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OAK RIDGE RESEARCH REACTOR QUARTERLY REPORT
APRIL, MAY, AND JUNE OF 1967

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SUMMARY

The ORR operated 83.4% of the time during the quarter at an average operating power level of 29.4 Mw.

The total of thirteen shutdowns included ten which were scheduled. In turn, the scheduled shutdowns included two which terminated low-power tests and one for training purposes. Unscheduled downtime totaled less than 0.6 hours.

The No. 2 fission chamber and preamplifier and the failed No. 2 safety chamber (PCP II-106-64-3) were replaced. A radiation monitoring system for the normal off-gas system was installed as per Controls Change Memo No. ORR 80.

Three of the four reactor heat exchangers were examined internally and found to be in good condition. Two of the exchangers were opened routinely, while the north heat exchanger was examined because of unusual noise levels. Battery banks for DC motors Nos. 2 and 3 were load tested (6-hour runs) and found to operate quite satisfactorily.

The No. 4 shim rod drive was routinely replaced after slightly more than three years of continuous service. The unit was found to function correctly and to be within specifications dimensionally, indicating a sound design and excellent service life.

The poolside facility part of the lattice housing was examined dimensionally and visually for possible deformation due to neutron bombardment. No appreciable damage was detected.

Recent rod-worth tests indicate that the change to heavier fuel (240-gram elements) has resulted in a negative differential rod worth for the last inch of travel of new shim rods. Partially depleted shim rods do not exhibit this characteristic, which is probably the result of moving the fuel at the bottom of the shim rod out of the reflector-peak and into a lower flux at the bottom of the fuel region.

Flux monitors were irradiated at core positions A7 and B2, and at poolside opposite position A5. Data from these monitors will be used to determine the fast and thermal flux gradients across aluminum and beryllium core pieces, and across the poolside "window".

INTRODUCTION

Operating experience, instrument and process maintenance, and experiment activities for the quarter are summarized in Tables 1 through 12 of this report. Figures 1 through 3 supplement this information. Items of particular interest or importance are designated in descending order by the letters A, B, or C at the left of the tables. Discussion of this portion of the report is minimized.

Special tests or unusual occurrences are, by contrast, discussed in some detail in the back portion of the report.

OPERATIONS

Table 1. ORR Basic Operating Data

Period April through June, 1967

	This Quarter	Last Quarter	Year To Date	January-June 1966
Total energy, Mwd	2,234.8	2,244.2	4,479.0	4,769.1
Average power Mw/operating hr	29.4*	29.8	29.6	29.9
Time operating, %	83.4	83.6	83.5	88.2
Reactor water radioactivity, $\frac{c/min}{ml}$ (av)	31,400	30,900	31,200	35,500
Pool water radioactivity, $\frac{c/min}{ml}$ (av)	455	530	490	860
Reactor water resistivity, ohm-cm (av)	1,020,000	1,113,000	1,070,000	1,102,000
Pool water resistivity, ohm-cm (av)	850,000	1,020,000	930,000**	491,000
Fuel elements depleted	24	26	50	65
Shim rods depleted	4	4	8	6
Research samples	32	36	68	31
Radioisotope samples	135	151	286	394

*Lower than normal because of special low-power runs for loop 1 tests on April 4, 1967. See Table 5.

**The increase in quality of the pool water is a result of replacing the resins in the demineralizer units.

Table 2. ORR Cycles of Operation

Cycle No.	Date Begun	Date Ended	Accumulated Energy (Mwd)
72	March 10, 1967	April 29, 1967	1194.05*
73	May 5, 1967	June 25, 1967	1445.59
74	June 30, 1967	In Progress	2.44

*Energy accumulated this quarter, 581.76 Mwd.

SHUTDOWNS AND POWER REDUCTIONS

Table 3. Summary of ORR Shutdowns

Description or Reason	Number	Downtime (hr)
Scheduled		
Regular, end of cycle	2	284.917
Special, midcycle and isotope work, limited experiment work	2	47.817
Regular, refueling	2	6.983
Special, refueling and limited experiment work	1	10.317
Special, end of tests at low power	2	10.683
Special, training	1	0.283
Subtotal	10	361.000
Unscheduled		
Instrument trouble, experiment	1	0.067
Electrical power outage or surge	1	0.467
Human error	1	0.050
Subtotal	3	0.584
Total	13	361.584

ORNL DWG. 67-12186

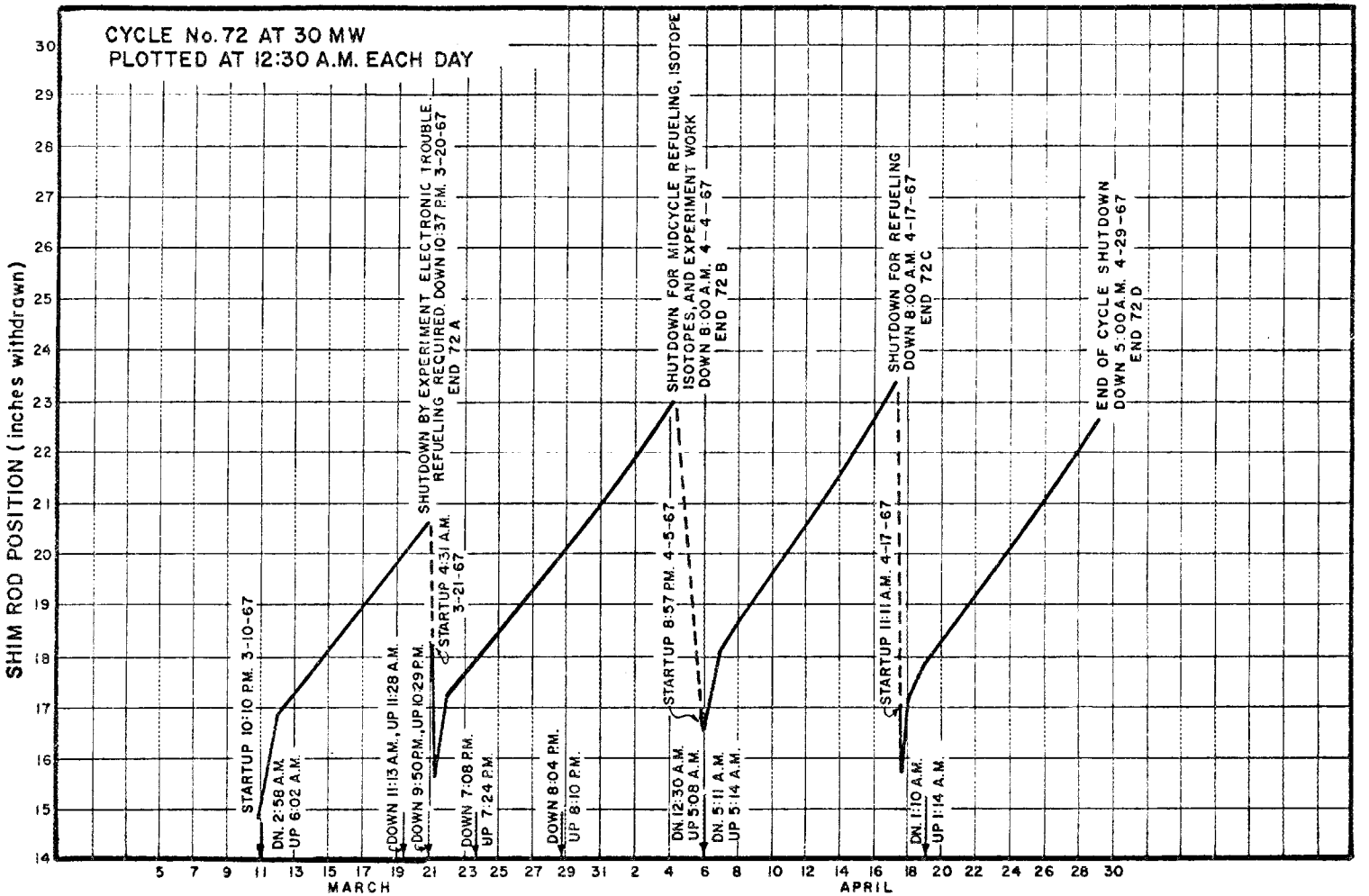


FIG. 1 SHIM ROD POSITION Vs TIME (CYCLE No. 72)

