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HISTORICAL EVENTS - SINGLE PASS REACTORS AND
FUELS FABRICATION

By

D. L. DeNeal

April 10, 1970

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HISTORICAL EVENTS - SINGLE PASS REACTORS AND
FUELS FABRICATION

The intent of this report is to record, in one place, the significant historical events associated with the Single Pass Reactors from initial startup through December, 1969. Significant events are chronologically listed in Section 1 and specific programs are summarized in Section 2.

Section 1 of the report will serve as a reference in determining when events and programs occurred. Details may then be known by procuring Monthly Record Reports, Project Authorizations, Production Tests, etc., which are listed at the end of Section 2; e.g., document numbers of Monthly Record Reports for the past 17 years are listed on page 68. Some of the more significant events briefly mentioned in the Section 1 chronological listing are more completely summarized in Section 2.

This report replaces and updates document DUN-3232 which may be returned to Document Control for destruction.

D. L. DeNeal

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HISTORICAL EVENTS - SINGLE PASS REACTORS AND
FUELS FABRICATION

<u>1944</u>	<u>Reactor or Fuels</u>	<u>Remarks</u>
Jan.	Fuels	Started loading uranium rods in Hanford Test Reactor.
Feb.	Fuels	Hanford Test Reactor attained first criticality.
March	Fuels	Testing of graphite in the Hanford Test Reactor began. Development work on lead dip canning process was terminated.
May	Fuels	Canning facilities installed in 313 Building.
June	Fuels	Production of fuel elements began.
Aug.	Fuels	Triple-dip canning process was adopted as the fuels production process at Hanford. Uranium cores machined from gamma extruded rods at Hanford. Aluminum components made from 1245 Al alloy.
Sept. 26	B	Initial start-up at 11:50 p.m. Nameplate design level - 250 MW. Xenon as an inhibitor (poison) to reactivity was discovered shortly after start-up.
Dec. 17	D	Initial start-up at 11:10 a.m. Nameplate design level - 250 MW.
<u>1945</u>		
	Fuels	Initiated rod extrusion of gamma phase uranium.
Feb. 25	F	Initial start-up at 3:00 p.m. Nameplate design level - 250 MW.
<u>1946</u>		
Mar. 19, 1946 to Jul. 2, 1948	B	Reactor shut down and held in standby status to conserve reactor life and assure the capability of producing polonium. By this time the growth of reactor graphite was apparent and the solution was unknown.
<u>1947</u>		
Oct.	D & F	Nominal level raised.
Nov.	F	Nominal level raised.

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	Reactor or Fuels	Remarks
<u>1947 - contd.</u>		
1947 Fuel Events	Fuels	Development work on lead dip process was resumed using cores from alpha rolled uranium rods. Fuel elements fabricated by triple-dip process began to blister during irradiation. Fuel element length reduced from eight inches to four inches for ease of charging in distorted (graphite growth) tube channels in the upper sections of the reactors.
During the early years of operation, irradiated metal was discharged from the reactors at an exposure of about 200 megawatts days per ton.		
<u>1948</u>		
Jan.	D	The first use of CO ₂ in the reactor atmosphere. Some details of events leading to the use of CO ₂ are listed on page 52.
May 30	F	First fuel element failure. An eight-inch, solid, natural uranium fuel element was removed from tube 1165 due to an end cap failure. The tube was charged May 19, 1948.
Jul. 2	B	Start-up following shutdown status since March 19, 1946.
Nov. 29	B	Second fuel element failure. An eight-inch, solid, natural uranium fuel element was removed from tube 0569 due to an end cap failure. The tube was charged October 11, 1948.
1948 Fuels Events	Fuels	All production was converted to lead dip process. Because of longitudinal growth of fuel elements during irradiation, fuels fabrication facilities were converted back to the triple-dip process after three months operation of lead dip canning. Development work on improved uranium grain structure was initiated. Rod extrusion discontinued at Hanford. Began the use of rolled uranium rods.
<u>1949</u>		
June	D	Nominal level raised.
Oct. 29	H	Initial start-up. Nameplate design level - 400 MW.
<u>1950</u>		
Jan.	F & H	Nominal levels raised.
March	H	Nominal level raised.

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	<u>Reactor or Fuels</u>	<u>Remarks</u>
<u>1950 - contd.</u>		
May	B & H	Nominal levels raised.
June	B & H	Nominal levels raised.
Jun. 10	H	Started the irradiation of lithium-aluminum target elements supported by oralloy for the production of tritium. Program completed during September, 1951.
Jun. 22	D	Third fuel element failure. This was the first of three fuel element failures during 1950.
Aug.	B & D	Nominal levels raised.
Oct. 3	DR	Initial reactor start-up. Nameplate design level - 250 MW. The DR Reactor was constructed, as a replacement for the D Reactor, with no water plant facilities. It was later decided to operate both reactors and water plant facilities were provided for DR.

Late in 1950, operation of the reactors at a specified nominal level was discontinued permitting operation at the highest levels attainable within approved operating limitations. At this time, power levels at the initial three reactors (B, D, F) ranged from 130% to 150% of nameplate design level.

1951

Mar. 31	All Reactors	Discharge exposure of natural uranium was raised from 400 MWD/ton to 600 MWD/ton.
Jun. 17	All Reactors	Bulk outlet water temperature limits raised from 80 C to 85 C for the summer months.
Summer	All Reactors	Initiated flux distribution control techniques for stabilizing equilibrium operation.
Sept. 24	H	Discharged the lithium target elements which were charged June 10, 1950 for the production of tritium. Thirteen of the lithium target elements failed during irradiation. Problems with target element swelling due to heat from adjacent elements were minimized in later irradiations with thicker end caps on the target elements. The tritium was separated at Building 108-B in an especially designed facility.

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	<u>Reactor or Fuels</u>	<u>Remarks</u>
<u>1951</u> - contd.		
Nov. 27	All Reactors	Bulk outlet water temperature limits reduced from 85 C to 80 C.
	Fuels	Design studies were initiated to mechanize the canning operation.
<p>1951 was the first year that a significant number of fuel element failures were experienced. During 1951, 102 fuel elements and 13 lithium target elements failed, compared to two failures during 1948, none in 1949, and three failures during 1950.</p> <p>The table on page 44 shows the trend in fuel and target element failures from 1948 to date.</p>		
<u>1952</u>		
Feb.	All Reactors	An increase in tube powers required that the elapsed time between a Panellit gage trip and a manual reactor scram be reduced from 20 seconds to 3 seconds. The 3-second limit was established by "excess header pressure" sufficient to restore coolant to the operating channel subsequent to removal of a partial flow block.
March	All Reactors	Started replacing solid aluminum pieces in the downstream dummy pattern with perforated aluminum pieces. A 4% increase in water flow resulted.
May 29	All Reactors	Graphite temperature limit raised from 380 C to 410 C.
June	All Reactors	Bulk outlet water temperature limit raised from 80 C to 85 C.
July 2	B	The first "quick" discharge of a failed fuel element. This procedure involved the discharge of a failed fuel element in about half an hour and resumption of reactor operation within the allowable recovery time. Many minimum outages (36 hours) were avoided in the removal of failures (that were not stuck) during the years of high rupture frequency using the "quick" discharge technique. The procedure was essentially discontinued late in 1958.
July 11	All Reactors	Bulk outlet water temperature limit raised from 85 C to 90 C.

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	<u>Reactor or Fuels</u>	<u>Remarks</u>
<u>1952 - contd.</u>		
Nov. 16 to Dec. 27	F	Ball 3X installation - Hoppers holding 3/8" diameter boron-steel balls were installed at the top of the reactor and connected to the vertical safety rod channels. Under emergency conditions, hopper gates automatically open permitting gravity flow of balls into VSR channels. This provides a second safety system assuring reactor shut-down under emergency conditions (graphite distortion) when VSRs could not enter the reactor.
Nov. 18	C	Initial reactor start-up. Nameplate design level - 650 MW.
Nov.	H	Charged 20 tubes with enriched uranium alloy to augment both reactivity and flattening.
Dec.	All Reactors	Tube power increases necessitated connecting the Panellit system to the safety circuit so that no delay replaced the three-second delay between a Panellit gage trip and a reactor scram. The no-delay feature was incorporated when the "excess header pressure" philosophy was replaced by a "trip-before-instability" limit which was replaced some years later by "trip-after-instability" limits.
1952 Fuel Events	Fuels	Completed development of salt bath core heat treating process. Initial production test of lead dip process fuel was charged into reactors. Fuels radiograph test was developed.
<u>1953</u>		
✓ Jan.	C & H	Reactors enriched. By mid-April, C Reactor was enriched with 28 tubes (20 pieces/tube) and H Reactor with 48 tubes (30 pieces/tube) of six-inch "C" uranium alloy containing 4.125% U-235 by weight.
Jan. 4-29	B	Ball 3X installation.
Feb. 3-25	D	Ball 3X installation.
Mar. 1 to Apr. 7	DR	Ball 3X installation.
Apr. 7	DR	Started the irradiation of lithium-aluminum target elements (3.5% Li by weight) for the production of tritium. Support enrichment, (J-2) elements containing 7.0% U-235 by weight, was also charged. The program was completed during March, 1955.

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	<u>Reactor or Fuels</u>	<u>Remarks</u>
<u>1953 - contd.</u>		
Apr. 5 to May 9	H	Ball 3X installation.
June 7-20	F	Replaced all reactor rear face thermocouples. These thermocouples monitor the outlet water temperature on each process tube. Thermocouple replacement was achieved at B, D, DR and H Reactors during the Ball 3X outages.
July 1	All Reactors	Seismoscope placed in operation and connected to the No. 1 safety circuit. The seismoscope has two functions. One is to detect a slight tremor and give an alarm in the control room; the other is to detect an earth tremor of damaging intensity and trip the No. 1 safety circuit.
July 1-19	All Reactors	The Ball 3X facility was connected to the automatic scram circuit which drops 3X system balls into the VSR channels if a trip of the 3X circuit occurs.
Aug.	C	Started replacement of rear neoprene connectors with a stainless steel type covered with neoprene. The program was completed during December, 1953.
Oct. 2	All Reactors	The automatic trip feature of the Ball 3X equipment, exclusive of the reactor low water pressure trip, was bypassed to minimize inadvertent ball dropping.
Nov.	All Reactors	All reactors allowed to approach 460 C graphite temperature.
Dec.	DR	The shipping of lithium-aluminum target elements to Building 108-B for the extraction of tritium was initiated.
Dec. 12-20	C	Installed venturis in place of orifices on the central 1822 tubes, replaced remaining rear face neoprene pigtails with stainless-neoprene type, and installed new Panellit gages.
✓ Dec.	C	An additional 34 tubes of enriched uranium alloy ("C" metal) were charged completing the new enrichment pattern in the third lattice ring.
Dec.	All Reactors	A program was initiated whereby the use of lithium-aluminum (P-10-A) and bismuth for reactor flattening was discontinued with thorium being used instead.

	<u>Reactor or Fuels</u>	<u>Remarks</u>
<u>1953 - contd.</u>		
1953 Fuels Events	Fuels	Large-scale testing of lead dip process was conducted. All uranium processing was transferred to new facilities at Fernald. Heat treatment of uranium at Hanford was terminated.
<u>1954</u>		
Jan.	All Reactors	Helium start-ups approved. Prior to a reactor start-up, air was formerly purged from the reactor atmosphere with carbon dioxide. With the substitution of helium as a purge gas, a significant production gain was made due to the minimizing of reactivity transients by taking advantage of lower cross section (neutron absorption) of helium.
Jan. 25	C	The first discharge of low exposure metal (four tons), requested by the AEC, was made at about one-third of the 625 MWD/T goal.
Jan. 25 to Feb. 2	F	Water flow was increased about 5000 GPM by the installation of venturis on 915 central tubes and the installation of secondary orifices on 850 outer tubes. Installed long-vane mercoids and recalibrated all Panellit ranges, installed some aluminum nozzles in place of rear face galvanized fringe tube nozzles, and rearranged tubes on crossheaders.
Jan.	All Reactors	Increased storage basin metal bucket loading from 140 to 280 irradiated eight-inch pieces.
Feb.	C	Started the pilot scale (60 tubes) irradiation of lithium-aluminum target elements for the production of tritium.
Feb. 24 To Mar. 18	B	Venturi outage. This venturi and double orifice work involved essentially the same pattern and work done at F Reactor January 25, 1954. A 7500 GPM gain in process water flow and an 85 MW increase in operating level resulted.
✓ Mar. 15	H	Started the fringe irradiation of thorium for the production of U-233. The program was completed during October, 1955. About 16,000 equivalent megawatt days were charged to the irradiation.
✓ Aug.	C	Started the irradiation of thorium for the production of U-233. Completed the program during October, 1955. About 23,000 equivalent megawatt days were charged to the irradiation.

