the copper dissolution promotes air oxidation immediately. Reducing the nitric acid concentration reduces the oxidation problem but is not sufficient.

Two copper brightening solutions have been tested and they work very satisfactorily. The two solutions, Zinctone, Brass Dip, are propriety compounds from Turco Products. The brightening solutions produce bright oxide-free copper consistently. The surface remains oxide free for several hours. One sample welded satisfactorily after sitting for 16 hours exposed to the atmosphere. Further information such as solution life and cost (\$3/gal) has been requested from the vendor.

A series of tests have been conducted using Everdur (97% Cu - 3% Si) as a material for billet canning rather than pure copper. This material looks very promising for the coextrusion process. The advantages are:

1. Easily cleaned and welded. Everdur can be cleaned with nitric acid consistently. The component can be welded with 1/2 the current. This is desirable since only one-half the heat is applied to the billet during welding. This will minimize the amount of oxidation of uranium core and zircaloy clad during assembly.
2. Minimize the problems of copper removal from the fuel tubes. Two tubes have been stripped to date. On pure copper clad tubes there is a visual copper film on the zircaloy cladding. With Everdur the cladding is stripped clean with no visual evidence of a copper film.

A series of tests have been conducted on the dissolution of Everdur in nitric acid (45% by weight). The tests indicate that this solution works very well. The solution life is reduced slightly by the presence of silica in the solution, present as a colloid, which gradually builds up to an appreciable amount when the copper reaches about 5% by weight. However, even with a high silica content in the solution the Everdur dissolves rapidly. The only objection to a high silica content is the difficulty of draining the solution from the tank as it would be thick. Reducing the maximum copper content to 5% by weight would remove this difficulty.

It has been demonstrated that high quality welds can be produced on the regular copper cans using the heliarc process and argon shielding gas rather than helium. The training of all personnel for production welding of copper jacket components is being done with argon.

Billet Preheating

Although current plans are to preheat billets in a pit type furnace for the coextrusion process, the use of induction looks attractive and some development tests are being performed.

During the month, four different tests were carried out using the same billet but using different cycling on the power to determine the best means of heating the billet. For run #1, the power was on until the surface temperature (Cu) reached 1400°F, which took 18 seconds. At this temperature the power was cycled on and off in such a manner as to bring the uranium, zircaloy and copper up to 1100°-1200°F, which was reached in 12 minutes. The pulsing was done manually. The second run was handled somewhat like the first but instead of pulsing manually, the pulsing was done with a Flex-o-pulse timer. The surface temperature of 1200°F was obtained before pulsing was started. Again the pulsing was done in such a manner to bring the uranium, zirconium, and copper to 1000°-1050°F, which took 12 minutes. On both runs, the outer Zr remained 75° to 100°F higher. For run #3, the power was on until the surface temperature reached 650°F, which took 8 seconds. The power was then pulsed in such a manner as to bring the uranium, zirconium and copper to 1125°-1150°F, which took 24 minutes. The outer Zr remained 100°F higher.

The power on these three runs was 560 KW using the 130 volt taps on the secondary of the transformer.

For run #4, the power was on until the surface temperature reached 300°F, in 10 seconds. The secondary voltage was reduced from 130 volts to 63 volts which reduced power to 120 KW. After the surface temperature reached 300°F, the pulsing of power was started. Operating with a reduced voltage on the coil and starting at a low temperature to pulse made the operation much easier to control. However, this operation increased the time to 22 minutes to bring the uranium, zirconium and copper to 1125°-1200°F.

It was also necessary to establish a standard location for a thermocouple to heat regular billets by.

On the four runs, a thermocouple was placed in the billet core with the sensing end of the thermocouple against the inner Cu. This temperature reading followed the uranium and zircaloy temperatures within 20°F. With this thermocouple location and an established cycling period, it is probable that a satisfactory heating process could be set up for billet heating. The next step is to extrude induction heated billets.

Coextrusion

The following extrusions were made during the month:

1. 6.0 Inch Tooling

20 Composites - T-98 through T-117

T-98, 99, 104, 109 & 110	NIT Normal
T-105 & 106	NIT .94 Enriched
T-100, 101, 102, 103, 107 & 108	I&E Depleted
T-111, 112, & 114	I&E .94 Enriched
T-113, 115, 116 & 117	I&E Normal

6 Zircaloy Billets - Zr-38 through Zr-43

Zr-38, 41 & 42	I&E Inner Clad
Zr-39	I&E End Caps
Zr-40	NIT Inner Clad
Zr-43	NIT Shroud Tube

3 Copper Billets

2. 11.1 Inch Tooling

9 Uranium Billets - U-30 through U-38

U-30, 31, 32 & 33	NOT Cores
U-34, 35, 36 & 37	I&E Cores
U-38	4-in. x 1-in. Core for HLO

1 Copper Billet

Extreme surface and interface roughness was encountered on ten coextrusions (3 NIT and 7 I&E) made during the month.

