APR 22 1967

MASTER

OAK RIDGE NATIONAL LABORATORY

operated by

UNION CARBIDE CORPORATION

for the

U.S. ATOMIC ENERGY COMMISSION

ORNL - TM - 1843

COPY NO. - 99

DATE - April 28, 1967

OAK RIDGE RESEARCH REACTOR QUARTERLY REPORT
OCTOBER, NOVEMBER, AND DECEMBER OF 1966

W. H. Tabor
S. S. Hurt, III

THIS DOCUMENT HAS BEEN REVIEWED,
NO INVENTIONS OF PATENT INTEREST
TO THE A.E.C. ARE DISCLOSED THEREIN.

NOTICE This document contains information of a preliminary nature and was prepared primarily for internal use at the Oak Ridge National Laboratory. It is subject to revision or correction and therefore does not represent a final report.

DB 85/23/67

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

LEGAL NOTICE

This report was prepared as an account of Government sponsored work. Neither the United States, nor the Commission, nor any person acting on behalf of the Commission:

- A. Makes any warranty or representation, expressed or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately owned rights; or
- B. Assumes any liabilities with respect to the use of, or for damages resulting from the use of any information, apparatus, method, or process disclosed in this report.

As used in the above, "person acting on behalf of the Commission" includes any employee or contractor of the Commission, or employee of such contractor, to the extent that such employee or contractor of the Commission, or employee of such contractor prepares, disseminates, or provides access to, any information pursuant to his employment or contract with the Commission, or his employment with such contractor.

PAGES 1 to 2
WERE INTENTIONALLY
LEFT BLANK

H.C. \$ 3.00; MN .65

CONTENTS

Summary.....	4
Operations.....	5
Shutdowns and Power Reductions.....	9
Instrumentation and Reactor Controls.....	13
Process Systems.....	19
Reactor Mechanical Components.....	24
Fuel.....	25
Experiment Facilities and Lattice Configuration.....	25
Special Tests.....	35
Unusual Occurrences.....	39
Appendix A.....	40
Distribution.....	55

LEGAL NOTICE

This report was prepared as an account of Government sponsored work. Neither the United States, nor the Commission, nor any person acting on behalf of the Commission:

A. Makes any warranty or representation, expressed or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately owned rights; or

B. Assumes any liabilities with respect to the use of, or for damages resulting from the use of any information, apparatus, method, or process disclosed in this report.

As used in the above, "person acting on behalf of the Commission" includes any employee or contractor of the Commission, or employee of such contractor, to the extent that such employee or contractor of the Commission, or employee of such contractor prepares, disseminates, or provides access to, any information pursuant to his employment or contract with the Commission, or his employment with such contractor.

SUMMARY

The ORR operated 89.1% of the time during the quarter, accumulating 2450 Mwd at an average power level, during operation, of 29.9 Mw. The process systems operated satisfactorily, with the considerable improvement in the quality of both the reactor and pool water continuing from the previous quarter.

There were only nine shutdowns, two of which were for training purposes. Unscheduled downtime, however, was high in comparison with recent experience due to the failure of an experiment which resulted in ~26 hours of downtime.

No significant problems occurred with the instrumentation for the facility, and performance in general was quite good.

A leak was discovered in the suction line for the pool cooling pump. The exact location of the leak was not known at the end of the quarter; however, it was definitely established to be in the concrete wall of the pool near the liner.

Contour measurements of Al-Cd shim rods Al-3 and Al-4 confirmed previous suspicions that the aluminum sections, normally in the core during reactor operation, were bowed. The bow, convex side toward the high flux region, produced deflections of ~0.038 and ~0.030 inches for Al-3 and Al-4, respectively.

One isotope stringer (core position C-2) was removed from service, and the N_F tray (core position A-7) was transferred from the Isotopes Division to the Reactor Chemistry Division.

Two contamination releases occurred, both related to experiments. The first involved small particles of ^{187}W from a thermocouple test while the second was due to the rupture of a fuel capsule which released ^{138}Xe into the building through the pool water.

OPERATIONS

Important operating data for the quarter are compared with data for the previous quarter, calendar year 1966, and calendar year 1965 in Table 1, below. The gain in operating time, compared with that for the previous quarter, was realized because there was only one end-of-cycle shutdown. Improvement in the quality of both the pool and reactor water is a result of replacing the resins in the demineralizers. The increase in the number of research samples (for the year) is due principally to short-term irradiations of tensile specimens.

Table 1. ORR Basic Operating Data
October, November, and December, 1966

	This Quarter	Last Quarter	Calendar Year 1966	Calendar Year 1965
Total energy, Mwd	2449.9	2286.1	9505.1	9255.0
Average power, Mw/operating hr	29.9	29.7	29.8	29.8
Time operating, %	89.1	83.6	87.3	85.1
Reactor water radio- activity, $\frac{\text{c/min}}{\text{ml}}$ (av)	34,100	36,900	35,500	40,500
Pool water radio- activity, $\frac{\text{c/min}}{\text{ml}}$ (av)	680	790	790	1,100
Reactor water resis- tivity, ohm-cm (av)	1,150,000	1,100,000	1,110,000	898,500
Pool water resis- tivity, ohm-cm (av)	1,180,000	715,000	760,000	622,000
Fuel elements depleted	44	47	154 (3)*	130 (3)*
Shim rods depleted	2	4	12	13
Research samples	32	38	101	33
Radioisotope samples	172	184	759	832

*The number in parentheses refers to the half-fuel elements depleted and is also included in the total.

The accumulated energy and beginning and ending dates for cycles 69 and 70 are presented in Table 2.

Figures 1 and 2 are plots of rod position (ganged) versus time for shim rods 3, 4, 5, and 6.

Table 2. ORR Cycles of Operation

Cycle No.	Date Begun	Date Ended	Accumulated Energy (Mwd)
69	September 22, 1966	November 13, 1966	1441.19*
70	November 19, 1966	In Progress	1249.84

*Energy accumulated this quarter (Cycle 69), 1200.06.