<u>Reactor or Fuels</u>		<u>Remarks</u>
<u>1954 - contd.</u>		
Oct. 15	DR	Achieved 49.8 days of continuous operation, a record for a Hanford reactor.
Nov. 14-21	D	Venturis or double orifices were installed on all tubes, 500 Panellit gages were recalibrated and equalization of tube flow from crossheaders was accomplished. Gained 2000 GPM flow.
Nov. 27 to Dec. 7	C	Replaced all rear stainless-neoprene connectors with aluminum connectors. Reorificed 466 tubes in the fringe zone resulting in improved water economy (reduced flow 2500 GPM).
1954 Fuels	Fuels	Lead dip process was adopted for all fuels. Core pre-heat and fuel assembly operations partially mechanized. Ultrasonic transformation (grain size) testers placed in operation. Semiautomatic welding machines replaced manual welders. Resumed fabrication of eight-inch normal fuel.
<u>1955</u>		
Jan. 4	KW	Initial reactor start-up at 8:47 a.m. Nameplate design level - 1850 MW.
Jan. 5	KW	Reactor shut down at 2:04 a.m. due to fuel element failures resulting from a coolant stoppage at the rear pigtail of tube 4669. The stoppage resulted from a plug not removed during start-up tests when pre-start-up static pressure tests on the delta-scale instrument had been incorrectly inferred to indicate flow. The tube and tube bearing graphite blocks were replaced after drilling a six-inch opening through the rear shield. Resumed operation March 11, 1955.
Feb. 4 to Mar. 2	F	In conjunction with Project CG-558, six horizontal safety rods were replaced with rods of the new thimbleless type. The other three rods were previously replaced during other outages. Also replaced rear face nozzle gaskets and replaced remaining fringe galvanized nozzles with aluminum nozzles.
Feb.	All Reactors	The hot start-up procedure, used in recovering from reactor scrams, was discontinued February 10. A revised procedure was initiated February 24, limiting the power level rise to 50 megawatts per minute.

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<u>Reactor or Fuels</u>		<u>Remarks</u>
<u>1955 - contd.</u>		
Apr. 18 to May 4	DR	In connection with Project CG-558, horizontal control rods were replaced with thimbleless type, venturis or orifices were installed in all process tubes and 168 galvanized nozzles were replaced with aluminum nozzles.
April 17	KE	Initial reactor start-up at 3:30 p.m. Nameplate design level - 1850 MW.
April	All Reactors	Irradiated metal cooling time in reactor building basins was increased from 90 days to 105 days due to iodine emission.
Apr. 25-28	KE & KW	Both reactors shut down when the KE effluent outfall line broke loose from its anchor in the river bed. The flow from both reactors was diverted to the KW line pending repair of the KE line. The KE line was returned to service May 18, 1955.
May 15	All Reactors	The process water pH was reduced from 7.5-7.8 to 7.2-7.4 in an attempt to reduce corrosion of aluminum process tubes and fuel element jackets.
June 26 to July 10	D	In connection with Project CG-558, seven horizontal control rods were replaced with the thimbleless type (two had previously been replaced) and all crossheader screens were replaced with a wide mesh screen.
July 8 to Aug. 3	B	In connection with Project CG-558, eight horizontal control rods were replaced with the thimbleless type (one had previously been replaced). Also replaced liners and mattress plates in discharge area and a relief downcomer was installed to permit repair of the main effluent system.
July 31 to Aug. 13	H	Eight horizontal control rods were replaced, in connection with Project CG-558, with thimbleless type rods (seven rods had been replaced previously), replaced all Panellit gages, replaced beta monitoring system for the detection of fuel element failures with gamma monitoring equipment and revised orifice pattern to provide 3000 GPM additional flow.
Aug. 8	DR	The shipment of "J" metal to Arco, Idaho was completed.
August		The first shipment of irradiated lithium to Savannah River was made. Nine casks containing 8300 pieces from routine poison column loadings were shipped.

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	<u>Reactor or Fuels</u>	<u>Remarks</u>
<u>1955 - contd.</u>		
August	KE & KW	Significant mercury separation in Panellit gage switch bottles was experienced.
Sept. 18-27	KW	Replaced all front face aluminum connectors with teflon-stainless steel braid reinforced connectors; all of the remaining original temperature monitoring bulbs (used to monitor coolant temperature in the process tubes) were replaced with interim type bulbs.
✓ Sept.	D & F	Started the replacement of aluminum process tubes. This program was initiated to control process tube water leaks caused largely by tube corrosion. The table on page 43 shows the tube leak and tube replacement experience at the smaller reactors from 1953 to date.
Sept. 29 To Oct. 8	DR	Replaced all Panellit gages in connection with CG-558. Also replaced beta monitoring system with gamma monitoring equipment for the detection of fuel element failures and installed poison column control facilities on 30 tubes.
October	All Reactors	Started using a helium detector for locating process tube water leaks. Gases from the reactor atmosphere, entrapped in reactor effluent, are drawn by vacuum pump from one header at a time. Presence of helium indicates a leak on that crossheader and tubes are individually pressure tested.
Oct. 2-13	KE	Replaced all front face aluminum connectors with teflon-stainless steel braid reinforced connectors. All except eight rows of tube temperature elements were replaced with new interim elements.
Oct. 21	D	Replaced all Panellit gages in connection with Project CG-558.
Nov.		Due to changing AEC requirements, the low concentration program (for metal discharged) was discontinued at H and KW Reactors but remained in effect at C Reactor.
✓ Dec.	H	Started the replacement of aluminum process tubes.
Dec. 1-24	D	Replaced beta monitoring system with gamma monitoring equipment for the detection of fuel element failures. Also replaced discharge area chute liners.

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	<u>Reactor or Fuels</u>	<u>Remarks</u>
<u>1955 - contd.</u>		
1955 Fuels Events	Fuels	Continued use of cored fuels - up to 15% of production. Developed I&E fuel and produced initial reactor test load. Production facilities expanded to meet requirements of two new reactors. Radiograph adopted for testing all fuel. Automatic core etch machine replaced manual line. Automatic quench replaced manual machine. Penetration tester adopted for all fuel.
<u>1956</u>		
Jan.	Fuels	Ultrasonic bond tester adopted for all fuel. Statistical sampling plan initiated for control of fuel length and cap thickness. Developed can-sleeve vibration for canning operation.
✓ Jan. 21	B	Started the replacement of aluminum process tubes.
Jan. 23	B	Gamma monitoring equipment installed as replacement for beta monitoring to detect fuel element failures.
Feb.	F	Gamma monitoring equipment installed as replacement for beta monitoring to detect fuel element failures.
April 29	KW	The first K Reactor fuel element failure occurred in tube 3585 at an exposure of 595 MWD/T. The failed element was eight-inch natural uranium and was a split type failure. This excludes the failures during initial start-up caused by a flow stoppage.
July 1-4	F	Installed Panellit gages in preparation for Project CG-558.
Sept.		The final discharge of low concentration material was made completing the HAPO commitment for high isotopic purity product.
Sept.	Fuels	Began large-scale reactor testing of I&E fuel elements. Automatic component cleaning machine replaced manual line. Automatic sleeve cleaning machine replaced manual line.
Oct. 31	C	Gamma monitoring equipment installed, replacing the beta monitoring equipment used for the detection of fuel element failures.

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<u>Reactor or Fuels</u>		<u>Remarks</u>
<u>1956 - contd.</u>		
Sept. 22 to Dec. 8	B	Reactor shut down for the completion of Project CG-558 - Reactor Plant Modification for Increased Production. This was a multimillion dollar project for the B, D, DR, F and H Reactors involving the modification of equipment to provide additional reactor coolant. In general, the water plant equipment was upgraded (including the addition of a 190 Building annex), reactor inlet hardware, instrumentation, and control systems were revised and the effluent system was upgraded. A significant increase in coolant flow and production capacity resulted from this project. (See page 51.)
Dec. 11-22	KE	Tie-in of 1706-KER facility. This is a test facility constructed adjacent to the KE Reactor in order to utilize recirculating loops and single-pass tubes in the KE Reactor.
<u>1957</u>		
Jan.	Fuels	Production of cored fuel elements was discontinued. Initiated use of X-8001 Al alloy for testing purposes.
Jan. 7 to Feb. 19	DR	Project CG-558 outage.
Jan.	A11 Reactors	Completed the installation of Separan feed facilities. Separan is a coagulant aid used in the filtering of process water.
Feb.	KE & KW	A second generator was placed in parallel with BPA to prevent scrams from power failures or surges.
Feb. 18 To Mar. 22	D	Project CG-558 outage.
Apr. to May 18	F	Project CG-558 outage.
May	Fuels	Process development transferred from 313 Building to 306 Pilot Plant. Autoclave time reduced from 40 to 20 hours. Spire vibration developed to improve wetting.

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	<u>Reactor or Fuels</u>	<u>Remarks</u>
<u>1957 - contd.</u>		
May 20 to July 4	H	Project CG-558 outage.
Summer	All Reactors	Partial fringe poison blankets of lithium target elements were charged to reduce biological shield temperatures and assure the continuing adequacy of shield attenuation.
July 7-17	C	Reactor shut down for the installation of continuous charge-discharge equipment (Project CG-651). This was a prototype installation (90 tubes) to test the charge-discharge of fuel elements while the reactor was in operation.
Sept.	Fuels	Use of standard tru-line fuel began. Conversion of reactor loading to I&E fuel began.
Nov.	KE & KW	Gamma monitoring system for the detection of fuel element failures put in service.
Dec.	DR	Started a process tube replacement program.
Dec.	Fuels	Bond-penetration testers installed in plant. Study of solid state diffusion bonding processes initiated.
<u>1958</u>		
Jan. 31		Reactor power level limits were recommended by the Advisory Committee for Reactor Safety, and imposed by the A.E.C. (See page 49.)
	B,D,DR,F,H	1440 MW
	C	1740 MW
	Ks	3140 MW
March	Fuels	Weld recovery process developed and adopted.
March	C	Started irradiation of depleted uranium metal for the high Pu-240 program. Discharged during January, 1959. The program was somewhat limited by depleted element failures at the inner weld of I&E elements.
First 6 Mos.	KE & KW	Started loading central zones with internally and externally cooled fuel elements.

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<u>Reactor or Fuels</u>		<u>Remarks</u>
<u>1958 - contd.</u>		
Aug. 11	KE & KW	The first shipment of watermix elements was received for use in the 17th fuel element position from the downstream end.
Nov. 3 to Dec. 1	KW	Started the installation of Resistance Temperature Detectors replacing Thermohms for monitoring tube outlet water temperatures.
Nov. 21	C	A tube (2470) was charged with fissionable metal (I&E natural) with the pressurized charging machine operated from the control room. This was the first such operation at Hanford.
Dec.	DR	Replacement of the original thermocouples completed. The program was initiated during Sept., 1958.
Dec.	Fuels	Special spire etch process adopted. Began the use of projection fuels.
Last 6 Mos.	Six Smaller Reactors	Started loading reactors with internally and externally (I&E) cooled fuel elements.
<u>1959</u>		
First 6 Mos.	Fuels	Automatic welders installed in production line.
Jan. 4-12	H	Replaced 1300 rear pigtails with O-ring type.
Jan. 16	All Reactors	ACRS limits relaxed. B,D,DR,F,H - 1900 MW C - 2100 MW Ks - 4000 MW
Jan. 16	F	Achieved 50.4 days of continuous operation, a record for a Hanford reactor.
Feb. 16	All Reactors	All Hanford reactors operated continuously for 8.9 days, a record for eight-reactor operation.
April	H	Installation of KAPL-120 loop equipment completed.
April 15 to May 10	KE	Completed the installation of Resistance Temperature Detectors.

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	<u>Reactor or Fuels</u>	<u>Remarks</u>
<u>1959 - contd.</u>		
May	Fuels	Fuel Quality Certification Program started.
March & April	C	Installed straight O-ring type connectors on rear face.
June	Fuels	Vendor (cladding components) Evaluation Program was initiated.
Oct.	DR	The Army Gas Loop was placed in operation for the first time with a fuel element charged. (This was an experimental, in-reactor gas cooled loop operated for the Maritime Commission.)
<u>1960</u>		
Jan.	KE	Nonequilibrium start-up losses significantly reduced by use of splines.
Feb. 1	F	Ball 3X electrical system modified to reduce spurious scrams.
Feb. 19	DR	Performed the first block discharge of irradiated metal from the reactor. About 1000 tubes were involved.
Apr. 19	C	Removed operational charge-discharge ball valves, officially completing the OCD experiment. Also completed the installation of thermocouple bundles.
Apr. 4	B	Ball 3X electrical system modified to reduce spurious scrams.
Dec.	KE	Started use of nitrogen-helium gas atmosphere.
Dec. 12	F	Exhaust air from 105 Buildings was routed through
21	C	absolute filters - Project CGI-791, "Reactor
22	B	Confinement."
Dec.	C	Two process tube channels overbored 550 mils. (See page 50.)
	Fuels	Full-scale use of X-8001 Al alloy clad fuel began. Pressure quench was installed in the plant.