The roughness on all of the above extrusions was caused by uranium billet core history. Die or mandrel pickup did not occur on any of these extrusions, and zircaloy components have proven satisfactory on other coextrusions. The billet integrity test indicated in each case that unusual grain size and variation existed as compared to billets which produced high quality coextrusions.

On the suspicion that 11-inch castings were not adequately beta treated prior to extrusion and using the billet tester to measure as-received billet quality, a series of tests have been made on both normal and enriched material by single and triple beta heat treating the as-received billet cores. The grounds for the above tests go back to original NIT coextrusions where the same condition existed and was improved considerably by heat treating of as-received billets.

The results, in general, of the above tests, although incomplete, are as follows:

1. The billet core tester has predicated on a 100% basis the billet cores which would produce rough surfaces.
2. Single beta heat treating of as-received cores that are rejected by the tester will reduce OD surface roughness to a point which will permit use of clad thickness and bond tester. The interface roughness, however, is increased, but clad variation still meets required specifications.
3. Triple beta heat treating does not produce any better outside surface finish and could produce greater interface roughness.

4. In one case, triple beta treating of an "A" billet from the primary extrusion did not improve the OD surface at the rear of the coextrusion which would be the front most part of the primary extrusion. This part of the primary extrusion receives very little work and this is probably the reason for the overall lower quality of all "A" billets which have been received in the past two months.

Copper Removal

The copper removal problem has been characterized by residual copper being carried over to the zircaloy-2 strip etch and not being removed completely during the stripping process. This resulted in preferential attack at the copper contaminated areas and pitting of the zircaloy-2 clad. Process techniques applied to overcome this problem were:

1. Immediate transfer of fuel elements from the copper removal bath to the zircaloy-2 strip. The freshly exposed clad surfaces resulted in rapid removal of the copper-zirconium layer. Temperature is also a factor since the copper stripping solution is maintained at about 60-70°C.
2. Point contact baskets are used for the first 30 seconds of the zircaloy-2 strip. Elements are then transferred to roller baskets for the remainder of the etch period.

Preliminary tests have been run on stripping Everdur and it appears to be removed more completely than the regular copper.

Chemical Milling

The past month efforts have been concentrated upon improving the surface smoothness of the end recess. The smoothness is dependent upon the chemical composition of the uranium metal and the composition of the etchant.

The pitting that occurs appears to be due to metal impurities in the uranium. Certain impurities, e.g. Fe, Ni, Cr, are dissolved more rapidly than the uranium. Small vacancies appear where the impurities were and these vacancies become larger. The pits grow to a depth of about 5 mils in some cases. Uranium metal with about 50 ppm Fe, 20 ppm Ni and 20 ppm Cr does not pit. This pitting effect is minimized when the sulfate concentrate is increased to about 4800 #/M gal. Increasing the sulfate anion concentration however suppresses the depolarizing action of the copper. Therefore, the copper level must be increased from 160 #/M gal. to somewhere around 260 #/M gal. Very smooth surfaces can be obtained but this introduces a small increase in the contour variation. It is possible that some sacrifice must be made between smoothness and contour variation.

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End Closure DevelopmentZr-Be Brazing

Approximately 75 inner natural and enriched and 20 outer natural pieces were closed. A new cooling technique has been developed which seems to eliminate the shrinkage cavities which were giving trouble before. This technique consists of retracting the coil so as to keep the braze metal molten on the surface until after it has solidified below the cap. This provides a pool of molten metal to feed into the cap-clad service. Initial brazing trials with the first I&E pieces indicated that it would not be practical to use the N inner braze rings as had been planned. Our outstanding orders with NMI for braze rings were modified to provide a different size for the I&E pieces. The first material sized expressly for I&E should be here February 1.

A Brown regulating control device was installed in the field of the braze induction heating unit. This regulator releases the need of one man to operate the equipment manually.

The temperature recording instrument used with the radiation pyrometer has two pens and only one in use. Another range (slide wire) was provided for the second pen and calibrated to the range on the first pen. This second range provides the signal to drive the magnetic amp (regulator) according to the temperature on the radiation pyrometer.

Brazed Closure TIG Welding

Continued work on the problem of braze segregation zones indicates that they are present in both the inner and outer welds. There appears to be a relationship between the width of the braze and the formation of these zones. Tests partially completed indicate that as the braze widens these disappear. Outer braze widths greater than 0.016 inch and inner braze widths greater than 0.026 inch show very few such regions.

Solid State Diffusion Bonding

Specimens autoclaved by BMI at 10,000 PSI, 600°C, and 6 hours at temperature have been received and the following checks performed:

1. Visual inspection for pressurization,
 - a. one piece leaked,
 - b. all pieces had a slight circumferential cladding indent at the interface between the cap and the uranium.