FIG. 1 SHIM ROD POSITION Vs TIME (cycle No. 69)

FIG. 2 SHIM ROD POSITION Vs TIME (cycle No. 70)

SHUTDOWNS AND POWER REDUCTIONS

Reactor shutdowns for the quarter are summarized in Table 3, below, while details are presented in Tables 4 and 5. The total number of scheduled shutdowns (7) is very nearly minimal for three months' operating time. Two of the seven scheduled shutdowns were for training purposes and preceded other scheduled shutdowns by a few minutes.

There was a significant increase in unscheduled downtime as compared with recent experience. This increase came as a result of a break in the containment at the F-3 experiment which released radioactive gases into the building. Details of the incident and the related shutdown are given in Table 4 and in the "Unusual Occurrences" section of this report.

Power reductions not resulting in a shutdown, i.e., power level is not decreased below 1% of full power, are of interest to the operator and experimenter and are detailed in Table 6.

Table 3. Summary of ORR Shutdowns

Description or Reason	Number	Downtime (hr)
Scheduled		
Regular, end of cycle	1	153.084
Regular, midcycle isotope work	2	10.133
Regular, refueling	1	3.000
Special, training	2	0.317
Special, refueling and ORNL open house	<u>1</u>	<u>48.700</u>
Subtotal	7	215.234
Unscheduled		
Experiment failure, mechanical	1	26.234
Human error	<u>1</u>	<u>0.250</u>
Subtotal	2	26.484
Total	<u>9</u>	<u>241.718</u>

Table 4. Unscheduled Shutdowns of the ORR, Details

Date	Duration (hr)	Remarks
10-21-66	0.250	The electrical circuit which provides power to the safety instrumentation at capsule experiment GCPR No. 3 was accidentally shorted to ground, causing a breaker to open. A slow scram resulted.
11-3-66	26.234	The reactor was shut down manually following the failure of the containment at the F-3 experiment. Fission gases from the experiment were released into the building and an evacuation signal was initiated by the Building Radiation and Contamination Alarm System. The experiment capsules were removed and the reactor was refueled. Details of the contamination incident are given elsewhere in this report. This shutdown terminated fuel cycle 69D.
	<u>26.484</u>	

Table 5. ORR Scheduled Shutdowns, Details

Date	Duration (hr)	End Cycle	Remarks
10-8-66	0.050		This shutdown was utilized for training purposes and simulated an unscheduled shutdown.
10-8-66	48.700	69B	The reactor was shut down for the duration of the scheduled ORNL open house. Refueling was accomplished and the failed thermocouple experiment in the A-2 irradiation facility was removed; the mock containment vessel for the F-9 fuel meltdown tests was installed in the reactor pool.
10-24-66	6.333	69C	The reactor was shut down for midcycle isotope work and refueling.
11-13-66	0.267		The reactor was shut down to provide an opportunity for training.
11-13-66	153.084	69E	This shutdown terminated operating cycle 69. Eight experiments were removed, and seven of these were replaced. The isotope stringer No. 2, core position C-2, was retired from service; and the fast neutron irradiation facility, core position A-7, was transferred from the Isotope Division to the Reactor Chemistry Division.
12-12-66	3.000	70A	The reactor was shut down for refueling.
12-22-66	3.800	70B	The reactor was shut down for midcycle refueling and isotope work.
	<u>215.234</u>		Total

Table 6. Reductions in ORR Power Not Resulting in Shutdowns

Date	Source of Signal	Type of Signal	Lowest Power (Mw)	Comments
10-20-66	Normal off-gas high pressure	Setback	9	The high pressure occurred during a manual switch-over to the auxiliary scrubber (3039 Stack area).
10-20-66	Normal off-gas high pressure	Setback	6	The high pressure occurred during a manual switch-over to the auxiliary scrubber (3039 Stack area).
11-1-66	Normal off-gas high pressure	Setback	4.5	The large entrance plug to the ORR hot cells was removed. High pressure conditions caused an automatic switch from the cell ventilation to the normal off-gas system, which was overloaded temporarily.
11-22-66	Manual	Setback	N_L	The reactor power was reduced to permit orderly correction of a vapor-lock condition in a coolant pump for the F-2 experiment.

INSTRUMENTATION AND REACTOR CONTROLS

Significant maintenance or changes to the instrumentation for the reactor complex are chronologically listed in Table 7. Mechanical portions of the fission chamber drives continue to be troublesome; however, there has been no loss of operating time and no excessive cost associated with this problem. Other maintenance items listed for the various nuclear and process instrument channels are attributed to normal usage and aging of equipment.

Table 7. Maintenance and Changes, Reactor Instrumentation and Controls

Date	Component	Trouble or Change	Reason or Maintenance
Safety System			
11-14-66	Magnet amplifier No. 6B	Unit replaced	This amplifier failed on November 22, 1966, due to a shorted vacuum tube. Amplifier 5A assumed the load and the system was operated with a single amplifier until repairs were effected. This method of operation complies with design criteria and accepted operating procedures.
No. 1 Count Rate Channel			
11-17-66	Chamber drive	Aligned, adjusted.	Adjustments were made to relieve a binding condition which had prevented full stroke travel of the chamber.
12-22-66	Count rate meter	Unit replaced	Electronic difficulty had prevented proper calibration of the meter.
12-6-66 through 12-12-66	Withdraw limit switch	Intermittent alarms	"Inactive-fission chamber inserted" alarms were initiated on several occasions, apparently because of slight difficulty with the withdraw limit switch. This switch was operated several times on December 12, 1966, and the alarm condition did not recur.

Table 7. (Continued)

Date	Component	Trouble or Change	Reason or Maintenance
No. 2 Count Rate Channel			
10-19-66	Fission chamber	Unit replaced	The B ⁺ voltage lead to the chamber was found to be broken.
10-21-66	A-1 amplifier	Unit replaced	Electronic trouble prompted this change.
11-18-66	Chamber drive	Worn gears	The faulty (stripped) gears were replaced.
No. 1 Log N Channel			
10-18-66	Log N amplifier	Unit replaced	This amplifier was replaced in an attempt to lessen the noise in the channel indicated by period spikes to ± 50 seconds.
12-12-66	Voltage regulator tube, Log N amplifier	Tube replaced	The tube was replaced to clear a "pre-amp grid offset" abnormal light. No further difficulties were encountered.
No. 2 Log N Channel			
10-19-66	Log N amplifier	Unit replaced	This amplifier was replaced in an attempt to lessen the noise in the channel as indicated by the period recorder (± 100 -sec period indications). Considerable improvement was noted.