As power levels increased, the trend toward greater production losses per start-up was markedly reversed during 1960 through the large-scale use of poison spline supplementary control.

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<u>Reactor or Fuels</u>		<u>Remarks</u>
<u>1961</u>		
Jan. 4	DR	Exhaust air from 105 Buildings was routed through absolute filters - Project CGI-791, "Reactor Confinement."
5	D	
18	H	
22	KW	
24	KE	
Administrative power level limits were increased 10% with particulate filters in use. The higher limits were:		
Jan. 9	B,D,DR,F	2090 MW
9	C	2310 MW
18	H	2090 MW
22	KW	4400 MW
24	KE	4400 MW
Jan.	C	Three fringe tubes overbored 550 mils and fitted with zirconium tubes.
Jan.	D	Completed charging 100-tube bumper fuel demonstration load.
March	C	Thirteen channels overbored and charged with overbore-size self-supported fuel elements.
April	C	Four channels overbored and charged with overbore-size self-supported fuel elements.
May 3	H	261-tube block of E-N material (Lithium-Alloy & Enrichment) charged. (See page 45.)
May 28	H	850 tubes charged with E-N material.
July	DR	3X system balls dropped into all VSR channels due to incorrect calibration of very low pressure switches. Several thousand balls entered voids in the distorted graphite block with resultant depression of reactivity and power level.
August	C	Twenty channels overbored and Zircaloy-2 overbore tubes installed.
Oct. 20	All Reactors	Reactor confinement project halogen filters installed and beneficial use obtained.
Dec. 8	C	Twenty channels overbored and fitted with Zircaloy-2 smooth-bore tubes.
Dec.	C	1800 Inconel pigtails installed on front face.

	<u>Reactor or Fuels</u>	<u>Remarks</u>
<u>1962</u>		
Jan.	B,DR,H	609 Process tubes replaced
Jan. 26	C	First overbore fuel element failure. 631 MWD/T, 79% of goal.
Mar. 13	B	First experience with Xenon over-ride. (IP-467-C) Charged 50-tube enriched core and saved 10-12 outage hours on Xenon over-ride at start-up.
Apr. 6	All Reactors	First total loss of 100 Area electrical power. Six operating reactors were scrammed. Reactor coolant loads were picked up by the secondary systems and there was no damage to reactor facilities.
July 10	All Reactors	All operating reactors (B and C were down) were scrammed by a BPA power fault. All equipment of importance to reactor safety operated satisfactorily.
July 21	KE & KW	Beneficial use of Project CGI-844 - 100-K Area Coolant Backup. This provides standby diesel and steam driven pumping facilities.
Oct. 2	KE & KW	Beneficial use of Project CGI-883 - Increased Process Water Flow. This project involved additional river pumps at the 181 Building, new impellers and associated equipment for the 190 Building low lift pumps, rewinding the low lift pump motors (from 900 HP to 1500 HP), re-working the high lift pumps and upgrading the electrical supply system. The process water flow at each K Reactor was increased by 30,000 GPM.
Dec.	B,C,DR,F	Power levels restricted by tube outlet temperature limits to control tube corrosion.
	All Reactors	A total of 6684 aluminum tubes was replaced during CY-1962.
	Fuels	Production of self-support fuels began. Development work on hot die sizing began.
<u>1963</u>		
Feb. 2	KW	Started the installation of zirconium tubes.
March 9 28	D F	Improvements to the Gamma Monitoring System (CG-904).

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	<u>Reactor or Fuels</u>	<u>Remarks</u>
<u>1963 - contd.</u>		
April	Fuels	Development of arch rail projection fuels began.
Apr. 27	H	Completed the installation of rear crossheader expansion joints.
May 2	KW	Charged 51 tubes with lithium target elements on a pilot irradiation (IP-561-C) at a K Reactor.
May 12	KE	Started the installation of zirconium tubes.
May	C	Achieved a new monthly input production record (64.3 KMWDs) for that reactor.
May	Six Small	A new monthly input production record (300.5 KMWDs) for the small reactors.
May	All Reactors	Three reactor scrams were experienced - a record (monthly) low for eight-reactor operation.
May	Fuels	Hot-die-sizing provisional process specifications published. Fuel grading program was initiated.
June 6	B	Mass foamed 1800 rear face bellows to reduce gas loss. Replaced all rear face thermocouples, installed temperature monitor stepping switches, reamed 1800 front face venturis from 0.310 to 0.344, and removed PCCF system.
June 14	D	Foamed 1190 rear face bellows. Concluded 42.3 days of continuous operation - a record for that reactor.
June	KW	First 100% (monthly) T.O.E. for a K Reactor.
July 8	KW	Concluded 45.2 days of continuous operation - a K Reactor record.
July 19	H	Concluded 60.6 days of continuous operation - a record for a Hanford reactor.
July	F	Achieved a new monthly input production record (51.2 KMWDs) for that reactor.

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	<u>Reactor or Fuels</u>	<u>Remarks</u>
<u>1963 - contd.</u>		
Aug.	DR	Substandard fuel elements (called "green-end") were utilized by charging this fuel in the upstream portion of the process tubes. By the end of 1963, about 14,600 pieces of this substandard fuel had been charged utilizing all reactors except B and H.
Sept. 13	H	The rear connector fittings of 138 tubes were reamed to improve coolant water flow.
Sept. 21	C	184 rear face bellows foamed through the can and 172 through the jack-bolt hole to reduce helium leakage.
Sept.	Fuels	First production test of hot-die-sized fuel charged in C Reactor. Discontinued radiograph as a fuels test.
Nov. 4	B	All Buna-N spline cap seals were replaced with compression type Arco-Flex spline cap seals.
Nov.	B	Established a new monthly input production record for that reactor (52.7 KMWDs).
Nov.	Fuels	Conducted study of thoria fuels fabrication.
Dec. 2	All Reactors	Reactor maximum power level limited to the highest level previously achieved. B - 1940 MW C - 2310 MW D - 2005 MW DR - 1925 MW F - 1935 MW H - 1955 MW Ks - 4400 MW
Dec. 31	H	All reactor fuel was discharged - the first time for a Hanford reactor. Modification to front and rear hardware and associated equipment resulted in a coolant flow of 93,200 GPM, an 8,600 GPM increase over the H Reactor base and a new record flow for one of the five smaller reactors (C excluded).
Dec.	All Reactors	A total of 5981 (3509 zirconium and 2472 aluminum) tubes was replaced during CY-1963.

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	<u>Reactor or Fuels</u>	<u>Remarks</u>
<u>1963 - contd.</u>		
Dec.	Fuels	Dimensional behavior problem of hot-die-sized fuels during irradiation became known.
<u>1964</u>		
Jan. 12	D	A program was initiated to enlarge 0.310 and 0.320 venturis to 0.344 to increase water flow (1%) in selected tubes.
Jan.	Fuels	Began investigation of hot-die-size fuel irradiation behavior. Test quantities of thoria elements fabricated in laboratories. Thoria element fabrication development began.
Jan. 14	F	Twenty thoria and 40 enriched uranium support charges were loaded (IP-648-AC). Mass foamed rear face bellows, and installed 276 front adjust Panellit gages.
Jan.	KW	Established an all-time monthly input production record for a Hanford reactor (136.2 KMWDs).
Jan.	DR	Established a new monthly input production record for that reactor (51.6 KMWDs).
✓ Feb. 6	KE	Completed the installation of zirconium tubes - 2351 installed.
Feb. 18	B,D,DR,F,H	Maximum power level limit relaxed to 2090 MW and 93.5 C bulk outlet temperature.
Feb. 24	B,D,DR,F	Bulk outlet water temperature limit raised to 95 C.
✓ March 1	KW	Completed the installation of zirconium tubes - 2358 installed.
March	KE	First 100% monthly time operated efficiency since start-up. Established an all-time monthly input production record for a Hanford reactor (136.5 KMWDs).
March	D	Established a new monthly input production record for that reactor (56.6 KMWDs).
March	H	Established a new monthly input production record for one of the smaller reactors, other than C (58.9 KMWDs).

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	<u>Reactor or Fuels</u>	<u>Remarks</u>
<u>1964 - contd.</u>		
March 4	Six Smaller	Maximum power level limit of 2090 MW at the five smaller reactors and the limit of 2310 MW at C Reactor were removed. Bulk outlet water temperature limit of 95 C established at six smaller reactors.
Apr. 1	D	Replaced snap rings on all front nozzles with Inconel rings. Installed nine rows of front adjust Panellit gages.
Apr. 3-5	H	The sixth E-N cycle reached 95% of goal exposure and experienced seven fuel element failures. The E-N block was discharged and the seventh E-N cycle was charged. The loading pattern was improperly interpreted, resulting in excessive reactivity and flux distortion. Approximately one-sixth of the newly charged core was replaced.
May	Ks	Established a new monthly input production record (242.0 KMWDs).
May	All Reactors	Established a new monthly input production record (542.1 KMWDs).
July 18	B	Seventy-six test columns of depleted uranium and supporting enrichment columns were charged into the central zone. The depleted columns are to be irradiated to exposures of 1400 MWD/T in order to meet the 18% Pu-240 requirement. (IP-669-A)
August	All Reactors	A monthly record quantity of (927 tons) irradiated metal was shipped to CPD.
August	F & KW	Irradiations of thoria in the six-ton U-233 demonstration program completed.
August	KE	Ninety columns of depleted uranium were charged. These depleted columns are to be irradiated to exposures of 1600 MWD/T to meet the 18% Pu-240 requirements. (IP-694-A)
August	Six Reactors	Reactor scram recovery attempts from equilibrium operation were discontinued as an improved safety measure during the transition to a new contractor. Scram recoveries had previously been discontinued at the K Reactors.

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	<u>Reactor or Fuels</u>	<u>Remarks</u>
<u>1964 - contd.</u>		
August	Fuels	Provisional process specifications for thoria process issued and fabrication began.
Sept. 20	H	Completed 68.7 days of continuous operation, establishing a new record for a Hanford reactor.
Sept. 22	H	The eighth E-N cycle discharged and replaced with a normal uranium loading.
Sept.	B & KE	A total of 184 columns of depleted uranium is now charged as part of a program to produce 25 kgs of plutonium with 18% Pu-240 content. Initial charging started in July, 1964 at B and in August at KE.
Sept. 30	KW	Initial loading of thoria target elements charged in KW fringe as part of 110 kg U-233 order. Details of the thoria program are shown on pages 46, 47 and 48.
Sept.	Fuels	Initial reactor charge of arch rail test elements fabricated.
Dec.	All Reactors	CY-1964 MWD input production exceeded record year 1963 by 8.2%.
Dec. 30	DR	Deactivation shutdown achieved at 2400 hours December 30. Process cooling water was shut off at midnight January 3, 1965.
<u>1965</u>		
Jan. 1	Fuels	A shorter canning cycle resulted in a 5.8% increase in productivity.
January	F	Established a new monthly production record for the smaller reactors other than C Reactor (61.6 KMWDs).
Jan. 6	F	A test (PT-IP-725) authorizing an increase in graphite temperature limit from 650 C to 700 C is under way.
February	B,C,D,KE, & KW	Thoria blankets now exist.
March	All Reactors	All seven reactors operated continuously for 9.3 days exceeding the seven operating reactors record of February 16, 1959 by 0.4 day.

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	<u>Reactor or Fuels</u>	<u>Remarks</u>
<u>1965 - contd.</u>		
March	All Reactors	Shipments of irradiated metal to CPD totaled 1024 tons, exceeding the previous monthly record of August, 1964 by 97 tons.
March	B,C,D	Project CG-966, "Safety Circuit Trip Identification System," was completed. This project provides a complete safety circuit trip identification to reveal the source of reactor scrams. The DR, F, and H Reactors were deleted from the project because of deactivation. Beneficial use of the system at B was February 2, 1965; D - October 30, 1964; and C - July 25, 1964.
March 1	KW	The hydriding of Zircaloy-2 process tubes was first observed.
April	C	First successful in-reactor splitting of a zirconium tube was achieved.
Apr. 21	H	Deactivation shutdown achieved at 0300 hours. Physics testing program was completed May 5 and metal discharge was completed May 6.
April	Fuels	Production test of oil quench hot-die-size fuel demonstrated a marked improvement in dimensional behavior during irradiation.
April	All Reactors	The shipment of 1135 tons of irradiated fuel elements exceeded the March, 1965 record by 111 tons.
Apr. 12	F	A supplement to PT-IP-725 authorizes the increase of graphite temperature limit to 750 C.
Apr. 16	Fuels	Fabrication of thoria target elements for the production of 140 kg of U-233 was completed.
May	B & KE	Depleted uranium irradiations for the production of 25 kg of plutonium containing at least 18% Pu-240 have reached goal. The irradiation will continue until October, 1965 or until ruptures occur, whichever is first.
May	Fuels	Preliminary development work began on fabrication of UO ₂ elements.
June 25	F	Deactivation shutdown achieved at 1600 hours. Final discharge of fuel was achieved at 1400 hours. June 30 1965.