ORNL DWG. 67-12187

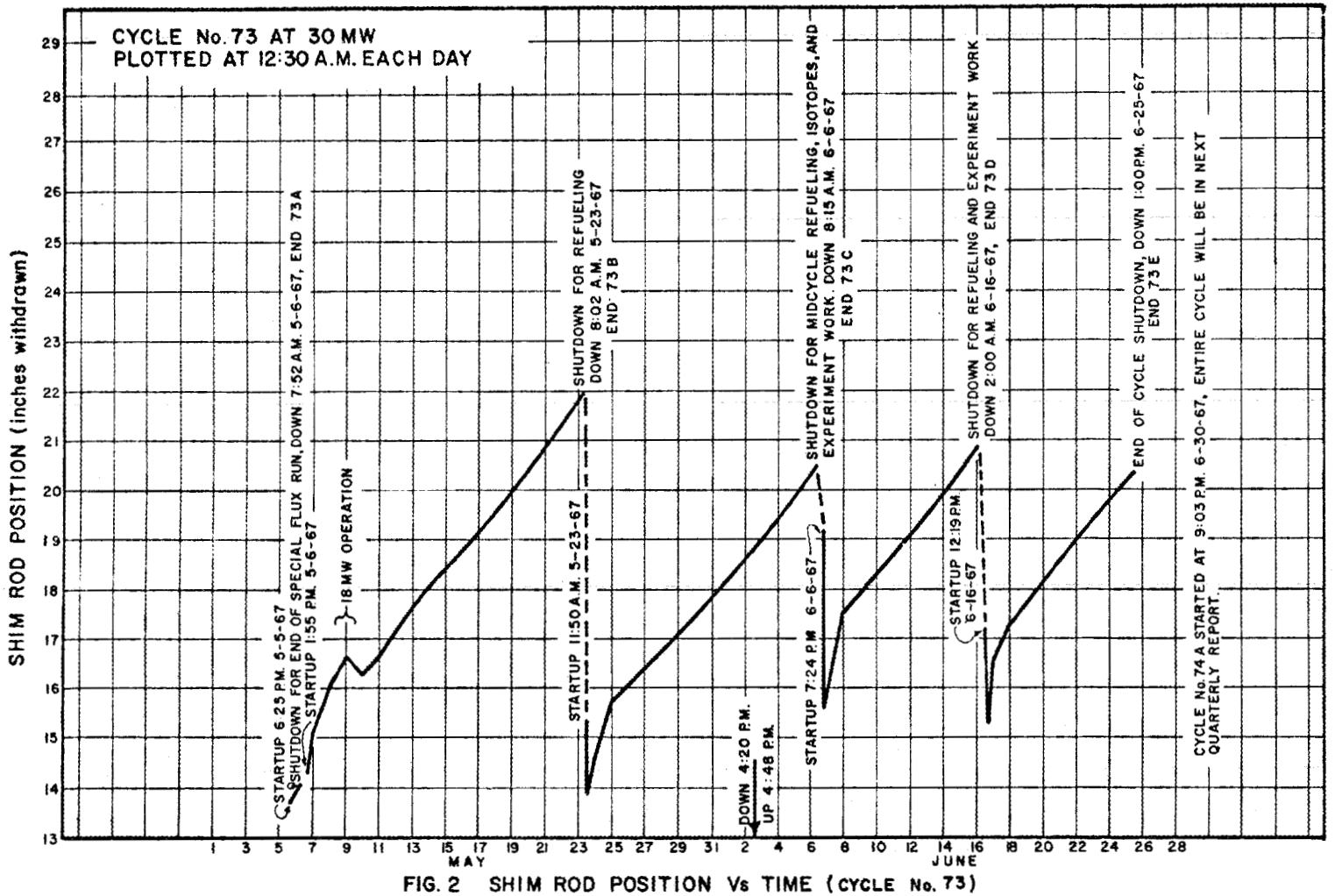


FIG. 2 SHIM ROD POSITION Vs TIME (CYCLE No. 73)

Table 4. Unscheduled Shutdowns of the ORR, Details

Date	Duration (hr)	Remarks
4-6-67	0.050	The reactor power level was inadvertently allowed to sag below accountable levels ($<N_L$) while the shim rods were being adjusted prior to proceeding to full power.
4-19-67	0.067	The reactor power was reduced to slightly below N_L by a setback from the F9-2 high-burnup capsule experiment. The setback signal originated from a temperature recorder and was the result of failure of the recorder amplifier.
6-2-67	0.467	This shutdown resulted from failure of a new electrical breaker at substation 0901. The breaker, No. 214, failed to assume the load when put on the line, thus causing a momentary power outage. Breaker 214 had previously been tripped erroneously on March 20, 1967.

Table 5. ORR Scheduled Shutdowns, Details

	Date	Duration (hr)	End Cycle	Remarks
	4-4-67	0.283		The reactor was shut down just prior to the end of the fuel cycle to provide training for startup following an unscheduled shutdown.
A	4-4-67	36.667	72B	The reactor was shut down for midcycle refueling, isotope work, and special experiment work which included the removal of the failed molten salt loop No. 2 and special tests of a failed fuel capsule in the GCR loop 1 facility. Operation at low power levels was required for the loop 1 tests. The downtime was utilized for the installation of the containment vessel for the F9 fuel meltdown experiment, for the replacement of the ionization chamber for the No. 2 safety channel, and for repairs to the south ^{16}N instrument channel.
	4-6-67	4.633		The reactor was shut down following low-power operation for tests at the GCR-loop 1 facility, as described above. Downtime was utilized for retracting the experiment from the high-flux zone after which the loop was purged.
	4-17-67	3.183	72C	The reactor was refueled.
A	4-29-67	156.867	72D	This shutdown terminated operating cycle 72. Eight experiments were changed. Jobs of most interest were: (1) the removal of the GCR loop 1 experiment, in-pile facility tube, and cooler section, (2) the removal of the 04-P6 capsule experiment, (3) the installation of the 06-11 capsule (HTGR type), and (4) the inspection of the north reactor heat exchanger. A vertical dimensional traverse of the poolside facility was made, using specially constructed tools. A flux run was conducted to provide data relative to the flux gradient across an aluminum core piece in core position A7, across the poolside "window" opposite core position A5, and across a solid beryllium piece in core position B2. The results of the flux run and the dimensional check are reported in the special tests section of this report.

Table 5. (Continued)

	Date	Duration (hr)	End Cycle	Remarks
	5-6-67	6.050	73A	This shutdown concluded the flux run described in the April 29, 1967, entry, above. The core was changed very slightly after the flux run, necessitating the establishment of separate fuel cycles. The downtime was utilized to remove the flux monitors and to make final preparations for full-power operation.
	5-23-67	3.800	73B	The reactor was shut down for refueling and limited maintenance work. A leak in the coolant-water supply to the No. 1 primary pump seals was repaired. The downtime was also utilized to install a lead-shutter plug at HB-1.
B	6-6-67	11.150	73C	The reactor was shut down for midcycle isotope work, refueling, and limited experiment work at the 06-11 capsule. Startup was delayed by the necessity for replacing leaking check valves in the 06-11 experiment piping. Several beryllium transfers were effected as part of the irradiation damage control program.
B	6-16-67	10.317	73D	The reactor was shut down for refueling and to permit the removal of the 06-11 capsule experiment, which had suffered a minor failure of its primary containment.
A	6-25-67	128.050	73E	Operating cycle 73 was terminated. Experiment work included the removal, installation, or replacement of experiments in six facilities. Operations maintenance included inspection of two reactor heat exchangers and the routine replacement of the No. 4 shim-rod drive unit.

Table 6. Reductions in ORR Power Not Resulting in Shutdowns

Date	Source of Signal	Type of Signal	Lowest Power (Mw)	Comments
4-6-67	F-2 experiment	Setback	29.9	A momentary setback was caused by the inadvertant actuation of the manual setback switch during an experiment position change.
4-14-67	C-1 experiment	Setback	28.8	A temperature recorder malfunctioned resulting in an upscale spike to the setback point. Repairs were effected by Reactor Controls personnel.
4-18-67	F-9 (fuel meltdown experiment)	Setback	29.9	This was an intentional, routine setback to check the experiment tie-in to the reactor controls.
5-8-67	GCR capsule 06-11	Setback	28.0	A setback signal was intentionally initiated from the experiment instrumentation as a check of the circuitry.
B 5-8-67	Reactor Controls (manual)	Setback	18.0	The power level was reduced to permit maintenance work at the No. 1 primary pump. The motor was aligned and leaking seals were replaced.
5-12-67	F-9 experiment	Setback	29.0	A momentary signal was intentionally initiated to check the continuity of the experiment-to-reactor-controls "tie-in".
5-23-67	F2-A experiment	Setback	29.7	The manual setback switch was inadvertently actuated by the experimenter while the experiment was being inserted into the high-flux zone.

Table 6. (Continued)

Date	Source of Signal	Type of Signal	Lowest Power (Mw)	Comments
5-24-67	F-9 (fuel meltdown experiment)	Setback	24.0	A momentary setback signal was initiated to check the continuity of the experiment-to-reactor "tie-in".
5-24-67	GCR experiment 5 (capsule experiment)	Setback	N_L(0.3)	The setback resulted from low blanket pressure in the experiment caused by misvalving on the part of the experimenter.
6-13-67	F-9 high burnup capsule experiment	Setback	2.0	A setback signal was initiated when the wrong switch was adjusted during routine alarm setting changes.
6-13-67	F9-2 high burnup capsule experiment	Setback	29.0	An intentional setback signal was initiated following setpoint changes as described above. The circuitry checked satisfactorily.

Table 7. Maintenance and Changes, Reactor Instrumentation and Controls

Date	Component	Trouble or Change	Reason or Maintenance
		Safety System	
3-10-67	Safety-level sigma amplifier	Drop point changed	The power level at which an electronic scram occurs (drop point) was returned to the normal setting of 1.45 N_F after three months of successful operation at a lower setting (1.25 N_F). The lower setting had been established to test the system performance at this level.
		No. 1 Count-Rate Channel	
5-23-67	Count-rate recorder	20 counts/sec switch failed to function	The switch apparently stuck, preventing the attainment of the instrument start mode. The switch was operated manually and then checked for proper operation several times. The trouble is apparently intermittent and repairs were scheduled for the end-of-cycle shutdown.
		No. 2 Count-Rate Channel	
4-13-67	Count-rate meter	Unit replaced	The replacement was made as part of the investigation of intermittent trouble in the form of false period spikes. This step did not correct the trouble.
4-29-67	Undetermined	Period spikes	Several period spikes to <5 seconds were recorded; however, the trouble cleared and no specific cause was found.

