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College of Engineering
Radiation Science and Engineering Center

(814) 865 6351
FAX: (814) 863-4840

Breazeale Nuclear Reactor Building
The Pennsylvania State University
University Park, PA 16802-2301

Annual Operating Report, FY 91-92
PSBR Technical Specifications 6.6.1
License R-2, Docket No. 50-5

October 6, 1992

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D. C. 20555

Dear Sir:

Enclosed please find the Annual Operating Report of the Penn State Breazeale Reactor (PSBR). This report covers the period from July 1, 1991 through June 30, 1992, as required by technical specifications requirement 6.6.1. Also included are any changes applicable to 10 CFR 50.59.

The Safety Analysis Report applicable to this license was amended during the previous reporting period (April 19, 1991) for two reasons. First, it described the new reactor control system that was installed in August and September 1991 (this reporting period). Second, it incorporated changes so as to update the SAR as of the date of the amendment. Changes to the SAR made since April 19, 1991 are enclosed.

A copy of the Thirty-seventh Annual Progress Report of the Penn State Radiation Science and Engineering Center is included as supplementary information.

Sincerely yours,

M H Voth

Marcus H. Voth
Director, Radiation Science
and Engineering Center

Enclosures

cc: Region I Administrator
U. S. Nuclear Regulatory Commission
D. A. Shirley

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PENN STATE BREAZEALE REACTOR

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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 and undergraduate students 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 Radiograpy, 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 Specifications requirement 6.6.1.a.

Between July 1, 1991 and June 30, 1992, the PSBR was

critical for	431 hours	or 1.7 hrs/shift
subcritical for	541 hours	or 2.1 hrs/shift
used while shutdown for	436 hours	or 1.7 hrs/shift
not available	187 hours	or 0.7 hrs/shift
Total usuage	1595 hours	or 6.[illegible] hrs/shift

The reactor was pulsed a total of 92 times with the following reactivities:

less than \$2.00	61
\$2.00 to \$2.50	30
greater than \$2.50	1

The square wave mode of operation was used 68 times to power levels between 100 and 500 KW.

Total energy produced during this report period was 211 MWH with a consumption of 11 grams of U-235.

Unscheduled Shut 'owns

Technical Spec.ifications requirement 6.6.1.b.

The 9 unplanned scrams during the July 1, 1991 to June 30, 1992 period are described below.

July 23, 1991 - A loss of electrical power to the building during a tnunderstorm caused a reactor scram from 1 KW.

October 9, 1991 - Reactor scram (RSS - hard-wired reactor safety system) while at 1 MW but no indication of the cause.

October 10, 1991 - Reactor scram (RSS) while at 1 MW but no indication of the cause. Two relays in the RSS were replaced since they could have intermittent failures causing the scrams. Noise was also found on the wide range channel. Subsequent tests showed the noise magnitude sufficient to cause a scram. The RSS scram circuit was changed so that scrams latch. A filter was installed in the wide range monitor to prevent scrams due to noise.

October 18, 1991 - Reactor wide range scram at ~ 1080 KW. Operator was manually moving the transient rod using short bumps upon reaching 900 KW power level while in auto 3 mode. The computer scans the keyboard to see if the rod up or down buttons are depressed; depending on the computer scanning rate and the operator bump rate, the computer may see the button as constantly depressed and therefore will be ramping the rod at an increasing rate towards its maximum withdrawal rate. As a result of the investigation, the transient rod up maximum velocity and ramp velocity were set for 50% of their previous values and training on proper rod movement was done for the licensed staff.

February 13, 1992 - Reactor wide range scram at 1060 KW while leveling power at 1000 KW. Circumstances and investigative results were the same as the October 18, 1991 event described above. Additional training concerning proper rod movement was done for the licensed staff.

March 5, 1992 - Reactor wide range scram at 1040 KW. A student operator in a Nuclear Engineering laboratory class had used a 0 period in auto mode to shut down from a previous operation. A student then did a startup and failed to insert a new period request before he entered auto. Reactor power increased from 1 KW to 1040 KW on a 0.4 second period as the auto controller was unable to handle the situation. On March 6, the staff conducted various startups (using a 0 period and changing the control system's deviation limiter) to study how the control system reacted to certain demands on it. Based on those findings, adjustments were made to the deviation limiter and period interlock to prevent the same event from recurring. Following further testing by the reactor staff and AECL (system designer) in April of 1992, permanent tuning changes were made to the control system software to prevent another March 5, 1992 type of scram and improve overall system performance.

March 10, 1992 - A reactor scram occurred due to a "transient rod interlock validation failure", as the transient rod approached its upper limit during a rod calibration. An investigation revealed that the two Transient Rod UP EOT (end of travel) switches don't always close at the same time; therefore, the hard-wired safety sytem and the DCC-X control computer don't always simultaneously sense the rod is up (this is compounded by the fact that DCC-X only senses events on a cycle basis). New parts were ordered for a redesign of the switches and mount. The staff was instructed on this problem; normally running the rod continuously for

the last 100 units (assuming this is desirable from a reactivity point of view) will assure the scram does not occur. The rod was being bumped in very small increments towards its upper limit when the scram occurred. Normally, the transient rod is only raised to its upper limit during rod calibration, usually once or twice a year. New EOT switches were installed July 30, 1992.