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	<u>Reactor or Fuels</u>	<u>Remarks</u>
1965 - contd. !		
June 15	Fuels	A second production run of thoria target elements was started.
June	KW	A flexible cooled HCR was installed in No. 2 channel.
July 13	F	Successful on-reactor demonstration of one-inch enlargement of a process channel was completed.
July 19	D	PT-IP-781, comparing hot-die-sized and Al-Si fuel using 0.947 percent enriched uranium was approved. Twelve tubes were charged with each type of fuel.
July 23	Fuels	While running pile periods, a record power level of 800 watts was achieved at the Hanford Test Reactor.
July 31	KW	The failure of the No. 3 boiler at KW was caused by an explosion in the oil-fired furnace. Following extensive repair the boiler was returned to service March 9, 1966.
August		Laboratory tests have demonstrated that Zircaloy hydriding will occur when Zircaloy is electrically coupled to aluminum in process water at 90 C.
August	All Reactors	The irradiation of thoria to meet the 140 kg U-233 program requirements was completed. The fringes of all reactors (B, C, D, KE, and KW) have been re-charged with thoria in anticipation of future U-233 needs.
August 9	All Reactors	As in past years, a program was initiated to achieve a reduction in reactor coolant water temperatures through controlled Columbia River discharge from Coulee Dam. This program involves discharging cool water through discharge gates at the bottom of the dam instead of releasing the warmer water over the spillway. The program was discontinued September 8. An average reduction of 2 C in water temperature was realized.
August	D	Two fuel element failures occurred in hot-die-sized (HDS) enriched (0.947 percent) elements charged on PT-IP-791. This production test is comparing failure resistance of HDS and Al-Si fuel.

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	<u>Reactor or Fuels</u>	<u>Remarks</u>
<u>1965 - contd.</u>		
Sept. 15	KE	VSR channel No. 49 was lined with a graphite sleeve. Boring of the biological and thermal shields was completed during August. The principal benefit from sleeving is to prevent the loss of 3X system poison balls into known stack voids in severely distorted VSR channels.
Oct. 24	C	Four VSR channels were bored and lined with graphite sleeves.
Oct.	KE & KW	A program has been established to sleeve 24 VSR channels at the K Reactors.
Oct. 14	Fuels	Thoria target element fabrication was resumed to prepare elements for charging into the K Reactor cores.
Oct.	D	PT-IP-781 material comparing the rupture resistance of HDS and Al-Si fuel was discharged due to the failure of the third HDS and the second Al-Si bonded element. Heavy groove corrosion was evident on all five failures.
Oct.	KE	The 12-ton depleted uranium irradiation (IP-694-A) was completed and the material was discharged at an average exposure of 2700 MWD/T and a Pu-240 content of 25.5 percent. A similar irradiation at B Reactor is continuing.
Oct.	KE	A partial E-Q core load was charged into KE Reactor.
Nov. 2	B	The ten-ton depleted uranium irradiation (IP-669-A) was completed and the material was discharged at an average exposure of 2360 MWD/T. The Pu-240 content of the discharged material was about 25%.
Nov.	F	One significant result of the high graphite temperature test (750 C) at F Reactor is the conclusion that the rate of stack graphite oxidation with carbon dioxide atmosphere is more dependent on radiation level than on graphite temperature at the lower temperature ranges.
Dec.	B & D	Established new monthly input production records - 52.9 KMWD at B and 58.3 at D.

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	<u>Reactor or Fuels</u>	<u>Remarks</u>
<u>1966</u>		
Jan.	C	Established a new monthly input production record for that reactor (66.7 KMWDs).
Jan. 21	KE	The No. 1 oil-fired boiler at 165-KE was internally damaged by a firebox explosion during scheduled engineering diagnostic tests of the combustion system. The boiler was returned to K Reactor Subsection April 22 by Project Engineering for routine PM work before placing in service.
Feb.	B,C,D	The reactor graphite temperature limit was increased to 700 C. This was accomplished by reducing the helium concentration in reactor gas which resulted in about a factor of two reduction in the helium loss rate.
Feb. 15	KW	Four NpO ₂ target elements with five weight percent neptunium in aluminum were charged (PT-IP-805) to confirm calculations on Hanford capability for producing Pu-238.
March	B	A new monthly input production record of 53.1 KMWDs was achieved.
March	All Reactors	Record reactor input production of 414.9 KMWDs exceeded the previous monthly maximum for the five operating reactors (B, C, D, KE and KW) by 6.6%.
March	Ks	Examination of three Zircaloy process tubes removed from the K Reactors further confirmed that hydriding has resulted primarily from the galvanic couple between the Zircaloy process tube and the aluminum dummies.
April	Fuels	In the hot-die-sizing process, a 500-piece per shift throughput capability with a 95% yield was demonstrated.
April 13	KE	One final column of depleted fuel (PT-IP-694-A) was discharged with an exposure of 4020 MWD/T. (25 weight percent Pu-240.) One similar column remains charged at B Reactor.
April 21	KW	Full reactor beneficial use of Project CGI-967, "High-Speed Scanning System for Temperature Monitor - KW Reactor," was obtained with tie-in of the scanner to resistance temperature detectors.
May	B	A new monthly input production record of 60.1 KMWDs was achieved for that reactor.

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	<u>Reactor or Fuels</u>	<u>Remarks</u>
<u>1966 - contd</u>		
May	B	A 100 percent (monthly) time operated efficiency was achieved for the first time since initial startup in September, 1944.
May	Fuels	Fabrication of a fuel element, approximately one inch larger in diameter than the nominal small reactor size, utilizing the rod-in-tube concept was achieved. This fuel assembly provides a high flux environment for isotope production and permits the use of various combinations of uranium enrichment and target materials.
May 14	KW	High power density fuel irradiations were initiated with the charging of five columns of 125 Metal (PTA-022).
May	All Reactors	The Columbia River cooling program for CY-1966 was initiated.
May	Ks	Initial on-reactor experiments with grit blasting of K Reactor zirconium process tubes for zirconium hydride removal were performed.
May	F	The Reactor Safing Seal, a tamper-proof inspection system for shutdown reactors, was demonstrated to local management, the AEC and other interested Government agencies.
June	KW	Analyses of samples from a Zircaloy-2 process tube removed from KW Reactor after six months' service with anodized aluminum dummies indicate no detectable hydrogen pickup.
July 8-9	B,C,D,KE & KW	All operating reactors had to be shut down because of strikes by the Hanford Atomic Metal Trades Council against two Hanford contractors - ITT/FSS and BNW. The KE Reactor was on a scheduled outage when the strike began.
July	Ks	The cause of hydriding of Zircaloy-2 process tubes in the K Reactors has been established as an electric coupling of the aluminum (dummies) and the Zircaloy-2.
July		A study was initiated to determine the capability to produce high Pu-240 in DUN-operated reactors to meet FY-1968 delivery schedules for the ZPPR program.
Aug. 25	B,C,D,KE & KW	All DUN-operated reactors were back in operation following a strike by the Hanford Atomic Metal Trades Council.

	<u>Reactor or Fuels</u>	<u>Remarks</u>
<u>1966 - contd.</u>		
Aug.		A water-cooled flexible horizontal control rod with Inconel sheathing, designed to replace round aluminum rods, has successfully completed reactor prototype testing.
Aug.	All Reactors	The Columbia River Cooling Program was canceled because of extended reactor outages resulting from the work stoppage.
Sept. 4	D	The test (PTA-010) to evaluate the corrosion resistance of a high silicon aluminum cladding alloy was discharged because of a second fuel failure indicating low failure resistance as compared to standard cladding alloys.
Sept. 5	KW	The initial test of 125 Metal fuel elements for high power density fuel irradiation was discharged at an average exposure of 1060 MWD/T (PTA-022). This was the initial irradiation of elements operating at specific powers up to 150% of current powers.
Oct.	D	A 100% (monthly) time operated efficiency was achieved for the first time since initial startup in December, 1944.
Oct. 23	KE	The first hot-die-sized rod-in-tube fuel elements to be given in-reactor testing were charged into a KER test loop.
Oct.	D	Tests relating carbon monoxide content of the reactor atmosphere to graphite temperature indicate that the filler blocks can be operated up to temperatures of about 680 C before the thermally induced graphite-CO ₂ reaction becomes significant.
Oct. 10	KE	The high speed scanner, Project CAI-174, was connected to the process tube temperature detectors, thereby achieving beneficial use of the system.
Nov. 1	Fuels	Installation of the facility for anodizing aluminum dummies was completed. These coated dummies are for use in Zircaloy tubes at the K Reactors to inhibit hydriding.
Nov. 16	F	The scheduled demonstration of the Hanford-developed safing seal by Douglas United Nuclear was conducted at F Reactor. It was attended by representatives of 43 of the United Nations General Assembly delegations and by 18 representatives of various news media.

	<u>Reactor or Fuels</u>	<u>Remarks</u>
<u>1966</u> - contd.		
Dec.	D	Reactor monthly input production of 63.6 KMWD was the highest ever achieved at one of the smaller reactors, excluding C.
Dec. 19	KW	The automatic scram feature of high speed scanning system which monitors the effluent water temperature of individual process tubes at the rate of 4000 per second was tied into the No. 1 safety circuit.
Dec. 25	KW	The first third of the KW Reactor E-D load was charged (PITA-048). This charging of 100 tubes of depleted uranium plus supporting enrichment (94 Metal) represented the start of a program in KE and KW Reactors to produce 215 kg of plutonium containing about 27% Pu-240.
Dec.	KW	Anodized aluminum dummies were used as downstream spacers in 800 process tubes. This action initiated the program to use anodized dummies in Zircaloy tubes at the K Reactors to inhibit hydriding.
Dec.	B	Upgrading of the 181-B river pump units and the installation of K-type rear nozzles and larger connectors resulted in a four percent increase in process water flow.
Dec.	B & KW	Examination of the first cycle of hot-die-sized monitor columns (PTA-011) from B Reactor indicate no significant difference between hot-die-sized fuel and Al-Si bonded fuel. Examination of the second cycle of HDS columns (PTA-011) from KW Reactor supports previous observations that, in the K Reactors, HDS fuel appears to suffer greater localized corrosion than Al-Si-bonded fuel.
<u>1967</u>		
Jan.	KW	The first discharge of nondefense plutonium (fuel with 8-9% Pu-240) for the Zero Power Plutonium Reactor program occurred. This is a continuing program to produce 1150 kg of nondefense plutonium for the ZPPR program.
Jan. 9	KE	The first 100 columns of depleted uranium fuel plus supporting 94 Metal were charged. This represents the first third of KE Reactor's E-D load under PITA-048, to produce plutonium containing 27% Pu-240.

<u>Reactor or Fuels</u>		<u>Remarks</u>
<u>1967 - contd.</u>		
Jan. 24		The AEC announced that one of the smaller DUN-operated plutonium reactors would be shut down and placed in standby about July 1, 1967.
Feb.	B	A 100 percent time operated efficiency and a B Reactor monthly input production record of 61.2 KMWD were achieved.
Feb.	KE & KW	A total of 160 columns of depleted uranium fuel, plus supporting 94 Metal, was charged into each of the K Reactors. This is the second segment of the E-D loads (under PITA-048) to produce plutonium containing 27% Pu-240.
Mar.	KE & KW	Because of lower than expected reactivity the last segment of depleted uranium to be charged in each K Reactor was split into two batches. Twenty-five tubes at KE and 24 at KW were charged.
April	B	A 100 percent time operated efficiency and a monthly input production record of 63.7 KMWD were achieved. This is the highest monthly input production achieved by one of the smaller units, excluding C.
April	Ks	Analysis of eight Zircaloy tubes removed from the K Reactors indicates the rate of hydride formation in the base metal to be 26.9 ppm/year, confirming previous observations indicating 25-30 ppm/year.
April	B & C	Graphite oxidation rates associated with the operation of B and C Reactors close to the stringer temperature limit of 790 C are as expected at B but higher than predicted at C.
April	D	The gas loss rate was reduced 50% by increasing the allowable nitrogen content in the reactor atmosphere from 0.1 to 1.0 percent which enabled lowering of gas system pressure.
April	KE	In the demonstration test for Pu-238 production, finished neptunium elements were made available for charging at KE Reactor only 44 days after the neptunium had been discharged from N Reactor. This is well within the 50-day turnaround considered critical for the recharging of neptunium.
April	B	A half-plant test, which started in February, to determine the effect on effluent radioactivity of adding 2 ppm activated alumina to the flocculation basin inlet, was terminated when results showed little effect on the concentrations of P-32 and AS-76 in the effluent.

