PENNSTATE

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RADIATION SCIENCE & ENGINEERING CENTER

Annual Operating Report, FY 12-13
PSBR Technical Specifications 6.6.1
License R-2, Docket No. 50-5

December 18, 2013

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

Dear Sir or Madame:

Enclosed please find the Annual Operating Report for the Penn State Breazeale Reactor (PSBR) at the Radiation Science and Engineering Center. This report covers the period from July 1, 2012 through June 30, 2013, as required by technical specifications requirement 6.6.1.

Sincerely yours,

Kenan Ünlü, Ph.D.
Director, Radiation Science
and Engineering Center

Enclosures:
Annual Operating Report, FY 12-13

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PENN STATE BREAZEALE REACTOR

Annual Operating Report, FY 12-13

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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 use 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 accounts for a significant portion of reactor usage, which involves Radionuclear Applications, Neutron Imaging, Neutron Beam Techniques, Detector development and testing, and multiple research programs by faculty and graduate students throughout the University.

SERVICE use provides vital techniques for industries in support of the national economy. Some examples include: radio-isotopes produced at the facility enable the critical petro-chemical industry to run at full capacity; the facility neutron beam laboratory serves an critical need in quality control of materials used to store the nation's spent nuclear fuel; and fast-neutron irradiation fixtures support the Nation's defense infrastructure and industry semiconductor production.

The PSBR facility operates on an 8 AM - 5 PM shift, five days a week, with early morning, evening, and weekend shifts to accommodate laboratory courses, public education and research or service projects as needed.

Summary of Reactor Operating Experience - Technical Specification 6.6.1.a.

Between July 1, 2012 and June 30, 2013, the PSBR was utilized while:

Mode of Operation	Time [hours]	Time / Shift [hours / shift]
Critical	1166	3.81
Sub-Critical	249	0.81
Shutdown	1024	3.35
Unavailable for Use	0	0
Total Usage	2438	7.97

The reactor was pulsed a total of 101 times with the following reactivities:

Reactivity	Number of Pulses
< $2.00	10
$2.00 to $2.50	81
> $2.50	0
Total	91

The square wave mode of operation was used 22 times to operate the reactor at power levels between 100 and 500 KW.

Total energy produced during this report period was 781 MWh with a consumption (and absorption) of 40.22 grams of U-235.

Unscheduled Shutdowns - Technical Specification 6.6.1.b.

During the reporting period, there were three unscheduled shutdowns resulting from reactor SCRAMs.

- On 11/7/12 a failure of the N16 diffusion pump resulted in area radiation levels above the reactor pool exceeding the setpoint (200 mR/hr) for building evacuation and initiating a scram. All systems functioned as designed. The reactor had been operating at 800 kW. The pump was replaced.
- On 2/4/13, during reactor startup (operating, not critical) a reactor scram on rod validation interlock occurred. The cause of the scram was failure of the manual rod pushbutton switch. The switch was replaced.
- 4/14/13, a high power reactor scram occurred when operators removed an irradiation sample from the core while operating at 1000 kW. The event was reportable (EN48938) and corrective action is documented in special report to the NRC dated 4/29/13.

Major Corrective or Preventative Maintenance with Safety Significance - Technical Specification 6.6.1.c.

Routine preventative maintenance required by Technical Specifications (TS) was completed within the TS required time frames. The following safety related maintenance actions affecting reactor control or safety equipment was also completed.

- 7/6/12 the Digital Control Computer power supply fans were replaced.
- 11/7/12 the ^{16}N diffuser pump was replaced following failure that resulted in a reactor scram.
- 2/4/13 the safety rod manual up pushbutton was replaced after failure resulted in a reactor scram on rod interlock validation.
- 4/20/13 the purification demineralizer area monitor was replaced as preventative maintenance, the existing monitor was obsolete.
- 6/6/13 the reactor safety system wide range drawer power supplies were replaced as preventative maintenance due to minor AC ripple.

Major Changes Reportable Under 10 CFR 50.59 - Technical Specification 6.6.1.d.

The changes made at the facility were minor and screened out of the 10 CFR 50.59 review process and are not required to be reported under 10 CFR 50.59.

Facility Changes of Interest

The following changes were completed during the 2012 to 2013 fiscal year:

- In July of 2012, a modification was completed to remove the abandoned-in-place liquid waste evaporator. The evaporator had been used to process water from the regenerative resin ion exchanger. Regeneration of resin is no longer performed.

