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FUELS PREPARATION DEPARTMENT

MONTHLY REPORT

OCTOBER

1961

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HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

GENERAL ELECTRIC

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FUELS PREPARATION DEPARTMENT

MONTHLY REPORT - OCTOBER 1961

Compiled by Fuels Preparation Department

November 7, 1961 - Richland, Washington

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TABLE OF CONTENTS

General Summary	A-1 through A-9
Manufacturing Operation	B-1 through B-13
Engineering Operation	C-1 through C-28
Financial Operation	D-1 through D-2
Plant Facilities Operation	E-1 through E-6

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HW-71571

PRODUCTION

Production of fuel elements during October was scheduled to maintain the current levels of finished fuels. Output was 97 per cent of forecast.

Manufacturing yield of 8-inch fuels remain at essentially the same level as that experienced during September, while the yield of six-inch fuels decreased slightly as a result of a problem encountered in the mating of AlSi rings and sleeves.

Finished fuel inventories at the end of October reflected a 2.4 month supply based upon projected reactor usage.

The inventory of bare uranium cores was reduced to a 1.6 month supply by month end.

ENGINEERING

Present Reactor Fuels

Three natural and eight enriched fuel elements failed in reactors during October. This was two more than the previous month and four more than were experienced during the same period a year ago under severity conditions about one-half those of the present. Fuel assembly ruptures (two side other and two hole) continue to emphasize the importance of process control and innovation to minimize weld and braze closure defects. Two failures were caused by transverse splits in dingot cores. Exact reasons for the splits are not known although the severity of quench after beta heat treating is suspected. Radiometallurgy study of these cores is planned. Heat treating in hollow blank form followed by quenching in 130 F oil is also being evaluated as a means to relieve stress which may cause core cracking.

Approximately 303 tons of additive dingot uranium are under irradiation and 811 tons have been discharged. Fifteen dingot ruptures have been experienced as compared to ten in the ingot control material. About 102 tons of dingot uranium, vacuum-outgassed-before-heat-treatment, and 40 tons of virgin dingot cores were canned during October. Until the cause of the four transverse split failures in dingot uranium has been established, the restriction limiting additive dingot cores to 125 tons per month will be continued.

Four natural uranium ingot cores were found to exceed the maximum carbon limit. The producer site was requested to take corrective action.

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A joint meeting of National Lead Company of Ohio, Mallinckrodt Chemical Works, Savannah River Plant, AEC and HAPO personnel was held at the National Lead Company of Ohio Fernald Plant to discuss uranium specifications, core improvements and standardized methods of data reporting. A number of important changes in the specifications resulted.

Seven fringe columns (32 pieces each) and two central columns (18 pieces each) of overbore fuel elements irradiated at specific tube powers of 75 to 80 KW/ft and 105 to 120 KW/ft respectively, were discharged at exposures ranging from 765 to 950 MWD/T. About 10 per cent of the projection rail supports were found to be broken or cracked at the bridge-tab juncture. In addition, several bridge sections were missing and several rails were either partially or completely collapsed. A weakness in rail design, influenced by cold work in making the support and subsequent vibration during ultrasonic welding may have been responsible for this problem. Longitudinal abrasion marks across collapsed rails indicate that improper alignment caused by reactor hardware may also have been a factor. Further investigation and development is under way to correct these difficulties.

Approximately 2000 CVIN overbore fuel elements were canned and a prototype eddy current tester (ET-5) was put into use to check the end cap thickness of these fuels.

Surface testing (UT-2) was completed on 10.4 tons of extruded dingot overbore cores vacuum-outgassed-after-heat-treatment.

Irradiation testing of seventy tubes of nickel-plated fuel elements proceeded without incident. An exposure of about 400 MWD/T has been reached. Twenty-four hundred nickel-plated enriched fuel elements have been completed for the 100 tube test in K Reactor.

Development work on a canning process using nickel-plated aluminum components was confined to a 100piece test designed to improve wetting and plate adherence.

Hot press assemblies (661) from the Sylcor Division of Sylvania Electric Products Corporation have been received. The bond strength of one fuel assembly was checked by stud pulling and a uniform and consistent strength of about 21,000 psi was found. Out of reactor testing will be continued.

Improved bond strength and reduced folding in the closure area of the spire have been realized in the preparation of HAPO hot press fuel elements. A production run is planned in early November to confirm results and to further test process effectiveness.

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One hundred sixty fluid pressure bonded fuel elements were received from Savannah River Laboratory. Six assemblies have been prepared for pressure bonding at the Battelle Memorial Institute autoclave facility. An improved nickel plating technique was used on these. Some will be bonded at pressures (10,000 psi) not attainable at SRL. Others will be bonded under SRL conditions.

About 2500 fuel elements were canned in the ALSi Pilot Plant and 1385 of these were for reactor use.

Bond and penetration tester (UE-1) downtime was the lowest in recent months and operating efficiency was 92 per cent. This reflected tester modifications and room shielding, which reduced tester interference. The effectiveness of the UT-2 tester was also increased and an operating efficiency of about 90 per cent was attained.

The UT-4 prototype for testing fuel element closures is operating on a near routine basis. Instrument sensitivity to defects has proven exceptional and the throughput capability is ten fuel elements per minute as predicted.

N Reactor Fuels Development

The seven NPR inner tube enriched fuel elements (NIE) in Loop #1 were discharged. Five had reached an exposure of 2300 MWD/T and two had reached an exposure of 1200 MWD/T. The loop was recharged with five 17-inch NIE fuel elements. The five 23" NIE fuel elements in Loop #2 have reached an exposure of about 550 MWD/T. Goal exposure is 3000 MWD/T.

Processing of NPR prototypic assemblies for modified loops 3 and 4 of KE Reactor was started by the Coextrusion Shop and a goal of 54 assemblies by December 15 has been established.

The Fuels Fabrication Development Operation, Hanford Laboratories Operation, and the Coextruded Product Engineering Operation, Fuels Preparation Department, are working together to produce 10 brazed and 10 non-brazed "modified end cap" (chevron or V-notch) fuel elements for testing in Loop #1.

The six tubes of K I&E² fuel elements charged during August have reached 550 MWD/T exposure. About 400 are also in process in the N Pilot Plant.

Fabrication of 20 NPR prototypic fuels for hot flow testing in the KER facility is about 70 per cent complete.

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HW-71571

National Lead Company of Ohio has cast approximately 1000 ingots. The Bridgeport Brass Company has extruded about 800 of these to satisfy HAP0 requirements during the period when Bridgeport Brass will be moving to Ashtabula, Ohio. The extrusions are being machined at National Lead Company of Ohio at a rate designed to meet HAP0 schedules. Approximately 300 outer tube billets have recently been machined with the following inspection results: 10 per cent acceptable; 10 per cent defective because of extrusion defects; 80 per cent defective because of pitting or porosity. Samples of ingots and extrusions from the whole lot of preproduced metal have been examined and all are affected to varying degrees. The seriousness of these defects is being studied and some will undoubtedly have to be rejected. Preliminary assessments indicate that the defects result from the shorter melting cycle and the colder pour which had been initiated to control carbon.

Outer tube supports have been proof tested and samples are being examined for welding characteristics and collapsing strength. Steel shoe production is under way. Inner tube support fabrication is proving difficult because of fractures during bending. A metal annealing step and other solutions to this problem are under consideration. Locking clips are tooled and proof parts are expected in ten days. End caps are on a full production status. An improvement in the design of rolled and welded copper-silicon outer cladding sleeves has been achieved, which will result in better welds and lower cost. The use of a filler wire technique should increase the reliability of copper can welding although further proof testing is necessary.

Development extrusions completed during October utilized 7-1/2", 6" and 4" tooling and five Zircaloy, five uranium, and sixteen composite extrusions were made.

Difficulties have been encountered in the control of wall thickness during extrusion. A series of tests are in process to determine the effect of billet temperature, graphite cut-off temperature, extrusion ram speed, tooling temperature, lubrication and mandrel techniques on wall thickness variation.

The use of powder metallurgy to prepare 5 per cent beryllium-Zircaloy for brazing end closures offers a potential for drastic price reduction. Although initial development work with two vendors has not solved the problem, the effort will be continued. Preliminary results indicate that various changes in manufacturing techniques may prove successful in providing an acceptable powder metallurgy alloy.

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The three NOT and two NIT tubes, which were pressure bonded at Battelle Memorial Institute, were faced off at the weld and autoclaved. All had failed by the end of 24 hours, indicating incomplete bonding between the Zircaloy-2 end cap and the Zircaloy-2 cladding. Hanford Laboratories Operation is investigating an alloy reported by KAPL as an end closure material for "end closure of Zircaloy-2 clad control rods." This alloy is a 2.5 per cent tin, 2 per cent niobium alloy and is reported to produce a strong diffusion bond with Zircaloy-2. The Fuel Element Development Operation, Hanford Laboratories Operation, will produce and test the effectiveness of this alloy as a closure ring material. Equipment is also being designed to study the vapor deposition of copper, tin, and other metals on Zircaloy-2 in order to test their efficiency as bonding accelerators between the cladding and end caps.

The magnitude of the change in warp during beta heat treating has been shown to be statistically significantly related to both fuel clad thickness and coextrusion variables. A change in the magnitude of beta heat treating warp exists as a result of increasing the outer clad on the inner fuel from 25 to 40 mils. The primary coextrusion process variables include the cooling method for tubes, the transfer conditions between billet soaking and extrusion, and billet soaking temperatures. A comprehensive study of these variables is under way.

The successful method of double reverse bending (cold) and re-beta heat treating to recover pieces warped out of specifications has been expanded to include inner fuels having more than 75 mils double throw warp and outer tubes having more than 30 mils double throw warp.

A production test to evaluate the effects of warp during irradiation and its relation to heat treating cycles and reverse bending is being fabricated.

Progress was made on the design of the equipment for use in 105-KE Viewing Basin. The main function will be to bond test the clad-core and cap-core bonds and to inspect the core for internal discontinuities such as cracks. A desired test to measure cladding thickness in the necked-down region is inherently more difficult and will probably not be available when needed in March, 1962. Over-all design is 50 per cent complete and some orders will be placed soon.

GENERAL

A new record high operating efficiency of 95.8 per cent exceeded the previous high attained in November, 1960.

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HW-71571

No failure of AlSi fuel elements occurred in the autoclaves during the month. Total failures for the year remain at ten.

A new Quarterly Review Production Forecast completed during October reflects a substantial reduction in reactor requirement for the 21 month period covered by the forecast.

PERSONNEL STATISTICS

Number of employees as of September 30, 1961 920

Number of employees as of October 31, 1961 916

	<u>Exempt</u>	<u>Nonexempt</u>	<u>Total</u>
General	1	1	2
Manufacturing	93	383	476
Engineering	46	26	72
Financial	14	8	22
Plant Facilities	48	296	344
TOTAL	202	714	916

<u>Employment</u>		<u>October</u>	<u>September</u>
Additions:	Exempt	0	1
	Nonexempt	4	22
		<u>4</u>	<u>23</u>
Reductions:	Exempt	2	4
	Nonexempt	6	14
		<u>8</u>	<u>18</u>

The two exempt reductions were one transfer to Relations and Occupational Health Operation and one resignation. Nonexempt reductions included three resignations, one deceased, one transfer to CPD and one transfer to IPD.

STAFF

General Manager, Fuels Preparation Department	R. L. Dickeman
Manager, Manufacturing Operation	W. N. Mobley
Manager, Engineering Operation	L. H. McEwen
Manager, Financial Operation	W. S. Roe
Manager, Plant Facilities Operation	E. Hilgeman
Acting Manager, Employee Relations Operation	G. D. Barr

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PATENT SUMMARY - OCTOBER 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 October except as listed below. Such persons further advise that for the period therein covered by this report, note book records, if any, kept in the course of their work have been examined for possible inventions or discoveries.

"A Method of Producing an End Closure on Metal Clad Nuclear Fuel Elements."

..... T. B. Correy

"Improved Techniques for the Elimination of Bond End Porosity for AlSi Bonded Fuel elements."