	<u>Reactor or Fuels</u>	<u>Remarks</u>
<u>1967 - contd.</u>		
April	KW	The last 23 tubes (for a total of 310) of depleted uranium were charged completing this special E-D loading (PITA-048) at KW Reactor. Approximately 850 tubes of 94 Metal have been charged in support of this irradiation.
April	KW	The 210 E-N test (PTA-054) which consists of 17 columns of 210 Metal fuel columns and five columns of lithium-bearing target elements was charged in a block array.
May	C	A 100 percent time operated efficiency was achieved for the first time since initial startup in 1952. This enabled C to achieve an input production of 70.1 KMWD which is 5.1 percent above its previous maximum.
May	B & C	Oxidation of graphite by CO ₂ at B Reactor at a graphite stringer temperature of 790 C is about 2-1/2 pounds per day. At C Reactor, the oxidation rate is about 6-1/2 pounds per day, indicating that 790 C is too high a temperature for long-term operation there.
May	Ks	Analysis of Zircaloy coupons irradiated for 240 operating days confirmed earlier tests that elimination of the galvanic couple between aluminum and Zircaloy would prevent further movement of hydrogen into the base metal of the K Reactor tubes. Thus, the use of grit-blast to remove the existing hydride layer appears unnecessary.
May	KE	The last 25 columns of depleted uranium (for a total of 310) were charged into KE Reactor completing the special E-D loadings in KE and KW in accordance with PITA-048.
May 7	KE	The supporting block for the neptunium irradiation was charged into KE Reactor during an outage May 7 and the first neptunium column was charged during operation on May 14.
May 25	KW	On the high power density fuel program, 20 tubes were charged on PTA-067 which authorizes the irradiation of 100 tubes in KW Reactor at 150% of base specific power.
June	B	A monthly time operated efficiency of 100 percent was achieved.
June 26	D	The reactor was shut down for deactivation at 1402 hours.

	<u>Reactor or Fuels</u>	<u>Remarks</u>
<u>1967 - contd.</u>		
June	B-C-KE-KW	A nondefense plutonium program, as specified by the AEC-RL, is under way at the four production reactors.
June	KE	Two columns of neptunium target elements, being irradiated under PTA-063, were charged during equilibrium operation.
July	B	B Reactor operated 53.9 days, exceeding its previous record of 39.0 days.
July	KE	KE Reactor achieved a K Reactor operating record when it concluded 46.5 days of continuous operation.
July 5	D	The discharge of all fuel and target material from D Reactor (deactivated June 26) was completed.
July	Ks	Based on results from GETR irradiations of graphite samples removed from KW Reactor in December, 1966, and at current KE-KW operating conditions, contraction of the graphite should continue for at least another three to four years, after which expansion can be expected.
July	B,C,Ks	A production test program, involving both natural and enriched fuel, has been developed for determining the ability of B, C and the K Reactors to produce plutonium with Pu-240 assays in the range of 12 to 15 percent.
July	B,C,D	Sufficient data have been obtained from B, C and D Reactors to show that B Reactor may operate routinely with a graphite stringer temperature limit of 790 C, and C Reactor with a limit of 770 C.
July	Fuels	Hot-die-sizing process development for producing the rods of the one-inch overbore rod-in-tube fuel elements was completed.
Aug.	C & KE	A 100 percent time operated efficiency was achieved at both reactors. At month-end, C Reactor had completed 46.1 days of continuous operation, exceeding its previous record by 8.1 days.
Aug.	B,C,KE,KW	All four reactors operated concurrently for 13.3 days, their longest period of combined uninterrupted production.

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	<u>Reactor or Fuels</u>	<u>Remarks</u>
<u>1967 - contd.</u>		
Aug.	B	Twelve test fuel columns were charged into B Reactor to provide operating and post-irradiation measurement data to establish the physics of Np-237 buildup in natural uranium with a high U-236 content (400 ppm) in reactors of the B-C-K type.
Aug.	KW	The first UO ₂ -Mo cermet fuel pin capsule cooled with recirculating helium was discharged from a special test facility at KW Reactor after achieving its goal exposure of 2000 hours. A similar second capsule was charged. These experiments are part of a NASA-Lewis Research Center program for the development of a nuclear space propulsion system.
Sept. 2		A pair of SR-85 radiation sources, shipped to Cape Kennedy on September 2, was used in the successful bio-satellite shot of September 7.
Sept. 18	KE	Reactor achieved 48.5 days of continuous operation, a record run for a K Reactor.
Oct.	KW	The 2.1 E-N test irradiation was terminated when one of the 210 Metal fuel elements failed due to the loss of element supports by corrosion.
Oct.	C	A reactor channel was successfully overbored one inch, and a tube installed, as a preliminary to overboring the entire 44-tube block.
<u>1968</u>		
Jan. 18	B	The AEC announced that B Reactor would be deactivated in mid-February.
Jan. 19 to Feb. 12	C	Forty-three process channels in the 44-tube test block were one-inch overbored.
Jan.		Experimental and computational work was started as needed for a preliminary basis for the safe handling of the Pu-Al elements to be used in the 10 kg plutonium irradiation.
Jan.	KW	Sixty-one columns of 125 Metal and five thermocouple trains were charged in the second phase of the 150 percent specific power test. (PTA-067)

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	<u>Reactor or Fuels</u>	<u>Remarks</u>
<u>1968 - contd.</u>		
Feb. 12	B	B Reactor, the world's first plutonium production unit, was deactivated. Fuel discharge was completed on February 19 and coolant flow was discontinued on February 22.
Feb.	Ks	An order was received for 360 kg of "clean" U-233 for use in the AEC's seed and blanket reactor development program.
March	C	Record monthly production was achieved at C Reactor - 70.2 KMWD.
April 2	C	Irradiation of surplus B Reactor fuel in C Reactor was approved. (PTA-127)
April	KE	Achieved 48.8 days of continuous operation, a new record for a K Reactor.
May	Ks	Results of the analysis of 14 Zircaloy process tubes removed from the K Reactors after 55 to 59 months of exposure indicate the anodized spacers have not stopped hydrogen entry into the base metal.
May	Ks	An economic study of segmental charge-discharge at the K Reactors showed a substantial incentive for the use of this technique if the refueling rate for natural uranium fuel elements can be made to equal current rates.
May 25	KE	Reactor shut down for the discharge of the depleted uranium load and the charging of a thorium load. The discharge in June of the remaining depleted metal in KW, and the charging of thorium there, will complete the program to produce plutonium containing 27 percent Pu-240, and will finish the initial charging of thorium loads in KE and KW to assure the delivery of 360 kg of "clean" U-233 as scheduled.
June 19	KW	The reactor was scrammed at 11:23 p.m. by a low-pressure Panellit trip on tube 3560. A piece of metal about 11/16" diameter by 3" long had lodged in the venturi throat, completely stopping coolant flow to the tube. The fuel charge and process tube were removed from the channel and operation was resumed July 28.

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	<u>Reactor or Fuels</u>	<u>Remarks</u>
<u>1968 - contd.</u>		
June	C & KE	For the year ended June 30, C Reactor exceeded its FY-1964 production record by 1.2 percent and KE exceeded its FY-1966 record by 0.1 percent.
Aug.	KE	The testing of lithium-aluminum splines was started. (PTA-136)
Sept.	Ks	Effective September 1, top-of-riser pressure and process tube power limitations were imposed at both K Reactors because of safety concern for the brittle fracture potential of the inlet piping. TORP was reduced 10%. Maximum power levels were in the 4000-4200 MW range.
Sept.	KE	Two lithium-aluminum splines were irradiated in KE Reactor for 15 days (PTA-136) to demonstrate this method for making tritium. No major problems were noted.
Nov.	K	Three additional lithium-aluminum splines have been irradiated 43 days without incident except that one broke during removal. Subsequent inspection revealed extreme brittleness.
Dec. 22	C	The first failure of a one-inch overbore rod-in-tube fuel element was experienced in the 44-tube test block.
Dec.	KE	The dome section and 25 inches of straight pipe were removed from the D riser as part of the riser sampling program for brittle fracture studies. (PTA-156)
<u>1969</u>		
✓ Jan. 24	KE	A prototype uncooled control rod was installed at KE. This flat rod has hinged 40-inch segments, each consisting of a dysprosium oxide-nickel cermet core in a coextruded Inconel sheath.
Jan.		The irradiation embrittlement of lithium-aluminum alloy splines was found to be too severe. This phase of the program has been dropped.
Feb. 20	KE	A 10 kg plutonium irradiation was charged into KE Reactor to establish neutronic interactions and to investigate plutonium fuel characteristic. (PTA-150)

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	<u>Reactor or Fuels</u>	<u>Remarks</u>
<u>1969 - contd.</u>		
March 27	KE	Discharge chute clearing equipment was installed. (DAP-510)
April 25	C	Reactor shut down at 4:10 p.m. for deactivation.
April	C	The Corrosion Product Test Facility was removed from C Reactor and installed at KE.
May 4	C	The discharge of fuel from the deactivated reactor was completed. Process water to the reactor was turned off May 5.
May 27	KE	Twelve target samples of americium for the production of medical-grade Pu-238 were charged into a single column. (PTA-171)
June	KE	Examination of two Zircaloy tubes from KE Reactor, which had been grit-blasted September 10, 1966 and subsequently operated with anodized dummies, agrees with earlier observations that no further hydriding occurs where the case layer removed by grit-blasting has been complete.
June	Fuels	\$395,000 was authorized for replacing the Al-Si bonding process with hot-die-sizing for the production of K Reactor fuels.
July	Ks	Tests indicate it is feasible to use type "O" (B-D-F Reactor) fuel in fringe tubes, and C Reactor fuel in the central zone of the K Reactors.
July 18	KE	Completed the modification of reactor coolant cross- tie piping.
Sept. 22	Fuels	AlSi canning operations were reduced from three to two lines per day, five days per week.
✓ Oct.	Ks	Thoria and supporting 94 Metal were discharged completely from KW and partially from KE, with replacement by natural uranium. Subsequent discharge of the remaining thoria from KE will complete the DNR U-233 program.
Oct.		Laboratory data on the ratio of Pu-236 to Pu-238 in neptunium-graphite wafer samples from the four-tube test block reinforce earlier conclusions that Hanford is capable of producing medical grade Pu-238.

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	<u>Reactor or Fuels</u>	<u>Remarks</u>
<u>1969 - contd.</u>		
Dec.	KE	The remaining thoria and supporting 94 Metal were discharged from KE Reactor completing the DNR U-233 program.
Dec.	KW	A 100 percent time operated efficiency represents the sixth time in its history that a full month of uninterrupted operation has been achieved.
Dec.	KW	Twenty-eight columns of 11-inch hot-die-size fuel elements were charged into the central zone to compare alternate heat treatment processes, as used by NLO, with respect to the dimensional stability of these fuel cores.

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RECAP OF SIGNIFICANT HISTORICAL EVENTS

Initial Start-up and Deactivation of Hanford Reactors

- *B - September 26, 1944 (Deactivated February 12, 1968)
- D - December 17, 1944 (Deactivated June 26, 1967)
- F - February 25, 1945 (Deactivated June 25, 1965)
- H - October 29, 1949 (Deactivated April 21, 1965)
- DR - October 3, 1950 (Deactivated December 30, 1964)
- C - November 18, 1952 (Deactivated April 25, 1969)
- **KW - January 4, 1955 (Deactivated February 1, 1970)
- KE - April 17, 1955 (Deactivated to shut down) Jan 29, 1971

*The B Reactor was shut down and held in standby status from March 19, 1946 to June 2, 1948.

**Reactor shut down from January 5 until March 11, 1955 due to coolant flow stoppage at the rear pigtail of tube 4667.

	Nameplate Design Level	Maximum Level Achieved (Held for 24 Hours)	
	Megawatts	Date	Megawatts
B	250	2-23-67	2210
D	250	2-25-66	2165
F	250	2-19-65	2040
H	400	1-2-65	2140
DR	250	2-29-64	2015
C	650	2-23-67	2500
KE	1850	1-12-62	4400
KW	1850	1-16-62	4400

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No. of Process Tube Water Leaks (Including Van Stone Leaks)

<u>CY</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>DR</u>	<u>F</u>	<u>H</u>	<u>Total</u>
1953	6	2	1		2	2	13
1954	9	3			8	5	25
1955		6	24	6	50	12	98
1956	2	4	19	10	91	28	154
1957	9	3	9	14	41	11	87
1958	12	4	7	28	18	9	78
1959	9	7	8	17	31	10	82
1960	16	3	5	18	20	27	89
1961	74	5	55	35	29	66	264
1962	35	21	42	14	14	35	161
1963	9	4	12	8	17	8	58
1964	6	3	5	5	11	-	30
1965	8	2	23	-	9	2	44
1966	13	7	4	-	-	-	24
1967	19	9	25	-	-	-	39
1968	9	11	-	-	-	-	20
1969	-	7	-	-	-	-	7

No. of Aluminum Process Tubes Installed

<u>CY</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>DR</u>	<u>F</u>	<u>H</u>	<u>Total</u>
1955			¹ 174		² 286	10	470
1956	³ 381		634		1081	⁴ 580	2676
1957	335		83	⁵ 16	269	320	1020
1958	163	16	119	711	295	37	1341
1959	164	22	125	237	333	136	1017
1960	157	71	207	51	247	140	873
1961	487	13	538	239	345	253	1875
1962	1130	⁶ 1110	811	847	924	1573	6395
1963	430	200	626	324	230	441	2251
1964	475	62	298	224	355	207	1621
1965	36	21	85	-	23	5	170
1966	69	30	200	-	-	-	299
1967	79	37	72	-	-	-	131
1968	5	102	-	-	-	-	107
1969	-	52	-	-	-	-	52

Initiated tube replacement programs:

¹D - September, 1955

⁴H - January, 1956

²F - September, 1955

⁵DR - December, 1956

³B - January, 1956

⁶C - March, 1962

A major tube replacement program initiated early in 1963 and completed early in 1964 resulted in the installation of 2351 zirconium tubes at KE Reactor and 2358 at KW.