Table 7. (Continued)

Date	Component	Trouble or Change	Reason or Maintenance
12-5-66	Log N amplifier	Unit replaced	Erratic readout at the period recorder (indicated periods of ± 100 sec) prompted the replacement of the amplifier. Performance of the channel was considerably improved.
12-21-66	Log N amplifier	Unit replaced	Erratic readout at the period recorder (indicated periods of ± 100 sec) prompted the replacement of the amplifier. Some improvement of performance was noted.
		No. 1 Safety Channel	
	None	No trouble	No maintenance was necessary
		No. 2 Safety Channel	
10-19-66	Safety recorder amplifier	Unit replaced	Slightly erratic readout of the recorder was corrected by this change.
		No. 3 Safety Channel	
	None	None	No maintenance was necessary.
		Servo Channel	
	None	None	No changes or maintenance were necessary.

Table 7. (Continued)

Date	Component	Trouble or Change	Reason or Maintenance
Gamma Channels			
	None	None	No changes or maintenance were necessary.
South ^{16}N Channel			
11-26-66	Recorder amplifier	Unit replaced	Erratic behavior on November 12, 1966, and again on November 21, 1966, prompted this change which apparently corrected the difficulty. Prior to the change, the recorder readout had drifted from a normal reading of 100 to a reading of 105, and had also shown spikes to 110 (alarm point).
North ^{16}N Channel			
	None	None	No changes or maintenance were necessary.
Radiation Detection Instrumentation			
10-12-66	Degasifier activity electrometer	Erratic readout	Vacuum tubes in the electrometer were replaced, thus correcting the erratic behavior.

Table 7. (Continued)

Date	Component	Trouble or Change	Reason or Maintenance
12-21-66	Building containment electrometer	False containment alarms	The building was placed in containment on several occasions during the weeks of December 5 and December 12. The electrometer was removed from service temporarily and all the vacuum tubes were replaced. This action apparently corrected the trouble.
Process Instrumentation			
12-22-66	Secondary system dual pen recorders TR-47B, 47K, and TR-47L, 48A	Reinstalled	These recorders for secondary mean temperature, secondary mean setpoint, basin temperature, and secondary valve position are nonessential to operation, and were removed after the flooding of August 11, 1966. They were cleaned and recalibrated before being reinstalled.
12-16-66	Cell-ventilation flow switch	False low air flow to stack alarm	The copper tubing from the pitot tube to the switch was found to have a hole in it, apparently due to abrasion caused by vibration. The tubing was replaced.
10-17-66	No. 1 reactor outlet temperature	Erratic readout	The recorder was overhauled, thus correcting the erratic behavior.

PROCESS SYSTEMS

Maintenance and changes to piping and/or equipment in the various process systems are listed in Table 8. The more significant items include: (1) the enlargement of the opening from the equalizer line to the pool (from 1 inch to 3 inches, (2) the inspection of the tube bundle from the pool heat exchanger, (3) the confirmation of a leak in the suction line (behind the pool liner) of the pool cooling pump, and (4) the addition of a basement sump and pump for the storm drain system. Elemental iodine removal efficiency tests were completed for the cell ventilation system (98.8% effective after replacing one filter bank) and the pressurizable off-gas system (99.9% for north bank, 99.7% for south bank).

Table 8. Process Systems, Maintenance and Changes

Date	Component	Remarks
Reactor Primary System		
10-3-66	South reactor demineralizer (anion column)	Thirty-seven cu ft of IRA-401 resin was loaded into the column.
11-14-66	Heat exchanger primary valves	The packing in the eight valves was replaced after minor leak problems were encountered.
11-15-66	No. 1 pump exit check valve	This Mission check valve was inspected and found to be in satisfactory condition.
11-15-66	Reactor tank and inlet lines	Gaskets at the tank top (experiment access ports) and at the bellows connections for the inlet water lines were inspected and found to be in satisfactory condition.
11-16-66	South reactor demineralizer (cation column)	Ten cu ft of IR-120 resin was loaded into the column.
11-17-66	Reactor-pool equalizer leg	The opening to the pool was changed from a 1-inch pipe to a 3-inch pipe by removing a reducer and a short section of pipe.
Pool Primary System		
11-14-66	Pool heat exchanger	The tube bundle was removed for cleaning and inspection. No unusual wear or corrosion was found, and routine cleaning methods were used.

Table 8. (Continued)

Date	Component	Remarks
11-18-66	Pool level switches	New switches, which are smaller and more reliable than the old units, were installed in the three pools. This work is described in detail in Controls Change Memorandum No. ORR-79.
12-16-66	Pool cooling line (exit from pool)	A routine leak-detector test revealed that water was present behind the pool liner near the point of penetration of line 201 (pool cooling pump suction). Further tests established that the line itself was leaking and that the water was confined to a relatively small area. Corrective action was planned for the end-of-cycle 70 shutdown.
12-20-66	Pool gates	One lower gate section was removed and transported to the decontamination facility in preparation for gasket replacement.

Pool Secondary System

11-22-66	Pool tower fan	An increase in the noise level at the pool tower was detected during routine checks. The fan was removed from service and checked by maintenance personnel who found that the gears, seals, and bearings in the gear box needed to be replaced. This work was accomplished, and the fan was returned to service on December 30, 1966.
----------	----------------	---

Table 8. (Continued)

Date	Component	Remarks
10-4-66	Charcoal filter sections	These filters were tested for elemental-iodine removal efficiency (semiannual test). A removal efficiency of 96.14% was reported.
10-20-66	Charcoal filter section	The elemental-iodine removal efficiency was rechecked and confirmed at 96.12%.
Cell Ventilation System (Continued)		
11-14-66 through 11-19-66	Charcoal filter section	The system was inspected, and several small leakage paths around the charcoal were eliminated. Elemental-iodine removal efficiency was found to be only 95.3% after the improvement, however, and the north bank of charcoal filters (first bank of two in series) was replaced with filter units acquired from the HFIR. The efficiency for elemental-iodine removal was increased to 98.8% by this change.
Pressurizable Off-Gas System		
11-14-66	Filter pits	Both the south and north banks were inspected for moisture accumulation. About 10 inches of water was found in the bottom of the south bank (below the filter frames), and a small amount of water was found in the east section of the north bank.