Table 7. (Continued)

	Date	Component	Trouble or Change	Reason or Maintenance
B	5-23-67	Fission chamber (snake	Unit replaced	Instabilities in the system, reported above, were found to be due to trouble in the fission chamber preamplifier assembly which was replaced. To date, the cause of the trouble has not been determined, i.e., the fission chamber and preamplifier have not been examined or tested.
				Log-N Channels
				No significant maintenance or changes were required; however, the No. 2 log-N chamber was replaced because of trouble in the uncompensated section as noted below (No. 2 safety channel).
				No. 1 Safety Channel
				This instrument channel operated satisfactorily throughout the quarter.
				No. 2 Safety Channel
A	4-5-67	Ionization chamber	Replaced	Instabilities in the output of this instrument channel were traced to the chamber which was installed in the ORR on January 27, 1967. This chamber, No. PCP-II-106-64-3, was previously used in the BSR. It is to be noted that the compensated section of the chamber (No. 2 log N) was operating and apparently in good repair at the time of the change.

Table 7. (Continued)

	Date	Component	Trouble or Change	Reason or Maintenance
				No. 3 Safety Channel
				No changes or maintenance of significance were required.
				Micromicroammeter Channel, North and South Gamma Channels
				Maintenance was not necessary.
				South ^{16}N Channel
B	3-14-67 to 4-5-67	Cable connectors (pipe chase)	Replaced	Upscale spikes, to above the alarm at 110% of normal output, were observed on March 14, 1967. The trouble was traced to that portion of the circuit in the pipe chase; and, during shutdown on April 5, 1967, the chamber output cable connectors were found to be defective. New connectors were installed, and the trouble did not recur.
				North ^{16}N Channel
	4-2-67	Micromicroammeter	Spiking	The micromicroammeter for the south ^{16}N channel was used with the north chamber until electronic repairs could be completed.
				Reactor Noise Monitor
				No maintenance or changes were required.

Table 7. (Continued)

	Date	Component	Trouble or Change	Reason or Maintenance
			Radiation Detection Instrumentation	
	4-10-67	POG activity electrometer	Erratic readout	Electronic tubes were replaced to correct the trouble.
C	5-1-67 to 6-8-67	NOG radiation monitor	Initial installation	The work related to the installation of the NOG radiation monitor was completed. The channel, described in Reactor Controls Change Memo No. ORR-80, monitors the radiation level at the air-water separator on the NOG header in the ORR basement.
	5-8-67	Degasifier radiation monitor	Variable output	A faulty amplifier was replaced.
	5-22-67	Reactor secondary radiation monitor	Erratic readout	The trouble was apparently due to moisture in the cable-way near the sensing element.
	6-9-67	Reactor secondary radiation monitor	Replaced amplifier	This amplifier was replaced following erratic readout of the instrumentation. The trouble was corrected.
			Process Instrumentation	
	6-2-67	Flow meter reactor secondary	Tubing failed	The plastic tubing connecting the orifice to the transmitter failed because of embrittlement due to exposure to the weather.

Table 8. Process Systems, Maintenance and Changes

	Date	Component	Remarks
		Reactor Primary System	
A	4-7-67	No. 1 (north) heat exchanger	A rattling noise was detected during routine area checks, apparently originating from inside the No. 1 (north) heat exchanger. Similar noises have occurred previously at other heat exchangers; however, no real cause for such rattling has been found. An internal inspection was scheduled for the end-of-cycle 72 shutdown (April 29), and frequent external checks were initiated to assure that the condition did not worsen perceptively in the interim.
A	4-30-67	No. 1 (north) heat exchanger	The heat exchanger was opened for inspection by removing the heads and the inlet and exit (primary side) valves. The impingement baffle above the inlet nozzle was found to be loose at one corner; however, all other visable areas were found to be in excellent condition. The cause of the rattling noise described above was not discovered, and the heat exchanger was reassembled after the inlet baffle was rewelded.
B	5-1-67	No. 3 primary pump outlet check valve	This Mission check valve was removed from the system for routine inspection. Considerable wear was found in the hole around the shaft. The flappers were replaced with new units, containing Stellite bearing inserts.

Table 8. (Continued)

	Date	Component	Remarks
C	5-1-67	No. 3 primary pump motor	The base for this motor was replaced because of alignment problems arising from poor design features of the original base. The new base, constructed of structural steel members, proved very satisfactory.
B	5-3-67	Trane coolers	These coolers were isolated from the reactor primary system by cutting and blanking the 24-inch pipe headers (trane cooler inlet and exit lines). Line 104, the inlet, was severed near the point of exit from the "Y" pit, while line 110, the trane cooler outlet header, was cut at the point of entry to the "T" pit.
A	5-4-67	No. 2 DC pony motor battery bank	The battery bank was tested by operating the dc motor under load for 6 hours with the battery charger disconnected. The flow rate at the end of the run was 1100 gpm as compared with a beginning flow of 1260 gpm. The batteries were recharged immediately following the load test, and the recovery was normal in every respect.
	5-23-67	No. 1 primary pump	The cooling-water lines for the pump seals were replaced. Leaks had developed in the piping following previous maintenance.
	6-6-67	Degasifier	Valve No. 13 in the degasifier complex (between the degasifier and the degasifier demineralizer) was repaired after it was found to be leaking.

Table 8. (Continued)

	Date	Component	Remarks
B	6-13-67	Degasifier	A leak developed in the steam condenser at the degasifier, allowing process cooling water to enter the exit waste stream. Four tubes were plugged to repair the leak, and a new stainless steel tube bundle was ordered since three tubes had failed previously.
A	6-26-67	Reactor heat exchangers	The heads were removed from heat exchangers 2 and 4 (No. 1 is the north exchanger) to permit inspection of the secondary side of the heat exchangers. The inlet and exit piping and plenums and the inside of the tubes were in very satisfactory condition, indicating that secondary water treatment practices are adequate.
	6-27-67	No. 1 primary pump outlet check valve	The Mission check valve was inspected and found to be in good condition.
	6-28-67	24-inch strainer	Corrosion coupons were replaced in the reactor 24-inch strainer (inlet to reactor tank). The strainer components were found to be in good condition. It was necessary to remove a few small pieces of neoprene rubber which probably came from old gaskets immediately upstream from the strainer.
A	6-29-67	No. 3 dc pony motor battery bank	Battery performance under load conditions was tested as described above (May 4, 1967, No. 2 dc pony motor battery bank). The performance of the batteries in the No. 3 bank was satisfactory, both under load, and during recharging.

Table 8. (Continued)

Date	Component	Remarks
6-29-67	No. 1 primary pump motor	A new motor base, constructed of structural steel members, was installed. A similar base installed at the No. 3 motor on May 1, 1967, proved very effective in alleviating alignment problems.
A 6-29-67	Emergency spray manifold (process water)	The emergency cooling spray heads were inspected and tested. All connections, piping, and valves were in good repair, and the sprays delivered full flow when valved into the process water system.
	Reactor Secondary System	
4-29-67 and 6-25-67	Reactor tower	The tower was thoroughly inspected during the two end-of-cycle shutdowns which occurred during the quarter (beginning dates given). Satisfactory conditions were found, and vibration tests indicated no significant alignment or balance problems.
5-4-67	Secondary pump motors	Lightning protection equipment was installed inside the secondary pump house.
5-4-67	No. 1 secondary pump	The pump base was regrouted, thus assuring better alignment.
5-4-67	Tower fans	(1) The oil was changed in both the north and south gear boxes, and (2) the motors for both fans were painted.

Table 8. (Continued)

	Date	Component	Remarks
			Pool Primary System
	5-15-67	Lower dam, center to west pool	This dam was removed from the pool to permit replacement of the gasket material which had age hardened.
	6-28-67	Center pool	Corrosion coupons were replaced.
			Pool Secondary System
	5-2-67	Pool secondary pump and piping	The pool secondary pump and adjacent lines were painted.
	6-28-67	Pool tower basin	Corrosion coupons were replaced.
			Cell Ventilation System
B	5-30-67	Charcoal filters	The I^{131} removal efficiency of the charcoal filter was measured as 93.661%.
			Pressurizable Off-Gas System
	4-10-67	Drainage system	New plugs of an improved design were installed in the pit drains.
B	4-27-67	Charcoal filters	Elemental iodine removal efficiencies were checked. Results were: north bank - 99.989%; south bank - 99.817%.*

*New charcoal filters containing activated charcoal for methyl iodide removal are on order and will be installed when delivered.

Table 8. (Continued)

	Date	Component	Remarks
			Intermediate Level Waste Systems
	6-29-67	BSR intermediate-level waste line	This line was connected to the demineralizer drain header between the ORR and WC-19.
			Building Overhead Cranes
B	4-17-67	1-ton and 20-ton cranes	Maintenance jobs were completed as listed: (1) clutch alignment, (2) hoist brake adjustment, (3) gear box oil seals replaced, (4) bridge motor aligned, (5) trolley rails cleaned, and (6) clutch brushes aligned.
B	5-16-67	1-ton and 20-ton cranes	The two hooks were dye checked and found to be free of detectable flaws.
B	5-23-67	1-ton and 20-ton cranes	Both cranes were load tested under full rated capacity after the cables had been fully inspected. The condition and operation of both cranes was quite satisfactory.

Table 9. Reactor Mechanical Components, Maintenance and Changes

	Date	Component	Remarks
	5-2-67	North thermal shield, poolside	This shield was removed to allow future installation of a pneumatic-tube experiment facility.
A	5-3-67	Poolside facility (inside tank)	Vertical traverse measurements (dimensional check of the poolside facility inside of tank) were made at positions A4, A5, and A6. The measurements were made to determine if neutron damage has caused deformation of the core tank. Results are reported in the special tests portion of this report.
A	6-27-67	No. 4 shim rod drive	Rod drive assembly D was removed from the No. 4 shim rod position after slightly over three years of continuous service. The unit was inspected prior to disassembly and found to be functionally and dimensionally acceptable according to the original specifications. This unit had not been removed from the reactor since its initial installation on June 15, 1964. It was still operating satisfactorily at the time of removal and was scheduled for removal only as part of the routine maintenance program. During disassembly of the engagement mechanism, galling occurred at the threaded joint between the ball-cage mechanism and the body of the drive tube. This problem has occurred on previous occasions and has been partially alleviated by increasing the thread tolerance slightly. There was very little wear in the area of the ball-latch mechanism, indicating the effectiveness of the line contact between the plunger and the engagement balls. There was a slight accumulation of a rust-like material on the top stop; however, the accumulation was not sufficient to be of any concern.