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Fuel and Target Element Failures Removed from the Reactors

<u>CY</u>	<u>Total Failures All Types</u>
1948	2
1949	0
1950	3
1951	115 - Includes 13 lithium target elements.
1952	142
1953	93
1954	211
1955	242
1956	191
1957	201
1958	174
1959	71
1960	130
1961	86
1962	95
1963	68
1964	97
1965	89 - Includes 23 thoria target elements.
1966	17 - Includes 3 thoria target elements.
1967	29
1968	20 - Includes one thoria target element.
1969	16 - Includes 7 neptunium and one thoria target element.

500-100-110

Irradiation of Lithium for the Production of Tritium
(Lithium target elements were a lithium-aluminum alloy)

H Reactor

- June, 1950 to Sept., 1951 - The irradiation of lithium target elements for the production of tritium. Thirteen lithium target elements failed during irradiation.

DR Reactor

- April, 1953 to March, 1955 - The irradiation of lithium target elements for the production of tritium.

C Reactor

- Feb., 1954 to March, 1955 - Lithium target elements were irradiated as fringe poison.

B, DR, H & KW Reactors

- 1957 - During the year lithium target elements were irradiated as fringe poisoning.

H Reactor - (E-Supporting Enrichment, N-Lithium-Aluminum Alloy Target Element)

- May 3, 1961 - 261-tube demonstration block of E-N material charged.
May 28, 1961 - First E-N cycle charged.
September, 1961 - First E-N cycle discharged and second cycle charged.
January 27, 1962 - Second E-N cycle discharged.
January 11, 1963 - Third E-N cycle charged.
April 27, 1963 - Third E-N cycle discharged and fourth cycle charged.
September 13, 1963 - Fourth E-N cycle discharged and fifth cycle charged.
December 31, 1963 - Fifth E-N cycle discharged and sixth cycle charged.
April 5, 1964 - Sixth E-N cycle discharged and seventh cycle charged.
July 5, 1964 - Seventh E-N cycle discharged and eighth cycle charged.
September 22, 1964 - Program concluded with the discharge of the eighth cycle.

KW Reactor

- May 2, 1963 - Charged 51 tubes with lithium target elements on a pilot irradiation at a K Reactor.

During the last half of 1963, lithium target elements were irradiated as fringe poison at the smaller reactors. The program continued during 1964 and was essentially discontinued early in 1965.

Irradiation of Thoria for the Production of U-233 at B, C, D, KE and KW Reactors
(Previous irradiations of thoria were made at the C and H Reactors during 1954 and 1955.)

1964

Sept. 30	KW	Initial loading of thoria oxide target elements charged in KW fringe as part of 110 kg U-233 order. The order was later increased to 140 kg.
Oct. 19	D	Charged fringe thoria - 168 tubes.
Nov. 14	B	Charged fringe thoria - 140 tubes.
Nov. 29	KW	Charged first half thoria core - 126 tubes.
Dec. 18	C	Charged fringe thoria - 168 tubes.
Dec. 31	KE	Charged fringe thoria - 190 tubes.

1965

Jan. 4	KW	Charged second half thoria core - 131 tubes.
Jan. 7	B	Charged additional fringe thoria - 28 tubes.
Jan. 23	KW	The first half thoria core (first cycle) discharged and fresh thoria recharged.
Feb. 18	D	Charged full thoria core load - 135 tubes.
Feb. 23	KW	The second half thoria core (first cycle) discharged and fresh thoria recharged (124 tubes).
Feb.	B,C,D,KE,&KW	Thoria blankets now exist.
Mar. 1	KE	Charged first half thoria core - 96 tubes.
Apr. 1	D	The first cycle full thoria core load discharged and fresh thoria recharged.
Apr. 1	KW	The first half thoria core (second cycle) discharged and fresh thoria recharged (134 tubes).
Apr. 9	KE	Charged second half thoria core (82 tubes). Also discharged the first half thoria core (first cycle) and fresh thoria recharged (95 tubes).
May 3	KW	Second half thoria core (second cycle) discharge and fresh thoria charge (134 tubes).

100-100000-100000
100-100000-100000

Irradiation of Thoria for the Production of U-233 at B, C, D, KE and KW Reactors - contd
1965 - contd.

May 18	D	The second cycle of full thoria core load was discharged and natural metal recharged.
May 20	KE	Second half thoria core (first cycle) discharged and fresh thoria recharged (55 tubes). Also the first half thoria core (second cycle) discharged and natural metal recharged.
June 1	KW	First half thoria core (third cycle) discharge and natural metal recharged.
July 5	KW	Second half thoria core (third cycle) discharge and natural metal recharged.
July 20	C	Fringe thoria was discharged and recharged in 168 tubes.
July		All central zone thoria loadings have been discharged and the reloading of the fringe tubes of D and KW with thoria is complete.
Aug. 1	B	Twenty-eight tubes of fringe thoria discharged and recharged.
Aug. 10	KE	Fringe thoria was discharged and recharged in 190 tubes.
Oct.	KE	About 43 tubes core thoria along with compensating enrichment charged.
Nov.	KE	Thirty-six core thoria charged.
Nov.	KW	Two hundred and nineteen core thoria charged.

1966

Jan.	KE	Thoria in the E-Q core loading was recharged.
Jan. 24	B,C,D,&KE	The fringe thoria blankets were recharged between Jan. 24 and Feb. 28.
Feb. 11	KW	The E-Q core loading was discharged and replaced with natural uranium.
Feb. 21	KE	The E-Q core loading was discharged and replaced with natural uranium.

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Irradiation of Thoria for the Production of U-233 at B, C, D, KE and KW Reactors - contd

1968

May	KE	Thoria and supporting 94 Metal were loaded to produce
June	KW	360 kg of "clean" U-233 for the DNR program.

1969

Oct.	KW	Thoria and supporting 94 Metal were discharged completing
Dec.	KE	the program to produce 360 kg of "clean" U-233 for the DNR.
		The reactors were reloaded with natural uranium. Shield
		protection thoria remains charged in top and bottom zones of
		the reactor.

Top and bottom thoria blankets became a continuing program and were utilized for shield protection.

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Reactor Power Level Limits

		Effective Date of Limits						
		<u>1-31-58</u>	<u>1-16-59</u>	<u>1-9-61</u>	<u>12-2-63¹</u>	<u>2-18-64</u>	<u>3-4-64²</u>	<u>9-1-68</u>
B	1440	1900	2090	1940	2090	95.0	-	
D	1440	1900	2090	2005	2090	95.0	-	
DR	1440	1900	2090	1925	2090	95.0	-	
F	1440	1990	2090	1935	2090	95.0	-	
H	1440	1900	2090	1955	2090	95.0	-	
C	1740	2100	2310	2310	2310	95.0	95.0	
KE	3140	4000	4400	4400	4400	4400	4400	(3)
KW	3140	4000	4400	4400	4400	4400	4400	(3)

¹Reactors limited to the maximum power level which had previously been achieved.

²Power level limit of 2090 and 2310 megawatts removed and a bulk outlet water temperature of 95.0 C established.

³Effective September 1, 1968, top-of-riser pressure and process tube power limitations were imposed at both K Reactors because of safety concern for the brittle fracture potential of the inlet piping. Maximum power levels were in the 4000-4200 MW range. An administrative maximum level of 4000 MW was imposed late in 1969.

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Overbore of Selected Tube Channels at C Reactor

- December, 1960 - Two channels overbored 0.550 inch.
- January, 1961 - Three fringe channels overbored 0.550 inch and fitted with zirconium tubes.
- March, 1961 - Thirteen channels overbored 0.550 inch and charged with overbore-size self-support fuel elements.
- April, 1961 - Four channels overbored 0.550 inch and charged with overbore-size self-support fuel elements.
- August, 1961 - Twenty channels overbored 0.550 inch and Zircaloy-2 overbore tubes installed.
- December, 1961 - Twenty channels overbored 0.550 inch and fitted with Zircaloy-2 smooth-bore tubes.
- March, 1967 - One 0.550 inch overbore channel was returned to normal size. This was the beginning of a program to return 16 of the 18 overbore tubes outside of the 44-tube block to normal size.
- April, 1967 - One 0.550 inch overbore channel was returned to normal size.
- June, 1967 - Fourteen 0.550 inch overbore channels were returned to normal size.
- October, 1967 - One channel was overbored 1.000 inch, and a tube installed, as a preliminary to overboring the entire 44-tube block.
- January 19 to February 12, 1968 - Forty-three process channels in the 44-tube test block were 1.000 inch overbored.

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CG-558 Outages - "Reactor Plant Modification for Increased Production"

- B - September 22 to December 8, 1956
- DR - January 7 to February 19, 1957
- D - February 18 to March 22, 1957
- F - April 1 to May 18, 1957
- H - May 20 to July 4, 1957

Much of the CG-558 work was done prior to the major CG-558 outages shown above.

Process Water Flow through the Reactor Prior to CG-558 Compared to the Increased Flow Resulting from CG-558

	GPM	
	Before CG-558	After CG-558
B	46,300	71,000
DR	51,800	71,000
D	51,000	71,000
F	47,700	71,000
H	56,900	71,000

Project CG-600, "100-C Alterations," was completed at C Reactor June 9, 1960. The installation of higher capacity pumps in the 190 Building and the addition of one pump in each the 181 and 183 Buildings resulted in a process water flow increase to the reactor of about 9000 GPM.

Project CGI-883, "Increased Process Water Flow," was completed at the K Reactors October 2, 1962. This project involved additional river pumps at the 181 Building, new impellers and associated equipment for the 190 Building low lift pumps, rewinding the low lift pump motors (from 900 HP to 1500 HP), reworking the high lift pumps and upgrading the electrical supply system. The process water flow at each K Reactor was increased by 30,000 GPM.

Project DAP-500, "Increased Raw Water Pumping Capacity - B and C 181 Building," was completed December 8, 1966. Upgrading the 181-B river pump units and the installation of K-type rear nozzles and larger connectors resulted in a four percent increase in process water flow at B Reactor.

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Events Leading to the Use of CO₂ to Control Graphite Growth

- July 31, 1944 - Production Test 105-I-P, "Effects of Pile Operation on the Characteristics of the Graphite Filler," was issued.
- 1945 - Late in 1945 it became apparent that the exterior dimensions of the reactor were changing.
- January 18, 1946 - Premeasured graphite samples were removed from one of the reactors. Post-irradiation measurements showed that the graphite samples had expanded appreciably in the axis normal to the axis of extrusion.
- January 20, 1946 - By sighting through empty process tube channels, it was evident that expansion of the graphite was resulting in bowing of the process tubes.
- February 11, 1947 - Production Test 105-85-P was initiated. Virgin and previously irradiated test samples of graphite were irradiated in CO₂ and air in gas-filled process tubes at D Reactor.
- January 27, 1948 - Under PT 168-P the first CO₂ was added to a reactor atmosphere at D Reactor. By February 1 a 10% CO₂ and 90% helium concentration was reached. Further increases in the CO₂ concentration were made until 40% CO₂ was reached August 31, 1948, and some months later 100% CO₂ was reached in reactor atmosphere.

It became conclusive that higher graphite temperatures resulting from the addition of CO₂, and later from higher power levels, were the sole mechanisms which prevented the three original reactors from becoming inoperable because of graphite growth.

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SIGNIFICANT REACTOR ASSOCIATED PROJECT WORK

(Letter Prefix Key Shown at End of Listings on Page Number 56.)