Table 8. (Continued)

Date	Component	Remarks
11-15-66 and 11-16-66	Charcoal filters	The efficiency for elemental-iodine removal was found to be 99.88% (north bank) and 99.77% (south bank). These tests were performed by the Inspection Engineering Department.
Storm Drain System		
12-19-66	Basement collection tank (new)	This tank was added to the storm drain system to facilitate collection of noncontaminated waste water. This water previously was routed to the process drain via the basement sump. The addition is part of the effort to reduce the volume of water channeled to the process waste system.

REACTOR MECHANICAL COMPONENTS

Shim-Rod Drives

The No. 2 shim-rod drive assembly (release mechanism and operator) was replaced on September 20, 1966, during the investigation of the trouble with the aluminum-cadmium safety rods (see below). The unit removed, assembly B, had been in service for 15 months. Inspection of the assembly revealed no excessive wear or corrosion.

Aluminum-Cadmium Shim Rods Al-3 and Al-4

The aluminum sections of the aluminum-cadmium shim rods in core positions F-4 and F-6 were found to be bowed on September 20, 1966.¹ The extent of the bowing was measured in the ORR hot cells using the apparatus formerly used for contour measurements of beryllium. The rod from core position F-4, Al-4, was found to be bowed about 0.038 inches; and the rod from core position F-6, Al-3, was bowed 0.030 inches. In both cases, bowing was toward the high flux region (convex side toward the west), as was the case for the beryllium previously in these core positions. Details and data are presented in Appendix A.

¹W. H. Tabor and S. S. Hurt, III, Oak Ridge Research Reactor Quarterly Report - July, August, and September of 1966, ORNL TM-1791 (March 1, 1967).

FUEL

Changes in fuel inventory are indicated in Table 9.

Table 9. ORR Fuel Status

	This Quarter	Last Quarter	Year To Date
Depleted fuel elements transferred for chemical separation	45	12	135 (3)*
Average % burnup of fuel elements	34.8	32.6	34.4
New fuel elements placed in service	25	29	127
New fuel elements available for use	178 (4)*	203 (4)*	
Depleted shim rods transferred for chemical separation	4	2	12
Average % burnup of shim rods	56.7	62.0	56.3
New shim rods placed in service	2	4	12
New shim rods available for use	4	4	
New shim rod fuel sections avail- able for use	19	21	

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

EXPERIMENT FACILITIES AND LATTICE CONFIGURATION

Facility assignments at the ORR are listed in Table 10, which is self explanatory and supplements Figure 3 which shows the lattice configuration at the end of the quarter. Two changes in facility assignment were made: (1) the C-2 core position was vacated by the Isotopes Division reducing the number of isotope stringers to one, No. 1 stringer in core position F-5, and (2) the fast-neutron irradiation facility in core position A-7 was transferred from the Isotopes Division to the Reactor Chemistry Division.

Usage of the experiment facilities is shown in Table 11.

Table 10. 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
A-3 and F-5		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	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, preirradiation	Reactor Chemistry
F-7		Available for capsule type experiments	Unassigned
F-8	V-4	Hydraulic-tube No. 1	Isotopes--Solid State
F-9	V-5	Fuel melting tests	Reactor Chemistry
	North slant tube		Unassigned
	South slant tube		Unassigned

* Final experiment installation is incomplete.

** The in-core section was temporarily installed on November 14, 1965, and then removed for alterations.

Table 10. (Continued)

Facility	Access Flange	Nature of Experiment	Division or Other Sponsor
Poolside Positions			
P-1, P-2 P-3, P-7, P-8, and P-9		GCR capsule irradiations	Reactor
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 experi- ment	Reactor Chemistry
HN-2		Pneumatic tube for high speed rabbits (activa- tion analysis)	Chemistry
HN-3		Pneumatic tube for acti- vation 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
Reflector Holes			
1 through 10		Capsule-type experiments	Unassigned

KEY

- EXPERIMENT
- FUEL
- BERYLLIUM
- SHIM ROD FUEL CADMIUM
- SHIM ROD ALUMINUM CADMIUM
- ISOTOPE
- HALF FUEL EXPERIMENT
- ALUMINUM

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

Fig. 3 Research Assignments and Fuel Loading 12-31-66

Table 11. Experiment Facility Usage

Facility	Date Installed	Date Removed	Description of Experiment	Division Sponsor
A-2	7-14-66	10-9-66	ORTC-1, tungsten-rhenium thermocouple	General Electric
A-2	12-22-66	12-24-66	Iridium wire irradiation	General Electric
A-3	Variable	Variable	I131 production facility	Isotopes
A-7	Variable	Variable	N _F facility for fast neutron irradiation tests	Reactor Chemistry
A-9	9-23-66		Capsule A9-8, pyrolytic carbon-coated UO ₂ particles (0.212 g 235-U)	Reactor Chemistry
B-1	11-14-66	11-16-66	The spare facility tube (in-core section) was installed in the tank and lattice; however, slight misalignment of the piping prevented permanent "tie-in" and the tube was removed for alterations	Reactor
B-8	9-22-66	11-13-66	ORR-169, 96 stainless steel tensile specimens	Metals and Ceramics
B-8	11-19-66		ORR-174, 64 stainless steel tensile specimens	Metals and Ceramics

Table 11. (Continued)

