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Annual Operating Report, FY 05-06
PSBR Technical Specifications 6.6.1
License R-2, Docket No. 50-5

December 12, 2006

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

Dear Sir:

Enclosed please find the Annual Operating Report for the Penn State Breazeale Reactor (PSBR). This report covers the period from July 1, 2005 through June 30, 2006, as required by technical specifications requirement 6.6.1. Also included are any changes applicable to 10 CFR 50.59.

A copy of the Fifty-First Annual Progress Report of the Penn State Radiation Science and Engineering Center will be forwarded at a later date as supplementary information.

Sincerely yours,

C. Frederick Sears
Director, Radiation Science
and Engineering Center

Enclosures

tlf

cc. E. J. Pell
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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 two 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 2500 visitors tour the PSBR facility each year.

RESEARCH/SERVICE 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.

The PSBR facility operates on an 8 AM - 5 PM shift, five days a week, with an occasional early morning, evening, or weekend shift to accommodate laboratory courses or research/service projects.

Summary of Reactor Operating Experience - Tech Specs requirement 6.6.1.a.

Between July 1, 2005 and June 30, 2006, the PSBR was

critical for	841 hours	or 3.1 hrs/shift
subcritical for	357 hours	or 1.3 hrs/shift
used while shutdown for	545 hours	or 2.0 hrs/shift
not available	147 hours	or 0.6 hrs/shift
Total usage	1890 hours	or 7.0 hrs/shift

The reactor was pulsed a total of 184 times with the following reactivities:

< \$2.00	12
\$2.00 to \$2.50	154
> \$2.50	18

The square wave mode of operation was used 38 times to power levels between 100 and 500 KW.

Total energy produced during this report period was 539 MWH with a consumption of 28 grams of U-235.

Unscheduled Shutdowns - Tech Specs requirement 6.6.1.b.

There were no unscheduled shutdowns during the the July 1, 2005 to June 30, 2006 period .

Major Maintenance With Safety Significance - Tech Specs requirement 6.6.1.c.

On May 31, 2006, during a fuel element and control rod inspection required by Tech Specs, operators were unable to remove a fuel element from the reactor core. The element appeared to bind just after the bottom third of the element entered the top grid plate. The element was returned to its core position and the remainder of the fuel elements and control rods were removed from the core. A detailed special procedure was developed and special tools were built to allow underwater removal of the top grid plate so the element could be retrieved using specially built fuel handling tools. The element was successfully removed and placed into storage. A borrowed underwater camera aided in the element removal and also allowed for close inspection of other reactor components. During this inspection on June 19, 2006, connection problems were noted where the shim and regulating control rods are fastened to their extension shafts; for the shim rod only one-half of six split pins were present and for the regulating rod only two halves of six split pins were present in two different holes. Following a safety evaluation and development of a special procedure, unique handling tools and fixtures were built and three sets of nuts, lock-washers and bolts were placed in the shim and regulating rods connections. Inspection of the safety rod found all three split pins present and intact. Inspection of the transient rod found three solid pins present and intact. A surveillance program was put into place to do periodic inspections of the control rod connections.

Major Changes Reportable Under 10 CFR 50.59 - Tech Specs requirement 6.6.1.d.

Facility Changes -

No major changes occurred during the fiscal year. A minor change was made for the replacement of the split pins with nut, washers and bolts in the shim and regulating control rod connections as discussed in the above section.

Procedures -

Procedures are normally reviewed biennially, and on an as needed basis. Numerous minor changes were made during the year and no attempt will be made to list them.

New Tests and Experiments -

None

Radioactive Effluents Released - Tech Specs requirement 6.6.1.e.

Liquid

There were no planned or unplanned liquid effluent releases under the reactor license for the report period.

Liquid radioactive waste from the radioisotope laboratories at the PSBR is under the University byproduct materials license and is transferred to the Radiation Protection 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

Gaseous effluent Ar-41 is released from dissolved air in the reactor pool water, air in dry irradiation tubes, air in neutron beam ports, and air leakage to and from the carbon-dioxide purged pneumatic sample transfer system.