April 1 ,1992 - Reactor scram at 1 watt while increasing power; Shim, Safety and Transient Up Interlock Validation Failure indications. The regulating rod up button was being pushed at the time of the scram. The regulating rod up pushbutton utilizes several sets of contacts; one set goes to the RSS hard-wired reactor safety system and one set goes to the DCC-X control computer. One set was stuck and the validation failure resulted since both sets were not activated at the same time; this was determined using the DCC-X control computer's bar chart display to determine switch status. The event could not be repeated and the switch was examined for mechanical or electrical problems but none was identified.

April 15, 1992 - Reactor scram at 2 watts while increasing power; same circumstances and investigative results as the April 1, 1992 scram described above. Again no mechanical or electrical problem could be seen with the regulating rod up pushbutton switch but it was replaced.

Major Maintenance With Safety Significance

Technical Specifications 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

August 12, 1991 to October 7, 1991 - A new reactor control and safety system was installed and tested. This system is described in the Safety Analysis Report (April 19, 1991) submitted during the last reporting period. This installation was done under a license amendment rather than a 50.59 change.

October 28, 1991 - The evacuation alarm system was changed from a horn system to a medium-toned whoop on the Public Address (PA) system. The PA system, which provides complete building coverage, is now continuously on an UPS (Uninterruptable Power Supply). Previously, only three horns of the old evacuation alarm system could be on UPS because of the large current demand; thus building coverage was limited during power outages.

December 19, 1992 - The new reactor control and safety system consists of a DCC-X control computer and a DCC-Z monitoring computer. DCC-Z can communicate via a local area network (LAN) to remote monitors. To take advantage of this system feature, a LAN monitor was installed in the reactor building west stairwell, the normal re-entry point following a building evacuation. The west stairwell LAN monitor displays reactor parameters such as control rod position, power level, pool level information and readouts from the major radiation monitoring equipment. Software was developed during June to August 1992 that will allow historical trends to be displayed on the LAN so past events can be analyzed. This LAN monitor replaced a light panel system which only indicated that a certain type of monitor had caused an evacuation.

February 17-19, 1992 - Two reactor bay area monitors, two reactor bay particulate air monitors, one reactor beam lab area monitor and one cobalt-60 facility area monitor (all Victoreen brand) were replaced with new Eberline brand instrumentation.

	Old System	New System
Bay East	1-10e7 mR/hr (Ion)	0.1-10e4 mR/hr (GM)
Bay West	1-10e7 mR/hr (Ion)	0.1-10e4 mR/hr (GM) 1-10e4 R/hr (Ion)
Beam Lab	0.1-10e4 mR/hr (GM)	0.1-10e4 mR/hr (GM)
Cobalt-60 Bay	0.1-10e4 mR/hr (GM)	0.1-10e4 mR/hr (GM)
Air East	10-10e6 CPM (GM)	10-10e5 CPM (GM)
Air West	10-10e6 CPM (GM)	10-10e5 CPM (GM)

June 30, 1992 - A new system was installed to provide facility alarms to Police Services via telephone lines. The system can send 17 (with capability for expansion to 64) individual coded alarms to Police Services (i.e. pool level low, intrusion alarm, east bay radiation high, etc.). With the previous system, Police Services could not distinguish, for example, between a radiation alarm and pool level low alarm. As a part of this system installation, all alarms to Police Services are hard wired. Previously, only a few were hard-wired; most alarms to Police Services were initiated through the DCC-X control computer prior to this change.

Procedures

All procedures are reviewed as a minimum biennially, 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. Procedure changes considered major were done to directly reflect Tech Spec changes associated with the April 19, 1991 license amendment.

New Tests and Experiments

None having safety significance.

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 is evaporated and the distillate recycled for pool water makeup. The evaporator concentrate is dried and the solid salt residue is 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 disolved 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 MW[illegible] highest for extended high power runs and lowest for intermittent low pow[illegible] 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 156 mCi and 473 mCi of Ar-41 is calculated for July 1, 1991 to June 30, 1992, resulting in an average concentration at the building exhaust between 10% and 29% 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 1m/s wind into the lee of the building is on the order of 0.11 % to 0.33 % 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 68 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 fro[illegible] dissolved air in the reactor pool are based on measurements made, in pa[illegible], whe[illegible] 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 since they operate with CO-2 and Nitrogen as fill gases.

Environmental Surveys

Technical Specifications requirement 6.6.1.f.

The only environmental surveys performed were the routine TLD gamma-ray dose measurements at the facility fenceline and at control points in residential areas several miles away. This reporting year's measurements (in millirems) tabulated below represent the July 2, 1991 to June 30, 1992 period. A comparison of the North, West, East, and South fenceline measurements with the control measurements at Houserville (1 mile away) and Bellefonte (10 miles away) show the differences to be similar to those in the past.

	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total
Fence North	17.89	21.64	20.23	18.57	78.33
Fence West	18.93	22.04	19.03	18.07	78.07
Fence East	21.75	24.41	21.39	21.61	89.16
Fence South	20.27	20.12	18.15	16.06	74.60
Control-Bellefonte	21.27	21.[illegible]	21.19	18.10	81.56
Control-Houserville	15.69	1[illegible]	16.66	14.31	66.15

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.