- [REDACTED]
2. Metallographic examination of the bond lines between the cladding and caps indicated approximately 70% of the joint was bonded. The unbonded areas were of varying short lengths.
 3. Caps on the ends of the 14 pieces autoclaved showed no evidence of unbonded areas with ultrasonic testing.
 4. One cap was removed from an N inner tube with a cold chisel and hammer without removing the cladding. It was found that there was a very strong uniform bond between the uranium and the cap. After 12 days exposure of the fractured surface to the air, the uranium showed only slight areas of discoloration indicating that it was protected with a film of zircaloy-2, or non oxidizing compound layer.
 5. The outer and inner cladding were removed to below the cap of an N inner tube. A Zygo test failed to show any discontinuity between the cap and uranium. An attempt was made to remove the cap with a hammer and cold chisel. The cap was deformed but no evidence of fracture was found between the uranium and zircaloy-2 cap.

Half of the second set which is to be autoclaved at 10,000 PSI, 640°C and one hour at temperature, has been prepared. It is anticipated that the others will be prepared by 2/10/61.

At the Vacuum Technology Conference at General Electric Co., Johnson City, New York, it was learned that General Electric is using cathodic etching at the Ithaca, New York plant as a production process. The technique they use was obtained and should produce better bonding as the localized action is not severe, producing less surface pitting.

Beta Heat Treating

Warp Studies

During the past month, the heat treating program was redirected to evaluate the effect of the tube cooling method after coextrusion on heat treated warp. Tubes 98N* and 99N were cooled in a V-trough while tubes 104N, 105E and 106E were cooled by rolling for 15 minutes on the run-out table.

On the basis of previous data from KER inner tube stock, one would predict that the V-trough cooled material would exhibit the more warp after beta heat treating and the rolled tubes would have less warp.

Although an alpha anneal prior to beta heat treating would have served as measure of difference in residual stress, the fuel lengths from these tubes were not annealed prior to heat treating because of the needs of other parts of the program. A summary of finished materials is shown in Table 1.

* N=natural uranium; E=0.947 enriched.

[REDACTED]

[REDACTED]

REF ID: A6800

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TABLE 1
WARP IN BETA HEAT TREATING

<u>Tube No.</u>	<u>Cooling Method</u>	<u>No. of Lengths Processed</u>	<u>Length of Fuels</u>	<u>No. Having Acceptable Warp*</u>
98N	V-trough	11	24-in.	5
99N	"	10	"	3
104N	Rolling	7	"	5**
106E	"	18	18-in.	18

* The goal for warp is not more than 30 mils double throw.

** The two rejects exceeded specification by only 0.5 and 1.5 mils.

The yield from tubes 98 and 99 is the poorest yet encountered. This yield prompted further work in methods of recovering warped lengths. Previously, it was shown that warp could be reduced by reverse bending followed by a second beta heat treating. Although that work reduced the magnitude of the warp in every piece, there was not a large recovery of fuel lengths.

To improve the yield from straightening, the amount of reverse bending in the same plane was increased from 1X (i.e. + 18 mils to -18 mils bow) to 2X (i.e. + 18 mils to -36 mils bow). Again after a second beta heat treatment, warp was reduced in every piece and 10 out of 12 pieces met specification. This yield is promising and indicates the need for more work on this method of recovery.

Study has indicated that a careful vector analysis of warp in a process of beta heat treating, reverse bending and re-beta heat treating must show minimum angular dispersion of the warp vector (i.e. force:distance) of the second heat treatment if the process is to be practical in production. It became apparent that the wall thickness variation might provide a variable stress whose strain could not be predicted if other variable stresses were present. To examine this point, three lengths of fuel were given additional heat treatments after the beta:reverse bend:re-beta. One piece given three more beta heat treatments and two pieces given two more beta heat treatments did not incur further warp. From these data one concludes:

1. The primary driving force of warp is that of preferred orientation. Thus, the largest change in warp will occur during a first beta heat treatment,
2. Wall thickness variation is a lesser driving force than preferred orientation.

At this time, one cannot conclude if the cooling method is an important variable. All other things being equal, the starting warp represents a condition (magnitude, position) from which a warp vector is added during beta heat treating. If the vector cannot be minimized, the initial condition is important. If the vector can be minimized, the initial condition is not as important.

Salt Bath Heat Treating

Previous criteria for beta heat treating incorporated the use of a T-bar to support the fuel. It was shown that the chloride salt froze in the bore of the N inner tube geometry and uniform heating was possibly not achieved. To improve both the handling and the uniformity of heating, a top support was developed by brazing a loop of zircaloy wire to one end cap closure at the time it is brazed. This wire allows the piece to hang vertically and has eliminated the concern that warp could result from buckling of the fuel on the T-bar.