- In June of 2013, the PSBR transitioned from core load 54 to core load 55. Four used 8.5wt% TRIGA fuel elements were moved from the front of the core to the rear and two more used 8.5 wt% TRIGA elements were also added to the rear of the core. The loading pattern is symetric and similar to past patterns. Analysis showed the core to be in compliance with technical specifications without approach to any limits. Pursuant to Technical Specification 2.2 the LSSS setpoint remains lowered by this modification to account for the instrumented element being in a position other than the maximum elemental power density. The table below compares key parameters for Core 55 and Core 55 at their most limiting positions.

Parameter	Initial Core 55	Initial Core 54
Total TRIGA Fuel Elements	102	100
12 wt%	37	37
8.5 wt%	65	63
Excess Reactivity (D2O Tank)	\$6.59	\$6.70
Power Defect at 1MW (R1)	\$3.26	\$3.72
Transient Rod Worth (R1)	\$3.04	\$3.01

Procedures

- In August of 2012, Operating procedures were modified to allow operation of the Reactor Building Heating Ventilation and Exhaust System (RBHVES) for operational testing. This allowance was continued to provide heat and air conditioning to the Reactor Bay pending approval of a license amendment to complete the modification and installation of the system (submitted February 2012).

Additionally, procedures are normally reviewed biennially, and on an as needed basis. Numerous minor changes and updates were made to maintain procedures during the year and do not require a report under 10 CFR 50.59.

New Tests and Experiments

- In April of 2013, the use of a thermal neutron shielded sample enclosure of in the central thimble and dry tubes was reviewed. The evaluation indicated the sample enclosure would not significantly alter core power distribution or introduce an unanalyzed condition and did not require a report per 10 CFR 50.59.

Radioactive Effluents Released - Technical Specification 6.6.1.e.

Liquid

There were no planned or unplanned liquid effluent releases under the reactor license for the reporting 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 per 10 CFR 20, and solidification for shipment to licensed disposal sites.

Gaseous

All gaseous releases were less than 20% of the allowed concentrations.

Argon-41 (^{41}Ar)

Gaseous effluent ^{41}Ar is generated 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 ^{41}Ar released from the reactor pool is 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 ^{41}Ar 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.

For a conservative calculation of the ^{41}Ar release, all power operations were assumed to take place at the location of greatest ^{41}Ar generation and release (Fast Neutron Irradiator (FNI) tube). The calculation method includes direct release from the pool as well as release from the FNI fixture and estimates a production of 3172 mCi for 781 MWh of operation in 2012-2013. Some of this ^{41}Ar will decay in place, but if released amount is similar to the measured maximums, then the ^{41}Ar released represents less than 6% of the release limit.

Tritium (^{3}H)

Tritium is released by evaporation of reactor pool water as a gaseous release. The total makeup to the reactor pool in 2012-2013 was approximately 11,000 gallons. The evaporative loss rate is dependent on relative humidity, temperature of air and water, air movement, etc.

For a pool tritium concentration of 32,165 pCi/l (average for July, 2012 to June, 2013) the Tritium activity released from the ventilation system would be ~1,340 μCi. A dilution factor of 2 x 10^8 ml /sec was used to calculate the unrestricted area concentration. This is from 200 m^2 (cross-section of the building) times 1 m/sec (wind velocity). These are the values used for the safety analysis in the reactor license.

Parameter	*Value*	*Units*
Tritium released	1340	micro curies
Average concentration, unrestricted area	~2.4x10-13	µCi/ml
Permissible concentration, unrestricted area	~1.2x10-7	µCi/ml
Percentage of permissible concentration	~0.00024	%
Calculated effective dose, unrestricted area	~1x10-4	mRem

Environmental Surveys - Technical Specification 6.6.1.f.

The only environmental surveys performed were the routine environmental dosimeters measurements at the facility fence line and two off-site control points (one in a residential area several miles away). The net measurements (in millirems) tabulated below represent the July 1, 2012 to June 30, 2013 reporting period.

Location	*3rd Qtr '12*	*4th Qtr '12*	*1st Qtr '13*	*2nd Qtr '13*	*Total*
Fence North	3	4	3	4	14
Fence South	3	4	3	4	14
Fence East	3	3	3	5	14
Fence West	4	3	3	6	16
Pleasant Gap	0	0	0	0	0
Child Care UP	0	0	0	0	0

The exposure measured at the facility fence-line are well within historical norms, while the off-site dosimetry is uncharacteristically zero for the year. No meaningful conclusion can be drawn from the data other the exposure to the public due to licensed operations remains well within the limits for the current fiscal year.