Table 9. (Continued)

Date	Component	Remarks
		This change of rod drives (engagement mechanism) is the seventh in the three-year period since the new design was adopted. The records indicate that there has been no trouble with the engagement mechanism except for galling of threads during disassembly as mentioned above. Other portions of the assemblies have functioned equally as well. Accordingly, the practice of removing a rod-drive assembly for inspection each six months will be discontinued; rather, the performance of the drives will be reviewed at each end-of-cycle shutdown and a more appropriate preventive maintenance schedule will be developed.
6-29-67	Poolside facility	The poolside facility window was inspected by utilizing the underwater periscope. The inside of the facility is apparently in fairly good shape. There is a coating of oxide much like that which is on the Be and Al lattice inserts. The oxide layer is scraped off where the fuel element pads rub the tank and the resulting edges are thick enough to be barely felt using a small wire on an extension handle. There are some small indentions on one line which do not seem to be very deep, as they could not be felt with the end of the wire. The outside of the "window" is scratched. The scratches look like normal wear. Pictures were made of the north side of the "window" and of the junction of the flat face with the north side. Poloroid shots show that some slight pitting has occurred at the corner, and that there may be some slight corrosion at the welds. Final analysis will await the prints from the regular film.

FUEL

Table 10. ORR Fuel Status

	This Quarter	Last Quarter	Year To Date	January Through June, 1966
Depleted fuel elements transferred for chemical separation	26	54	80	78 (3)*
Average % burnup of fuel elements	39.1	35.8	36.9	35.5
New fuel elements placed in service	29	19	48	73
New fuel elements available for use	240 (4)*	249 (4)*	-	-
Depleted shim rods transferred for chemical separation	2	2	4	6
Average % burnup of shim rods	64.3	64.3	64.3	50.2
New shim rods placed in service	4	4	8	6
New shim rods available for use	4	2	-	-
New shim rod fuel sections available for use	11	15	-	-

*The number of partial fuel elements is included in each total and is also given in parentheses.

EXPERIMENT FACILITIES AND LATTICE CONFIGURATION

Table 11. ORR Facilities Assignment

Facility	Access Flange	Nature of Experiment	Division or Other Sponsor
		Lattice Positions	
A-1*	V-11	On standby	Operations
A-2	V-11	Uninstrumented and instrumented capsule irradiations	General Electric
F-5 and F-7		Radioisotope production	Isotopes
A-7		Fast neutron irradiations	Reactor Chemistry
A-9	V-2	Fuel tests	Reactor Chemistry
B-1	V-10	Gas-cooled loop No. 1 (standby)	Reactor
B-8	V-1	Radiation-damage studies	Metals and Ceramics
B-9	V-2	Fuel tests	Reactor Chemistry
C-1	V-9	Fuel tests	Reactor Chemistry
C-3		(Half-fuel position, on standby)	Solid State
D-8	V-3	Hydraulic-tube No. 2	Isotopes--Chemistry
F-1	V-8	On standby	Reactor
F-2	V-6	Fuel tests, radiation damage tests	General Electric
F-3	V-7	Fuel-meltdown test samples, irradiation only	Reactor Chemistry
F-8	V-4	Hydraulic-tube No. 1	Isotopes--Solid State
F-9	V-5	Fuel-meltdown tests	Reactor Chemistry
		Poolside Positions	
P-1, P-2, P-3, P-7, P-8, P-9		GCR capsule irradiations	Reactor

*Final experiment installation is incomplete.

Table 11. (Continued)

Facility	Access Flange	Nature of Experiment	Division or Other Sponsor
P-4		Radiation-damage studies	Metals and Ceramics
P-5		Radiation-damage studies	Metals and Ceramics
P-6		Radiation-damage studies	Solid State
		Large Facilities	
HN-1		Molten salt loop experiment	Reactor Chemistry
HN-2		Pneumatic tube for high-speed rabbits (activation analysis)	Chemistry
HN-3		Pneumatic tube for activation analysis	Chemistry--Analytical Chemistry
HN-4		Neutron spectrometer	Solid State
HS		Gas-cooled loop No. 2 (on standby)	Reactor
		Beam Holes	
HB-1		Fission fragments studies	Physics
HB-2		Neutron spectrometer	Solid State--Physics
HB-3		Neutron spectrometer	Solid State
HB-4		Neutron spectrometer	Chemistry
HB-5		Neutron spectrometer	Physics
HB-6		Time-of-flight (neutron spectrometer)	Physics

Table 12. Experiment Facility Usage

Facility	Date Installed	Date Removed	Description of Experiment	Division or Other Sponsor
A-2	2-2-67		ORM-53, tensile and bend specimens of refractory metals	General Electric
A-7	1-30-67		Fast neutron irradiation facility (new holder)	Reactor Chemistry
A-9	3-10-67	4-29-67	Capsule A9-10 (0.288 g ^{235}U) containing pyrolytic carbon coated UO_2	Reactor Chemistry
A-9	5-6-67	6-25-67	Capsule A9-11, carbon coated uranium carbide particles (0.26 g ^{235}U)	Reactor Chemistry
A-9	6-25-67		Capsule A9-12, pyrolytic carbon coated UO_2 particles (0.25 g ^{235}U)	Reactor Chemistry
B-1	3-10-67	4-29-67	Experiment No. 16, containing ~7.5 g of ^{235}U (heat generation ~11 kw) was irradiated. The cladding apparently failed shortly after installation. The in-pile facility tube was also removed.	Reactor
B-8	1-15-67	4-29-67	ORR-176, 96 stainless steel tensile specimens	Metals & Ceramics
B-8	5-6-67		ORR-189, 67 stainless steel tensile specimens	Metals & Ceramics
B-9	3-10-67	4-29-67	Capsule B9-34, pyrolytic carbon coated UO_2 and UC particles (0.153 g ^{235}U)	Reactor Chemistry

Table 12. (Continued)

Facility	Date Installed	Date Removed	Description of Experiment	Division or Other Sponsor
B-9	5-6-67	6-25-67	Capsule B9-35 silicon carbide coated UO_2 particles (0.17 g ^{235}U)	Reactor Chemistry
B-9	6-25-67		Capsule B9-36, 0.12 g ^{235}U as UO_2 particles, 90% pyrolytic carbon coated, 10% uncoated	Reactor Chemistry
C-1	2-9-67	6-27-67	Capsule C1-18, hollow cylinder of UO_2, (0.1 g ^{235}U)	Reactor Chemistry
C-1	6-30-67		Capsule C1-20, 0.035 g ^{235}U, as a hollow cylinder of UO_2	Reactor Chemistry
D-8	3-10-67		Hydraulic tube No. 2 used for isotope production and short-term irradiation. New in-tank section was installed.	Isotopes
F-2	3-10-67		ORR F-3, refractory fuel test (~3 g ^{235}U) irradiated throughout the quarter.	General Electric
F-3 Pos. 1	3-10-67	4-29-67	Capsule No. 7A, 5.965 g UO_2 (10.5% enriched) Zircalloy clad	Reactor Chemistry
F-3 Pos. 2	3-10-67	4-29-67	Capsule No. 8A, 5.910 g UO_2 (10.5% enriched) Zircalloy clad	Reactor Chemistry
F-3 Pos. 2	6-30-67		Capsule No. 4, 5.955 g UO_2 (10.24% enriched) Zircalloy clad	Reactor Chemistry
F-3 Pos. 4	3-10-67	4-29-67	Capsule No. 9A, 5.971 g UO_2 (10.5% enriched) Zircalloy clad	Reactor Chemistry
F-3 Pos. 4	6-30-67		Capsule No. 6, 5.945 g UO_2 (10.2% enriched) Zircalloy clad	Reactor Chemistry

Table 12. (Continued)

Facility	Date Installed	Date Removed	Description of Experiment	Division or Other Sponsor
F-7	1-14-67		Iodine production facility transferred from A-3	Isotopes
F-8	6-2-64		Hydraulic tube No. 1 for isotope production and short-term irradiations	Isotopes
F-9	3-10-67	4-10-67	F9-2, high burnup capsule experiment No. 2. UO_2 and UC_2 in stainless steel primary container	Reactor
F-9	4-18-67	4-27-67	Fuel meltdown, experiment No. 31	Reactor Chemistry
F-9	5-12-67	5-22-67	Graphite-ignition test No. G4	Reactor Chemistry
F-9	5-24-67		F9-2, high burnup capsule reinstalled	Reactor
GCR-3	3-13-65	6-26-67	03-9 (MPRE capsule) UO_2 fuel in stainless steel can with NaK blanket	Reactor
GCR-3	6-30-67		03-P7 fast gas capsule	Reactor
GCR-4	3-10-67	4-29-67	04-P6 fast gas capsule containing ~18 g of ^{239}Pu and ~8 g of ^{235}U	Reactor
GCR-5	3-10-67		05-11 capsule experiment	Reactor
GCR-6	5-6-67	6-16-67	06-11 HTGR-type fuel test	Reactor

Table 12. (Continued)