Facility	Date Installed	Date Removed	Description of Experiment	Division Sponsor
B-9	9-22-66		Capsule B9-32, pyrolytic carbon coated UO_2 (0.23 g ^{235}U) irradiated throughout the quarter	Reactor Chemistry
C-1	2-9-66		Capsule C1-18, hollow cylinder of UO_2 (0.1 g ^{235}U), irradiated throughout the quarter	Reactor Chemistry
D-8	12-18-63		Hydraulic tube system (No. 2) used for isotopes production and short-term irradiations	Isotopes
F-2	8-23-66	10-21-66	ORM-48, Hastelloy R-235 specimens, removed temporarily from September 16, to 26, 1966, to permit maintenance on the hydraulic cylinder	General Electric
F-2	11-19-66		ORR-F2, refractory fuel test containing ~3 g ^{235}U	General Electric
F-3 (Pos.1)	9-22-66	11-4-66	Capsule A-1 Zircaloy clad UO_2 , 5.971 g fuel ~10.24% enrichment	Reactor Chemistry

Table 11. (Continued)

Facility	Date Installed	Date Removed	Description of Experiment	Division Sponsor
F-3 (Pos. 2)	9-22-66	11-4-66	Capsule A-2, Zircaloy clad UO_2 , 5.956 g UO_2 (10.24% enriched)	Reactor Chemistry
F-3 (Pos. 3)	9-22-66	11-4-66	Capsule A-3, 5.964 g UO_2 (10.24% enriched), clad with Zircaloy 2	Reactor Chemistry
F-3 (Pos. 4)	9-22-66	11-4-66	Capsule A-4, 5.962 g UO_2 (10.24% enriched), Zircaloy 2 cladding	Reactor Chemistry
F-3 (Pos. 5)	9-22-66	11-4-66	Capsule A-5, 5.935 g UO_2 (10.24% enriched), Zircaloy 2 cladding	Reactor Chemistry
F-3 (Pos. 6)	9-22-66	11-4-66	Capsule A-6, 5.933 g UO_2 (10.24% enriched)	Reactor Chemistry
F-8	6-2-64		Hydraulic tube system No. 1 for isotope production and short term irradiations	Isotopes
F-9	10-10-66		A containment vessel simulator was installed in the reactor pool	Reactor Chemistry

Table 11. (Continued)

Facility	Date Installed	Date Removed	Description of Experiment	Division Sponsor
F-9	11-19-66		F9-2 high-burnup capsule experiment No.2	Reactor
GCR-3	3-13-65		03-9 (MPRE capsule) UO ₂ fuel in stainless steel can with NaK blanket, irradiated throughout the quarter	Reactor
GCR-4	7-25-66	11-14-66	04-P5 capsule containing UO ₂ fuel pellets in Hastelloy-X can in NaK; ~36 g ²³⁵ U	Reactor
GCR-4	11-19-66		04 flux monitoring tube	Reactor
GCR-4	12-3-66	12-3-66	Flux monitors installed and then removed because of failure of positioning device	Reactor
GCR-5	11-19-66		05 flux monitoring tube	Reactor
GCR-5	12-3-66	12-5-66	Flux monitors	Reactor
GCR-7	10-21-65		Capsule 07A-10, extensometer experiment (UO ₂)	Reactor
P-4	9-22-66	11-13-66	Dummy experiment ORR-71 (Solid State)	Solid State

Table 11. (Continued)

Facility	Date Installed	Date Removed	Description of Experiment	Division Sponsor
P-4	11-19-66		ORR-173, 32 stainless steel tensile specimens	Metals and Ceramics
P-4 ^a	9-22-66	11-13-66	ORR-79, 100 Charpy steel specimens	Solid State
P-4 ^a	12-22-66		Metallurgical samples in Cd	Solid State
P-5	9-22-66	11-13-66	Experiment ORR-168, stainless steel specimens	Metals and Ceramics
P-5	11-19-66		Experiment ORR-171, 10 INOR-9 tube burst specimens and 70 fatigue specimens	Metals and Ceramics
P-5 ^a	9-22-66	11-13-66	ORR-170, 47 stainless steel tensile specimens	Metals and Ceramics
P-5 ^a	11-19-66		Experiment ORR-175, 47 stainless tensile specimens and 42 shim specimens	Metals and Ceramics

^aFirst piggy-back position

Table 11. (Continued)

Facility	Date Installed	Date Removed	Description of Experiment	Division Sponsor
P-6	9-22-66	10-13-66	Experiment ORR-163, 32 INOR-8 tensile specimens	Metals and Ceramics
P-6	11-19-66		Experiment ORR-163, 10 INOR-8 tube burst specimens	Metals and Ceramics
P-6 ^a	7-25-66	11-13-66	Experiment ORR-80, 50 Charpy steel (A212B) specimens electrically heated to 650°F	Solid State
Other Poolside	11-7-66	11-7-66	Flux monitor for TREAT program	Reactor Chemistry
Other Poolside	11-7-66	11-13-66	TREAT capsule - UO ₂ pellets in Zircaloy (irradiated in thermal convection loop)	Reactor Chemistry
Other Poolside	11-9-66	11-9-66	Stainless steel tubing specimens	Chemistry
Other Poolside	12-2-66	12-2-66	Stainless steel tubing specimens	Chemistry

^aFirst piggy-back position

SPECIAL TESTS

Reactor Flow Decay Tests - November 17, 1966

Flow decay curves were obtained for three-pump operation (initial flow nominally 18,000 gpm) both with the primary bypass valve open, Figure 4, and with the primary bypass valve closed, Figure 5. For each position of the primary bypass valve, flow decay toward zero final flow is compared with decay toward ~1000 gpm final flow (one pony motor operable).

Flow decay toward zero final flow with the primary bypass valve closed is compared with flow decay curves made in 1958 and 1959 in Figure 6. This curve was selected for comparison because the conditions under which it was obtained most nearly represent the earlier conditions, i.e., Trane cooler system with manual bypass valve.