..... G. R. Hanson

RL Dickeman

General Manager
Fuels Preparation Department

RL Dickeman:mkm

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MANUFACTURING OPERATION

OCTOBER, 1961

CURRENT OPERATIONS

Production

Statistics

	NORMAL					ENRICHED				
	8"	C	K	O		C	K	O		Total
	<u>Solid</u>			<u>Reg.</u>	<u>Bumper</u>			<u>Reg.</u>	<u>Bumper</u>	
<u>Current Month's Production</u>										
Acceptable Fuel Elements Produced (Tons)	-	2.7	270.5	279.7	29.1	0	35.7	37.3	19.6	674.
As % of Forecast Production	-	5	97	194	22	-	81	-	93	97
Cum. % of Forecast for Current Quarter	-	5	97	194	22	-	81	-	93	97
As % of Past 3 Month's Average Production	-	4	107	190	50	-	85	287	46	104
As % of Past 12 Month's Average Production	-	5	113	141	79	-	83	177	65	104
% of Forecast Achieved Last Fiscal Quarter	-	136	97	91	119	106	92	125	98	101
% of Forecast Achieved Last 4 Fiscal Quarters	-	108	105	105	97	84	98	92	93	102

Operating Efficiency

Current Month (%)	95.
Forecast (%)	91.
Previous Month (%)	95.

Manufacturing Yield

Current Month (%)	-	84	87	90	82	-	92	92	-
Forecast (%)	-	86	86	86	82	86	86	86	82
Previous Month (%)	-	90	88	91	85	93	93	-	-

Bare Uranium Available for Processing (Tons)	849
Finished Products in Storage (Tons)	1381
Special Products Finished (Pieces) Boll	188
Uranium Utilization	98.

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Plant Operation - AlSi

Operation of the plant during October was scheduled at a lower rate than that shown on the July forecast. Output of fuel elements, although slightly lower than that shown on the production forecast, was adequate to maintain the current level of inventories of finished fuels.

The October yield for eight-inch I&E fuel elements continued at essentially the same relatively high level as that experienced during September.

The slight decrease in six-inch yield was caused by an increase in the AlSi slopover reject rate from 2.1 percent to 3.3 percent. An increase in the AlSi ring-sleeve mating problem caused this increase even though the preliminary sampling plan reported last month was in effect. Initial data indicate that the improved sampling plan, and component rework plan, both presently in use, will result in better control of this type of defect.

Bumper welding activities were cut back sharply during October, part of which was planned and partly because of mechanical and process difficulties at the welders. The October forecast review showed a decrease in bumper fuel element requirements for November and December, 1961 so the second welder shift per day was discontinued. Due to weak-weld and rail feeder problems; however, output from the bumper welding facilities was somewhat reduced from that planned. Operation of the second welder shift is expected to be restored earlier than previously planned to maintain finished inventory levels.

Production and reactor charging of bumper fuels for October and to date is as follows:

	<u>October (tons)</u>		<u>To Date (tons)</u>	
	<u>Enriched</u>	<u>Normal</u>	<u>Enriched</u>	<u>Normal</u>
FPD Produced	20	29	384	479
IPD Charged	29	49	351	356
Finished Inventory	33	123	33	123
Average Welding Yield	88%	91%		

There was a total of 1,385 CVIN (oversize) fuel elements canned in the 306 Pilot Plant during October. Special Products activities included the canning of 5,318 acceptable bismuth elements, 2,896 of which were moved to finished inventory storage. A core yield of 98 percent was experienced during the month on bismuth element production.

There were no autoclave failures of AlSi Process fuels during October. Total for the year remains at ten.

The inventory of finished fuel elements at month end indicated an increase over the previous month to an equivalent 2.4 month supply based upon projected reactor usage.

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The month-end inventory of bare cores reflected a reduction from the September level to a 1.6 month supply based upon projected fuels process needs. Deliveries of cores from uranium suppliers were 210 tons less than the delivery schedule. Reduced inventories in each of two enriched model cores have required modifications to the November delivery schedule.

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

8" Normal I&E	15,345
6" Enriched I&E	7,521
6" Water Mix	332
Total	23,198

Three scrap shipments containing 40,498 pounds of natural uranium and 25,437 pounds of enriched uranium were made during October.

Plant Operation - Coextrusion

Production through the Coextrusion Shop was influenced during the first half of the month by essential material availability. Significant improvement in the availability of essential material was achieved by month end. Mechanical problems with the leak detectors and process problems associated with the copper wire filler welding of copper cans affected output particularly during the last half of the month.

Following is a total throughput for the major operations during the month of October:

	Inners	Outers
Billet Assembly	5 billets	49 billets
Extrusion	0 "	49 "
Cutup	0 "	692 pieces
Chemical Milling	60 pieces	537 "
Braze	68 ends	812 ends
Heat Treat	33 pieces	352 pieces
Machining	110 "	532 "
Vacu-Blast	82 "	314 "
Welding	0 "	257 "
N.D. Testers	138 "	263 "
Support Welders	12 "	62 "
*Autoclaves	42 "	62 "

*All material processed through the autoclaves was practice material.

A total of 26 extrusions were made for engineering process studies, of which 15 were processed through the cutoff saw after heat treat.

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Manufacturing Engineering

Design and Projects

CAF-847 - New Fuel Cladding Facility

	<u>Scheduled</u>	<u>Actual</u>
Design	100	100
Construction	95	95

The chemical equipment installation contract and the paving contract have been completed. All construction work is now complete except the four additional autoclaves, autoradiograph, and the sprinkler system. Startup work is proceeding.

Initial check out of the new billet heating furnace has been completed. Some modification work remains on this unit before billets will be run through it.

CGF-903 - Projection Fuel Element Modifications

	<u>Scheduled</u>	<u>Actual</u>
Design	100	100
Construction	97	97

Modification to the etch machine exhausts and to conveyor has been started.

CGF-915 - Increased Warehouse Space - 303 Area

	<u>Scheduled</u>	<u>Actual</u>
Design	100	100
Construction	92	93

Major structural and site work has been completed and the sprinkler system has been installed. Remaining work is in the nature of clean up.

CGF-934 - UT-4 Testers, 313 Building

	<u>Scheduled</u>	<u>Actual</u>
Design	93	93
Construction	4	4

Work on the debubbler, electrical, and exhaust facilities has been started.

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Drafting and Files**DECLASSIFIED**

The following drafting work was completed:

New Drawings	46
Revised Drawings	78
Charts	27
Miscellaneous	31

PLANT CONDITIONS, INCIDENTS, AND IMPROVEMENTSAlSi ShopGeneral

A new record high operating efficiency was attained during October exceeding the previous high of 95.7 which was attained in November, 1960. Outages for operational reasons were responsible for 30 percent of the time losses and equipment failures caused the remaining 70 percent. The quench machines were the major contributors to the equipment time losses, accounting for almost half of the total. Canning jacks were also significant contributors to this month's equipment outage times.

As a result of increasing finished fuel element inventory levels, storage space and pallet capacity are causing some inconvenience. By the end of November the inventory level will reach a peak at which time additional storage space is expected to become available in the new warehouse.

The prototype canning line identification stamper has been evaluated on a laboratory basis and found acceptable. It is now in use on one canning line. This device stamps the canning line number on the side of the male end of each fuel element. The installation of stampers on the remaining canning line is being scheduled.

Reject and yield data are now being compiled on a production shift basis rather than "lot" basis. This change was made to provide better data for production control and to improve data feedback. The data system was also expanded to include all phases of the fuel element process, viz, bare core processing, reclamation work, and pilot plant activities in addition to normal production flow information. These attribute data are being processed by electronic data processing techniques, thus permitting more complete routine data analysis and providing a large file of historical information for non-routine analysis.

A high incidence of "AlSi slop" rejects during October led to a careful examination of specifications for incoming aluminum cans. It was found that the specifications governing the amount of upset metal resulting from application of the AlSi grooves had been changed

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HW 71571

earlier in the year to achieve a larger diameter ridge than before. However, under the new specifications, when the upset metal and the outside diameter of the can occur simultaneously near the maximum allowed, the over all diameter is sufficiently large to prevent seating of the can in the steel sleeve. Corrective measures have been taken with the vendor to rectify this problem within the boundaries of the present specifications.

The pressure quench machines have continued to be a major source of canning line downtime. The major problem during the month has been maintaining proper alignment of the bell and the basket. The alignment difficulties have been aggravated by the excessive wear which has been occurring to the basket bushings. New material ordered for the bushings has been received and the first sets were installed late in October. Study of the problem and evaluation of the new bushing material is continuing.

Difficulty encountered in the operation of the bumper welding equipment required the replacement of part of the hydraulic piping of one welder and the disposal of hydraulic fluid containing foreign material. New basket conveyors and new soap tank unloaders are being installed to facilitate the handling of bumper fuels. A new rail feeder has been developed to reduce the rail alignment problems which have been encountered.

The number 4 tester was removed from service this month for complete overhaul and installation of the new reject divider assembly on the tank. Work is scheduled for completion during the first week of November.

Down time for October on the UT-2 testers was 46 tester hours as compared to 36 hours in September; however, this figure includes the time that one test station was out of service for overhaul and modification. There have been no canning line outages due to UT-2 tester down time during this month.

Down time during the month on the UE-1 testers was 47 hours as compared to 74 hours for September. There were no outages serious enough to cause extensive finishing line backlogging or that resulted in canning line down time.

306 Pilot Plant

Reclamation work was continued in the Pilot Plant as 4,285 fuel element welds were machined and re-welded with a 91 percent yield. In addition to the above activities, four AlSi development tests were conducted. Included in these studies were fuel elements etched in Turco caustic for weld studies, fuel elements prepared for nickel plating, nickel plated components canned, and welding tests.

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HW 71571

305 Test Reactor

The routine production testing backlog for the Hanford Test Reactor was reduced to approximately five days. This was accomplished even though the reactor was shut down for one week while the crew was utilized for production of special products (bismuth). Approximately 33 percent of the reactor operating time was utilized for special testing of "poison" splines and graphite bars for plant groups and EGCR, Oak Ridge.

Coextrusion Shop

The leak detectors proved to be the largest mechanical holdup in the extrusion area. Loss of sensitivity made it necessary to clean the leak detectors several times during the month. Plans are being made to replace the diffusion pump oil with a new type of oil.

Installation of the new billet preheat furnace is approximately 80 percent complete. Calibration tests are scheduled on this equipment prior to placing it in service. The straightening press was put in service during the early part of the month with satisfactory performance. A more suitable guard with an interlocking device in conjunction with sliding doors is being designed to replace the present one.

The drive mechanism on the chemical milling horizontal basket was re-designed to use a chain drive. This was necessary because no material could be found for gears which would work in the acid solution. The work should be completed on the basket by the middle of November. Parts for the bright etch agitator have been fabricated and the unit should be ready to operate about the same time.

Excess carbon in the oil caused the 2300 volt starter to the 350 HP motor of the extrusion to ground out. Although no serious interruption in production resulted, inspection of the equipment is being scheduled routinely to prevent recurrence.

The warp problem of NIT pieces during heat treating continued to receive a great deal of attention. Only 5 percent of the NOT pieces processed were rejected for greater than a 30 mil warp. Experiments with straightening these NOT pieces showed moderately satisfactory results.

An evaluation of nozzles for the vacu-blast was continued. Some worked fairly well and lasted through as many as 100 pieces, whereas others experienced earlier failure. A drive motor for the second machine was received on October 23, 1961.

Problems associated with the inner probes and crystals of the non-destructive testers had a significant effect on the operating continuity of the testers. While the autoclaves were being operated for tests and operator training, a considerable amount of maintenance work was required. Major items of difficulty were leaking fittings, leaking filters, and difficulty experienced with the operation of the preheaters.

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HW 71571

The inconsistency of wall thickness of the NOT extruded tubes appears to be a potential problem area. Studies to date have failed to disclose a definite solution. Reasons for the NIT mandrels separating and their reduction in diameter will be pursued with the scheduling of NIT extrusions early in November.

Operating of the beta heat treat conveyor has been satisfactory with the use of baskets to accommodate NIT material and T-bars for processing NOT pieces. The squareness of the cut at the cutoff saw has not improved sufficiently to eliminate the facing operation.

Using specially designed standards it was determined that the internal bond test was incapable of detecting anything but gross unbonds. The test was expected to detect a square unbond 1/16 inch on a side. In reality it cannot reliably detect a square unbond with less than 1/4 inch on a side. Development work to improve this sensitivity is in progress.