Monitoring of the drag out losses of both chloride and nitrate salts has been started. This work is aimed at determining:

1. the dependence of quench rate in the nitrate salt as a function of chloride contamination,
2. the dependence of cooling rate in the water bath as a function of brine concentration,
3. the economics of the drag outs.

Induction Heat Treating

The last phase of the existing contract with Ajax Magnethermic Corp. was completed during the week of January 9, 1961. The only outstanding data yet to be received are the calculations on coil designs.

Ten N inner tubes were induction heated and air-blast quenched. In the initial set-up, uniformity of temperature was indicated by both thermocouples (6 per piece) and a radiometer (Minneapolis Honeywell Miniature). Visually, the pieces showed a cold spot over a distance from 1/2 to 3-in. at the bottom of the fuels but neither technique substantiated the observation. However, a radiometer (solar cell) built by the Optical Shop, HLO, showed the cold spot.

In work at HAP0, the Optical Shop have completed a radiation-ratio pyrometer (essentially a 2-color pyrometer) and this has been calibrated against the solar-cell radiometer and thermocouples using a static technique on the scanner. Tests are scheduled for further calibration during scanning tests.

Etching and Autoclaving

There has been a serious problem in the pilot plant operations with respect to the formation of white oxide on brazed weld beads after autoclaving ever since the braze operation was started. The problem has been a hit or miss proposition but has affected the major quantity of material processed in the pilot plant.

A series of tests are under way, or planned, to investigate and establish cause factors for white weld oxide.

1. Uranium Contamination

Uranium analyses are being performed on weld bead surfaces showing white oxide to determine the presence of uranium.

Special test pieces are being fabricated in which the braze base will be zircaloy-2 instead of uranium. These will be brazed, welded, etched and autoclaved with uranium base companion pieces.

2. Etch Bath Contamination

Four N inner elements which had corroded white were reprocessed through vapor blast and etch and were autoclaved. Two elements were etched in uranium and copper contaminated etchant and two other elements were etched in freshly prepared etchant. This test was designed to determine if these contaminants contributed to white weld oxide formation. In all four elements, one end of each had good black films. Varying amounts of white oxide were present on the other ends. Since one of the I&E elements had failed during autoclaving, it is believed that the ends which had been in contact with the uranium sludge had been contaminated during the autoclave cycle.

A series of Be-Zr braze rings were etched and autoclaved using various etchants. In all cases where etching was the final step prior to autoclaving, varying degrees of white oxide were present.

One piece of solid Be-Zr braze material was prepared by running weld beads on the surface. The weld bead was black as contrasted to the whiter background of braze material.

3. Mechanical Polishing Prior to Autoclave

A test now in the autoclave is designed to determine if a black weld bead can be obtained by eliminating the etch as the last treatment of the weld bead prior to autoclave. Test elements were etched, followed by polishing of the weld bead with fine emery cloth.

Side Support Welding

The tool design for resistance welding supports on the NPR inner and outer tubes has been completed, and fabrication on the tooling will be started January 30.

The tools for each fuel element size will have a steel ring mounted in the block to be used as a gage to expand each support against before spot welding. The tooling is designed in such a manner that each support can be spot welded on one end, the fuel element moved back 7/8 inch, the support expanded against the ring and then the other end of the support can be spot welded. The fuel element can be indexed in the ring, moved forward and the second support spot welded in place. Same operation is repeated for the third support.

Canadian General Electric Company has developed a method of resistance welding known as "spike" welding which may have application for support welding. It is accomplished by generating a very narrow, high peaked current pulse at the midpoint of each alternating current half cycle and using a low electrode force. The time-amplitude relationship is such that the heat is generated virtually at the surfaces to be joined and no metal is melted or indent formed by the electrodes. The weld has the appearance of a diffusion bond with grain refinement. A contract is being negotiated with Canadian General Electric for the test welding of supports on KER single tube to see if side supports and locking devices can be attached without alteration of the structure of the uranium. In welding 0.065 inch zircaloy-2 to 0.065 inch zircaloy-2, the heat affected zone extends approximately 0.010 inch from the interface of the two pieces.

TESTING METHODS

Process Fuel Element Inspection

Bare Core Station

Surface quality inspection equipment is now operational in all UT-2 testers. Equipment performance during the past month's operation has been good, although some problems remain in fully integrating this test into the production line. As optimum performance is rather critically dependent upon ultrasonic beam alignment, special techniques need to be developed to insure equivalent test results between testers. This problem should be helped considerably by improved test head fixtures which are scheduled for installation within the next two weeks.

New Methods Development

Detection of Core Defects in Canned Fuel Elements

A test hastily developed and put into operation in the 313 Building for the purpose of detecting surface defects in canned fuel elements has given good results. This test utilizes a 2 MC ultrasonic beam, carefully aimed to penetrate the core through the aluminum jacket. Operating two shifts per day for approximately ten days, the test inspected some 20,000 fuel elements. Destructive examination of the rejects revealed fifteen cores whose surface were cracked with the "mud-flat" pattern characteristic of high iron cores.