Fig. 4. ORR Main Cooling Water Flow Decay Tests - Bypass Valve Open, November 17, 1966

Fig. 5. ORR Main Cooling Water Flow Decay Tests - Bypass Valve Closed, November 17, 1966

Fig. 6. Comparison of Main Cooling Flow Decay Measurements

UNUSUAL OCCURRENCES

There were two relatively minor spills of radioactive materials from experiments. In each case, the building was evacuated to facilitate an evaluation of the situation and to permit orderly cleanup. No overexposures were received.

The first instance occurred on the evening of October 8, 1966, during a scheduled reactor shutdown. Tungsten-187, probably in the form of minute oxide particles, was spilled at poolside, third level. This contamination resulted from an attempt to replace a tungsten-tungsten rhenium thermocouple in the A-2 experiment facility. Personnel in the building were directed via the public address system to a central collection point outside the building. Some shoe soles were found to be contaminated, and an immediate survey of the building was initiated. Contamination in various degrees was found on all levels of the building. The extremely small particles were rather difficult to locate and this fact somewhat complicated cleanup operations; however, the building was clean by 2:00 p.m. of the next day.

The second release occurred on the evening of November 3, 1966. In this instance, xenon-138 escaped from a failed fuel experiment (F-3 facility) into the building through the pool water. Building containment was automatically effected, and the reactor was manually scrammed. Radiation doses to personnel involved were insignificant. Approximately 12 hours after the release, the activity had decayed sufficiently to permit unrestricted access to the building. The F-3 fuel capsules were removed, and normal operation was resumed.

APPENDIX A

Bowling of Aluminum-Cadmium Safety Rods Al-3 and Al-4

Normal pre-startup checks (September 20, 1966) of shim rod No. 2 revealed that its freedom of movement was restricted to the point that the rod would not fall freely into its seated position. This shim rod (Al-4 in position F-4) was removed and examined under water. Preliminary indications were that the rod was bent or bowed; however, the examination was not exact enough to be conclusive.

The shock absorber for the No. 2 rod was also inspected visually, utilizing the underwater omniscope. No large objects were found; however, a number of small particles were observed, and the shock absorber was removed, cleaned, and replaced. The shim rod was still not free to move and both rods Al-3 and Al-4 (core positions F-6 and F-4) were replaced with depleted fuel-cadmium shim rods. These fuel-cadmium rods were satisfactory in all aspects.

Shim rods Al-3 and Al-4 were more carefully examined under water at the isotope working platform. It was established that the rods were definitely bowed or bent by using a straight-edge, and preparations for hot cell examination were started. These preparations included: (1) sawing the aluminum section from the rods, (2) scheduling time for hot cell work, and (3) altering and calibrating the measuring device formerly used to measure beryllium. Preparations were completed on October 5, and the aluminum sections of the rod were checked for bowing on October 6.

Calibration of the measuring device (Figure 1A) was accomplished by using a standard bar 24 inches long. The dial indicator was zeroed at the left end of the bar (at the 8-inch mark on the reference scale). Measurements were made at one-inch intervals along the bar, and the results were plotted as uncorrected data. A straight line was drawn through the end points of this curve, and the distances from the straight line were replotted as shown in Table 1A and Figure 2A, Standard Bar at Second Floor. The above procedure was repeated after the apparatus was moved into the north hot cell at the ORR. The second calibration curve, Figure 3A (Table 2A) is labeled Standard Bar at Hot Cell. Preparations

were completed on October 5, and the aluminum sections of the rod were checked for bowing on October 6.

The aluminum sections of rods A1-3 and A1-4 were measured on all four sides in the same fashion as the standard bar, with the top end of each section at the 8-inch mark on the reference scale. The data (Tables 3A, 4A, 5A, and 6A) were corrected using the calibration curves and plotted as Figures 4A, 5A, 6A, and 7A.

The data indicate that the shim rods were bowed rather than bent. It is suspected that the bowing is the result of unequal irradiation by neutrons, and that the bowing is quite similar in nature to that which beryllium undergoes when subjected to unequal irradiation at relatively low temperatures.

Rods A1-3 and A1-4 were placed in the core on about June 12, 1964, and were removed on September 21, 1966, (832 days). The reactor operated 85.5% of the time during this period, with an average power level of 29.8 Mw/operating hour. The aluminum sections of shim-safety rods A1-3 and A1-4 were bowed toward the west 38.5 and 30.4 thousandths of an inch, respectively. The rates of bowing may then be calculated as 0.0165 and 0.0134 inch per calendar year or as 1.82×10^{-6} and 1.44×10^{-6} inches per Mwd, respectively.

Fig. 1A. Device for Contour Measurements of ORF Lattice Components, Shown with a Beryllium Reflector Unit in Position for Measurements

Table 1A. Standard Bar at Second Floor

Distance From Left End (inches)	Deflection, Average of Two Measurements	Deflection, Corrected
0	0	0
1	-0.2	-0.7
2	0	-1.0
3	-0.1	-1.6
4	0	-2.1
5	0.2	-2.4
6	0.8	-2.3
7	1.1	-2.5
8	2.5	-1.6
9	3.4	-1.2
10	4.8	-0.3
11	5.6	0
12	6.2	0
13	7.0	0.3
14	8.0	0.8
15	9.0	1.3
16	10.0	1.8
17	10.7	2.0
18	11.1	1.9
19	11.9	2.2
20	12.2	1.9
21	12.3	1.5
22	12.4	1.1
23	12.6	0.8
24	12.3	0

ORNL DWG. 67-4654

Fig. 2A. Calibration of Standard Bar, Second Floor West

ORNL DWG. 67-4655

Fig. 3A. Calibration of Standard Bar, North Hot Cell, October 6, 1966

Table 2A. Standard Bar at Hot Cell

Distance From Top, (inches)	Deflection, Average of Two Measurements	Deflection, Corrected
0	0	0
1	-0.2	-0.7
2	-0.2	-1.2
3	-0.5	-1.9
4	-0.1	-2.0
5	0.1	-2.3
6	0.2	-2.6
7	1.0	-2.3
8	2.1	-1.7
9	3.1	-1.1
10	3.8	-0.9
11	4.8	-0.4
12	5.3	-0.4
13	6.1	0
14	7.1	0.5
15	8.0	0.9
16	9.0	1.5
17	9.7	1.7
18	10.3	1.8
19	11.0	2.1
20	11.3	1.9
21	11.5	1.6
22	11.4	1.0
23	11.6	0.8
24	11.3	0

