SCHOOL

OF

NUCLEAR ENGINEERING

ANNUAL REPORT

REACTOR OPERATION - 1977

Purdue University

West Lafayette, Indiana 47907

REPORT ON REACTOR OPERATIONS

For The Period

January 1, 1977 to December 31, 1977

PURDUE UNIVERSITY REACTOR - 1

PURDUE UNIVERSITY

West Lafayette, Indiana

March, 1978

1. INTRODUCTION

This report reviews the operation of the Purdue University Reactor (PUR-1) for the period January 1 to December 31, 1977. The report is to meet the requirement of 10CFR50.59. The format for the sections that follow conforms to the requirements in the Hazards Summary Report For The Purdue University Reactor, and to those portions of Section 6.6.1 of the Technical Specifications that were initiated prior to NRC approval.

During 1977 the operation of the PUR-1 has provided assistance to a wide variety of research and educational programs. It provides neutron irradiation services for all the Schools of Engineering as well as other Schools and Departments of Purdue and is available for industrial organizations as needed. Staff members teach classes related to reactor operation and the PUR-1 in particular and assist in reactor related laboratories.

Tours are provided for school children, university students, and the public at large as part of a public education program. During 1977 over 785 persons visited the reactor facility.

2. PLANT DESIGN AND OPERATION CHANGES

Research, sample irradiation, instruction in reactor operation, and surveillance checks made up the major portion of the routine operation in 1977.

2.1 Facility Design Changes

No changes in the facility design were made during 1977.

2.2 Performance Characteristics

The reactor instrumentation has continued to be a source of problems. Solid state replacement instrumentation is either on hand or being developed to interface the new components to the present system, as soon as the technical specifications are approved. Preventative maintenance has minimized some of the instrumentation problems, but has not prevented the problems. In all cases, the instrumentation problems have been such as to fail in a safe manner, causing inconvenience, but no safety problems.

No change was noted in the fuel performance. Micrometer measurements and visual inspection of the fuel revealed no significant change in the aluminum cladding of the fuel plates.

2.3 Changes in Operating Procedures Concerning Safety of Facility Operations

No changes in operating procedures which relate to the safety of facility operations were made during the year.

2.4 Results of Surveillance Tests and Inspections

2.4.1 Fuel Plate Inspection. The annual inspection of the ninth fuel plate of fuel assembly F-4, serial number number 4-3-73, showed no noticeable

change in the surface defect which we have agreed to inspect. Measurements of the thickness of selected fuel plates with a micrometer gave no evidence of deterioration of the fuel plate cladding.

2.4.2 Absolute Filter Inspection. The integrity of the filter medium of the absolute filter and the seal around the outside edges showed no signs of failure. These inspections were conducted each time new prefilters were installed.

2.4.3 Source Missing Interlock. Control rod motion was tested at quarterly intervals in four modes as follows:

1. Both fission chamber and source at lower limits
2. Fission chamber at upper limit and source at lower limit
3. Both fission chamber and source at upper limits
4. Fission chamber at lower limit and source at upper limit

The control rod mechanisms would function only in the first mode thus guaranteeing an adequate count rate before any control rod withdrawal was possible.

2.4.4 Fast Scrams And Magnet Current Settings. The fast scrams and magnet currents were checked and adjusted as necessary at quarterly intervals and as necessary following instrument maintenance.

2.4.5 Survey Instrumentation Calibration. The semiannual calibrations of all survey instruments were completed with appropriate sources for the range of the instruments. Adjustments to the calibration were made where needed and possible or calibration curves were supplied.

2.4.6 Meter Contact Switches. Meter contact switches which initiate setbacks or slow scrams were checked quarterly with satisfactory results.

2.4.7 Exhaust System Operation. Semiannual checks of the operation of the dampers and exhaust fan were completed satisfactorily.

2.4.8 Integrity of Boral Plate In Storage Racks. The annual inspection of the boral separator plate in each storage rack gave results that are comparable with past years indicating no change in the integrity of the plates.

2.4.9 Evacuation Alarms. The annual test of the evacuation alarm for the reactor room and the laboratory area proved satisfactory.

2.4.10 Fuel Inventory. All accountable material was inventoried during the year. No discrepency was found between the inventory and the check lists.