Sufficient materials have been assembled, and arrangements made, to autoradiograph all production pieces received prior to the installation of the permanent darkroom facility. The initial production pieces received at autoradiograph have been filmed. No flaws or other rejectable clad characteristics have been found.

A technique has been developed and necessary equipment ordered to assure that the heat treated fuel elements enter the quench bath at the required 680°C. This technique is based on controlling the transfer time between heat treat and quench as a function of established fuel element cooling rates and heat treat bath temperature. The bath temperature will be sensed daily and the transfer time will be recorded on an automatic printing counter.

OPERATING PLANS

The quarterly review of the Fuels Preparation Department Production Forecast was completed and issued during October. For the 21 month period covered by this forecast, reactor requirements were substantially below amounts shown on the last review. In order to support these requirements, it is planned that the AlSi Shop will remain on ten (10) canning line shifts per day operation through most of the period. However, during June and July, 1962, the number of canning lines operated will be reduced to six (6) per day, while AlSi Shop personnel complete their 1962 vacations.

The uranium receipt schedule has been adjusted to maintain adequate working inventories at the lower levels. A planned decrease in receipts over the entire forecast period provides more stability to the receipt schedule and allows time for more operating experience before significant reductions are effected.

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Bumper fuel elements will be produced to supply the normal and enriched fuel requirements for the five old reactors and enriched fuels for the 'K' reactors. This is an increase in bumper fuel element usage from amounts shown on the July forecast, since the recent forecast did not include the Reactor Modification Program as an operating assumption.

FPD HEALTH AND SAFETY

	<u>October</u>	<u>September</u>
Disabling Injuries	0	0
Serious Accidents	0	0
Medical Treatment Injuries	57	50 *
Medical Treatment Frequency	3.94	3.13*

*corrected figures of
previous report

Medical Treatment Frequency Rate year to date is 3.84.

Program Council membership for the six months November through April includes H. C. Money, Chairman; M. G. Petersen, Special Programs; E. N. Wells, Safety Topic; and L. A. Jones, Publicity and Office Personnel Safety Meetings.

The fitting service provided by First Aid for safety glasses has been revised to include disbursement of safety glasses through the first aid station. Employees will be fitted and given their spectacles upon presentation of a store order from their supervisor requesting a pair of plano glasses. The nurse will complete the order by inserting the proper caption number of the pair of glasses dispensed and then process the order through General Stores for replacement of stock.

Job Hazard Breakdown coverage in the Department presently includes 348 completed written breakdowns. Work hazards evaluation will be continued for the purpose of improving safe practices and broadening the coverage of work activities.

Fire Prevention Month programs included a central display depicting home safety, total Department inspections conducted by approximately 70 members of management, a letter to employees from the General Manager, fire safety instruction pamphlets for all employees, safety meeting presentation by selected speakers, special posters for all Department buildings, and a slogan contest for all employees.

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HW 71571

FPD SUGGESTION PLAN

<u>Suggestion Plan Participation</u>	<u>October</u>	<u>September</u>
Number of eligible employees	708	711
FPD Suggestions received	74	53
Annualized rate per 1000 eligible employees	1254	895
Number of suggestions adopted	24	71
Net annual savings	\$4,150	\$7,394
Amount of awards	\$ 666	\$1,515
Percent of total awards to savings	15.8	20.5
Average amount of awards	27.75	21.34

SIGNIFICANT REPORTS ISSUED

HW 71231	Monthly Report, Quality Control Operation, Fuels Preparation Department, September, 1961	10-2-61 A. G. Blasewitz
HW 71272	Uranium Quality Control Analytical Results	10-6-61 G. B. Hansen
HW 71282,	Production Forecast, Fuels Preparation	10-26-61 R. L. Dickeman
Rev. 1	Department, October 1961 through June 1963	
HW 71386	Uranium Quality Control Analytical Results	10-18-61 G. B. Hansen

MANUFACTURING EMPLOYEE RELATIONS

Safety

Members of the Manufacturing Operation sustained 35 medical treatment injuries during October, a frequency of 4.72.

Security

One security violation was experienced during the month involving an unlocked repository containing classified material. The violation was discussed with concerned personnel and control procedures changed to minimize a recurrence of the incident. The repository involved has been removed from use for the storage of classified material.

Radiation and Toxic Material Control

The total exposure received by Manufacturing Personnel for the four week badge period ending September 8, 1961 was 7,686 mrad compared with the average for the last year of 7,230 mrad for the four week reporting periods. There was one exposure over 300 mrad during the last badge period. The revision of the Radiation Work Procedure for bare core testing in the AISI Shop has been completed.

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The beryllium concentration in all eighteen air samples taken during the month was well below maximum acceptable concentration of 2.0 ug/m^3 . The HAPO surface contamination limit for beryllium is 0.01 ug/in^2 . Beryllium approaching this concentration was detected on the wooden platform at the lathe and on top of a transformer in the heat treat areas. The wooden platform at the lathe will be replaced with a steel one to facilitate cleaning. A beryllium control procedure for maintenance work on beryllium contaminated equipment has been prepared and is currently being routed for approval signatures.

Training

In addition to the scheduled classroom instruction, the craft instructor has been providing in the field instruction on both the UT-2 and UE-1 equipment. During the last month, eleven of the non-destructive instrument craftsmen were given a total of 26 hours instruction on an individual basis on circuit theory, operation and trouble shooting.

During this period all electronic prints on both the UE-1 and UT-2 testers were updated by the craft instructor and issued to the non-destructive instrument craftsmen.

The craft instructor is currently following the UT-4 tester construction and testing in preparation for craft instruction scheduled to start in November. Complete electronic prints are not available for this equipment at the present time because circuit revisions are still being made on the prototype.

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 October.

Manager - Manufacturing

WNM:HFT:mr'b

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FUELS ATTRIBUTE DATA

8" NORMAL

8" BUMPER

6" NORMAL

6" BUMPER

PUEBLO AIRPORT DATA

8"

6"

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B-13

ENGINEERING OPERATION

October, 1961

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VISITORS

<u>Name</u>	<u>Company</u>	<u>Contact</u>	<u>Date</u>	<u>Reason</u>
W.J. Devine	AEC, Washington	L.H. McEwen	10/18/61	Attend N-Fuels
B. Schwartz	AEC, Washington	"	"	Program Review
B.M. Robinson	AEC, Oak Ridge	"	"	Meeting.
	Operations Office			
N.J. Donahue	AEC, Savannah River	"	"	"
	Operations Office			
C.L. Karl	AEC, Fernald Area	"	"	"
	Office			
W.T. Warner	AEC, Fernald Area	"	"	"
	Office			
E. Lewis	Bridgeport Brass	"	"	"
	Adrian, Mich.			
J.F. Puterbaugh	Bridgeport Brass	"	"	"
	Adrian, Mich.			
R.C. Pugh	duPont, Wilmington	"	"	"
M.H. Wahl	duPont, Wilmington	"	"	"
W.E. Tragert	GERL, Schenectady	"	"	"
D.W. White	GERL, Schenectady	"	"	"
J.A. Fellows	Mallinckrodt Chem.	"	"	"
	Works, St.Louis, Mo.			
C.E. Bussert	National Lead Co.	"	"	"
F.L. Cuthbert	Cincinnati, Ohio	"	"	"
C.E. Polson		"	"	"
P. Loewenstein	Nuclear Metals, Inc.	"	"	"
	Concord, Mass.			
W.J. Devine	AEC, Washington	L.H. McEwen	10/19/61	Attend Fall
B. Schwartz	AEC, Washington	"	"	Meeting, Fuel
B.M. Robinson	AEC, Oak Ridge	"	"	Element Develop-
	Operations Office			ment Committee
N.J. Donahue	AEC, Savannah River	"	"	"
	Operations Office			
C.L. Karl	AEC, Fernald Area	"	"	"
	Office			
W.T. Warner	AEC, Fernald Area	"	"	"
	Office			
M.H. Wahl	duPont, Wilmington	"	"	"
J.A. Fellows	Mallinckrodt Chem.	"	"	"
	Works, St.Louis, Mo.			
F.L. Cuthbert	National Lead Co.	"	"	"
	Cincinnati, Ohio			

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HW-71571

VISITORS (Continued)

<u>Name</u>	<u>Company</u>	<u>Contact</u>	<u>Date</u>	<u>Reason</u>
R.A. Graham	Wah Chang Corp. Albany, Oregon	G.W. Riedeman S.M. Gill	10/2/61	Negotiate Qualification Contract for cladding shells.
H.F. Sawyer	Nuclear Metals, Inc. Concord, Mass.	S.M. Gill G.W. Riedeman C.H. Shaw W.K. Alexander T.R. Groupman	10/9 & 10/10/61	Consult on copper can and welding problems.
R.A. Quadt	Reactive Metals Niles, Ohio	G.W. Riedeman	10/13/61	Technical consultation on N-fuel components.
P. Loewenstein	Nuclear Metals, Inc. Concord, Mass.	W.K. Alexander	10/17 & 10/18/61	Consult on contract.
L.L. Becker	Bridgeport Brass Riverside, Calif.	G.W. Riedeman	10/17 & 10/18/61	Consult on contract.
J. Posakony J. McElroy	Automation Indus. Boulder, Colo.	C.J. Denton	10/3-4 & 10/5/61	Discuss nondestructive testing.
L. Langford	Automation Indus. Seattle, Wash.	"	"	"
P.D. Edwards	IASI, Los Alamos, New Mexico	D.C. Worlton	10/30/61	Discuss nondestructive testing techniques.

TRIPS

<u>Name</u>	<u>Company</u>	<u>Contact</u>	<u>Date</u>	<u>Reason</u>
E.A. Weakley J.T. Stringer	National Lead Co. Fernald, Ohio	F.L. Cuthbert	10/4-5/61	Discuss uranium technology and specifications.
	Mallinckrodt Chem. Works, Weldon Spring, Missouri	R.F. Hartmann	10/6/61	"
M.F. Zeuschel	Argonne National Lab. Chicago, Ill.	---	10/3-7/61	Attend symposium on nondestructive testing.
R.L. Brown, Jr.	Detroit, Mich.	---	10/22 - 10/28/61	Present paper at National Convention of the Society for Nondestructive Testing.

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TRIPS (Continued)

<u>Name</u>	<u>Company</u>	<u>Contact</u>	<u>Date</u>	<u>Reason</u>
G.W. Riedeman	Torrance Brass Foundry, Los Angeles, Calif.	C.A. Spurrier	10/4/61	N-Reactor fuel cladding component development.
	Bridgeport Brass Riverside, Calif.	C. Hoehne	10/5/61	"
	Westmetal Products Los Angeles, Calif.	A.H. Neubauer	10/5/61	"
	Airline Welding & Engineering Gardena, Calif.	H. Meredith	10/6/61	"
	U.S. Chemical Milling Manhattan Beach, Calif.	G. Scates	10/6/61	"
I.V. Nelson	Nuclear Metals, Inc. Concord, Mass	H.F. Sawyer	10/19/61	Discuss Zr. pin welding.
	National Research Corp. Boston, Mass.	P. Clough J. Dolan	10/20/61	Discuss evaporation and cathodic sputtering.
G.W. Riedeman S.M. Gill	ASM Metals Show Detroit, Mich.	---	10/23/61	Attend Show.
	Metallurgical Prod. Detroit, Mich.	R.J. Stuligross	10/24/61	Discuss Zircaloy developments.
	National Lead Co. Cincinnati, Ohio	C.E. Bussert	10/25 & 10/26/61	Discuss uranium technology.
	Mallinckrodt Chem. Works St. Charles, Mo.	N. Neumann	10/27/61	"
K.W. Norwood	National Lead Co. Cincinnati, Ohio	F.L. Cuthbert	10/4-5/61	Plant orientation and discussion of fuel element quality data.
	Mallinckrodt Chem. Works Weldon Spring, Mo.	R.F. Hartmann	10/6/61	"
L.T. Hagie	MSVD, GE Philadelphia, Pa.	J.S. Youtcheff	10/2/61	Data processing and statistical analysis.
	National Lead Co. Cincinnati, Ohio	F.L. Cuthbert	10/3-5/61	Data processing of feed site data.
	Mallinckrodt Chem. Works Weldon Spring, Mo.	R.F. Hartmann	10/6/61	"

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PERSONNEL

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Additions

<u>Name</u>	<u>Title</u>	<u>Reason</u>	<u>Date</u>
S. K. Caldwell	Steno-Typist	Temp. to Permanent	10/16/61
N. C. Davis	Technician	Transfer from FPD-Mfg.	10/16/61
A. B. Johnson	Engineer, Proc. & Dev.	Transfer from FPD-Mfg.	10/1/61

Removals

W.B. Anderson	Engineer, Proc. & Dev.	Resigned	10/12/61
A.C. Barkoff	Technician	Transferred to FPD-Mfg.	10/23/61
E.E. DuPuy	Stenographer	Resigned	10/16/61
G. Miller	Engineer, Proc. & Dev.	Transfer to FPD-Mfg.	10/1/61
D.R. Thorson	Technician	Deceased	10/11/61

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

"A Method of Producing an End Closure on Metal Clad Nuclear Fuel Elements"
T. B. Correy, 10/9/61

"Improved Techniques for the Elimination of Bond End Porosity for AlSi Bonded Fuel Elements"
G.R. Hanson

SIGNIFICANT REPORTS ISSUED

HW-61276, "A Method of Producing an End Closure on Metal Clad Nuclear Fuel Elements", T. B. Correy, 10/9/61 (Unclassified).