Facility	Date Installed	Date Removed	Description of Experiment	Division or Other Sponsor
GCR-7	10-21-65		Capsule 07A-10, extensiometer experiment irradiated throughout the quarter	Reactor
P-4	3-10-64	4-29-67	ORR-182, 96 tensile specimens, Hastelloy, Incoloy, and stainless steel	Metals and Ceramics
P-4	5-6-67	6-26-67	ORR-187, 96 INOR-8 tensile specimens	Metals and Ceramics
P-4	6-30-67		ORR-191, 96 stainless steel tensile specimens	Metals and Ceramics
P-5	3-10-67		ORR-183, 6 graphite bend test specimens irradiated throughout the quarter	Metals and Ceramics
P-5[a]	3-10-67	6-27-67	ORR-185, ladder-type experiment containing 47 tensile specimens	Metals and Ceramics
P-5[b]	4-11-67	4-13-67	Semiconductors with flux monitors for Fundamental Methods Incorporated	Isotopes
P-5[b]	4-18-67	4-20-67	Reinsertion of semi-conductors	Isotopes
P-5[b]	4-28-67	4-29-67	Reinsertion of semi-conductors	Isotopes
P-6	3-10-67	4-29-67	Experiment ORR-184, 5 Mo creep specimens	Metals and Ceramics

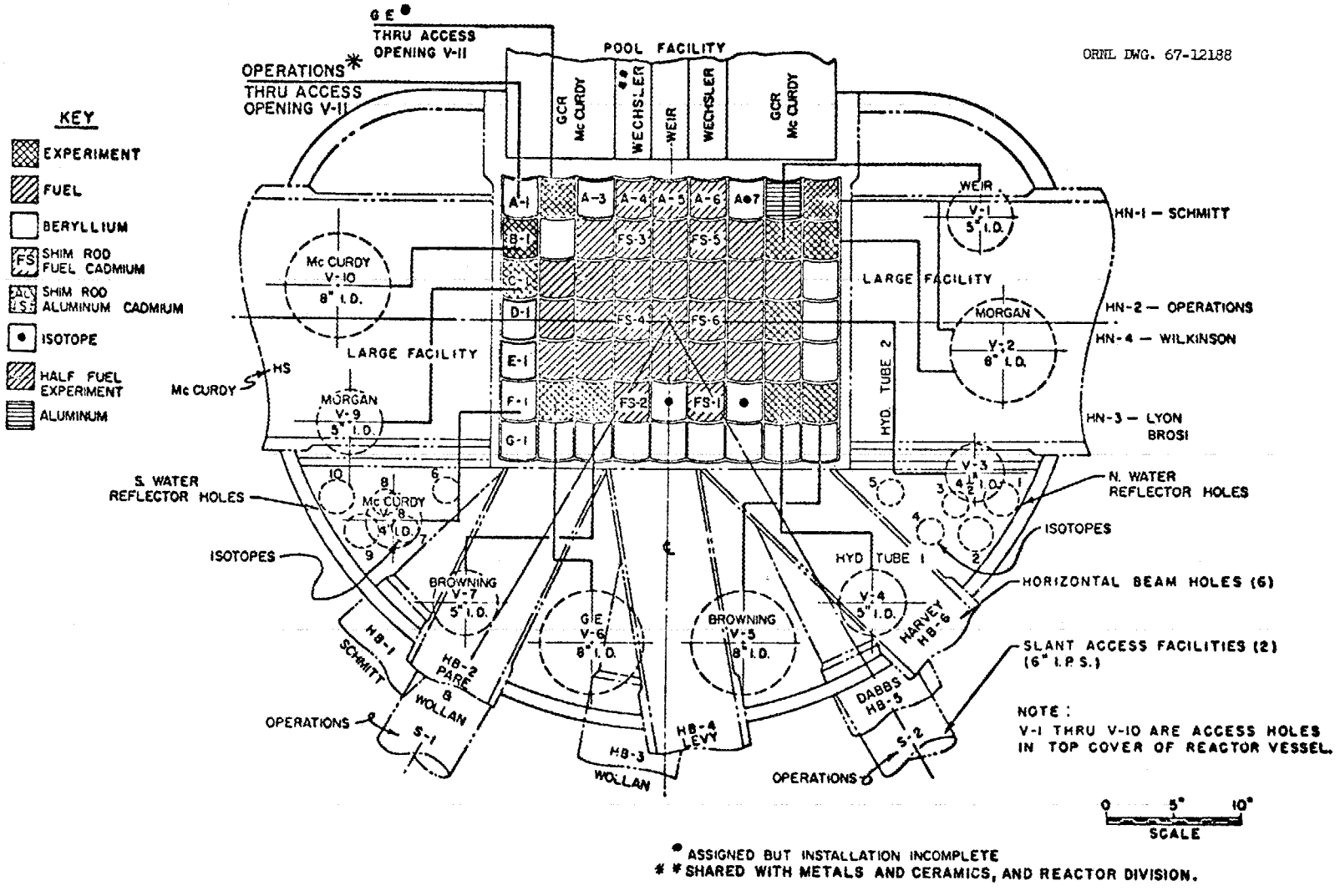
[a]First piggy-back experiment

[b]Second piggy-back experiment

Table 12. (Continued)

Facility	Date Installed	Date Removed	Description of Experiment	Division or Other Sponsor
P-6	5-6-67	6-26-67	ORR-188, 20 stainless steel specimens	Metals and Ceramics
P-6	6-30-67		ORR-190, 20 Hastelloy N specimens	Metals and Ceramics
P-6[a]	3-10-67	4-29-67	ORR-186, 47 stainless steel tensile specimens	Metals and Ceramics
Other pool-side	5-11-67	5-14-67	Sb-Be source (University of Florida) irradiated opposite P-8 position	Isotopes
HN-1	4-5-67		Dummy plug	Reactor Chemistry

[a]First piggy-back experiment



● ASSIGNED BUT INSTALLATION INCOMPLETE
* * SHARED WITH METALS AND CERAMICS, AND REACTOR DIVISION.

Fig. 3 Research Assignments and Fuel Loading 6-30-67

SPECIAL TESTS

ORR Shim-Rod Calibration

T. P. Hamrick

The ORR shim rods were calibrated during the end-of-cycle No. 73 shutdown (June 30, 1967). Results of these calibrations are shown in Figures 4 through 9. During the calibration of the No. 4 shim rod, it was noticed that a negative period was obtained when the shim rod was withdrawn the last inch of travel. The same result was obtained with the No. 6 shim rod. Since these shim rods were new, the No. 6 rod was exchanged with the No. 5; and, as a result, the No. 5 rod now showed the same results (see Figure 10). Apparently, since the new shim rods contain evenly distributed fuel, the flux distribution is such that during the upper portion of travel the fuel position is moved away from the reflector peak into a less important flux region, causing a negative worth in the last inch of travel of approximately 0.02% $\Delta k/k$ for shim rods 4 and 6.

The curves were plotted both using a least-squares fit and a visual fit. All shim rods exhibited the same characteristic curve; No. 1 and 2 show a more pronounced flattening since approximately 55% of the original fuel present in the followers has been burned up (Figures 4 and 5). Figure 11 shows the gang-rod worth of all six rods.

Plans are under way to investigate the shim-rod worth abnormalities more thoroughly. It must be pointed out that these phenomena occur only in the final inch of travel and only in new shim rods. Once the rods are irradiated, the differential worth curve returns to normal.

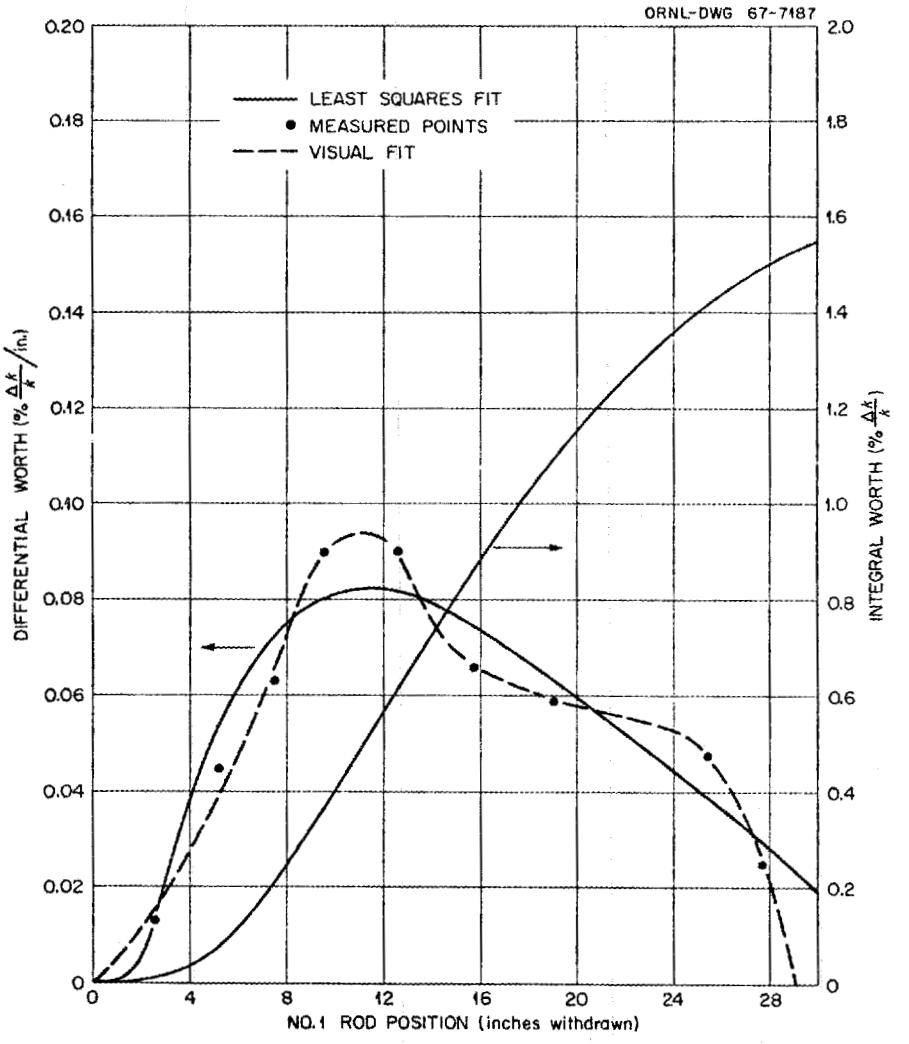


Fig. 4. Differential and Integral Worth Curves, No. 1 Rod (Fuel-Cd) June 30, 1967