UT-4 Project

Approximately 500 overbore pieces were tested in the prototype UT-4 equipment. Results indicated that these elements contained significantly less cap-can braze porosity than is normally encountered in process fuel elements. Evidence of porosity adjacent to the end of the core, however, was comparable with process fuel.

Special emphasis is being given the design of simple, reliable, mechanical systems for the production line UT-4 equipment. Shop drawings are nearing completion. Work is also rapidly progressing on the electronic designs. Shop work on one unit, being built for the 306 Pilot plant under an Appropriation Request, will begin during the month. Work on the five units scheduled for 313 Building will be delayed pending approval of a project proposal.

Ultrasonic Weld Monitor

The considerable data gathered to evaluate the ultrasonic welder monitor continues to look favorable. A recent incident which at first appeared

to be an exception was traced to an intermittent fault in two channels of the automatic welder. In this case the 15 KC oscillator voltage dropped from a normal sixty volts to four volts. Although the quality of welds produced at the lower operating level was better than might be expected, the harmonic content of the output voltage became immeasurable. It thus appears that the technique may be useful for quickly revealing abnormal operating conditions that may not be readily apparent from an examination of the finished weld.

Further evaluating data will be obtained with a four channel instrument now nearing shop completion.

N Reactor Fuel Testing

Billet Testing

Ultrasonic inspection of uranium billets prior to extrusion has been particularly successful in selecting those billets which do not extrude properly. This test is based upon the experimental observation that as-received billets which have high ultrasonic attenuation, and hence are of large grain structure, produce fuel elements whose surfaces are unacceptably rough. Positive correlation came with a billet which had only a few inches of large grain material near the end of the billet. Fuel elements corresponding to this region were unacceptable because of surface roughness, while the rest of the extrusion was indeed satisfactory.

More recent studies in which beta heat treated billets produce good extrusions suggest, however, that the ultrasonic test may be influenced to a degree by grain orientation. Studies are under way to explore this possibility.

Cladding Tests

Autoradiograph techniques are being investigated as a supplemental method of assuring the integrity of fuel cladding. Films exposed for approximately six hours clearly show two mil variations in a nominal twenty-five mil wall. An artificial defect 0.015 inches in diameter drilled about half-way through the cladding is much more clearly resolved by this test than it is by the present eddy-current test.

Another test in which a fuel tube was set on and directly on an X-ray film clearly showed braze porosity at the weld closure. This test appears attractive in that it provides a convenient method of inspecting the zirconium closure ring as well as the braze layer.

Zirconium Orientation

Efforts are being made to develop methods of detecting regions of preferred crystal orientation in pre-extruded zirconium components. One approach of promise uses a "Libby" coil to look for variations in electrical

conductivity around the circumference of the piece. Samples tested so far show definite variations at roughly ninety degree intervals along the circumference. Plans are to correlate these data with warp measurements.

Lamb Wave Testing

A method of converting frequency to amplitude for use in the Lamb wave thickness test has promise for a limited range of thickness. In most applications a small range at high sensitivity is needed rather than a large range, low sensitivity test. To reduce interference from other modes operation is restricted to the lowest mode, giving less sensitivity. A range of less than one megacycle would be sufficient for the tubing test. In order to get the required accuracy, instead of using frequency analyzer techniques a frequency to amplitude conversion method was tried. The amplitude limited signal is amplified on the skirt of an amplifier frequency response curve. Over a range of 300 KC the system gave good results but obtaining a larger range is being investigated. If this method proves satisfactory it will be used in the tubing test. Use of a contour corrected lens over the transducers in the thickness test resulted in about 5 db signal increase per transducer. This would result in averaging the thickness over about 1/4 inch instead of about 1/16 inch without the lens.

Comparison of response of Lamb wave mode reflection from defects in flat plate with reflections in tubing show a very similar response. It appears that the large variations in signal amplitude obtained from rotation of the tubing is an interference phenomena caused by the many angles of incidence to the curve wall. In flat plates such interference can be obtained by adjusting the crystal angle or defect orientation.