HW-71334, "Heat Treating and Warp of NPR Fuel elements", A. E. Guay, 10/13/61.

SECURITY

Two security violations were recorded in Engineering in October. Violations CY to date total seven.

ALSI PRODUCT ENGINEERING

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Fuel Performance & Requirements

Three (3) natural and eight (8) enriched fuel elements failed in the reactors during October. Two (2) of the eleven ruptures were caused by mechanical damage during charging. A summary of these ruptures is as follows:

<u>Fuel Element Type</u>	<u>Tube and Reactor</u>	<u>Exposure (MWD/T)</u>	<u>Rupture Classification</u>	<u>Failure Date</u>	<u>Canning Date</u>
I&E Natural	*2762 D	758	Hole (Cap End)	10-10-61	3-16-61
	**2377 F	274	Split (Transverse)	10-29-61	3-25-61
	**2369 F	337	Split (Transverse)	10-31-61	6-21-61
I&E Enriched	*1978 H	109	Mechanical Damage	10-5-61	5-11-61
	3985 DR	582	Side Hot Spot	10-10-61	4-18-61
	2576 C	230	Side Hot Spot	10-12-61	7-21-61
	1460 DR	285	Mechanical Damage	10-15-61	8-11-61
	2658 DR	498	Side Other	10-20-61	4-10-61
	*4173 DR	1017	Hole (Cap End)	10-23-61	5-12-61
	2271 C	386	Side Hot Spot	10-26-61	7-21-61
	2987 DR	389	Side Other	10-27-61	8-11-61

* "Bumper" Fuel

** Dingot Fuel

The fuel performance trend was relatively unchanged. Total ruptures sustained in October was two more than for last month, and four more than experienced during the same period a year ago under severity of service conditions that were about 2-fold lower than present levels. Fuel assembly oriented ruptures (2 hole and 2 side other) continue to emphasize the importance of process innovations and control to minimize weld and braze closure defects. The third and fourth transverse splits (previous I&E splits were in June and July, 1961) in dingot uranium are similar in appearance to the earlier split failures. The first split rupture was emitting gas and was canned after brief examination. The other split appeared to have several transverse cracks. These ruptures are scheduled for further examination in Radiometallurgy Laboratory to determine the cause of failure.

Difficulties

Installation and charging of 21 additional overbore tubes to complete the expansion of the C Reactor test facility to sixty-two (62) tubes has been deferred by IPD until early December. Seven fringe columns (32 pieces each)

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HW-71571

and two central columns (18 pieces each) of overbore fuel irradiated at maximum specific powers of 75-80 KW/ft. and 105-120 KW/ft., respectively, were discharged at exposures ranging from 765 to 950 MWD/T. Five of the fringe columns in aluminum process tubes discharged at pressures of 3500 to 5000 psi, as compared to discharge pressures of less than 3300 psi (charging machine capacity) for the two central columns and one fringe column in zircaloy tubes. Visual examination of the fuel elements in C-Basin has not accounted for the higher discharge pressure; however, an estimated 10 percent of the projection rails were cracked or broken at the bridge-tab juncture. In addition, the bridge was missing on some supports, and several of the rails were either partially or completely collapsed. Downstream pieces with the bridge section of the rails missing showed light to medium hot areas and pitting of the cladding, indicating the presence of the rail tabs may have prevented corrosion failures. Longitudinal abrasion marks across the entire length of the rails that were collapsed, suggests the rails were collapsed as a result of improper alignment or design of reactor hardware. The observed weakness in the rail design at the bridge-tab juncture was apparently influenced by the amount of cold work introduced during rail stamping from X-8001 alloy plate, coupled with the vibration and flexing incurred during ultrasonic welding, which tends to stress or fatigue the rails at this point. Relief of the stamping dies to strengthen juncture and annealing of the rails is being investigated as possible means of alleviating this problem. If through further investigation and development effort, the aforementioned problems cannot be corrected, an alternate rail design may be required. Three fuel elements have been selected for a more detailed examination in Radiometallurgy.

Quality certification data from 80 tubes recently discharged indicate a downward trend in fuel warp but a slight increase in diameter growth as measured following irradiation. The average values for warp, tube filling capacity, and fuel element center O.D. of fuel elements canned between November, 1960 and June, 1961, and irradiated in 1961 were:

	<u>WARP</u>	<u>TFC</u>	<u>OD₂</u>
AVERAGE, MILS	3.8	10.9	4.1
AVERAGE MAXIMUM, MILS	16.7	21.9	13.6

These averages represent a 21 percent decrease in warp, with 3 and 8 percent increases in TFC, and OD₂ values, respectively, over the values* for the period November, 1959 to November, 1960. The principal differences between reporting periods were the conversion from OIII to OIII and KIII to KIV fuel geometries and decreases in reactor tube power during the summer months (latter period).

* HW-70920 Engineering Operation, Fuels Preparation Department Monthly Report, August, 1961, L. H. McEwen, 9-7-61.

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HW-71571

Uranium Technology

Approximately 303 tons of additive dingot and uranium were being irradiated and 811 tons had been discharged by the last of October. Two failures occurred in regular dingot lots at 274 and 337 MWD/T that were classified as transverse split and one failure occurred in a control ingot lot at 758 MWD/T that was classified as an internal failure. This makes a total of 15 dingot failures (4 have been transverse splits) and 10 control ingot failures to date. The split failures this month will be sent to the Radiometallurgy Laboratory for examination. About 102 and 40 tons of vacuum-outgassed-before-heat treatment OIIIIN and regular KIVN virgin dingot cores, respectively, were canned this month. Conversion of the dingot cores to the KIVN model at both feed sites is now complete. Until the cause of the four transverse split failures in dingot uranium has been established, the restriction limiting additive dingot cores to 125 tons/month will be continued.

The Quench Crack Circuit in the UT-2 testers rejected three quench cracked recovered cores this month. One was a "Mud-Flat" Standard used in adjusting the testers that had been lost. The other two were dingot cores; one heat treated by NLO, the other by MCW. Neither core had the same dingot number as the previous quench cracked dingot cores found in June, but they were shipped to HAPO at about the same time.

Four normal uranium cores were found by our chemical analysis audit of one core per incoming lot that exceeded our maximum limit on carbon of 750 ppm. The four cores analyzed 768, 777, 810 and 827 ppm carbon. NLO was contacted to try to prevent future shipments of out-of specification ingot cores.

UT-2 and surface testing of 10.4 tons of vacuum-outgassed-after-heat-treatment extruded dingot CVIN overbore cores was completed this month. The grain reject rates were 0.4, 4.1, and 1.9 percent for large grains, fine grains, and grain variation, respectively. The surface tests rejected 1.4 and 2.0 percent for internal and external defects, respectively.

A joint meeting of NLO, MCW, AEC, SRP and HAPO personnel was held at Fernald on October 4 and 5 to discuss uranium core specifications, methods of reporting data, and proposed uranium core irradiation tests. The major changes to the core specifications were:

1. Ingot and Dingot Chemistry

a. New elements added:

Aluminum	150 ppm	Maximum
Cadmium	0.25 ppm	"
Copper	75 ppm	"
Zirconium	100 ppm	"

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HW-71571

B. Revisions

Iron	185 ppm	Maximum
Silicon	140 ppm	"
Iron plus Silicon	100 ppm	Minimum

2. A specification for both ingots and dingot-bars of 2.5 ppm maximum for non-outgassed material was established with a provision that 3 percent of the cores can be produced from ingots or dingot-bars having 2.6 through 3.0 ppm hydrogen if the high hydrogen material is segregated into special lots called Class III cores.

3. Grain Size

An FEDC grain size of A-3 through A-7 was established.

No specification was agreed upon concerning ingot charge make-up, but an agreement was reached with NLO to group the ingots into identifiable lots according to the briquette content for shipment to HAP0 as follows:

Class X - 23 through 27% Briquettes

" Y - Less than 23%

" Z - Greater than 27%

" W - Unidentifiable cores such as bar ends, regrinds, Class II O.D., Class III, and waived material.

Process Development

Irradiation testing of seventy (70) tubes of nickel-plated fuel elements in 105-DR proceeded without incident. The exposure range as of November 1 is 350 to 400 MWD/T, with an approximate 400 MWD/T goal. Included are both 0.2 mils and 0.5 mils thick plate with ten (10) special pick-up charges of each, and two tubes being sampled for effluent contamination.

Preparation of nickel plated enriched fuel elements for the 100-tube test in K Reactor included canning of approximately 1100 fuel elements and finishing approximately 2400, including 1300 which were canned during September. Plating with a .1-.2 mils thick coating, initiated in mid-october, proceeded without incident throughout the plating of approximately 600 pieces. It was then observed that nickel adhesion was gradually deteriorating.

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Based on preceding experience, contamination and age of the plating bath were major factors affecting adhesion. Although the bath usage was at only approximately 50 percent of its expected life, the bath was discarded and the system thoroughly cleaned. A subtle change in the surface appearance of the fuel elements after the final zinc deposition step (immediately prior to plating) had also been observed. Hence, the zinc deposition bath was also replaced. Subsequently, nickel adhesion was vastly inferior to anything produced before. Further investigation revealed the poor adhesion coincided with use of two particular containers of a proprietary compound used to make up the zinc deposition bath. Tests using material from a third container received in a different shipment are underway at present, along with chemical analyses, which it is hoped will aid in characterizing the behavior of the zinc deposition.

Of the 600 fuel elements plated, approximately 80% will be accepted for use, with 5-10% rejects due to mechanical damage of the weld head by the plating rack (which is being reduced by improved handling techniques) and about the last 10 percent plated will be rejected for marginal plate adhesion. Plate porosity in fuel elements, determined by overnight immersion in the caustic cleaning tank (initially @ 80° C) has markedly improved with 0 to 3 pores/fuel element, compared with 10 to >50 pores/per 8-inch C-64 alloy fuel element core, used in preceding tests.

Development of the canning process using nickel-plated aluminum components was confined to a 100 fuel element test, employing a variety of baking and cleaning treatments for the components and a device to improve wetting the underside of the cap by mechanical abrasion. The abrasion effected some improvement, with 80-100% wetting on 14 fuel elements using a 15 second pulse vibration, followed by abrasion, while without abrasion a 40 second period of pulse-vibration produced generally 80-95% wetting, but with two out of 13 pieces 0 to 40% wetted. The starter pulse vibration and pre-assembly conversion time also maintained greater strength and straightness of the spire, thus reducing assembly rejects. A small proportion (15%) of the components used were coated with a low phosphorous (4-5 wt.%) plate. These appeared to behave the same as the normal plate, which is 7 to 9 wt.% phosphorous.

Development of chromic-acid autoclave films on X-8001 alloy aluminum (by HLO Coatings and Corrosion) included statistical analysis of weight-loss data from accelerated corrosion tests, and preparation of a report. In summary, the most corrosion resistant films may be produced by autoclaving for three hours in water followed by 27 hours in 1 wt.% chromic acid, both at 250° C. Reducing the temperatures to 170° C (approximately the same as current production autoclaves) still provides good corrosion protection, with factors of 15 to 25 improvement over water autoclaving only. In view of the preceding encouraging in-reactor experience with

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HW-71571

chromic acid autoclave failures,* it appears that in-reactor testing of the improved process might be carried out, omitting the time consuming and sometimes inconclusive ex-reactor flow-tube tests.