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 Radiation Protection 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 409 mCi and 1240 mCi of Ar-41 is calculated for July 1, 2005 to June 30, 2006, resulting in an average concentration at ground level outside the reactor building that is 0.7 % to 2 % of the effluent concentration limit in Appendix B to 10 CFR 20.1001 - 20.2402. The concentration at ground level is estimated using only dilution by a 1 m/s wind into the lee of the 200 m² cross section of the reactor bay.

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 410 mCi. Since this production occurred in a stagnant volume of air confined by close fitting shield plugs, much 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; some of the Ar-41 releases from the tubes are part of rather than in addition to the release figures quoted in the previous paragraph. Even if all of the 410 mCi were treated as a

separate release, the percent of the Appendix B limit given in the previous paragraph would still be no more than 2.6 %.

Production and release of Ar-41 from reactor neutron beam ports was minimal. Beam port #7 has only three small collimation tubes (each 1 cm² area) exiting the port and any Ar-41 production in these small tubes is negligible. Beam port #4 has an aluminum cap installed inside the outer end of the beam tube to prevent air movement into or out of the tube as the beam port door is opened or closed. The estimated Ar-41 production in beam port #4 for all beam port operations is 23 mCi. With the aforementioned aluminum cap in place, it is assumed that this Ar-41 decayed in place. Radiation Protection Office air measurements have found no presence of Ar-41 during beam port #4 reactor operations with the beam port cap in place.

The use of the pneumatic transfer system was minimal during this period and any Ar-41 release would be insignificant since the system operates with CO-2 as the fill gas.

Tritium release from the reactor pool is another gaseous release. The evaporation rate of the reactor pool was checked previously by measuring the loss of water from a flat plastic dish floating in the pool. The dish had a surface area of 0.38 ft² and showed a loss of 139.7 grams of water over a 71.9 hour period giving a loss rate of 5.11 g ft⁻² hr⁻¹. Based on a pool area of about 395 ft² the annual evaporation rate would be 4680 gallons. This is of course dependent upon relative humidity, temperature of air and water, air movement, etc. For a pool ³H concentration of 31588 pCi/l (the average for July 1, 2005 to June 30, 2006) the tritium activity released from the ventilation system would be 560 μCi. A dilution factor of 2 x 10⁸ ml s⁻¹ was used to calculate the unrestricted area concentration. This is from 200 m² (cross-section of the building) times 1 m s⁻¹ (wind velocity). These are the values used in the safety analysis in the reactor license. A sample of air conditioner condensate a previous year showed no detectable ³H. Thus, there is probably very little ³H recycled into the pool by way of the air conditioner condensate and all evaporation can be assumed to be released.

³ H released	560 μC
Average concentration, unrestricted area	8.88 x 10 ⁻¹⁴ μCi/ml
Permissible concentration, unrestricted area	1 x 10 ⁻⁷ μCi/ml
Percentage of permissible concentration	8.88 x 10 ⁻⁵ %

Calculated effective dose, unrestricted area 4.44×10^{-5} mRem

Environmental Surveys - Tech Specs requirement 6.6.1.f.

The only environmental surveys performed were the routine TLD gamma-ray dose measurements at the facility fence line and at control points in two residential areas several miles away. This reporting year's gross measurements (in millirems) tabulated below represent the July 1, 2005 to June 30, 2006 period.

	<u>3rd Qtr '05</u>	<u>4th Qtr '05</u>	<u>1st Qtr '06</u>	<u>2nd Qtr '06</u>	<u>Total</u>
Fence North	22.6	26.7	28.0	28.3	105.6
Fence South	25.2	26.7	24.7	27.9	104.5
Fence East	22.6	27.3	27.0	30.1	107.0
Fence West	22.6	26.9	24.9	25.2	99.6
Control	17.5	22.3	18.9	15.7	74.4
Control	24.5	28.4	26.4	26.0	105.3

The net exposure at the facility fenceline due to licensed operations appears to be essentially zero for the '05-'06 fiscal year.