PENN STATE BREAZEALE REACTOR

ANNUAL OPERATING REPORT, FY 87-88
PSBR Technical Specifications 6.6.1
License CDW R-2, Docket No. 50-5

Reactor Utilization

The Penn State Breazeale Reactor (PSBR) is a TRIGA Mark III facility capable of 1 MW steady state operation, and 2000 MW peak power pulsing operation. Utilization of the reactor and its associated facilities falls into three major categories:

EDUCATION utilization is primarily in the form of laboratory classes conducted for graduate, undergraduate, associate degree candidates, and numerous high school science groups. These classes vary from neutron activation analysis of an unknown sample to the calibration of a reactor control rod. In addition, an average of 2000 visitors tour the PSBR facility each year.

RESEARCH accounts for a large portion of reactor time which involves Radionuclear Applications, Neutron Radiography, a myriad of research programs by faculty and graduate students throughout the University, and various applications by the industrial sector.

TRAINING programs for Reactor Operators and Reactor Supervisors are continuously offered and are tailored to meet the needs of the participants. Individuals taking part in these programs fall into such categories as power plant operating personnel, graduate students, and foreign trainees.

The PSBR facility operates on an 8 AM - 5 PM shift, five days a week, with an occasional 8 AM - 8 PM or 8 AM - 12 Midnight shift to accommodate reactor operator training programs or research projects.

Summary of Reactor Operating Experience

Technical specification requirement 6.6.1.a.

Between July 1, 1987 and June 30, 1988, the PSBR was

critical for	489 hrs or	2.0 hrs/shift
subcritical for *	378 hrs or	1.5 hrs/shift
used while shutdown for	482 hrs or	2.0 hrs/shift
not available for	42 hrs or	0.2 hrs/shift
Total Usage	1391 hrs or	5.7 hrs/shift

* 2 hrs of subcritical time involved fuel movement

The reactor was pulsed a total of 167 times with the following reactivities:

less than $2.00	39
$2.00 to $2.50	128
greater than $2.50	0

The square wave mode of operation was used 63 times to power levels between 100 and 500 KW.

Total energy produced during this report period was 216 MWH with a consumption of 11 gms of U-235.

Unscheduled Shutdowns

Technical specification requirement 6.6.1.b.

There were 9 unplanned scrams during this period. Power range switching errors by students or industrial trainees account for 3 of the 9 scrams. The other scrams are described below.

July 1, 1987 -- Period scram in auto mode; auto mode was being used to bring the reactor critical in preparation for a pulse. While system malfunction was considered, the most likely cause of the event was determined to be a deviation from SOP-1, the Reactor Operating Procedure, as to when use of the auto control system is permitted. SOP-1 has been changed to better clarify proper use of the auto control system.

September 30, 1987 -- Operator scrammed reactor as per procedure when experimenter reported Rabbit II sample did not return from the core to the hood. Investigation revealed sample had returned to the hood but radiation measurements revealed that the sample had not been in the reactor core; this

lack of radioactivity is what initially led the experimenter to believe that the sample didn't return to the hood. A system valve malfunction may have been the reason for the sample not traveling to the core; cycling of the system's valves did not reveal any problems.

November 9, 1987 -- Reactor manual scram by operator as per procedure when a Rabbit I capsule failed to return to the laboratory terminus. SRO with Health Physics assistance (as per procedure) located the capsule in the aluminum bend under the reactor bridge. The aluminum section was removed and the sample was retrieved intact. No definite reason was found for the sample to be stuck; the capsule cap was slightly crooked and the capsule was discarded. System was re-assembled; two other rabbit capsules were each run successfully in and out of the reactor core three times each with the reactor at standby. Reactor operations resumed with no further problems for thirteen more rabbit runs that day.

November 19, 1987 -- Manual scram due to overheated experiment in the reactor low bay. It was first thought that the vaporization being seen was a fire. The experiment was lithium carbonate powder; the experiment was not connected to the reactor irradiation tube at the time. Health Physics was called since it was suspected that some tritium may be present. The experimenter was immediately available in the building and confirmed that there was no fire but only vaporization of some ethylene glycol that got into the catalyst heater used in the experiment. Health Physics investigation concluded there was no radiation hazard from the tritium.