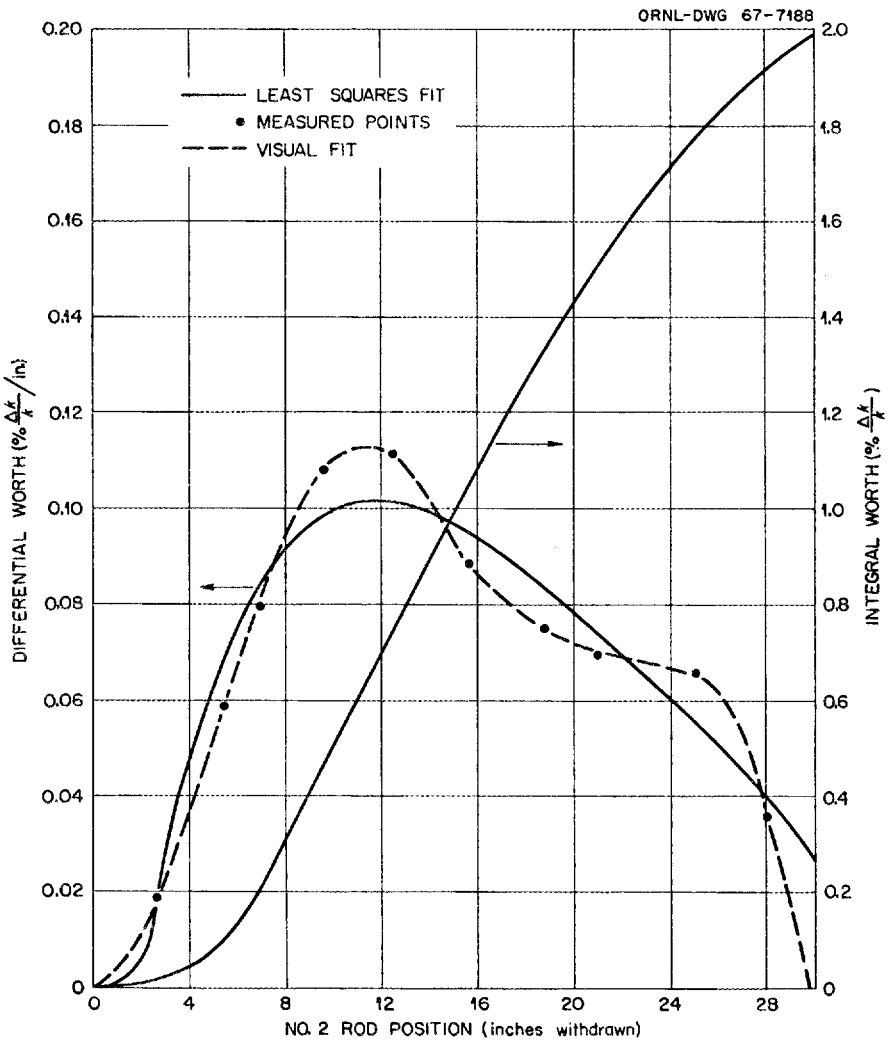


Fig. 5. Differential and Integral Worth Curves, No. 2 Rod (Fuel-Cd) June 30, 1967

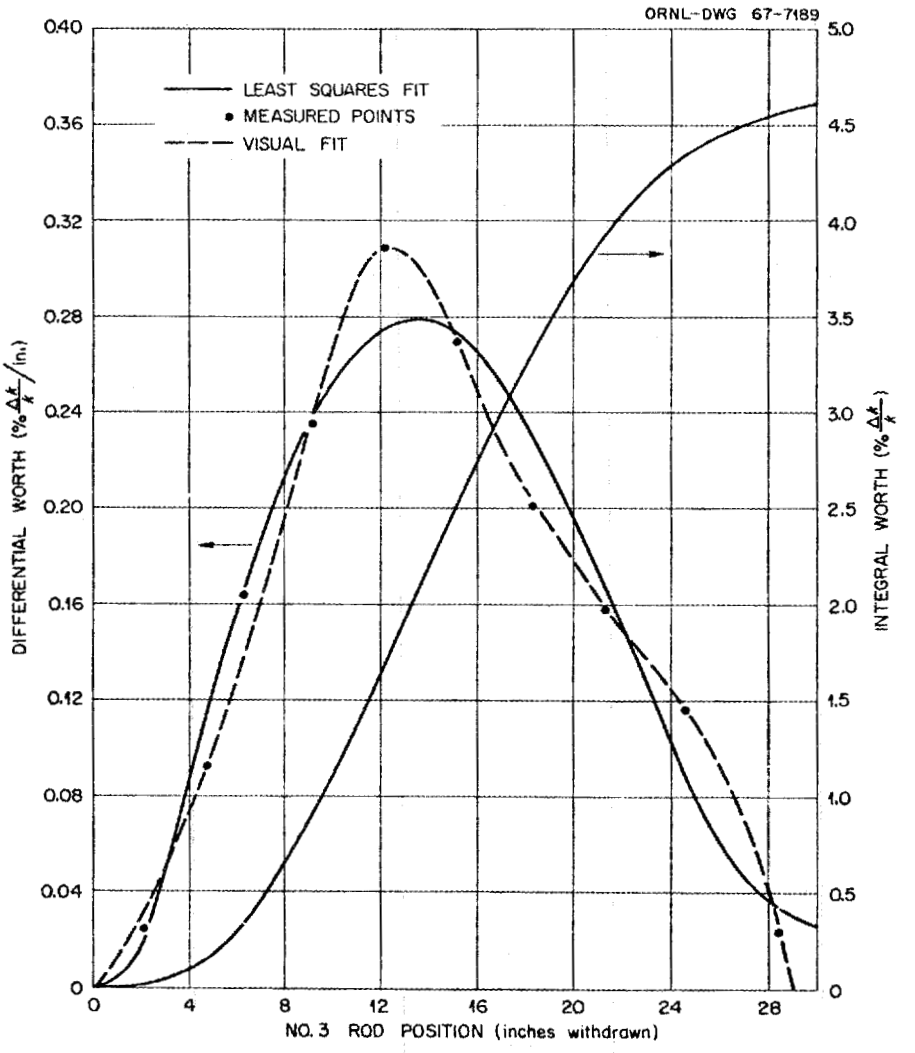


Fig. 6. Differential and Integral Worth Curves, No. 3 Rod (Fuel-Cd) June 30, 1967

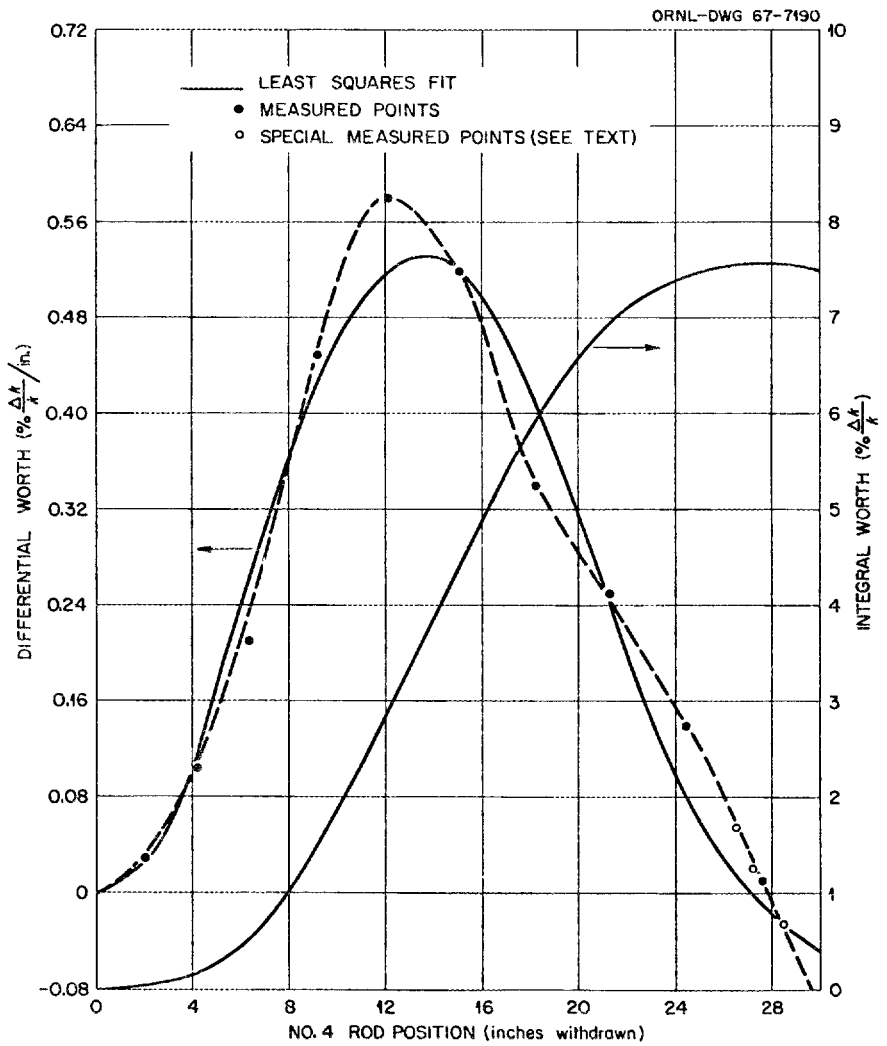


Fig. 7. Differential and Integral Worth Curves, No. 4 Rod (Fuel-Cd) June 30, 1967