ENGINEERING GENERAL

Power Asymmetry Measurements

A column of metal, which had neutron flux perturbation caused by two control rods, was selected for power asymmetry studies. The metal exposure time was typical, and highest fuel element powers in the column were about 60 KW/ft. The control rods were directly above this column during about 90% of the exposure time. One control rod was at the upstream position and one was at the midstream position of the column. Neutron flux gradients, caused by these rods, were most severe in the vicinity of piece numbers 17, 18, 24, and 25. These fuel elements were carefully measured for power differences at diametrically opposite points along a number of axial positions. The maximum measured power asymmetry for pieces 17 and 18 was about $3\% \pm 3\%$. The higher readings were obtained in the neighborhood of the rib marks and the lower diametrically opposite. Based on front to rear weasel data, piece number 24 appeared to have been exposed to the greatest flux gradient therefore, was expected to have greater power asymmetry. The maximum measured power difference for this piece was $7.5\% \pm 3\%$. Here again this difference occurred at points near and opposite to, the rib marks with the higher reading near the ribs. Piece number 25 had a hot spot near the male end at a circumferential position almost opposite to the rib marks leading to the assumption that this area was cocked toward the control rod. Front to rear

weasel data showed less axial neutron flux gradient than piece number 24. However, the radial gradient could have been more severe since this hot spot area would have been nearer to the control rod if cocking did occur. Measurements at this hot spot and diametrically opposite showed $12\% \pm 3\%$. Again the higher readings were on the rib side which was opposite the hot spot area. Less detailed measurements were made on most of the remaining pieces in the column and no more than 5% asymmetry was detected. A few other "hot spots" were also examined and little asymmetry was observed.

Before firm conclusions are made more information is needed. Following a quality certification analysis on this column, the fuel elements which show the greatest warp, jacket corrosion, ellipticity, etc. will be carefully examined for power asymmetries. Power asymmetries associated with predicted rib heights for this column will also be established. More hot spots will be examined. Asymmetry caused by poison splines will also be measured. More columns which are effected with flux perturbations will also be examined. An attempt will be made to evaluate the probable damage to the fuel elements caused by these measured asymmetries.

Plant Improvement Program

Fuels Preparation Department Plant Improvement Program, HW-68140, was completed and distributed.

Manager, Engineering

LH McEwen:dl

FINANCIAL OPERATION

JANUARY, 1961

Meetings between representatives of the Manufacturing and Financial Sections were continued for the purpose of establishing accounting procedures for the Coextrusion Shop operations. Segregation of the process steps into logical cost centers which will provide the bases for cost accumulation, reporting, interpreting and measuring performance is now underway.

Information regarding Fuels Preparation Department's On-site-Off-site Fixed and Variable Cost to HAPO was updated January 5, 1961. Plans are to revise this information every six months unless analyses by the Department or receipt of more current off-site data necessitate interim revision. (Reference document - HW65811 - Rev. 2).

Cost studies were made regarding conversion and unit cost of new fuel models, including normal and enriched projection and overbore elements. In addition, cost information was updated for NPR Startup and the fuel cost for the initial N-Reactor Load. N-Reactor fuel cost estimates were revised as a result of design changes in the fuel element.

Preparations are currently underway for establishment of a spare parts inventory and cost standards for process material and operating labor for the manufacture of N-Reactor fuel elements.

Cost data were prepared for presentation at the meeting with AEC Washington officials. Included were charts comparing production and unit cost performance at HAPO with Savannah River, along with cost estimates covering FPD's conversion cost for both the old and new fuel element models.

The weekly work order cost-to-date report was revised to include additional information which will assist operating foremen in more clearly defining the cost status of work orders.

The weekly Overrun Report, summarizing all work order overruns by foreman, has been completely mechanized. Mechanization of this report has resulted in clerical savings of approximately nine hours per week in C&AO. The new report will be issued during the first week in February.

Reconciliation of January's quarterly physical inventory of precious metals indicated no discrepancies between quantities held by Department custodians and reconciled book balances.

Recommendations were made that physical inventories of rare and precious metals be taken semi-annually rather than quarterly, as currently required by HAPO OPG 8.14. Since the AEC Manual requires only semi-annual physical inventories of rare and precious metals, a considerable HAPO-wide cost savings would be effected by eliminating two of the quarterly inventories currently being taken.

Expenditure estimates for equipment for the third and fourth quarters of FY 1961 have been developed and submitted to Contract Accounting. The

estimates indicate complete utilization of the current allocation and are summarized below:

(Amounts in Thousands)

	Actual		Estimate		Total
	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	
Non-Project Related	\$147	\$166	\$165	\$272	\$750
Project CGF 903	<u>3</u>	<u>17</u>	<u>100</u>	<u>280</u>	<u>400</u>
	<u>\$150</u>	<u>\$183</u>	<u>\$265</u>	<u>\$552</u>	<u>\$1 150</u>

The HAPO miscellaneous capital work order allocation was increased \$100,000 and of this amount the Department received \$6,000 based on indicated need and priority. The present allocation provides approximately \$85,000 for the last half of FY 1961.

The major machine tool summary for the six-month period ending December 31, 1960, was completed and submitted to Property Management, C&AO.

The Automotive and Heavy Mobile Equipment Budget for FY 1963 and Revision of FY 1962 Budget has been prepared for submittal to Transportation and Maintenance CE&UO. Other budgets prepared during the month include Photographic Equipment, Office Equipment, and Radio and Audio Visual Equipment. A call letter was sent to Section Managers requesting Equipment Not Included in Construction Projects requirements for fiscal years 1962 and 1963.