Table 3A. ORR-A1-3 (F6) Measured in North Hot Cell
(Deflection, Thousandths of an Inch)

Distance From Top (in.)	North Side			South Side		
	Uncorrected*	Corrected For Zero	Corrected (Final)	Uncorrected*	Corrected For Zero	Corrected (Final)
0	0	0	0	0	0	0
1	0.7	0.1	0.8	1.0	0.1	0.8
2	1.0	-0.2	1.0	2.0	0.1	1.3
3	1.6	-0.3	1.6	2.5	-0.3	1.6
4	2.5	0	2.0	3.0	-0.8	1.2
5	3.4	0.3	2.6	4.2	-0.5	1.8
6	4.4	0.7	3.3	5.0	-0.6	2.0
7	5.2	0.9	3.2	6.0	-0.6	1.7
8	5.8	0.9	2.6	7.1	-0.4	1.3
9	6.9	1.3	2.4	8.3	-0.1	1.0
10	7.9	1.7	2.6	10.0	0.6	1.5
11	9.3	2.5	2.9	11.1	0.8	1.2
12	10.2	2.8	3.2	12.3	1.0	1.4
13	10.2	2.2	2.2	13.0	0.8	0.8
14	11.3	2.7	2.2	14.2	1.1	0.6
15	11.8	2.5	1.6	15.8	1.7	0.8
16	12.4	2.5	1.0	16.4	1.4	0.1
17	12.9	2.4	0.7	17.8	1.9	0.2
18	13.8	2.7	0.9	19.0	2.1	0.3
19	13.9	2.2	0.1	20.0	2.2	0.1
20	14.0	1.7	-0.2	20.8	2.0	0.1
21	14.3	1.4	-0.2	21.4	1.7	0.1
22	14.5	0.9	-0.1	22.0	1.4	0.4
23	14.7	0.5	-0.3	22.0	0.6	-0.2
24	14.8	0	0	22.5	0	0

*Uncorrected deflections are an average of two measurements.

Table 4A. ORR-A1-3 (F6) Measured in North Hot Cell
(Deflection, Thousandths of an Inch)

Distance From Top (in.)	East Side			West Side		
	Uncorrected *	Corrected For Zero	Corrected (Final)	Uncorrected *	Corrected For Zero	Corrected (Final)
0	0	0	0	0	0	0
1	-4.3	-5.4	-4.7	7.4	7.1	7.8
2	-7.9	-10.1	-8.9	12.4	11.8	13.0
3	-11.3	-14.7	-12.8	16.9	16.0	17.9
4	-14.6	-19.1	-17.1	21.8	20.6	22.6
5	-17.0	-22.6	-20.3	26.2	24.7	27.0
6	-19.4	-26.1	-23.5	30.3	28.5	31.1
7	-21.0	-28.8	-26.5	33.6	31.5	33.8
8	-21.8	-30.7	-29.0	36.7	34.3	36.0
9	-21.7	-31.7	-30.6	38.9	36.2	37.3
10	-21.0	-32.2	-31.3	40.6	37.6	38.5
11	-20.0	-32.3	-31.9	40.9	37.6	38.0
12	-18.5	-31.9	-31.5	40.9	37.3	37.7
13	-16.3	-30.8	-30.8	39.8	36.0	36.0
14	-13.3	-28.9	-29.4	39.0	34.9	34.4
15	-10.1	-26.8	-27.7	37.9	33.5	32.6
16	-6.0	-23.8	-25.3	35.4	30.7	29.2
17	-2.0	-20.9	-22.6	32.7	27.7	26.0
18	2.1	-17.9	-19.7	29.8	24.5	22.7
19	6.6	-14.6	-16.7	26.6	21.0	18.9
20	11.1	-11.2	-13.1	23.2	17.3	15.4
21	15.1	-8.3	-9.9	19.3	13.1	11.5
22	19.1	-5.5	-6.5	15.6	9.1	8.1
23	23.1	-2.6	-3.4	11.6	4.8	4.0
24	26.8	0	0	7.1	0	0

*Uncorrected deflections are an average of two measurements.

Table 5A. ORR-A1-4 (F4) Measured in North Hot Cell
(Deflection, Thousandths of an Inch)

Distance From Top (in.)	North Side			South Side		
	Uncorrected*	Corrected For Zero	Corrected (Final)	Uncorrected*	Corrected For Zero	Corrected (Final)
0	0	0	0	0	0	0
1	0.6	0.1	0.8	0.3	-0.4	0.3
2	2.2	1.3	2.5	0.5	-0.9	0.3
3	2.6	1.2	3.1	0.3	-1.8	0.1
4	3.7	1.9	3.9	0.4	-2.4	-0.4
5	4.6	2.3	4.6	0.7	-2.8	-0.5
6	5.1	2.4	5.0	1.1	-3.1	-0.5
7	6.0	2.8	5.1	1.6	-3.2	-0.9
8	7.0	3.4	5.1	2.6	-2.9	-1.2
9	8.9	4.8	5.9	3.9	-2.3	-1.2
10	8.9	4.4	5.3	5.3	-1.6	-0.7
11	9.6	4.6	5.0	6.3	-1.3	-0.9
12	10.5	5.1	5.5	7.6	-0.7	-0.3
13	11.1	5.2	5.2	8.4	-0.6	-0.6
14	11.7	5.4	4.9	9.5	-0.2	-0.7
15	12.6	5.8	4.9	10.6	0.2	-0.7
16	13.2	6.0	4.5	11.8	0.7	-0.8
17	13.6	5.9	4.2	13.5	1.7	0
18	14.2	6.1	4.3	15.1	2.6	0.8
19	14.1	5.5	3.4	14.7	1.6	-0.5
20	14.0	5.0	3.1	15.7	1.9	0
21	13.6	4.1	2.5	16.6	2.1	0.5
22	13.1	3.2	2.2	16.1	0.9	-0.1
23	11.6	1.2	0.4	16.5	0.6	-0.2
24	10.8	0	0	16.6	0	0

*Uncorrected deflections are an average of two measurements.