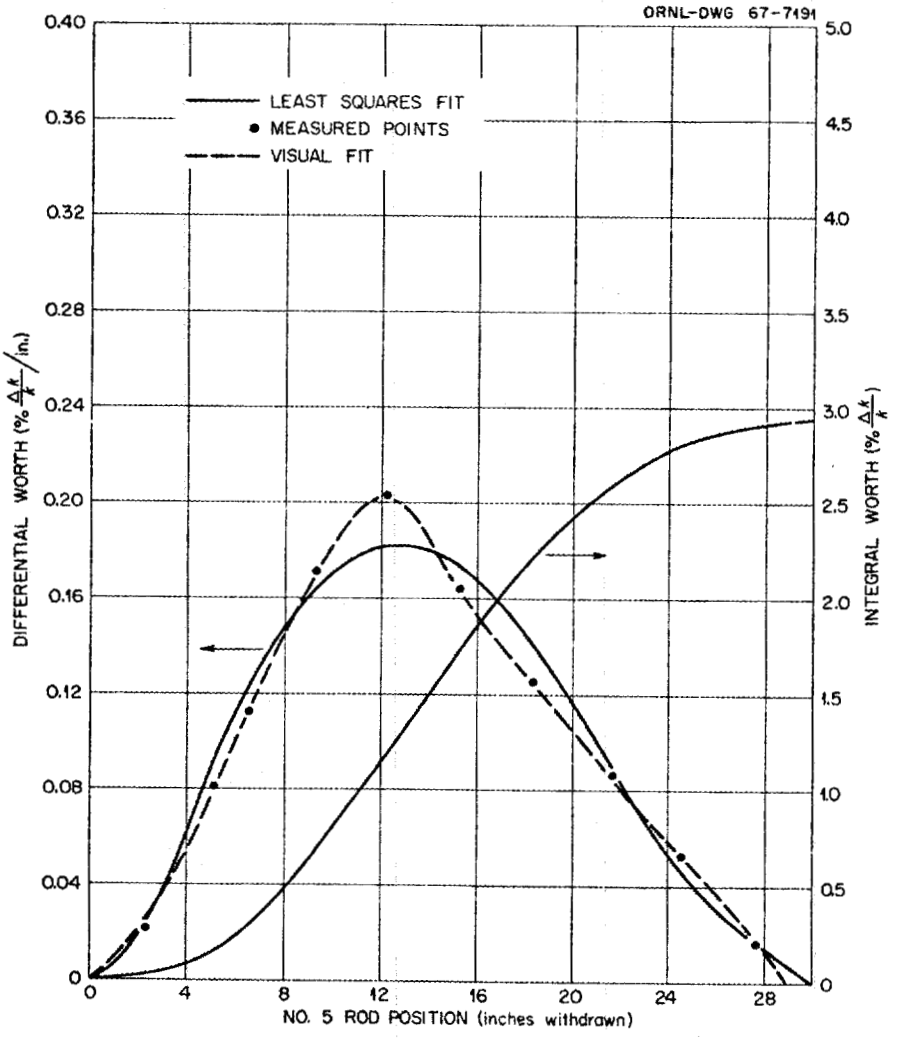


Fig. 8. Differential and Integral Worth Curves, No. 5 Rod (Fuel-Cd) June 30, 1967

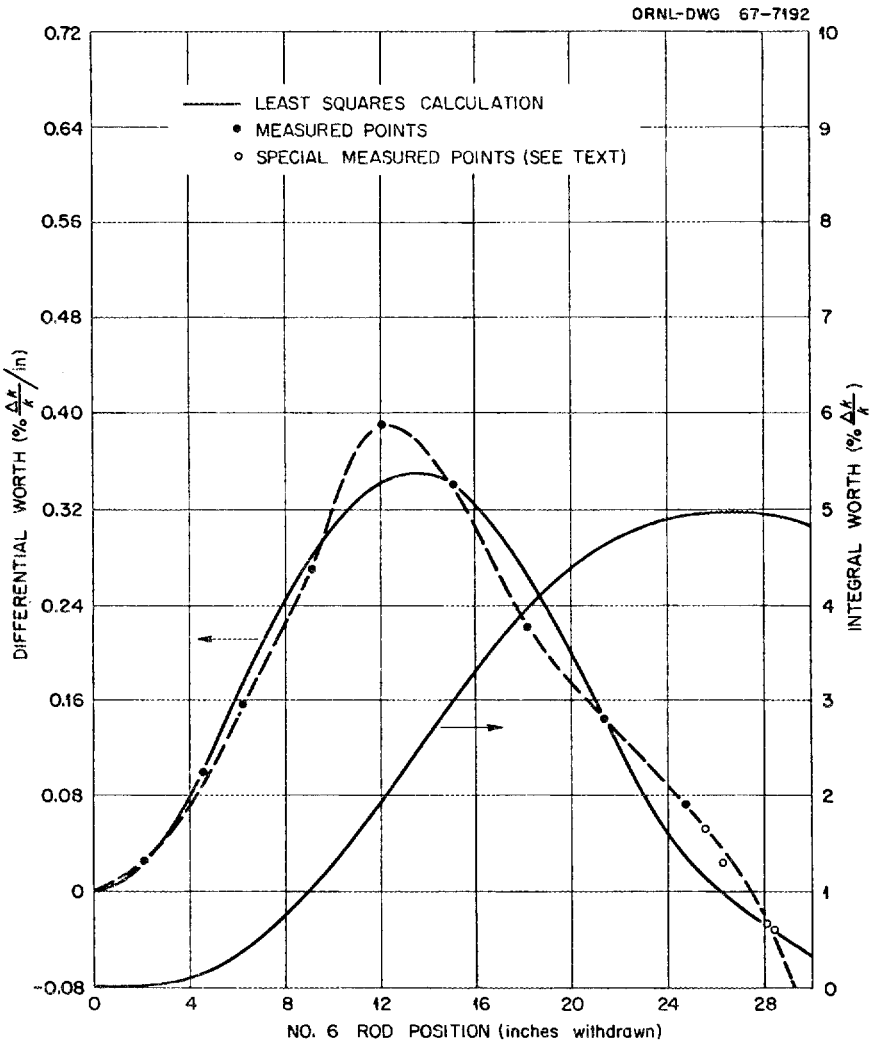


Fig. 9. Differential and Integral Worth Curves, No. 6 Rod (Fuel-Cd) June 30, 1967

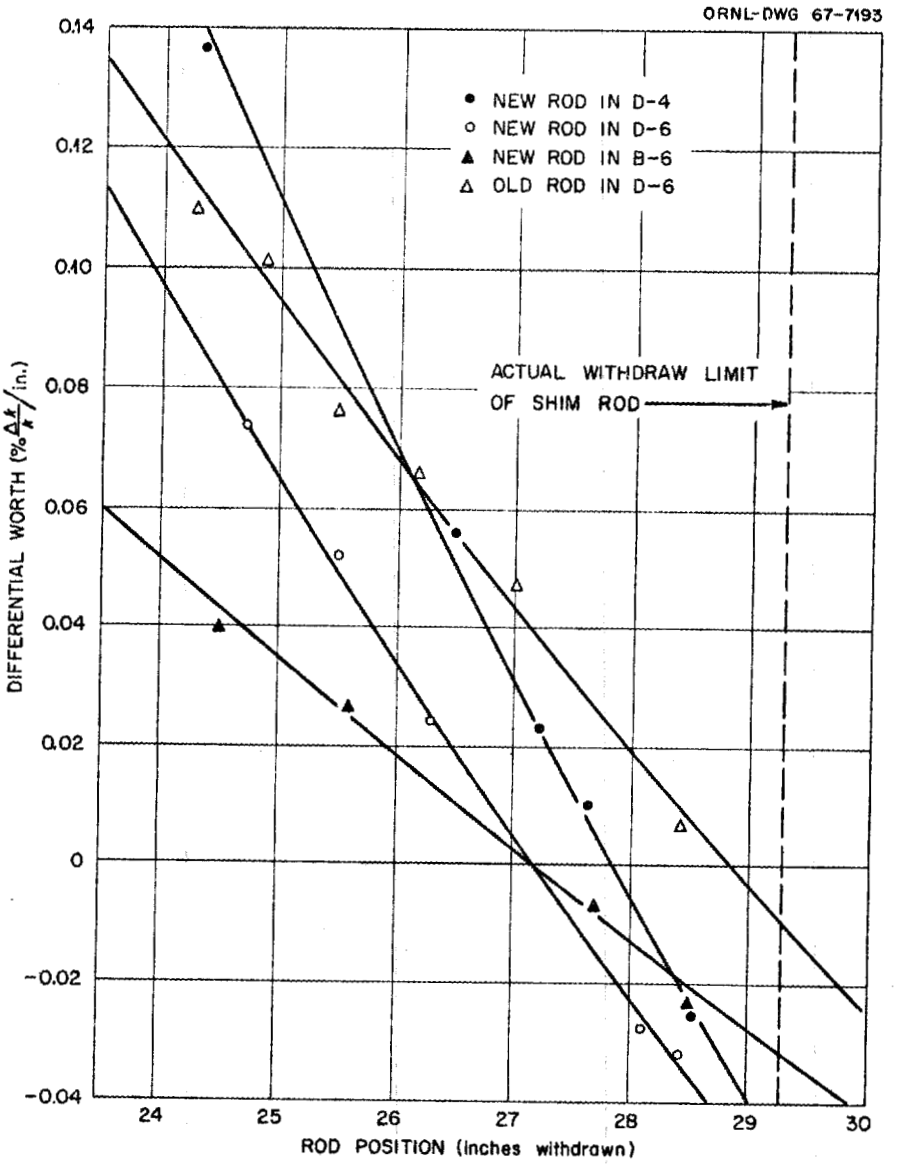


Fig. 10. Differential Worth Curves, Upper Portions of New and Used Shim Rods, June 30, 1967