Travel for the month amounted to \$1,800 as compared to \$2,700 for January, 1960. Seven months travel totals \$32,200, about \$700 below the same period of FY 1960. January activity included eight trips and 32 days in travel status.

A package of eleven HAPO and two FPD OPGs has been prepared for immediate issuance pending Department approval. The Department OPG on Attendance at Professional and Trade Society Meetings, Off-Site Courses, and Company Conferences has been revised and will be ready for issuance during February. Other guides undergoing revision at present are Procurement Procedure and Research and Development.

Notification has been received concerning nine employees who are eligible for tuition refunds totaling \$135.00. Refund checks will be issued during February.

Information was transmitted to Section Managers emphasizing Department policy with respect to restricting sources of supply to specific suppliers. In addition, an internal review procedure was established to insure that appropriate attention be given the matter.

Report of follow-up on the Duplicating Audit of October, 1960 has been issued. Audit of FPD suggestion awards for CY 1960 is currently underway.

Work is continuing in the study of mechanized inventory control and accounting procedures for essential materials.

Manager - Finance

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PLANT FACILITIES OPERATION

JANUARY 1961

I. RESPONSIBILITY CHANGES

None.

II. ACHIEVEMENTS

A. Statistics

1. Duplicating

<u>Process</u>	<u>No. of Impressions</u>
Multilith	550,027
Verifax	6,364
Ozalid	<u>12,171</u>
Total	568,562

2. Utilities

	<u>Jan.</u>	<u>Dec.</u>
Average steam generated (M lbs/hr)	95	97
Maximum steam generated (M lbs/hr)	129	119
Total steam generated (M lbs)	70,491	72,512
Coal consumed (Tons)	3,298.05	3,542.69
Evaporation rate (Steam/#coal)	10.68	10.23
Efficiency - Actual	72.0	69.4
Efficiency - Theoretical	73.6	73.6
No. of Boilers on: 4 3 3		
Date of Change : 5		
Sanitary water from 3000 Area (M Gals.)	121.06	120.60
Total water from 3000 Area (Avg. rate GPM)	2,712	2,702
Total water from #3 and #4 wells (M Gals.)	11.14	10.55
Total water from #2 well (M Gals.)	.30	.30
Peak water consumption for 24 hrs. (M Gals.)	4.4	4.5

B. Operating Experience

Numbers 4, 5 and 6 Boilers were in service for the entire month with the No. 3 as first reserve and placed in service for short periods on several occasions to prevent overloading of No. 6 Boiler. Hand-cleaning of the ashes from the left hand grate section of No. 6 Boiler will be continued until such time as the unit can be made available for extended

overhaul. The engineering analysis of the No. 6 Boiler failure has been completed and the report, including recommendations, will be completed in February.

A super high range (Totem Pole) radiation instrument was fabricated for use at HAPO in the event extremely high radiation levels are encountered, which would exceed the capabilities of the normal radiation instruments.

The clutch mechanism on the gasoline engine driver of No. 5 sanitary water pump overheated and failed during the month; however, sanitary water loads were met without difficulty while the clutch assembly was being removed for repair and during reinstallation. The engine driver was left uncoupled from the pump pending further investigation to prevent any future failures of this nature.

Due to corrosion in the two inch main vacuum line in the 321 Building canyon, the entire line of black iron pipe was replaced with stainless steel. One inch outlets were fabricated every five feet.

C. Equipment Experience

A service engineer visited the 325 Building to inspect the freon refrigeration compressor. Several recommendations were submitted by him to improve the operation of this equipment and to reduce excessive maintenance. These recommendations are being evaluated for necessary action.

The automatic sample programmer at the Bioassay Laboratory in the 700 Area failed on automatic and was repaired and adjusted. The analog to digital converter for the whole body counter was unstable and quite a problem to correct. The trouble centered around a defective zener diode. The new Dimec tape punch was not accurately punching out information and was repaired along with other associated equipment.

Major effort continues to be expended in modifying and improving the equipment in the PRTR. The repair of the D₂O pressurizer turned out to be a much more complex problem than had originally been expected. The discovery of Inconel in the Area to be welded required the development of a welding procedure and qualifying tests for weldors to perform the work. This was all accomplished in a matter of days and the unit is expected to be ready for stress relieving February 3, 1961. Recommended changes to the demineralizing system to increase the capacity and improve the quality are being processed and will be put into service during February. Work on the twenty-three shim control rods was completed.

Considerable trouble has been experienced on the Phase II loop in the 314 Building. The Wheelac MMC controller and the bellows assembly on the Fischer positrol have not been operating correctly and have caused a good deal of down time on the loop.