2.4.11 Intrusion System. The monthly checks of the intrusion system was completed with no deficiencies indicated.

2.4.12 Key Inventory. A semiannual inventory was initiated of all keys to the reactor room and the associated security system.

2.4.13 Shim-safety Rods. An annual visual inspection of the shim-safety rods was started, with no noticeable change observed as compared with pictures taken in March, 1969.

Quarterly rod drop tests were conducted with all drops within the approved limits.

2.4.14 Primary Coolant System. On March 1, 1977, a weekly check of the primary coolant pH and conductivity was started. This was in addition to the water level and conductivity checks made during each prestartup. Monthly water samples to check for gross alpha and beta activity were continued. All primary coolant checks were within specifications.

2.4.15 Containment. The negative pressure in the reactor room was included on the weekly check list started on March 1, 1977.

2.5 Summary Of Changes, Tests and Experiments Covered by 10CFR 50.59 (a). No changes, tests, or experiments were conducted during the year which required authorization from the commission pursuant to 10CFR 50.59 (a).

3. POWER GENERATION

During 1977 the PUR-1 produced a cumulative energy of 1,792,714 watt-minutes distributed over 80 runs which covered an integrated running time of 154.4 hours.

4. UNSCHEDULED SHUTDOWNS

A total of 19 unscheduled shutdowns occurred during the year. These shutdowns were distributed as to cause as follows:

15 composite safety amplifier trouble

3 instrument noise

1 operator error

4.1 Composite Safety Amplifier Trouble

The safety channel portion of the composite safety amplifier (CSA) was originally designed for the trip point to be at 150% of the licensed power

level. As reactor power increases the magnet current drops very slightly until the power level approaches the trip point. In the range between 120-150% power, the magnet current drops sharply. Calibration of the fast scram-high level trip point consists of adjusting the magnet current so that the safety rods would drop at 150% power. This operating range would permit the magnet current to be near its maximum value when the reactor was operating at 100% of power.

The specifications for the PUR-1 call for the trip point to be set at 120% of power which means that when operating at 100% power the magnet current has dropped much more than the design intended at this power level and operation is much closer to the trip point on the curve. The random nature of the alignment of the magnet and control rod or the accumulation of a bit of dust between the magnet and the control rod introduces changes in the magnet current drop point following each rod drop. When an unscheduled shutdown is caused by such a shift in the magnet current drop point the only indication on the annunciator panel is CSA TROUBLE. The most conservative setting of the magnet currents requires both accurate alignment and a clean innerface between the magnet and control rod and any change in these parameters will shift the drop point in the direction of an earlier and safer shut down. The short term solution to reducing the frequency of this type of unplanned shutdown is to keep magnets and control rods as properly aligned and dust free as possible. The long term solution that is being pursued is a change in the design of the CSA's which will maintain the magnet power well above the drop point until the trip point is reached. At this time the magnet current will be quickly reduced by electronic or relay action. Both the short and long term solutions are being pursued.

4.2 Instrument Noise

Maintenance of existing instruments is the immediate solution to noise induced shutdowns. For a more permanent solution to this problem solid state instrumentation is being accumulated to replace the vacuum tube design. The sequence for replacement first requires changing the CSA's because some of the new instrumentation is not compatible with the present models. These changes will be completed as soon as practical.

4.3 Operator Error

This shutdown was caused when the set point on the pool-top radiation area monitor remained at 7 1/2 mr/hr during a sample removal.

The necessity for alert operation was impressed upon the operator responsible for the unplanned shutdown and it is felt this will be sufficient to prevent a repetition.

5. MAINTENANCE

The main power transformer on one of the Composite Safety Amplifiers had to be replaced along with 2 resisters, a relay and some associated wiring following failure of the transformer. No obvious cause for the failure could be determined, but the equipment is ≈15 years old.

The HEPA filter in the exhaust system was replaced.

6. CHANGES, TESTS, AND EXPERIMENTS

No change, tests, or experiments were made without prior Commission approval, pursuant to the requirements of 10CFR 50.59(b).

7. RADIOACTIVE EFFLUENT RELEASES

No radioactive effluents or discharges were made to the environs beyond the effective control of the licensee as measured at or prior to the point of such release or discharge.