December 2, 1987 -- Manual scram as per procedure when experimenter reported that two samples had not returned to the hood terminus. The first sample was a blank run to test the system and the second sample was olivine. No activity is usually expected on a blank; the radiation reading is the way an experimenter knows when a sample is back. When the second sample showed no activity on its supposed return, the experimenter then discovered neither sample had returned. SRO with Health Physics assistance (as per procedure) surveyed and visually inspected all of the Rabbit II system poly tubing but could not locate the missing rabbits; therefore, it was assumed the rabbits were still in the core terminus. With Health Physics permission, the Rabbit

II system was manually cycled twice; each time a rabbit capsule returned. Further inspection revealed an aluminum union between the Rabbit II core terminus and the rest of the system's poly tubing was damaged; the nature of the damage allowed samples to travel to the core but restricted their return. The union was repaired and the system was tested successfully. This aluminum union has since been replaced with a stainless steel union which is less subject to damage.

March 8, 1988 -- Operator error when attempting a 200 KW square wave. The reactor was critical at 100 watts; normally at this point the transient rod is ejected from the core to take reactor power to several hundred kilowatts. Before ejecting the transient rod, the operator failed to upscale the reactor power switch, so the reactor scrammed when reaching approximately 330 watts (110% of range).

Major Maintenance With Safety Significance

Technical specification requirement 6.6.1.c.

No major preventative or corrective maintenance operations with safety significance have been performed during this report period.

Major Changes Reportable Under 10 CFR 50.59

Technical specifications requirement 6.6.1.d.

Facility Changes

September 25, 1987 -- The three Victoreen Vamp area monitors in the Hot Cell clean area, Hot Cell hot area, and reactor demineralizer room were replaced with Eberline SRM-100's with HP-270 energy compensated G-M detectors. These new state-of-the-art monitors retain the mR/hr readouts and perform the same functions as the previous monitors. The Victoreen Vamp in the Cobalt-60 facility demineralizer room was replaced with an Eberline RM-14 with a HP-260 pancake GM detector; this monitor now reads counts per minute instead of the previous mR/hr.

September 30, 1987 -- The fission product monitor and all its piping were removed from the pool recirculation system. This monitor had not been in service since February 10, 1986, when it was determined by the reactor staff

and the Health Physics staff to be of little value in light of the protection afforded by the two facility air monitors and weekly assay of pool water samples. This monitor has never been a requirement of the facility reactor license.

September 30, 1987 -- A distillate line coming from the evaporator building to the pool recirculation system was disconnected from the recirculation system and a portion of the distillate line was removed. A new plumbing connection from the large air compressor in the mechanical equipment room to the remaining portion of the distillate line, allows compressed air to be supplied to operate a steam regulating valve in the evaporator building.

February 16, 1988 -- The West Air Monitor detector holder and shield assembly were rebuilt to accommodate a pancake type G-M detector that replaced a previous type of G-M detector that is no longer available. The air pump and motor were moved from the reactor bay to the demineralizer room to reduce noise in the reactor bay. The air intake to the monitor is still at the same location in the reactor bay as previous. The bypass valve, flow meter, readout module electronics, and recorder are retained. There was no change in the monitoring function of the air monitor.

March 14, 1988 -- The East Air Monitor was modified in the same manner as the West Air Monitor except that the air pump and motor remained in their location in the reactor bay.

Procedures

All procedures are reviewed as a minimum annually, and on an as needed basis. Changes during the year were numerous and no attempt will be made to list them. A current copy of all facility procedures will be made available on request. Since none of the procedure changes were a result of Tech Specs changes, none of the procedure changes are considered major.

New Tests and Experiments

Ar-41 was produced in sample irradiation containers at the reactor core face for use by a commercial company for refinery tracer studies. The safety evaluation by the reactor staff and the Reactor Safeguards Committee considered the following classes of events: core damage associated with compressed gas, radiation induced degradation of non-metallic components, contamination due to impurities in the Argon-40 charge gas, equipment failures or operator errors resulting in loss of containment, and shipping container handling accidents.