Alternate Process

Sylcor Hot Press

The contract with Sylcor Division of Sylvania Electric Products has been completed. The first shipment of 388 pieces was received on October 11, 1961. A second shipment of 273 pieces was received on October 30, 1961. These 661 pieces represent the yield from 835 core blanks shipped to Sylcor in May, 1961. The initial checking of the fuel elements has shown that the male contour was out by over .050" on total height. This was corrected on all the initial 388 by reworking except on those that had been welded by Sylcor prior to shipment (66 pieces). The welding cycle has been determined for this fuel element configuration and this is presently being completed. The bond strength on one fuel assembly was checked by stud pulling and an average of 21,000 psi was obtained. The bond strength was uniform and consistent over all areas checked. This suggests that the bonds are probably very good. Out-of-reactor testing of the Sylcor pieces is continuing.

HAPO Hot Press

The work the past two months has been directed towards improving the internal bond and elimination of the folding problem in the closure area on the spire surface. The improvement in the internal bond has been gained by increasing the pressing pressure from 16 TSI to 18 TSI. The spire folding problem has been determined to be a function of strength of the aluminum alloy. The metal can be sufficiently softened by increasing the cycle preheat to anneal the spire completely. The cycle that will be used during the next bonding run will be 15 minute preheat, 1 minute pressing with a pressure of 18 TSI for pressing.

Problems with the electric cartridge heaters have forced a two-week delay in the production run. It is now planned to start the production run on November 6, 1961.

Fluid Pressure Bonding

During May, 1961, 160 fuel assemblies were shipped to the Savannah River Laboratory for fluid pressure bonding. The bonding of these assemblies

* HW-55016, (SECRET), "In-Reactor Corrosion of Fuel Elements Autoclaved in 1% Chromic Acid", Bruce Griggs, 3-4-58.

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was completed during September. The fuel assemblies were received at HAPO on October 12, 1961. No testing work has been completed on these pieces.

Discussions with SRL personnel suggested that the nickel plating of the fuel assemblies could be improved and better bonds would result. It was suggested that sufficient components be shipped to them for making 12 assemblies. These assemblies would be electro-nickel plated by them and pressure bonded at SRL. The components were shipped on October 23, 1961.

In addition, six assemblies have been prepared for pressure bonding at the Battelle Memorial Institute autoclave facility. An improved nickel plating technique was used on these assemblies. Some of the assemblies sent to BMI will be bonded at pressures (10,000 psi) not attainable at SRL; others will be bonded at conditions similar to those at SRL to determine the effect of the nickel plating process change.

Hot-Die Sizing

The initial shipment of 827 cores and the shipment of 637 cans has been received at HAPO for producing hot-die sized fuel elements of the CV configuration.

Process Technology

Approximately 15171 enriched and normal bumper fuel elements were manufactured during the month with an overall yield of 89.1 percent compared to 93.3 percent for September. The loss in yield has been mainly due to a 3.5 percent increase in the rejects due to alignment and mechanical functioning of the rail feeding equipment.

The drying rate of elements as they leave the soap solution was found to be critical to ultrasonic weld strength. This was not evident during Pilot Plant development since a manual soap dip was used. Temporary blowers were installed on the Manufacturing automatic soaping tank to facilitate rapid drying. The average weld strength has been maintained at a high level. A permanent blower system is to be installed.

Ten charges of solid elliptical bumper fuel elements were produced during the month. Half of the elements had inclusions after autoclave. The included material apparently was silicon and appeared to be in the jacket at fabrication. It was decided not to use the material for the primary evaluation of elliptical bumper elements. Test and control elements were prepared from another material and will be ready for reactor use the first week in November. No difficulties were encountered with ultrasonic welding of the elliptical rail. The average tensile-peel strength of the quality control samples was 63.9 pounds.

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HW-71571

Approximately 2,000 overbore (CVIN) fuel elements have been canned and are currently being finished and tested to provide replacement charges for the C Reactor test facility.

A prototype ET-5 eddy current tester has been calibrated and evaluated for non-destructively checking the end-cap thickness of overbore fuel elements. The results indicate the tester is accurate and reliable for this purpose. Other potential uses include auditing the cap and base thickness of regular fuel production, and recovery of certain types of fuel element length rejects.

306 AlSi Pilot Plant Achievements

One manual welder and its A.C. power supply have been relocated adjacent to the semi-automatic D.C. Welders. It will be used for the weld recovery operation, which was transferred from Special Products in 313. This work requires about 90 man-hours per month, and will be used as fill-in work to utilize the crew. The manual weld booth partitions and associated equipment have been removed to make room for the testers, and the Bond and Pen tester re-located to make room for the office re-location. All equipment re-location is being carried out in accordance with the master layout for a "complete" Pilot Plant. Modifications to the ultrasonic welder to accommodate CVI size fuel elements have been completed. The pressure quench machine is being modified to match the production machines in 313 Building. This work, along with additional improvements, is scheduled to be completed November 1.

During the month, 2,477 fuel elements were canned in the Pilot Plant, of which 1,385 were for reactor use. In addition, 1,400 nickel-plated pieces for Reactor use were Turco etched.

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COEXTRUDED PRODUCT ENGINEERINGN-Reactor Fuel Development**DECLASSIFIED**KER Loop Testing

The seven NPR inner tube fuel elements in Loop 1 were discharged this month (10/28/61). Five of the discharged elements were 17-inch NIE-1 elements charged 5/28/61 and at an exposure of about 2300 MWD/T. The other two elements were 17-inch NIE-1's charged 7/17/61 and at an exposure of approximately 1200 MWD/T. The loop was re-charged with five 17-inch NIE-1 elements.

The five 23-inch NIE-1 elements charged 9/17/61 in Loop 2 are operating satisfactorily to date and are now at approximately 550 MWD/T with a goal exposure of 3000 MWD/T.

Examination of the cross section at a support location on a companion NIE-1 fuel element from Loop 4 by Radiometallurgy has given no indication of the possible failure mechanism of the suspect rupture element discharged in April. The element has been shipped back to KE reactor basin for further studies.

Processing of the NPR prototypic assemblies for modified Loops 3 and 4 of KE reactor was started this month by the Coextrusion Shop with a goal of 54 assemblies by December 15th. The selection of billets and components and the actual processing is to be prototypic, but extra data on conditions, measurements and examinations is to be recorded for subsequent analyses.

The fabrication of two coextruded NIE tubes (T-258 and T-304) to 17-inch elements has been started in the 306 Pilot Plant. These two tubes will be fabricated into 10 brazed and 10 non-brazed "modified end cap" (chevron or V-notch) design fuel elements for Loop 1. Fuel Fabrication Development Operation (HLO) and Coextruded Product Engineering are working together to produce these test pieces.

Coextruded I&E² Program

The six tubes of K-I&E² fuel elements charged during August are at about 550 MWD/T and operating satisfactorily. There are approximately 400 K-I&E² fuel elements in process in 306 Pilot Plant with about 30 elements in storage.

Production Test Fabrication - Pilot Plant

Work has been performed on fabricating 20 NPR prototypic fuels for hot flow tests in the KER test facility. Progress has been delayed due to operational problems encountered in the abrasive blaster. Fabrication work is about 70% complete.

A production test is being fabricated to evaluate the effects of warp during irradiation and its effect in relation to heat treating cycles and reverse bending. This test consists of two groups, five each of 23-inch NIE's. The first group had less than 30 mils double throw warp after the initial heat treat.

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HW-71571

The second group was warped in excess of 75 mils on the initial heat treat and was reverse bent and reheat treated. These elements were in-process in the 333 Production Facility and are being finished in the pilot plant.

A backup charge for Loop 2 KER test facility is approximately 75% complete. These are 23-inch NIE fuel elements - Tubes 226 and 227. Five reactor grade fuel elements are required for the charge.

Materials Development and Procurement

Uranium Billets

National Lead Company of Ohio has cast approximately 1,000 ingots, NOE and NIE combined, of which Bridgeport Brass Company has extruded approximately 800 to satisfy HAPO requirements during the period Bridgeport Brass will be shut down while moving to Ashtabula, Ohio. The extrusions are being machined at National Lead at a rate meeting HAPO schedules and large quantities are already in HAPO inventory.

Approximately 300 outer tube billets have been machined recently with the following inspection results:

- 10% acceptable
- 10% defective because of extrusion defects
- 80% defective because of pitting or porosity

The extrusion defects can be characterized as two groups: One, massive graphite inclusions in the surface; two, metal smears, or slivers on the OD. The pitting, or porosity, appears to have been caused by an excessive accumulation of impurities within the cast ingot. These imperfections have been found with equal frequency as much as one and one-half inches below the OD surface by successive machining cuts and are definitely not a surface phenomenon. Samples of ingots and extrusions, of both NOE and NIE geometries, from the whole lot of preproduced metal have been examined and all are affected to varying degrees. Some will undoubtedly have to be rejected. The defects are being studied.

Preliminary assessment indicates the defects are the result of a shorter melting cycle and colder pour in an effort to control the carbon content which had been giving trouble.

Zircaloy Components

Fuel Supports

Outer tube supports have been proofed and samples are being examined for welding characteristics and collapsing strength. Upon satisfactory completion of these tests, production will be released.

Steel shoe production is released. Delivery is expected within days.

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HW-71571

Inner tube supports have proven difficult to fabricate in that 0.035-inch strip cannot take the bending required during forming without fracturing without an intermediate anneal. An intermediate anneal was not scheduled and will be difficult to incorporate into the process. All development parts fabricated without an anneal here at HAPO were of 0.030-inch strip. In increasing thickness to 0.035-inch, the strip breaks. The vendor can fabricate at 0.031-inch but not at 0.032-inch. there are several solutions to this problem, but as yet it is still under consideration.

Locking Clips

Locking clips are tooled and proof parts are expected in about 10 days.

End Caps

After a recent design change, the end caps are again in full production. No further problems.

Copper Sleeves

An improvement in the design of rolled and welded copper-silicon outer cladding sleeves has been achieved. The result is in better welds and lower cost.

A development order for seamless copper-silicon, sleeves originally planned at 3% silicon, has been altered to purchase an alloy of 1.0-1.5% silicon. The lower silicon material casts and extrudes much better than the original alloy. Preliminary welding tests show no deterioration.

Extrusion Process

Extrusions

The following extrusions were made during the month:

7-1/2 Inch Tooling

Two Zircaloy Billets (bare)-Zr-121 and 122
4-inch rod for HLO
Three Uranium Billets-U-86, 87 and 88 - Upset 1.6 enriched for HLO.
Ten Composites - X-1, 3, 4, and 5; L-1; T-300 through 303 and 308
X-1, 3, 4, and 5 - Special billets for interface cleanliness
and bonding studies.
L-1 - Dual enriched single tube for HLO
T-300 through 303 & 308 - Standard NOE

6 Inch Tooling

Three Zircaloy Billets - Zr-118, 119 and 120
Zr-118 & 119 - For copper diffusion studies
Zr-120 - NIE shroud tube

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HW-71571

6 Inch Tooling (cont.)

Six Composites - T-304 through 307 and ZT-1 and 2
T-304 & 305 - Standard NIE
T-306 & 307 - Standard I&E²
ZT-1 and 2 - NIE billets with three piece outer clad shells
representing each vendor

4 Inch Tooling

Two Uranium Billets - U-89 and 90
Both billets extruded bare to I&E size at 700°F and 9X
reduction.

Wall Thickness Variation (Outer Tube)

Considerable difficulty has been encountered with wall thickness control on NOE extrusions. The major portion of the large variances (exceeding $\pm 3\%$) occurred at the middle and rear of the extrusions. The exact cause or causes for these variances are not known. A series of tests have been initiated and are in process to determine the effect of billet temperature, graphite cutoff temperature, extrusion ram speed, extrusion tooling temperature, lubrication techniques, and mandrel techniques on wall thickness variation.

Inner Clad Thickness Variation (Outer Tube)

Approximately 10 to 15% of the first outer tube elements at final inspection were rejected due to variation in inner clad thickness (nondestructive tester results). These rejects are now being autoradiographed to confirm tester results.