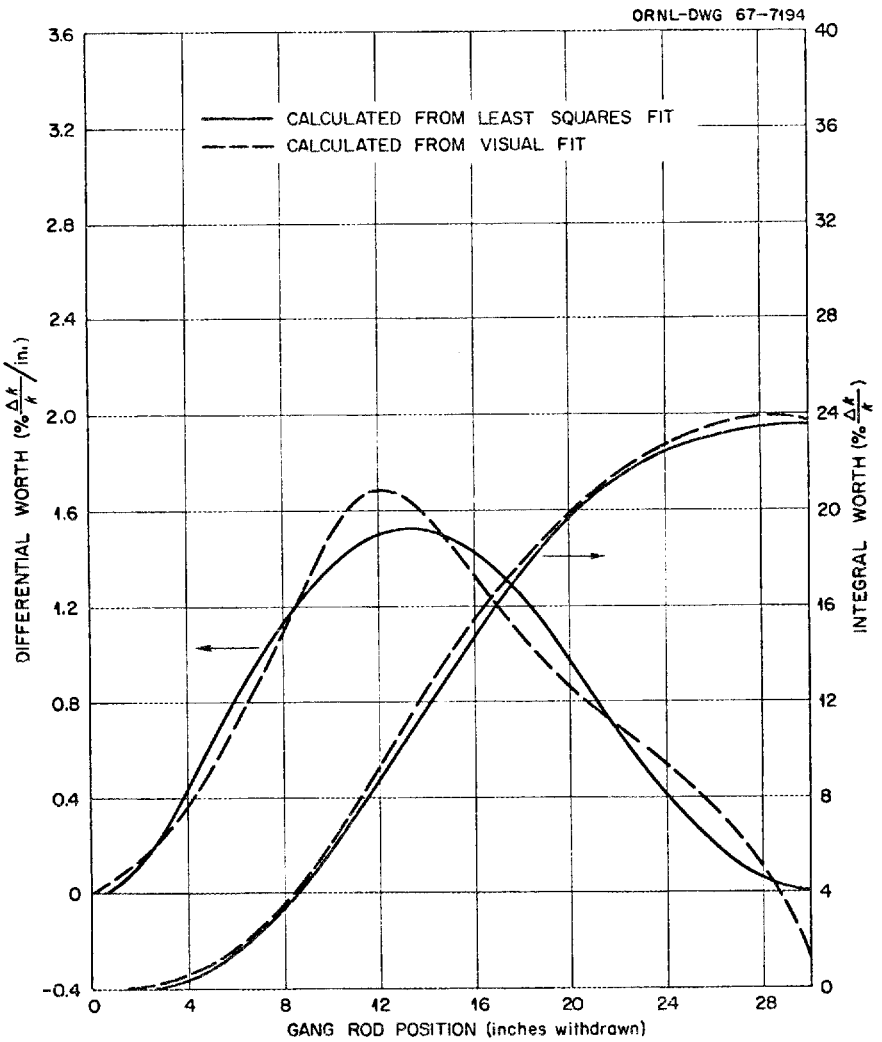


Fig. 11. Differential and Integral Rod Worth Curves, Rods Ganged, June 30, 1967

Profile Measurements of the Lattice Housing Opposite Core Positions A-4, A-5, and A-6; May 3, 1967

W. H. Tabor

During the end-of-cycle (cycle No. 72) shutdown, a series of measurements were taken to determine the vertical profile of the lattice housing immediately opposite core positions A-4, A-5, and A-6. These locations were chosen for measurements since fuel elements have been in these core positions since 1958; they were accessible without disturbing any operating experiments, and it was felt that this area had probably been subjected to the largest total nvt.

The procedure which was applied to accomplish this endeavor utilized mechanical equipment. The equipment consisted of a reference bar which was attached to an ORR-type end box; a dolly which could be moved in the vertical plane (attached in a spring-loaded manner to the reference bar); a dial indicator (graduated to 0.001 in.) which was attached to the dolly; and an indexing system to identify the vertical position of the dial indicator probe.

The data were obtained in the following manner:

> The measuring gadget was positioned with its end box section in the lower grid and the reference bar placed in an approximately vertical position. With the probe of the dial indicator in contact with the lattice housing, the dolly-dial indicator unit traversed the face of the lattice housing over a span of 24 in. Unfortunately, in core positions A-4 and A-6, which are normally occupied with auxiliary shim rods, the end box adapters did not fully seat; therefore, in these positions the traverse covered only 18 in. During the traversing, the dial indicator was read and the results are given on the attached graph. The results include corrections which were necessary due to slight bowing of the reference bar.

While the results, which are plotted on the following graph (Figure 12), indicate a maximum deflection of about 6 mils, the accuracy of the measurements is estimated to be ±0.002 in. Since profile measurements of the lattice housing prior to operation are not available, the deflections measured cannot be attributed entirely to irradiation effects. It is, therefore, concluded that there is not appreciable bowing of the lattice housing in the subject region.

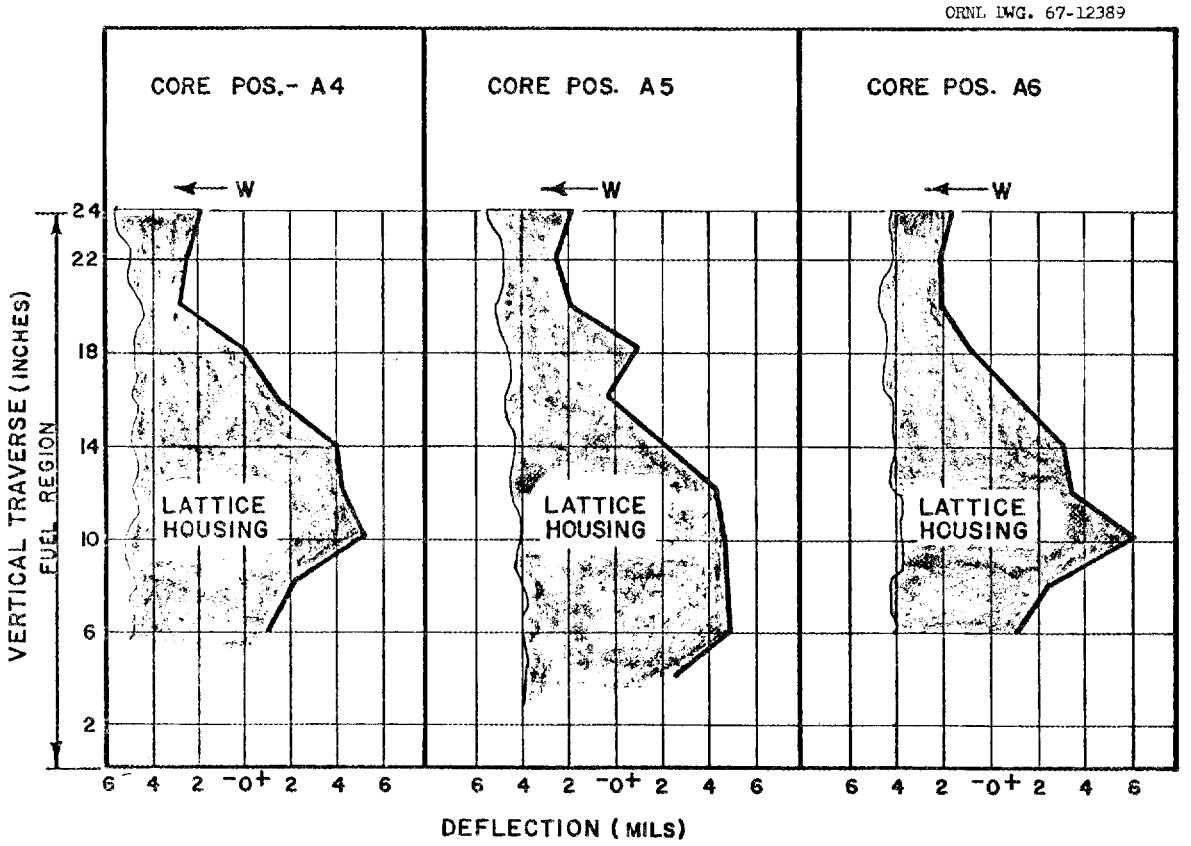


Fig. 12. Profile of Lattice Housing at A4, A5, and A6 Core Positions

Flux Measurements

Flux monitors were irradiated at core positions A-7 and B-2 and at the poolside "window" (opposite position A-5) to provide data for determining the fast and thermal flux gradients across both aluminum and beryllium lattice members as well as across the poolside "window". Final analysis of the data will be presented in a separate report; however, preliminary indications are that the fast flux changes by a factor of approximately 3 across both the aluminum and beryllium pieces. The thermal flux gradient is apparently much less severe.

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