<u>Project</u>	<u>Date Project Was Closed</u>	<u>Title</u>
C-29	--	Third Safety Device - 105 Buildings
C-76	--	Pneumatic Charging Machines - 105 Buildings
C-206	10-5-49	Construction of DR Reactor
C-323	4-3-50	Vertical Rod Replacement - 105-B, D and F
C-342	11-30-50	Design of 100-DR Water Plant
C-347	2-28-51	Replace Process Tube Nozzles - 105-B, D, F and DR
C-420	12-16-52	CO2 Bulk Storage Facilities - 105-B, D, F and DR
C-431 A & B	4-20-55	New Reactor - 100-C
C-431 C	4-20-55	Metal Examination Facilities
C-438	4-1-54	Ball 3-X Safety System - 105-B, D, F, DR and H
C-475	10-31-52	Crossheader Pressure Monitoring - 105-B, D, F, DR and H
C-482	8-14-53	Pile and Pile Water Plant Improvements
C-483	6-12-53	Downcomer Repairs - 100-B, D, DR and H. Replacement in 100-F.
C-495	7-7-53	Outlet Tube Temperature Monitoring Spare Thermocouples - 105-B, D and F
C-495	3-31-53	Earthquake Detectors for 100-B, D, DR, F and H Areas
CA-512-R	--	100-K Reactor
CA-512-W	--	100-K Water Plant Facility
CG-553	4-8-55	Outlet Tube Temperature Monitoring High Speed Electric Transcriber for 100-D, DR and F
CG-558	12-13-57	Reactor Plant Modifications for Increased Production

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Significant Reactor Associated Project Work - contd.

<u>Project</u>	<u>Date Project Was Closed</u>	<u>Title</u>
CG-583	5-1-57	Moisture Monitoring System for Detection of Leaking Process Tubes - 100-B, D, DR, F and H (CG-584 at 100-C)
CG-600	6-9-60	100-C Alterations
CG-609	5-31-55	Charge-Discharge while Operating - Test Facility
CG-651	10-21-57	Continuous Charge-Discharge Equipment - C Reactor
CG-666	2-16-60	Zone Temperature Monitoring - 100 Areas
CG-674	10-22-59	Water Plant Component Test Loop - 1706-KE
CG-705	9-16-58	Reactor Trip for Loss of Rod Cooling Water - 105-B, C, D, DR, F and H
CG-706	3-30-61	Installation of Improved Reactor Gas Instrumentation - 100-B, C, D, DR, F and H
CG-707	3-17-60	Improvements to Reactor Nuclear Instrumentation - All Reactors
CG-708	2-3-60	Installation of Additional VSRs, KE and KW
CG-709	5-1-59	VSR Improvements - All Reactors
CG-775	6-20-60	Water Plant Expansion - 100-KE and KW
CG-786	1-9-59	Flux Monitoring Dual Trip System - 105-B, C, D, DR and F
CGI-791	1-11-61	Reactor Confinement
CGI-802	2-20-61	Pressure Monitoring System, High Speed Scanning Type for Temperature Monitoring
CGI-806	6-12-61	Nuclear Instrumentation for Reactor Safety and Control - All Areas
CGI-817	7-25-60	Crossheader Pressure Differential Indicators and Alarm System - Hanford Reactors
CGI-839	8-28-64	Modification of Fuel Element Test Facilities - 1706-KER

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Significant Reactor Associated Project Work - contd.

<u>Project</u>	<u>Date Project Was Closed</u>	<u>Title</u>
CGI-844	1-30-63	100-K Area Coolant Backup
CGI-845	9-21-60	Increased Pumping Capacity - 181-C
CGI-883	11-21-62	Increased Process Water Flow - 100-K Area
CGI-884	3-7-62	Rear Face Crossunder Lines - B, D, DR, F and H Reactors
CGI-904	7-17-63	Improvements of Gamma Monitoring Systems - 105-B, C, D, DR, F and H
CGI-905	5-31-63	Interim Modifications to High Tank and Raw Water Systems for Improved Coolant Backup - 105-B, C, D, DR, F and H
CGI-939	8-15-63	Analog to Digital Converter System for Temperature Monitoring - 100-B, C, D, DR, F and H
CGI-966	3-11-65	Safety Circuit Trip Identification Systems - 105-B, C, D, DR, F and H
CGI-967	Active	High Speed Scanning System for Temperature Monitoring - KW Reactor
CGI-998	12-8-64	Improvements to Gamma Monitoring Systems, 105-KE and KW
CGI-103	11-8-64	Fuel Element Charging and Handling System - KE and KW Reactors
CAI-105	9-15-67	Modification for the Use of Bauxite, KE and KW Water Plants
CGI-125	7-13-67	Replacement and Improvement of Fixed Gamma Radiation Monitoring Instrumentation - Existing Hanford Production Reactor Areas
CAI-142	10-29-65	Coolant Backup Modifications Required by Reactor Deactivation - Three Small Reactors
CGI-143	9-30-66	Linear Power Rate of Rise Instrumentation, 105-KE and Three Small Reactors
CAI-174	8-30-67	High Speed Scanning System for Temperature Monitoring - KE Reactor
AEC-186	12-12-65	Equipment for Reactor Deactivation

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Significant Reactor Associated Project Work - contd.

<u>Project</u>	<u>Date Project Was Closed</u>	<u>Title</u>
AEC-187	12-30-65	Plant Modification for Reactor Deactivation

Key to letter prefix for project nos. 29 through 998 and 105 through 187 listed above:

- C - Construction Project
- A - AEC Managed
- G - General Electric Managed
- I - Irradiation Processing Department

DAP-500	12-8-66	Increased Raw Water Pumping Capacity - 181-B/C River Pumphouse
DCP-503	8-31-67	"C" and "D" Work Platform Safety Improvements
DCE-505	Active	Boiler Control Improvements, 165-KE and KW
DAP-507	Dec. '67	Work Area Fog Spray Systems - B, C, KE and KW Reactors
DAP-510	Active	Discharge Chute Clearing Equipment - K Reactors

Key to letter prefix for project nos. starting with no. 500 (established at the time of DUN takeover):

- D - Douglas United Nuclear, Inc.
- A - AEC Managed
- C - Contractor Managed
- P - Funds from Plant Acquisition and Construction Budget
- E - Funds from Equipment Project

DAP-516	Active	Storage Building Addition 105-KE & KW
DAE-518	Active	Effluent Radioiodine Monitor, C, KE and KW Reactors
DAP-520	Active	300 Area Sanitary Water System Additions

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Significant Reactor Associated Project Work - contd.

<u>Project</u>	<u>Date Project Was Closed</u>	<u>Title</u>
DCP-522	Active	Modification of Reactor Coolant Crosstie Piping - 105-KE and KW
DCP-524	Active	Replacement Fuel Production Process (H-D-S)
DAP-526	Active	Deactivation of Hanford Production Reactor C

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SIGNIFICANT REACTOR MAINTENANCE WORK PERFORMED ON
"MAINTENANCE JOB AUTHORIZATIONS"
(1956 to December, 1969)

<u>MJA No.</u>	<u>Title</u>
2	Rehabilitate Pile Gas Moisture Monitoring System - 105-B, C, D, DR, F and H
3	Replace Thermohms - 105-KE and KW
7	Replacement of Individual Tube Temperature Thermocouples - 105-D and DR
8	Ball 3-X Electrical Modifications - 105-B, D, DR, F and H
9	Restoration of Vertical Safety Rods - 105-DR and H
12	Modification of Process Water System for I&E Slugs - 105-D
15	Improved Gas Seals for Front and Rear Bellows - 105-C
18	K Graphite Stack Restoration
20	Replace C Reactor Tube Outlet Thermocouples with Improved Type
21	Pressure Monitor Repairs and Modification - 105-C
24	Rear Face Outlet Connectors - 105-F
25	Pressure Monitor Repairs and Modification - 105-KE and KW
29	Pressure Monitor Repairs and Modification - 105-H
32	Modification for Bumper Fuel Elements - 105-D and H
33	Thermocouple Replacement - 105-D
35	Replacement of Thermal Shield Thermocouples and Leads - 105-KE and KW
37	Conversion of Front Face Nozzles and Modification of Charging Machines at B, DR, F KE and KW Reactors for Use of Bumper Fuel
43	Replacement of Rear Face Thermocouples, Terminal Board, Extension Wire and Stepping Switches - Temperature Monitoring System - B Reactor
47	Pressure Monitor Modification and Repair - 105-B, D, DR, F and H

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Significant Reactor Maintenance Work Performed on "Maintenance Job Authorizations" - contd.

<u>MJA No.</u>	<u>Title</u>
48	Install Ten Knuckle Type VSRs in C Reactor
49	Install New Rear Face Connectors and Connector Elbows, Modify Thermocouple Well Connector; Remove Original Thermocouples from Crossheader and Install 1/4" Pipe Plugs - C Reactor
51	Replace Rear Face Temperature Monitoring Wire and Wells, Relocate Terminal Boards, Install New Lead Wire and Zone Temperature Terminal Boards - H Reactor
53	Installation of Rear Crossheader Expansion Joints - 105-B, D and H
54	Thermocouple Temperature Monitoring Stepping Switch Replacement and Associated System Repairs - C, D, DR, F and H Reactors (Work Authorized at B Reactor on MJA-43)
55	Zone Temperature Monitor Terminal Board Relocation and Controller Revision - B, C and D Reactors
59	Resistance Temperature Detector Extension Lead Replacement and Relocation 105-KE and KW Process Tube Temperature Monitoring System
60	Resistance Temperature Detector and Lead Wire Replacement - 105-KE and KW Tube Temperature Monitoring System
61	Steam Boiler Repair, 165-KE Building
62	Repair Line Cracks 105-C for Downcomer and Near Downcomer and Effluent Expansion Boxes
64	Repair to 107-C Tanks and Diversion Box
65	Downcomer Approach Box Strengthening 105-KE and 105-KW
66	Steam Boiler Repair - 165-KW
67	Steam Boiler Repair - 165-KE
68	Rear Face Piping Supports and Other Modifications - 105-B and D
69	107-KE and KW Retention Basin Repair

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Significant Reactor Maintenance Work Performed on "Maintenance Job Authorizations" - contd.

<u>MJA No.</u>	<u>Title</u>
70	107-B Retention Basin Repair
71	K Outfall Drainage Trenches
73	Repair of Effluent Pipe Joints and Retention Basin Valves for the 105-KE and KW Plants
75	Repair of 107-C Effluent Tanks
76	Confinement Filter Replacement - KE, KW and N Reactors
77	Decontamination and Retubing of Graphite Cooling System Heat Exchanger No. 4
81	Reinforcement of Branch Connections, 100-K Primary Coolant Piping

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SIGNIFICANT PRODUCTION TESTS

<u>P.T. No.</u>	<u>Date</u>	<u>Document No.</u>	<u>Title</u>
IP-4-A	--	HW-50333	Irradiation of Cored Slugs in Production Quantities
IP-5-A	9-25-56	HW-45658	Operation of the 1706-KER Recirculation Test Facility
✓ IP-8-C	5-10-55	HW-36647	Reducing Side Shield Temperatures by Fringe Poisoning
IP-12-AE	9-19-56	HW-45201	Poison Spline Flexible Control System
✓ IP-19-A	11-5-56	HW-46452	Pilot Charging of I&E Fuel Elements - C Reactor
IP-25-A	--	HW-29739	Graphite Burnout Monitoring Program
IP-38-A	--	HW-36550	Exposure of Aluminum Canned Slugs in a Zircaloy-2 Process Tube
IP-40-A	--	HW-42407	Evaluation of Watermix Slug
IP-64-ACE	3-25-57	HW-49191	Poison Column Displacement During Operation
IP-82-C	5-17-57	HW-50252	Determination of Feasibility of Quickie Rupture Removal and Scram Transients Curves During Low Level Reactor Operation
IP-88-C	8-13-57	HW-50770	Transition to Poison Splines
✓ IP-109-AC	--	HW-52311	Preliminary Irradiation of I&E Metal at C and the K Reactors
IP-132-AC	--	HW-54250	Production of High Pu-240 at C Reactor
IP-142-A	1-29-58	HW-54765	Pilot Charging of Columns Containing Watermix Pieces - C Reactor
✓ IP-142-A	1-30-58	--	Evaluation of Zirconium Process Tubes in C Reactor
IP-156-AI	4-8-58	--	Effect of Water Quality on Effluent Activity
IP-162-E	--	HW-55911	Routine Uranium Charging During Reactor Operation

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Significant Production Tests - contd.

<u>P.T. No.</u>	<u>Date</u>	<u>Document No.</u>	<u>Title</u>
✓ IP-189-I	7-9-58	HW-56685	Test Loading of I&E Fuel Elements at B, DR, F and H Reactors
IP-248-D	3-25-59	--	Operation at KAPL-120 Loop
IP-262-A	--	HW-60444	Evaluation of Projection Fuel Elements for Use in Ribbed Process Tubes - Demonstration Loading
IP-287-E	9-24-59	HW-62057	Installation of Prototype Analog to Digital Converter (Flexowriter)
IP-291-AE	11-4-59	HW-62620	Graphite Channel Overboring Demonstration
IP-312-A	3-17-60	HW-64374	Increase of Graphite Temperature Limit at KE and KW Reactors
IP-345-J	7-8-60	--	Experimental Poison Column Ball Valve Installation - B Reactor
✓ IP-350-C	8-3-60	--	E-N Demonstration Load at H Reactor
IP-357-A	9-8-60	HW-66736	The Use of Liquid Alum Feed for Water Treatment
IP-358-AC	10-3-60	HW-66973	Replacement of Carbon Dioxide with Nitrogen as a Constituent of the K Reactor Atmosphere
IP-381-A	12-8-60	HW-67720	Irradiation of Oversize Fuel Elements in the C Reactor Overbored Process Channel Facilities
✓ IP-409-AFP	6-19-61	HW-69964	Pilot Test of Self-Supported Fuel Elements in K-Size Smooth Zirconium Process Tubes
IP-433-AE	8-24-61	HW-70843	Reactor Test of Van Stone Seal Insert Modifications
IP-463-AE	11-21-61	HW-71754	Installation of Modified Inlet Nozzle in Support of Leak Detection While Operating
IP-467-C	12-6-61	HW-71809	Reducing Minimum Downtime
IP-471-AE	12-21-61	HW-72087	Detection and Temporary Repair of Leaking Process Tubes While Operating
IP-483-AT	1-19-62	HW-72367	Installation of Test Sleeves in One Vertical Safety Rod Channel for Force Measurements - 105-C Reactor

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Significant Production Tests - contd.