Ten of the first thirteen pieces rejected were at the front or rear of the extrusion and were rejected for variation on the thick side. Very little data is available on this problem to date. However, due to the location of the large variances (front and rear) and the fact that the cladding is thick may indicate that some preshaping of the inner clad component could possibly reduce the number of rejects.

Post Extrusion Development

Tube Cutting

The capabilities of the abrasive cutoff saw have been thoroughly defined. It was found that NIE material could be cut within one-half degree of square, but NOE material could not be cut with this accuracy at reasonable production rates. It was therefore recommended that the tubes be subsequently faced on a lathe which allows maximum cutting speeds on both sizes of tubing.

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HW-71571

Billet Assembly - Copper Welding

As has been previously reported, considerable trouble has been experienced in the past in attempting to weld commercial grades of copper into coextrusion cans reliably, while 3% silicon copper alloy appears to weld satisfactorily. Because the properties of copper may be somewhat better for the coextrusion process, additional development work has been concentrated in the area of attempting to produce sound and reliable welds on the copper can. To improve the welding, development has concentrated on the filler wire technique in conjunction with the TIG process since alloyed filler wire can be used to take advantage of the welding properties of the silicon bearing copper and the coextrusion properties of pure copper. An automatic wire feed mechanism was installed on the welder in 333 Building and has been used for this development work. Because of the placement of the evacuation tube on one end of the billet, it has not been possible to use the automatic feed mechanism to make the inner weld on this end of the can, and this weld has been made by adding filler metal manually. The other welds have generally been made with the automatic feed device. The filler wire used in the development work has been .030 inches diameter Oxweld 26 (3.4% silicon) and Oxweld 63 (0.28% silicon). In the initial test, two copper (DHP grade) cans containing only uranium billets and copper preforms were welded, one with each grade of welding wire and subsequently processed through a standard coextrusion preheating cycle. Subsequently, both cans were still vacuum tight. A second test was performed on four similar assemblies. One of the inner welds appears to be quite light and could easily have been repaired manually but was used in an attempt to determine some guide as to the penetration required. This weld failed during the test, but all other welds remained vacuum tight. One of the good billets was extruded and the bond was satisfactory in all respects.

In order to permit machine or automatic feeding for all of the welds, the evacuation tube hole is being moved nearer to the OD on the end cap and some modifications are being made to the machine feed. An additional automatic feed mechanism is being procured for the pilot plant equipment in the 306 Building.

It appears that the use of filler wire technique should permit the welding of commercial grades of copper reliably, although further proving is necessary. In addition, it is planned to teach Manufacturing operators manual welding for this process inasmuch as it appears that occasional hand welding will be needed.

Chemical Milling

Further development work is being conducted on horizontal milling of NPR fuels. Analysis of data from recent tests indicates depth tolerances obtained by horizontal milling are not as close as produced by vertical milling. Further development work, such as reverse rotation and solution adjustment will be performed to try to improve depth tolerance, although the current process does meet specification requirements.

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HW-71571

Braze Closure Development: Alloy Fabrication Development

The use of powder metallurgy to prepare the 5% beryllium-zircaloy alloy used for brazing of the end closure conceivably offers a significant economic advantage over the present methods of making these braze rings. Development work with two potential vendors has indicated that the problems of making satisfactory braze rings by powder metallurgy techniques are not yet solved. Materials submitted from Vendor A has not quite been able to meet corrosion requirements, nor has it had fluidity satisfactory to fill the cavity required in brazing of the end closure. It appears that additional work, however, may perfect techniques to permit braze alloy to be manufactured by the specific techniques that this vendor uses.

Vendor B is using a slightly different technique and has produced a somewhat more satisfactory product although the the ability to flow, or fluidity, is not yet quite satisfactory. Because of the high cost of the material now being procured and the significant potential for drastic price reduction, work will be continued on application of powder metallurgy techniques to the fabrication of this material.

Beta Heat Treating

Warp in N-Inner Tubes During Initial Production in 333 Building

The beta heat treating of the first N-inner fuels in the 333 Building has been carefully monitored.

Rather than load five fuel pieces at each conveyor position, only one piece was charged. With this arrangement, it was possible to unload the pieces as they emerged from the nitrate:nitrite quench and measure their warp at 300°C. Because the warp of the pieces had been measured at 300°C prior to beta heat treating, a complete set of vector quantities could be calculated, these quantities are:

As-coextruded:	1. vector of alpha heating
	2. vector of alpha cooling
As-beta heat treated:	3. V_1
	4. V_1 cooling, and
	5. vector of preferred orientation.

Each of the five vector quantities is different in both magnitude and direction from the material produced to date. The most dramatic difference is that the magnitude of these vector quantities can be shown to be dependent upon the position of the piece related to the coextruded tube. There is no explanation for this at the present time.

As the reason for the abnormal behavior during beta heat treating has been studied, the as-received warp was shown to be different from all other inner tubes produced to date. Again, as-received warp was shown

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HW-71571

to be related to the position of the piece in the original coextruded tube. This correlation indicates that an abnormal characteristic of the coextrusion process has led to an abnormal as-coextruded warp and this has in turn lead to an abnormal beta heat treated warp.

Abnormal as-received warp was not unexpected. During the cooling of the coextruded tubes on the runout table, they were seen to warp to a far greater degree than previous tubes. These first tubes were co-extruded at 1170°F (compared to 1140°F for pilot plant practice). To determine if the abnormal warp was a function of coextrusion temperature, subsequent coextrusions were made at 1155°F. Though some improvement in both as-received and heat treated was noted, the yield of 67% of pieces having less than 30 mils double throw warp was not realized.

Because the throughput was reduced by the study on warp and because the number of good pieces was so low, the special heat treating study on warp was discontinued. Thus, only the magnitude of as-received and as-beta heat treated warp was measured and no vector quantities could be determined. The recovery of inner tubes as a function of warp for pilot plant vs production plant practices is shown in the table below:

TABLE 1
WARP OF N-INNER FUELS

<u>Producer</u>	<u>Coextrusion Temperature</u>	<u>No. of Fuels</u>	<u>Per Cent of Fuels With Warp</u>		
			<u>>30 Mils</u>	<u>>30 & 75 Mils</u>	<u>>75 Mils</u>
Pilot Plant	1140°F	102	67.3	30.7	2.0
*Production Plant	1170°F	102	20.6	19.6	59.8
**Production Plant	1170°F	42	16.7	47.6	35.7
**Production Plant	1155°F	162	33.3	45.7	21.0

* Pieces which were completely characterized for warp vectors.

** Pieces which were not completely characterized for warp vectors.

From the data in Table 1, one concludes that the predicted yield has not been realized and that the coextrusion temperature may be a real variable. However, one other important variable is that only six of the pilot plant pieces were derived from coextrusions made from assemblies with Everdur copper components (Cu plus 3% Si). In comparison, all of the production plant coextrusions have been made with Everdur components. Thus, the difference in follower block practice, ability of the coppers to retain lubrication and their hot workability became variables.

Warp in N-Inner Tubes Produced for Materials Handling Tests

A principal cause of warp during beta heat treating could be a variation in longitudinal preferred orientation. The variation in preferred orientation could be caused by temperature gradients in the coextrusion billet.

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HW-71571

To test the hypothesis of temperature gradients: preferred orientation: warp, the direction of heat transfer in the billet was varied on the basis that the direction of V_1 would vary in relation. The direction of heat transfer was varied within the limits available with the contact lines of the billet loader and the liner of the extrusion press. The standard process of co-extrusion is thought to direct V_1 at 210 degrees as a function of the equal and additive effects of cooling by:

1. the loader in the "out" position where the billet is contact at lines of 225° and 285°.
2. the loader in the "in" position where the billet is contact at lines of 225° and 125°.
3. the liner where the billet is contact at lines of 180°.

Table 2 is a summary of V_1 data for billets given variable cooling by variable handling practice. The mean value of V_1 (mils and degrees) has been computed for each variation in billet handling practice and these have been compared to the mean value of V_1 for recent pilot plant fuels.

TABLE 2
VARIATION IN BILLET HANDLING PRACTICE VERSUS
 V_1 FOR THE MATERIALS HANDLING FUELS

<u>Extrusion Number</u>	<u>Billet Handling Practice</u>	<u>Mean Value, V_1 (Mils/Degrees)</u>	<u>Difference From V_1 For New Pilot Plant Fuels</u>
189	Standard	26/254	Not determined
203	"	124.5/311	"
190	3 minute delay on loader at the "in" position	40/358	Highly significant
191	3 minute delay on loader at the "out" position	7.5/154	Not significant
204	" "	12.5/121	"
205	3 minute delay on loader at the "out" position and then rotated 85° clockwise	16/170	Not significant
206	" "	14/185	"
207	Standard except billet loader heated to 550°F	4/267	Not significant
All	All conditions	--	Significant

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HW-71571

Although the difference in direction of V_1 is only statistically significantly different for one billet, the overall distribution of all materials handling fuels vs new pilot plant fuels is statistically significantly different. Therefore, it is concluded that V_1 can be influenced by temperature although many billets would have to be co-extruded for each specific condition. (This latter conclusion is a correction of an earlier mistaken conclusion, August 1961, which denied the correlation).

Warp in N-Inner Fuels As a Function of Coextrusion Process Variables

The previous section has stated that the direction of V_1 for Materials Handling fuels can be statistically significantly distinguished from the direction of V_1 for new pilot plant fuels. The latter fuels are those characterized by the new clad geometry (40 mil outer clad). Both of these classes of fuels can be distinguished as different from the old clad geometry (25 mil outer clad) and the old geometry which was V-trough cooled rather than table-rolled cooled.

It is concluded that both clad thickness and cooling stresses are significant variables in the warp problem.

Recovery of Inner Tubes Having More than 75 Mils Double Throw Heat Treated Warp

Recovery of fuels having double throw warp as large as 250 mils has been accomplished. It is shown that great care must be taken to get good pieces. Too, some slight correction needs to be applied to the factor of reverse bending that results in elastic recovery when the reverse bent pieces are unloaded.

Recovery of Outer Tubes Having More Than 30 Mils Double Throw Heat Treated Warp

Outer tubes having more than 30 mils warp have been straightened and re-beta heat treated by three different processes. The processes and results were:

1. cold straightening (to zero warp) and re-beta heat treating. No good.
2. cold reverse bending (from +X to -X) and re-beta heat treating. Better.
3. cold double-reverse bending (from +X to -2X) and re-beta heat treating. Acceptable process.

Design of A Special PT on Heat Treatment and Warp

A special PT has been proposed to evaluate in-reactor performance of:

1. the acceptable fuels from the start-up of the production plant.
2. fuels having more than 75 mils double throw warp after beta heat treating that have been subsequently recovered by reverse bending and re-beta heat treating.

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HW-71571

Abrasive Blasting

The use of 180 mesh aluminum oxide abrasive was tested in the 306 Pilot plant. The results showed no change in surface finish quality. Further, the 180 mesh abrasive appeared to increase blasting efficiency. The 180 mesh abrasive is now being used to blast I&E pieces for further evaluation.

Pressure Bonding

Cladding to Cap Bond Autoclave Test

The three NOT and two NIT tubes were autoclaved (BMI Lot III) after facing off the closure welds. All tubes had failed by the end of twenty-four hours. Water entry was through the residual channels left by the striations on the inside of the cladding. Most pieces showed a strong bond, though obviously incomplete, between the zircaloy-2 cladding and zircaloy-2 end cap. This was demonstrated by the expansion of the cladding and deformation of the caps without rupture of the cap to cladding bond. One NOT tube end had the cladding pulled from both the inner and outer bonds. Another NOT had one-half the cladding pulled from the inner bond. In both cases there was a large expansion of the cladding before the failure occurred. None of the NIT ends showed fracture of the cap to cladding bond.

Pressurized Bond Intrusion

A pattern appearing to be cracks was found in the zircaloy-2 side of the Zr-U bond layer by E. A. Smith of HLO-FFDO, in die pressure bonded fuel tubes. It was also found that the same thing occurred in gas pressure bonded fuel tubes. (It occurred in both the pressure bond and extruded bond). These were first diagnosed as cracks, but it has now been established that they are solid material which is harder than the zircaloy-2 and the U-Zr compound layer. Magnification of 500X or greater and polishing with Linde A and water with at least a two hour oxidation period in air is required to make the structure visible. These are found in as-pressure bonded, pressure bonded plus one beta heat treat, and pressure bonded plus two beta heat treats. Specimens examined so far indicate that they occur in any region subjected to pressure and heat. In addition, the total number is greater in the inner clad of the NIT than in the outer clad of the NIT. No study of the frequency relationship of the NOT has been made.