Additional control instrumentation has been added to the graphite burning furnace in the 3730 Building. This instrumentation consists of a Minneapolis-Honeywell curve follower, a magnetic amplifier and a saturable core reactor to drive the furnace heating element. This curve follower is unique in that the furnace temperature can be programmed on a piece of chart paper, fed into the instrument at a given rate and control the furnace temperature as plotted on the chart paper.

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 January 1961.

E. Costs and Savings

One cost reduction item in the amount of \$661 is being processed.

Mild weather during the month kept coal consumption at a lower level than anticipated; however, this saving will be partially offset by the less efficient operation of the No. 6 Boiler. Due to the failure of the left-hand traveling grate section and the repaired tubes, this boiler is being operated at 50% capacity. Numbers 4 and 5 Boilers must be kept in operation at less than optimum load as back-up for the No. 6 Boiler.

F. Status of Projects and Major Jobs

3717 Building Sheetmetal Shop Addition - Field construction is approximately 65% complete and on schedule. The new press brake has been received and will be installed as soon as the contractor completes his work.

384 Building Railroad Siding - All work is complete and has been accepted.

384 Building Personnel Facilities - The construction contractor has completed his work and minor clean-up items remain to be completed by Plant Forces. Partial use of the facilities has been attained.

303 Grounds Improvement - Moderate planting of available shrubbery on the south side of the 313 Building was decided on during the period. The over-all work is on schedule.

North Ground Storage Reservoir Piping Modification - Construction has been completed and transferred to Operations. A few minor clean-up items will be completed by Plant Forces.

Modification of Ash Sluice, 384 Building - Progress on this work is 95% complete. Marked improvement in operating conditions has been achieved.

Project CAF-894, Increased Compressed Air Capacity, 384 Building - Final review made on compressor foundation and manufacturer's drawings. Tie-in of the new 6-inch line in the 303 Area has been completed. All work is on schedule.

No. 4 Sand Separator Station - The bid opening for this work is scheduled for February 2, 1961.

Revision of 120 Volt Circuits, 382 Building - This work was completed after the receipt of the replacement 3 KVA emergency power transformer.

Budget Studies - Rough drafts of the Budget Studies on the Sanitary Water and the Laboratory Area Steam Line were completed and forwarded to Facilities Engineering for final budget preparation. Justification for the Budget Study, Additional Steam Generating Capacity, 300 Area, was also completed in rough draft form and forwarded to Facilities Engineering. The order of magnitude estimate for this item is in excess of \$500,000.

G. Special Reports Issued

PRTR D₂O Pressurizer Nozzle Repair Procedures by
C. K. Michaelis.

III. PERSONNEL

A. Safety, Security and Radiation Experience

Medical Treatment Injuries	22
Frequency Rate	4.07
Disabling Injuries	0
Serious Accidents	0

B. Meetings

Round Table-Staff	28
Safety and Security	21
Information	7

Manager
Plant Facilities Section

E Hilgeman:RTM:mkm

RELATIONS PRACTICES OPERATION
JANUARY, 1961

STATISTICS

<u>EMPLOYMENT</u>	<u>January</u>	<u>December</u>
Additions: Exempt	3	7
Nonexempt	<u>15</u>	<u>18</u>
Total	18	25
Reductions: Exempt	5	0
Nonexempt	<u>5</u>	<u>6</u>
Total	10	6

HEALTH AND SAFETY

Disabling Injuries	0	0
Serious Accidents	0	3
Medical Treatment Injuries	53	48
Medical Treatment Frequency	3.65	3.52

SECURITY

Violations - FPD	1	2
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SUGGESTION PLAN PARTICIPATION

Eligible employees	673	667
FPD suggestions received	102	78
Annualized rate per 1000 eligible employees	1,819	1,403
No. of suggestions adopted	8	63
Net annual savings	\$704	\$38 731
Amount of awards	160	3 840
Percent of total awards to savings	21.6	9.9
	20	60.95

GENERAL

Department personnel growth during the past few months has resulted in a change in the safety award class from J to I as outlined in Accident Prevention Standard No. 5. The Department is now accumulating exposure hours in excess of 130,000 hours per month.

The Department completed 1960 with a medical treatment frequency rate of 3.94 compared to the calendar year goal of 3.75. A new goal for CY 1961 has been established at 3.65, 5% below the previous four-year average. The medical treatment frequency rate for the month of January was 3.65.

The Department Health and Safety Program Council has arranged for an off-the-job first aid training course for FPD employees through the adult education program. The course will offer a refresher for current card holders, and complete instruction for new participants.

One security violation was reported in January. Seven security violations were reported in the Department during CY 1960.

Several candidates for Department openings in the journeyman Instrument Technician classification were interviewed in the Midwest and San Francisco Bay area. Five candidates appeared to have the desired electronic experience and offers have been extended. Approval was obtained from the Commission to include travel and moving allowances in the offers.

RW McCullugh

Manager - Relations Practices

RW McCullugh:mfj

END

**DATE
FILMED**

11 / 27 / 92