The PSBR safety analysis considers a non-mechanistic release of gaseous fission products from a ruptured fuel element. Both the Ar-41 experiment and the safety analysis consider encapsulated radioactive gas. Therefore, the Ar-41 experiment does not introduce a new type of accident. Steps were taken to minimize the potential for a release of Ar-41, such that the probability of a release is not significantly altered. The potential consequences of an Ar-41 release are clearly bounded by the previously analyzed event; therefore, the experiment does not constitute an unreviewed safety question.

Radioactive Effluents Released

Technical specifications requirement 6.6.1.e.

Liquid

There were no liquid effluent releases under the reactor license for the report period. Liquid from the regeneration of the reactor demineralizer was evaporated and the distillate recycled for pool water makeup. The evaporator concentrate was dried and the solid salt residue was disposed of in the same manner as other solid radioactive waste at the University. Liquid radioactive waste from the radioisotope laboratories at the PSBR is under the University byproduct materials license and is transferred to the Health Physics Office for disposal with the waste from other campus laboratories. Liquid waste disposal techniques include storage for decay, release to the sanitary sewer as per 10 CFR 20, and solidification for shipment to licensed disposal sites.

Gaseous

The only gaseous effluent is Ar-41, which is released from dissolved air in the reactor pool water, dry irradiation tubes, and air leakage from the pneumatic sample transfer systems.

The amount of Ar-41 released from the reactor pool is very dependent upon the operating power level and the length of time at power. The release per MWH is highest for extended high power runs and lowest for intermittent low power runs. The concentration of Ar-41 in the reactor bay and the bay exhaust was measured by the Health Physics staff during the summer of 1986. Measurements were made for conditions of low and high power runs simulating typical operating cycles. Based on these measurements, an annual release of between 164 mCi and 496 mCi of Ar-41 is calculated for July 1, 1978 to June 30, 1988, resulting in an average concentration at the building exhaust between 10% and 30% of the MPC for unrestricted areas. These values represent the extremes, with the actual release being between the two values. The maximum fenceline dose using only dilution by the 1 m/s wind into the lee of the building is on the order of 0.1% to 0.4% of the unrestricted area MPC.

During the report period, several irradiation tubes were used at high enough power levels and for long enough runs to produce significant amounts of Ar-41. The calculated annual production was 134 mCi. Since this production occurred in a stagnant volume of air confined by close fitting shield plugs, most of the Ar-41 decayed in place before being released to the reactor bay. The reported releases from dissolved air in the reactor pool are based on measurements made, in part, when a dry irradiation tube was in use at high power levels; the Ar-41 releases from the tubes are part of rather than in addition to the release figures quoted in the previous paragraph.

The use of the pneumatic transfer systems was minimal during this period and any Ar-41 releases would be insignificant.

Environmental Surveys

Technical specifications requirement 6.6.1.f.

The only environmental survey performed was the routine TLD gamma-ray dose measurement at the facility fenceline and at control points in residential areas several miles away. The measurements tabulated below (in mrem dose) represent the 3 July 1987 to 17 August 1988 period. The 4th quarter measurements reflect an extended 4th quarter measuring period. The dosimeters used for the Fence East second quarter readings were missing at the end of the quarter and were assumed to be stolen; therefore, a cumulative dose equivalent for the year is not available. However, a quarterly comparison of the North, West, East, and South reactor fenceline measurements with the control measurements at Houserville (1 mile away) and Howard (18 miles away) show the differences to be similar to those in the past; the higher fenceline readings are attributed to a higher concentration of K-40 in the soil at the fenceline.

	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Totals
Fence North	21.44	23.73	20.62	30.42	96.21
Fence West	20.28	22.09	18.33	28.37	89.07
Fence East	22.63	---	21.15	33.64	---
Fence South	21.57	22.81	19.06	30.15	93.59
Control-Howard	19.09	20.32	17.18	27.60	84.19
Control-Houserville	16.51	17.28	16.16	23.81	73.76

Personnel Exposures

Technical specifications requirement 6.6.1.g.

No reactor personnel or visitors received dose equivalents in excess of 25% of the permissible limits under 10 CFR 20.