Fuel tubes with a Be-Zr brazed closure show some evidence of this structure. As-extruded bonds also show evidence of the structure.

High Strength Zirconium Alloy

A paper was given by KAPL during the AEC Welding Forum in San Antonio on October 1961 on the "end closure of zircaloy-2 clad control rods". The core of the rods was boron carbide in a matrix of HSZ-A. It is a 2.5% tin, 2% niobium alloy that produces a diffusion bond with zircaloy-2. The

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HW-71571

documents on this work have been received from KAPL. This alloy has been discussed with J. E. Minor, HLO-FFDO, who believes that it has possibilities as a closure ring material even though the corrosion rate is slightly higher than zircaloy-2. He has volunteered to produce buttons of the alloy of sufficient size to be used for coupons. The coupons will be used for bonding tests to zircaloy-2 coextruded cladding, to uranium and to rolled zircaloy-2 sheet the thickness of cladding.

Zircaloy-2 to Zircaloy-2 Bonding Improvement

A four inch vacuum system is being assembled to provide a portable unit to permit the study of vapor deposition of metals, cathodic etching of metals and cathodic sputtering (deposition) of metals.

Equipment is being designed and fabricated to study the vapor deposition of copper, tin and other metals to zircaloy-2 coupons and zircaloy-2 closure rings to determine their efficiency as bonding accelerators between zircaloy-2 cladding and zircaloy-2 closure rings. It is hoped that this mechanism will eliminate the voids in the zircaloy-2 bond, as well as accelerate the rate of bonding. The same equipment is to be used to study the sputtering of copper, tin and other metals to zircaloy-2. It has been found that copper will diffuse into zircaloy-2 at 600°C in vacuum.

A unit is being designed and fabricated to study cathodic etching and determine optimum etching parameters. Parameters to be studied are gas pressure, argon and neon gas and types of modified alternating current.

Electron Beam Welder

Difficulties with the vacuum system of the electron beam welder have prevented the finishing of Lot V for BMI. It is hoped that it will be completed during the week of 10/30/61.

Bond Test Standards

The bond test standards assembled of zircaloy-2 tubing and uranium tubing have been received and evaluated. One end each of one NOT and one NIT tube leaked and did not bond. After bonding, the areas prepared to prevent bonding could not be located. Beta heat treating of the NOTs released the unbonded areas. There is anomaly with the NIT testers on the test specimens that produce a signal has not been interpreted.

All uranium to zircaloy-2 bonds are the usual high quality. The zircaloy-2 cap to zircaloy-2 cladding bonds are the same as previous lots. They will not prevent water entry during autoclaving.

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Brazed End Closure Welding

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Step Cut Dimension Change

The width of the step cut for welding on brazed end closures has been changed to 0.075 inch $\pm$ 0.015 inch. The welding technique is being evaluated.

Arc Characteristics

It is very desirable to use a sharply pointed electrode to produce a high plasma velocity in order to obtain maximum penetration and mixing in the molten weld metal. Voids in the braze blow-out with explosive force, blunt the electrode tip and deposit metal on the electrode. Currently there are enough voids in the braze to blunt the electrode before ten pieces have been welded. The process requires that the electrode be resharpener after ten fuel tubes have been welded. Multiple blowouts occur occasionally in a single weld.

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Process Fuel Element Testing

UE-1 Bond Penetration Testers

Improved test tank control panels are being placed in operation. Prototypes have been in operation on the 306 UE-1 station and on a 313 UT-2 station, and have demonstrated their reliability. The improved circuit increases photocell life by reducing the electrical load placed on them. A bridge network is sensitive to a phase shift caused by the change in resistance of a photocell. Light pipes are being installed on the photocells which gets them out of the water and in a position more convenient to servicing.

A change was made to the electrical network driving the total count decade counters on the bondtesters. This change will eliminate a cause of extraneous counts which in the past has contributed to the non-reproducibility of test results.

A method has been devised to utilize the total count decade counters to measure the translation time of the UE-1 fuel elements. This method, when adopted, will allow more precise calibration procedures.

The shielded room has already made a substantial reduction in noise affecting the bondtesters. The internal bondtester especially has experienced relief.

UE-1 downtime during the month was the lowest of recent months. Operating efficiency was ninety-two percent for the testers in operation.

UT-2 Fuel Core Test Stations

Revisions have been made to the UT-2 gate circuits to allow linear response to a large range of video signals. This insures a more reliable operation of the peak and averaging circuits. The revisions are custom applied and have been made to all testers.

It has been known for some time that transistorized circuitry is temperature sensitive. The UT-2 circuits have been stabilized to an extent, but recently, it has been found that an additional degree of stability may be obtained by controlling the console air temperature. Plans are now being carried out to thermostat control the console blowers.

New techniques for making grain size transducers were developed. Results are measured in terms of improved reproducibility and longer life.

The UT-2 downtime during the month was lower than previous months. Operating efficiency was eighty-nine and five-tenths percent for the testers in operation.

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HW-71571

The grain size testers can be set up to provide ± 0.2 volt on ninety percent of the cores and tests are continuing on how well this can be maintained.

The quench crack test continues to operate satisfactorily. The reject rate for October was 0.24 percent.

"I" Fuel Testing

Instrument sensitivity checks have revealed a relatively insensitive internal bondtester. This tester will detect a fabricated defect of one-fourth inch times one-fourth inch whereas the external bondtester will detect a fabricated defect of one-thirty-second inch times one-fourth inch. The insensitivity has been determined to be caused largely by the type crystal used. A new type crystal was ordered and is expected to alleviate the problem by December 1, 1961. This type crystal has been in operation on closure tests and given good testing results, but has been failure prone. The manufacturer of these crystals has been informed and longer-lived crystals have been promised.

All the bondtesters were found to be adversely affected by the noise from the end closure welders. The closure bondtesters may be operated in such an environment since the noise is random but the tester response is repeated. The cladding bondtesters, however do not repeat their test results and hence noise can not normally be distinguished from defects. The noise is entering the testers through their external cabling. The problem should be alleviated by shielding the welders.

An improved internal bondtest for regions near the ends is being obtained by testing before welding instead of the normal after-welding. The weld "overhang" has in the past caused a faulty crystal positioning until the probe has gone past the overhang. A group of N.O.T.'s tested before welding will be retested after welding with the UT-9 testers to insure no detrimental effect to the bonds as a result of welding.

The throughput of the UE-2B and UT-9 stations has met the predicted rate of fifteen pieces/hour which includes standards and re-runs.

A breadboarded test was set up in the laboratory to detect inclusions in copper sleeves. The inclusions were successfully detected and identified as iron. All inclusions on the outer surface were visually detected. A cleaning process and visual inspection should eliminate the need for an electronic test.

The ET-6 cap thickness tester has been put into operation with good results. Drift has been measured to be less than four mils/hour. Accuracy of ± 5 percent should be readily obtained. The test is capable of measuring cap thicknesses within the range of 0 to 300 mils.

Testing of zircalloy outer-tube outer-clad components has been performed in an attempt to determine correlation between zirconium grain size and a rough exterior

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HW-71571

zirconium surface on some of the recent extrusions. Test results indicative of large grain areas were found on some of the components. One of the shells will be used for extrusions and results compared with the known condition of the zircalloy before extrusion.

A more thorough investigation of billet test performance has been started. The primary goal is to obtain a better understanding of why outer tubes' zirconium-uranium interface extrudes relatively smooth compared to that of the inner tubes when billet testing predicts both should be rough. A secondary goal will be to evaluate billet testing through using a crystal placed within the billet core rather than the conventional external crystal.

UT-4 Prototype

The UT-4 prototype station is operating on a near routine basis. Most operating difficulties have been corrected and a cycling arrangement has been set up to allow continuous tank operation. The optimum mode of operation and calibration procedures are now being developed. The UT-4 circuits are designed to provide flexibility in their operation. The initial mode of operation will relate the numerical readout to the length of the defect along the longitudinal axis. The closure region is electronically divided into "discs" the number of which is equal to the number of revolutions of the fuel element in making the complete inspection from weld bead to core. If there is a defect anywhere in one of these "discs", it is numerically registered as such. In addition, the maximum number of successive "discs" containing defects is registered. For instance, a typical test result may be ten "discs" out of twenty-five total which have defects but only four "discs" which are successive. This means that in the process of detecting the ten "discs", there was at least one "disc" with no defects separating groups of "discs". Once a defect has been detected in any given "disc", then subsequent defects in the same "disc" do not register in the readout. This in effect gives a longitudinal meaning to the readout and largely ignores the defect size in the circumferential direction.

Instrument sensitivity has been found to be exceptional. A defect 0.032 inch in diameter is easily detected. A 0.020 inch hole drilled longitudinally along the braze layer is also detected. This type of defect has previously been detectable only through using the more difficult to interpret shear wave techniques. A high degree of sensitivity has been made possible for the UT-4 by there being no acoustical impedance mismatch at the clad-closure interface. The same is not true at the clad-core interface and echoes here are indistinguishable from defect echoes unless the defect is large enough and oriented in such a manner as to cause reverberations to be set up. Utilization of this lack of acoustic mismatch has resulted in the application of very fast circuits capable of resolving very small defects located as near as approximately thirty-five mils from the surface.

The throughput capability of the UT-4 station has been proved to be ten fuel elements per minute as predicted. A greater throughput is possible - at a slight sacrifice in defect definition.

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Production model UT-4 testers are expected to be received from the Electronic Shop by November 10, 1961. Subsequent units should follow at the rate of two every two weeks. Allowing check-out time, it is realistic that four electronic units will be available for 313 installation by the end of the calendar year. Control panels are being received on schedule from Minor Construction. Fabrication of mechanical components is slightly behind schedule. The first tank is scheduled to be completed at about the same time as is the first electronic unit.

New Test Developments

"N" Fuels Surface Contamination Monitor

Revisions have been made to the monitor to allow for detection of end cap contamination from the weld. Some circuit optimizing must be done. Experiments to measure contamination on the inside surface of the inner tube were unsuccessful as was an autoradiograph technique tried on the outside surface. A production test is being set up.

Hydrogen Content in Zirconium

Experiments to detect a change of 0 PPM to 500 PPM hydrogen using a crystal operating in its fundamental modes at twenty-six to forty-one megacycles were inconclusive. It appears that the inconclusive results are largely due to improper coupling of energy between crystal and zirconium. Experiments are underway to eliminate this problem.

Post Irradiation Studies

Progress was made on design of the equipment for use in 105 KE viewing basin. The main functions of the equipment are to bondtest the clad-core and cap-core bonds, and inspect the core for internal discontinuities such as cracks.

Another desired function is to measure the thickness of cladding in necked-down regions. This latter function is inherently more difficult and will probably not be available when first needed in March, 1962. Overall design is about fifty percent completed and some orders may be placed as soon as the Appropriation Request is approved.

Lamb Wave Testing

Specifications have been written for construction of internal bondtest probes having fixed crystal mounting. Five of these probes are being constructed on-site and five off-site for comparative evaluation.

Recent studies on the use of Lamb waves for bond evaluation of "N" fuels have given encouraging results. Several regions were found which responded with large Lamb wave signals in modes having larger horizontal to vertical displacement ratios, and small signals at the modes having more vertical displacement. For various large signal return areas, the response was found to be frequency sensitive indicating thickness variations. Plans are underway to repeat scans of these and other areas using various angles and modes. Recordings will be made of these areas using an intensity modulated mapper.

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DeWitt for LHM
Manager, Engineering

LH McEwen:dl

FINANCIAL OPERATIONOCTOBER, 1961

The October physical inventory of essential materials for the AlSi and Coextrusion Shops was observed by Financial representatives. Physical quantities were checked and verified with perpetual inventory ledger cards

Results of the Semi-annual physical inventory of precious metals for the period ended September 30, 1961, were received from C&AO. The reconciliation indicated no discrepancies between quantities in custody of Department holders' and reconciled book quantities. A formal report will be issued to Department personnel.