<u>P.T. No.</u>	<u>Date</u>	<u>Document No.</u>	<u>Title</u>
IP-494-E	2-15-62	HW-72698	On-Pile Test of Flexible Vertical Safety Control Rod - 105-C Reactor
IP-512-A	6-13-62	HW-73982	K Reactor Graphite Distortion Measurements
IP-530-AL	3-1-63	HW-74887	Continuous Measurement of Reactor Materials Corrosion
IP-541-A	10-29-62	HW-75387	Reactor Effluent Studies
IP-546-A	11-1-62	HW-75465	Irradiation of Hot-Die-Size Diffusion Bonded Fuel Elements
IP-550-I	11-19-62	HW-75607	Routine Monitoring for Moderator Oxidation Rates
IP-561-C	1-3-63	HW-76102	E-N Demonstration Test in Zirconium Tubes
IP-565-AM	1-16-63	HW-76254	Installation of Zirconium Tubes - 105-KW Reactor
IP-572-A	2-6-63	HW-76481	Evaluation of the Irradiation Behavior of KVNS Fuel Elements
IP-593-J	6-6-63	HW-77827	Evaluation of the Graphite Reaction with Higher Percentage Carbon Dioxide
IP-614-A	8-29-63	HW-78789	Irradiation of Thorium Target Elements
IP-654-A	2-3-64	HW-80468	Evaluation of Ten-Inch Enriched Uranium Fuel Elements
IP-659-AC	2-12-64	HW-80828	Evaluation of a Thorium Oxide Loading
IP-669-AC	4-1-64	HW-81379	Depleted Uranium Irradiation
IP-696-A	7-15-64	HW-82790	Evaluation of Arch-Rail Supports
IP-700	6-30-64	HW-83083	Graphite Core Boring Equipment Proof Test
IP-709	7-29-64	HW-83460	VSR Channel Enlargement and Sleeving - K Reactors
IP-725	10-19-64	RL-REA-14	Increased Graphite Temperature Limit - F Reactor
IP-739	4-26-65	--	Confinement Development

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Significant Production Tests - contd.

<u>P.T. No.</u>	<u>Date</u>	<u>Document No.</u>	<u>Title</u>
IP-750	1-22-65	RL-REA-532	Raw Water as a Reactor Coolant
IP-754	2-1-65	--	Physics Testing at H Reactor Deactivation
IP-761	3-19-65	RL-REA-778	Installation of Flat Horizontal Control Rod - KW Reactor
IP-777	5-1-65	RL-REA-2102	Evaluation of Arch Bumper Elements
IP-781	5-3-65	RL-REA-2020	Comparison Test Between Hot-Die-Sized and Al-Si Fuel
IP-783	5-19-65	RL-REA-2116	Strap-on Resistance Temperature Detectors on-Reactor Tests - K Reactors
IP-785	5-24-65	RL-REA-2133	Production of Co-60 in KER 1, 2, 3 and 4 Test Facilities - KE Reactor
IP-786	5-26-65	RL-REA-2146	Irradiation of Coated Fuel Elements
IP-787	6-4-65	RL-REA-2184	Irradiation of Low Silicon AlSi Elements
IP-794	8-1-65	RL-REA-2331	Evaluation of Larger Core Blanks
IP-797	7-29-65	RL-REA-2403	Comparison Between HDS and AlSi Fuel at High Specific Powers
IP-803	9-3-65	RL-REA-2518	Irradiation of Enriched Uranium Oxide Fuel Elements
IP-805	11-1-65	DUN-176	Irradiation of Neptunium Target Elements
IP-807	9-30-65	RL-REA-2575	Zircaloy Hydride Evaluation and Control
IP-810	10-11-65	RL-REA-2585	Installation of Flat Aluminum HCRs - D Reactor
IP-812	10-6-65	RL-REA-2620	Cobalt Pilot Irradiation in the Hanford C Reactor
IP-817	11-1-65	DUN-191	Irradiation of 1.25% Enriched Fuel Columns - KW Reactor

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Significant Production Tests - contd.

The following numbering system was established at approximately the time of DUN takeover:

<u>P.T. No.</u>	<u>Date</u>	<u>Document No.</u>	<u>Title</u>
PTA-002	12-17-65	DUN-370	Increased Graphite Temperature Limit - B, C, D Reactors
PTA-003	12-15-65	DUN-387	Evaluation of T-Section Bumper Elements - C Reactor
PTA-004	12-7-65	DUN-296	HDS Core Optimization - C Reactor
PTA-005	1-4-66	DUN-461	High Temperature Irradiation of Snap-8 Fuel Candidates - KE Reactor
PTA-010	2-3-66	DUN-644	Evaluation of High Silicon Aluminum Alloy Fuel Element
PTA-011	2-28-66	DUN-765	HDS and AlSi Fuel Performance Monitoring
PTA-012	3-8-66	DUN-787	Long-Term Evaluation of Alternate Dummy Effectiveness in the Control of Progressive Hydriding
PTA-016	3-21-66	DUN-817	Half-Plant Zeta Potential Control of Coagulant Dosage
PTA-022	4-1-66	DUN-931	Preliminary Irradiation of 125 Metal
PTA-038	6-24-66	DUN-1232	Half Plant Activated Alumina Test
PTA-040	8-1-66	DUN-1300	High Power Density Core Alloy Evaluation
PTA-048	11-15-66	DUN-1627	Central Zone Irradiation of Depleted Uranium - K Reactors
PTA-054	2-21-67	DUN-2136	210 E-N Demonstration Loading
PTA-063	3-7-67	DUN-2272	Quick Turnaround Neptunium Demonstration
PTA-067	3-30-67	DUN-2223	105 Percent Specific Power Demonstration Test
PTA-068	4-3-67	DUN-2331	Experimental Determinations of Reactor Heat Output Following a Controlled Power Failure
PTA-069	4-4-67	DUN-2441	Np-237 Buildup from Fuel with a High U-236 Content

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Significant Production Tests - contd.

<u>P.T. No.</u>	<u>Date</u>	<u>Document No.</u>	<u>Title</u>
PTA-070	4-11-67	DUN-2352	The Effect of Zircaloy Fuel Elements on Effluent Water Activity
PTA-076	2-28-68	DUN-3034	Irradiation of On-Site Recycled Thoria
PTA-079	--	DUN-2467	The Severance and Wrapping with Stainless Steel Shrouds Specific KE & KW Reactor Ball 3X Entry Bellows
PTA-084	--	DUN-2781	Evaluation of Fuel Performance at High Exposures - B Reactor
PTA-086	7- -67	DUN-2726	Segmental Discharge of Reactor Fuel
PTA-093	--	DUN-2965	High Exposure Depleted Fuel Test HDS-AISI Evaluation
PTA-102	10-9-67	DUN-3213	Installation of a 44-Tube Reactor Modernization Facility at 105-C
PTA-103	10-9-67	DUN-3214	Operation and Evaluation of 44-Tube Reactor Modernization Facility at 105-C
PTA-107	--	DUN-3548	Irradiation of High U-236 Content Elements in KE Reactor
PTA-109	--	DUN-3430	Installation of Uncooled Horizontal Control Rod - KE
PTA-126	1-7-69	DUN-3927	Installation and Irradiation of Cobalt Bearing Process Tube
PTA-149	6-28-68	DUN-4462	Large-Scale Wafer Thoria Irradiations
PTA-150	2-7-69	DUN-4747	K Reactor Plutonium Irradiations
PTA-156	--	DUN-4756	Removal of Top Portion of K Reactor Risers for Metallurgical Testing
PTA-158	--	DUN-4913	Through Reactor Decontamination
PTA-163	6-3-69	DUN-5113	Clean Plutonium-238
PTA-171	5-20-69	DUN-5535	Americium Irradiation

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Significant Production Tests - contd.

<u>P.T. No.</u>	<u>Date</u>	<u>Document No.</u>	<u>Title</u>
PTA-177	--	DUN-5786	Irradiation of Surplus Small Reactor Fuel at the K Reactors
PTA-181	--		Irradiation of Eleven-Inch HDS Elements
PTA-202	12-31-69	DUN-6589	Piping Proof Test KE & KW Reactors

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MONTHLY RECORD REPORT DOCUMENT NUMBERS

	1953 HW*	1954 HW	1955 HW	1956 HW	1957 HW	1958 HW	1959 HW	1960 HW	1961 HW	1962 HW	1963 HW	1964 HW	1965 RL-REA
J	26946	30724	34631	41205	48046	54689	58686	63753	68343	72567	76398	80581	472
F	27288	31006	35530	41702	48769	55101	59041	64122	68718	72813	76769	81000	473
M	27624	31267	35891	42219	49205	55462	59456	64555	69080	73153	77045	81001	474
A	27932	31734	36440	42626	49826	55870	59840	65013	69491	73473	77499	81002	475
M	28267	31964	36928	43137	50368	56184	60246	65527	69835	73777	77749	81003	476
J	28576	32317	37658	43938	51067	56527	60594	65924	70211	74101	78029	81004	477
J	28906	32624	38375	44580	51703	56911	60918	66296	70625	74309	78451	82940	2248
A	29229	32889	38828	45115	52053	57278	61399	66685	70952	74780	78780	82941	2249
S	29513	33200	39260	45717**	52809	57435	61789	66970	71230	75089	79070	82942	2250
O	29794	33585	39751	46349	53355	57597	62184	67286	71584	75451	79411	82943	2251
N	30130	33962	40182	47021	53719	57840	62599	67681	71910	75692	79757	82944	DUN 205***
D	30423	34147	40692	47615	54291	58360	62900	68039	72179	75931	80171	82945	206

*Manufacturing Department, Reactor Section

**Irradiation Processing Department

***Douglas United Nuclear, Inc.

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MONTHLY RECORD REPORT DOCUMENT NUMBERS - contd.

	1966 DUN	1967 DUN	1968 DUN	1969 DUN
J	558	2011	3595	5254
F	559	2012	3596	5255
M	560	2013	3597	5256
A	561	2424	4017	5610
M	562	2425	4018	5611
J	563	2426	4019	5612
J	1293	2872	4450	5965
A	1294	2873	4451	5966
S	1295	2874	4452	5967
O	1638	3179	4811	6270
N	1639	3180	4812	5271
D	1640	3181	4813	6272

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TITLES OF FEATURE ARTICLES IN MONTHLY REPORT

1967

July	Zircaloy Process Tube Hydriding in the K Reactors
August	Poison Spline System for Supplementary Control in the B, C and K Reactors
September	N Reactor 4800 MW Demonstration Test
October	Speciality Irradiation Services
November	Nuclear Safety Instrumentation - B, C and K Reactors
December	None

1968

January	N Reactor Piping Decontamination
February	Systems Reliability Analysis - C & K Reactors
March	N Reactor Steam Generator Retubing Program
April	Reactor Modernization by Process Channel Enlargement
May	The Quality Program in Fuels Manufacture
June	Development of Mark IV Fuel for N Reactor
July	N Reactor Licensability Program
August	None
September	Depleted Uranium Irradiations in the Single-Pass Reactors to Produce High Pu-240 Plutonium
October	None
November	Restoration of Tube 3560 in KW Reactor
December	N Reactor Coproduct Demonstration

1969

January	Technical Evaluation of 3560 KW Incident
February	Backup Coolant Supply Systems - B & C Reactors
March	The 300 Area Environmental Control Program as Administered by Douglas United Nuclear [REDACTED]

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Titles of Feature Articles in Monthly Report - contd.

1969 - contd.

April	Ball Safety System Bellows Shrouding - K Reactors
May	Uncooled Horizontal Control Rod - K Reactors
June	The Application of Fracture Mechanics to an Assessment of K Reactor Piping Integrity
July	Operating Experience with the N Reactor Ball Safety System
August	Transuranium Target Element Fabrication
September	Resistance Temperature Detectors for Process Tube Effluent Monitoring - K Reactors
October	None
November	Maintenance of Horizontal Control Rod System - K Reactors
December	Hot-Die-Size Fuel Fabrication Process at Hanford

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[REDACTED]
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