Table 6A. ORR-A1-4 (F4) Measured in North Hot Cell
(Deflection, Thousandths of an Inch)

Distance From Top (in.)	East Side			West Side		
	Uncorrected*	Corrected For Zero	Corrected (Final)	Uncorrected*	Corrected For Zero	Corrected (Final)
0	0	0	0	0	0	0
1	-2.6	-3.4	-2.7	5.0	4.7	5.4
2	-6.0	-7.7	-6.5	9.2	8.5	9.7
3	-9.2	-11.7	-9.8	13.0	12.0	13.9
4	-12.0	-15.3	-13.3	17.0	15.6	17.6
5	-14.7	-18.9	-16.6	20.4	18.7	21.0
6	-16.0	-21.2	-18.6	23.6	21.5	24.1
7	-17.6	-23.4	-21.1	26.3	23.9	26.2
8	-18.2	-24.9	-23.2	28.7	26.0	27.7
9	-18.0	-25.5	-24.4	31.2	28.1	29.2
10	-17.1	-25.4	-24.5	33.5	30.1	31.0
11	-16.0	-25.2	-24.8	33.8	30.0	30.4
12	-14.9	-24.9	-24.5	34.1	30.0	30.4
13	-13.2	-24.0	-24.0	34.1	29.7	29.7
14	-11.0	-22.7	-23.2	33.8	29.0	28.5
15	-8.2	-20.7	-21.6	32.9	27.8	26.9
16	-5.0	-18.3	-19.8	31.2	25.7	24.2
17	-2.0	-16.2	-17.9	29.7	23.9	22.2
18	1.4	-13.6	-15.4	27.9	21.7	19.9
19	5.3	-10.5	-12.6	25.2	18.7	16.6
20	8.7	-8.0	-9.9	23.9	16.1	14.2
21	11.9	-5.6	-7.2	19.2	12.0	10.4
22	15.3	-3.0	-4.0	16.3	8.8	7.8
23	18.0	-1.2	-2.0	12.9	5.0	4.2
24	20.0	0	0	8.2	0	0

* Uncorrected deflections are an average of two measurements.

ORNL DWG. 67-4656

Fig. 4A. Bowing Measurements, South and North Sides of A1-3
(Core Position F-6)

Fig. 5A. Bowing Measurements, East and West Sides of A1-3
(Core Position F-6)

Fig. 6A. Bowing Measurements, South and North Sides of A1-4
(Core Position F-4)

Fig. 7A. Bowing Measurements, East and West Sides of Al-4,
(Core Position F-4)

INTERNAL DISTRIBUTION

1.	R. G. Affel	55.	C. E. Mathews
2.	M. A. Baker	56.	R. V. McCord
3.	A. E. G. Bates	57.	H. C. McCurdy
4.	E. E. Beauchamp	58.	F. R. McQuilkin
5.	R. B. Berggren	59.	C. E. Miller
6.	F. T. Binford	60.	J. M. Miller
7.	G. E. Boyd	61.	J. G. Morgan
8.	A. R. Brosi	62.	K. Z. Morgan
9.	F. R. Bruce	63.	F. H. Neill
10.	C. D. Cagle	64.	H. G. O'Brien
11.	W. R. Casto	65.	R. G. Orrison
12.	R. L. Clark	66.	M. E. Ramsey
13.	T. E. Cole	67.	L. D. Roberts
14.	E. S. Collins	68.	H. M. Roth, AEC
15.	J. A. Conlin	69.	D. P. Roux
16.	D. F. Cope, AEC	70.	A. F. Rupp
17.	R. A. Costner, Jr.	71.	H. E. Seagren
18-27.	J. A. Cox	72.	T. M. Sims
28.	E. N. Cramer	73.	O. Sisman
29.	J. H. Crawford, Jr.	74.	M. J. Skinner
30.	F. L. Culler	75.	W. L. Smalley, AEC
31.	J. E. Cunningham	76.	A. H. Snell
32.	R. J. DeBakker	77.	L. E. Stanford
33.	S. J. Ditto	78.	G. G. Stout
34.	E. P. Epler	79.	J. H. Swanks
35.	C. B. Gaither	80.	W. H. Tabor
36.	J. P. Gill	81.	E. H. Taylor
37.	J. H. Gillette	82.	J. R. Thomas
38.	L. A. Haack	83.	W. E. Thomas
39.	T. P. Hamrick	84.	D. E. Tidwell
40.	J. A. Harvey	85.	A. A. Walls
41.	V. O. Haynes	86.	C. C. Webster
42.	K. M. Henry	87.	A. M. Weinberg
43.	S. S. Hurt, III	88.	R. C. Weir
44.	W. H. Jordan	89.	K. W. West
45.	F. B. K. Kam	90.	E. J. Witkowski
46.	C. P. Keim	91.	E. I. Wyatt
47.	V. J. Kelleghan	92-94.	Laboratory Records Dept.
48.	E. M. King	95.	Laboratory Records, RC
49.	H. V. Klaus	96-97.	Central Research Library
50.	E. D. Lance	98.	Document Reference Section
51.	L. C. Lasher	99-113.	Division of Technical
Information Extension
52.	H. G. MacPherson		
53.	J. F. Manneschildt		
54.	F. C. Maienschein		

EXTERNAL DISTRIBUTION

114.	Hector Barcelo, PRNC	121.	O. D. Oner, Turkey
115.	Eric Blomberg, Sweden	122.	G. Rada, Venezuela
116.	K. J. Bobin, Belgium	123.	J. J. M. Snepvangers,
The Netherlands
117.	F. B. Buoni, WPAFB	124.	R. Wakabayashi, NAIG, Japan
118.	J. R. Colley, Republic of
South Africa	125.	K. E. Wirtz, Germany
119.	Kiyoshi Inoue, Hitachi, Japan	126.	A. C. Woods, Australia
120.	Masanori Kanbara, JAERI, Japan		