A schedule was prepared showing the estimated labor and material cost per reject for each of the major fuel elements in the AlSi Shop. Cost estimates are cumulative by process flow through each of the major cost centers and were based on current labor and material standards. Cost estimates will be revised upon completion of new labor and material studies which are currently under way by the Methods Engineering group.

Sample report of operating costs detailed by station within the Coextrusion Process received acceptance from operating management; therefore, formal issue will be made this month with costs for months of July and August also shown in same format.

Several meetings have been held with management concerning procedures used in developing unit costs and production cost. Changes have been suggested for simplifying reporting in order to facilitate better understanding by management.

A new Engineering Cost Report was developed during September. The new format provides a breakdown of Engineering expenditures according to Present and New Fuels programs.

A meeting was held with C&AO Cost representatives to discuss and review current fiscal year plans relative to further mechanization and refinements of the Department's cost accounting system.

Travel reported in October amounted to \$5,200. This included ten trips representing 64 days in travel status. Of the ten trips reported, two combined attendance at professional and trade society meetings with other business, while the remaining eight encompassed the areas of essential material quality and delivery problems and discussions of Uranium and N-Fuels technology, fabrication and testing programs. Movement of employees' household goods cost \$1,500 during the month.

An FPD supplement to OPG 1.12, Responsibilities for detail design on Plant Projects, has been issued as a final step in the implementation of the Guide as revised by the General Manager, HAPO. The supplement outlines the procedures

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HW-71571

to be followed in authorizing CE&MO to expend design funds and defines funding of the various phases of project engineering and management work.

Preparation of the equipment expenditure pattern for the last three quarters of FY 1962 has been postponed and will be combined with the Midyear Budget Review due in November.

Submittal of both the Utilities Extension and Hi Pressure Autoclave Facility project proposals previously reported as FY 1962 requirements has been delayed. Work is currently underway on the proposal covering the Hi Pressure Autoclave Facility while the Utilities project has been postponed indefinitely.

Although formal audit memorandums are not expected from the Traveling Auditors prior to the middle of November, 1961, appropriate follow-up has been instituted on the basis of preliminary information.

Status report on the Manufacturing Procedures study was prepared and issued to the FPD General Manager, and the Manager, Manufacturing.

A new Cost Improvement Display covering cost of laundering and replacing cover-alls, towels, and gloves was completed and placed in the 3707-D lunch room.

The HAPO-AEC audit schedule for the audit year ending July 31, 1962 has been reviewed and responsibilities of the FPD Specialist, Audits and Procedures and C&AO Auditing clearly defined.

Seven cost improvement proposals totaling \$690,677 were received during October. Of this amount \$313,401 represented direct savings to FPD. The balance, \$377,276, represented savings at feed sites resulting from reduced scrap generations. Including this item, FPD cost improvements accepted CY to date total \$1,134,474. Six cost improvement proposals totaling \$341,321 are currently under evaluation.

No significant reports were issued by the Financial Section during October.

No security violations were recorded in the Financial Section during October.

Manager - Finance

WS Roe:mh

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HW-71571

PLANT FACILITIES OPERATION

OCTOBER 1961

I. RESPONSIBILITY CHANGES

The nonexempt employment functions for the Department were taken over as of October 2, 1961.

Effective November 6, 1961, the functional responsibilities for providing maintenance for the PRTR will be transferred to Hanford Laboratories Operation along with the entire complement of personnel assigned to the PRTR Crafts Sub-Section.

II. ACHIEVEMENTS

A. Statistics

1. Duplicating

<u>Process</u>	<u>No. of Impressions</u>
Multilith	811,473
Xerox 914	20,384
Ozalid	14,441

The high quality of the prints made by the 914 Copier has increased the demand for its services. During the month, production requests have almost doubled over that previously requested from the Verifax.

2. Utilities

	<u>Oct.</u>	<u>Sept.</u>
Average steam generated (M lbs/hr)	66	52
Maximum steam generated (M lbs/hr)	105	81
Total steam generated (Mlbs)	49,165	37,140
Coal consumed (tons)	2,308.2	1,879.5
Evaporation rate (steam/#coal)	10.64	9.88
Efficiency - Actual	68.3	64.0
Efficiency - Theoretical	72.5	68.0
No. of Boilers on: 4 3 2 1 2 3		
Date of Change : 5 10 14 17 30		
Sanitary water from 3000 Area (M Gals.)	167.49	159.83
Total water from 3000 Area (Avg. Rate GPM)	3,752	3,700
Total water from #3 & #4 Wells (M Gals.)	18.86	19.93
Total water from #2 Well (M Gals.)	.30	.30
Peak water consumption for 24 hrs. (M Gals.)	6.0	5.9

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The peak water consumption of 6.0 million gallons for twenty four hour period exceeds the previous high of 5.9, which was experienced during August and September 1961. The increased consumption was caused by the increased operating time at PRTR.

B. Operating Experience

No. 6 Boiler was placed in service on October 4, 1961 and remained in service during the entire month. Satisfactory performance of No. 6 permitted it to carry the entire 300 Area steam load for several days until increased demands required the addition of Nos. 1 and 3. The No. 5 Boiler overhaul is complete with some exceptions and could be put in service immediately, if needed. No. 4 Boiler was removed from service on October 9, 1961 for annual overhaul. The annual overhaul of all 384 Building boilers is expected to be completed by 12/1/61. Replacement of the coal conveyor belt required careful planning and was accomplished in five hours.

No additional failures have occurred in the ash sluice transport line and the new 8" line is in place except for tie-in to the existing line. This is planned for November 6, with over-all job completion scheduled by November 17, 1961.

The No. 5 Air Compressor was in service for the entire month except for a short outage caused by a slipped collar at the inboard motor shaft bearing. The revision to the air intake manifold on this compressor is now scheduled to be accomplished during November.

On October 18, the process waste water was switched from the north to the south pond. The north pond appears to have twice as much sludge in it now as it did when cleaned in the fall of 1960. At that time, approximately fifty-eight truck loads of sludge were removed. About 30 days drying time will be required before this accumulation can be cleaned out.

Considerable effort was employed to revise or repair steam system components before winter operation sets in and steam outages were impossible.

Arrangements have been made to stockpile AlSi scrap along the railroad leading into the 300 Area, thus relieving the burial ground as a holding area. Component parts shipping pallets will also be stockpiled at the same site.

Air balance of exhaust flows from some forty units in the 333 Building required considerable time. Additional air balance was required in the 313 and 309 Buildings and adjustments became necessary in laboratory buildings with the full winter heating cycle in operation.

C. Equipment Experience

Total reactor operation at PRTR this month exceeded 1200 MWD, the best achieved to date. Considerable effort was extended during the early part of the month to reduce D₂O losses with reasonable success. Losses were cut about 50 per cent. Helium losses have been higher than normal but it is believed that a major portion is from one source which developed after the start of this last extended operating period.

New trim was installed in the P-34 valve to provide better flow control for primary D₂O injection. In the past this valve was very sensitive and was difficult to set to give proper pressure drop. Difficulty is still being experienced with boiler feed and blowdown valves due to excessive vibration. Some corrective action has been taken but additional improvements are necessary to eliminate the hazard involved. With the exception of a few minor items, all requested work on the fuel element examination facility has been completed. Design tests should be finished and the facility go into operation in November. An improper pneumatic relay installed in the process air supply damper controller was found to be the cause of the difficulties in maintaining good control in this system. Temporary modifications were made until the proper relay can be obtained. Modifications to the dump valve relay system were made to eliminate the extreme hazard of two grounds holding the valves open as was experienced during September.

Several operational failures occurred with the retention waste pumps in the 326 Building. Most of this trouble appeared to be caused by sand, gravel, and dirt which had been dumped into a slop sink.

The distilled water unit in 3706 Building continues to be a problem with its slow rate of distillation. The unsatisfactory effect on laboratory analytical work has been noticeable. This unit is now undergoing repair and cleaning.

Assembly of the NPR charging machine is essentially complete. Numerous electrical modifications remain to be completed -- limit switches require adjusting, and a test box remains to be fabricated. Scheduled completion of all known work appears to be late December.

Closing and leak checking of the hydrogen furnaces in 308 Building is progressing very slowly due to the poor workmanship on the original installation and to the numerous modifications which are being requested. At the present rate, it is estimated that this work will be completed early in December.

D. Inventions and Improved Methods

All personnel in the Operation engaged in work which might lead to inventions and/or discoveries advised that to the best of their knowledge, none were made in the course of their work during the month of October 1961.

E. Costs and Savings

One Cost Improvement item in the amount of \$618 has been approved and two suggestions with annual savings of \$1,162 for a total cost savings of \$1,780 during the month. Three Cost Improvement items totaling \$11,268 are currently being evaluated. Total annual savings for the calendar year are \$94,863 or 79 per cent of target goal.

F. Status of Projects and Major Jobs

Compressed Air Expansion, 384 Building, Project CAF-894 -- Procurement for the modification of the intake air filter system on No. 5 Compressor is still in progress by J. A. Jones. There has been no field work.

Replacement of Beeching Damper and Draft Gages -- Work is continuing and is approximately 50 per cent complete. No work has been done on the draft gage installation except for the installation of some lines.

Ash Disposal System, 300 Area -- Final excavation and shaping of ash disposal basins is nearing completion.

Modification of No. 1 I.D. Fan -- Decision was made to proceed with the modification of the fan. The new rotating fan assembly was installed and the turbine is currently being installed on the new foundation. The high pressure steam connection from the auxiliary loop and the major exhaust line tie-in were completed. The tie-in service target date remains November 10, 1961.

384 Building Maintenance Shop - The construction contract was awarded to R. J. Britton in the amount of \$14,700 with a contract completion date of January 16, 1962. Construction was started October 31, 1961.

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HW-71571

No. 6 Boiler Overhaul -- The I.D. fan modifications and equipment were completed and the boiler placed in service October 4, 1961.

Ash Disposal Line Replacement -- The 8" ash sluice line is in place except for tie-in to the existing line. Field work is approximately 70 per cent complete with completion scheduled November 17, 1961.

Street Paving, 303 Area -- This work was completed on crash program basis September 30, 1961.

Lawn Sprinkler System, 3760 Building -- The Request for Contract Service was forwarded to the Commission. They are holding the bid package pending clarification of the work.

Monumenting Burial Grounds, 300 Area -- Construction drawings are being prepared for the bid package which is scheduled for completion in November.

Air Dryer Installation, 384 Building -- Design work is under way for the procurement and installation of an air dryer system for all 300 Area compressed air.

Modification of No. 6 Sanitary Water Pump -- All material is on hand and fabrication for a new base plate for pump and motor is under way. Field work is scheduled to start in November.

No. 5 Pump Modification -- The Appropriation Request to increase the capacity of this pump from 1000 to 1600 gpm is being processed for approval.

Heating and Ventilation, 303-J Building -- Field work under way by J. A. Jones is 70 per cent complete.

Auxiliary Instrument Panel, 384 Building -- Design work is 40 per cent complete for the installation of an auxiliary instrument panel which will include (1) total hardness of boiler feed water, (2) water pressure at five locations, (3) operational time recorder for sand separator dump valves, and (4) operational time recorder for air compressors.

New Water Distillation Facility, 3706 Building -- Three portable laboratory demineralizers were placed in operation in the 3706 Building to permit the Analytical Laboratory to continue operations until the permanent still is installed. Delivery of this equipment is expected by February 1, with installation completed by March 1, 1962.

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Major Studies

Coal Handling -- A study is under way to evaluate existing coal handling procedures, coal car storage and handling with intent of reducing overtime premium for coal handling and eliminate safety problems created by coal cars blocking the street.

G. Significant Reports Issued

A manuscript entitled, "Window Blind Cleaning Tank," by T. H. Whatley, was prepared and approved for publication in a trade journal.

III. PERSONNELA. Safety, Security and Radiation Experience

Medical Treatment Injuries	21
Frequency Rate	3.94
Disabling Injuries	0
Serious Accidents	0
Security Violations	0
Radiation Incidents	0

B. Meetings

Round Table-Staff	22
Safety and Security	28
Information	11

Manager
Plant Facilities Operation

E. Hilgeman:RTM:mkm

END

**DATE
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12 / 2 / 92