



KENAN ÜNLÜ, Ph.D.
Director, Radiation Science and Engineering Center
Professor, Department of Mechanical and Nuclear Engineering
The Pennsylvania State University
University Park, PA 16802-2304

Phone: (814) 865-6351
Fax: (814) 863-4840
E-mail: k-unlu@psu.edu



Annual Operating Report, FY 13-14
PSBR Technical Specifications 6.6.1
License R-2, Docket No. 50-5

December 5, 2014

Attention: Document Control Desk
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555-0001

Dear Sir or Madame:

Enclosed please find the Annual Operating Report for the Penn State Breazeale Reactor (PSBR) located at the Radiation Science and Engineering Center. This report covers the period from July 1, 2013 through June 30, 2014, as required by our Facility Operating License R-2 Appendix A Section 6.6.1.

If you have any questions, please contact Mark Trump, Associate Director for Operations (814-865-6351).

Sincerely yours,

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

Enclosures:
Annual Operating Report, FY 13-14

cc: N.A. Sharkey
A. Elnashai
A.A. Atchley
J.S. Brenizer
J.A. Leavey
X. Yin – NRC
O. Font – NRC
D. Morrell- DOE

A020
NRR

PENN STATE BREAZEALE REACTOR

Annual Operating Report, FY 13-14

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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 or attend educational sessions at the PSBR facility each year.

RESEARCH accounts for a significant portion of reactor usage and involves Radionuclear Applications, Neutron Imaging, Neutron Beam Techniques, Detector development and testing, and multiple research programs by faculty and graduate students throughout the University. The facility also supports research activities for universities without a research reactor.

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 a 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.

PSBR utilization for the period July 1, 2013 through June 30, 2014 was:

Mode of Operation	Time [hours]	Time / Shift [hours / shift]
Critical	911	3.14
Sub-Critical	299	1.03
Shutdown	1212	4.179
Unavailable for Use	0	0
Total Usage	2421	8.3504

The reactor was pulsed a total of 178 times with the following reactivities:

Reactivity	Number of Pulses
< \$2.00	9
\$2.00 to \$2.50	161
> \$2.50	8
Total	178

The square wave mode of operation was used 53 times to operate the reactor at power levels between 100 and 500 KW.

Total energy produced during this report period was 574.33 MWh with a consumption of about 29.6 grams of U-235.

Unscheduled Shutdowns - Technical Specification 6.6.1.b.

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

- On 4/29/14, a building fire alarm actuated due to smoke originating from a building heating condensate pump in Co-60 basement. The Reactor was secured and all personnel evacuated without incident. The pump motor was replaced. See internal event report AP-4 2014-03
- On 5/9/14, a Reactor SCRAM and building evacuation resulted from a spurious High Radiation signal from the West Bay Rad Monitor. The signal occurred simultaneously with a pulse for a small group tour. Upon investigation it was shown that the West Bay Monitor failed high and did not alarm due to actual high radiation condition. The failure mode was indeterminate and monitor was replaced with a spare. See internal event report AP-4 2014-05 and AP-13 Troubleshooting (2014-11)

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.

- On 5/27/14, The Transient Rod Up, Down, and Rod Bottomed switches were replaced with a more reliable design and mounting. The change was made to correct an existing issue which often resulted in improper indication to the operator. The minor change was completed consistent with 10 CFR 50.59 (See AP-12 2014-005). The change does not alter the operability of the safety system in any way.

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

All 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 of interest were completed during the 2013 to 2014 fiscal year:

- In August of 2013, a modification to the building evacuation circuit was completed to ensure that the Reactor Bay Heating Ventilation and Exhaust System (RBHVES) would be automatically isolated in the event of an evacuation. The modification does not impact the operation of the circuit, was completed under 50.19, and is described in the license amendment request submitted in February 2012.
- In May of 2014, a noble gas head calibrated for ^{41}Ar was placed in service in the reactor bay. The monitor has no control functions.

- In May of 2014, the PSBR transitioned from core load 55 to core load 55a during the biennial fuel inspection maintenance shutdown. The change was minor and only entailed swapping the position of two 12wt% elements within the core. All other maintenance and testing was completed and the reactor was returned to service on May 23rd. The loading pattern was symmetric 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 55a. (See AP-12 2014-04 Core 55a)

Parameter	Initial Core 55a	Initial Core 55
Total TRIGA Fuel Elements	102	102
12 wt%	37	37
8.5 wt%	65	65
Excess Reactivity (R1)	\$5.41 (6/9/14)	\$5.84 (6/7/13)
Power Defect at 1MW (at R1)	\$3.32	\$3.26
Transient Rod Worth (at R1)	\$3.03	\$3.04

Procedures

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

There were no substantially new tests or experiments implemented in the current reporting period

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 (⁴¹Ar)

Gaseous effluent ⁴¹Ar 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 ⁴¹Ar 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 ⁴¹Ar 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 ⁴¹Ar release, all power operations were assumed to take place at the location of greatest ⁴¹Ar 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 2333 mCi for 574 MWh of operation during 2013-2014 fiscal year. Some of this ⁴¹Ar will decay in place, but if all the ⁴¹Ar were released it represents less than 5% of the release limit.

Tritium (³H)

Tritium is released by evaporation of reactor pool water as a gaseous release. The total makeup to the reactor pool in 2013-2014 was approximately 12,140 gallons or ~ 1.4 gallons per hour. The evaporative loss rate is dependent on relative humidity, temperature of air and water, air movement, etc.

For a pool tritium concentration of ~34,000 pCi/l (average for July 1, 2013 to June 30, 2014), the Tritium activity released from the ventilation system would be ~1,700 µCi. A dilution factor of 2×10^8 ml/sec was used to calculate the unrestricted area concentration. This dilution is calculated from the cross-section of the building (200 m^2) times wind velocity (1 m/sec). These are the same values used in the reactor safety analysis report for the reactor license.

<i>Parameter</i>	<i>Value</i>	<i>Units</i>
Tritium released	~1700	micro curies
Average concentration, unrestricted area	<3x10 ⁻¹³	μCi/ml
Permissible concentration, unrestricted area	1x10 ⁻⁷	μCi/ml
Percentage of permissible concentration	<0.0003	%
Calculated effective dose, unrestricted area	<2x10 ⁻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 residential area several miles away). The net measurements (in millirems) tabulated below represent the July 1, 2013 to June 30, 2014 reporting period.

<u>Location</u>	<u>3rd Qtr '13</u>	<u>4th Qtr '13</u>	<u>1st Qtr '14</u>	<u>2nd Qtr '14</u>	<u>Total</u>
Fence North	0	5	4	2	11
Fence South	2	4	3	2	11
Fence East	1	4	2	0	7
Fence West	2	3	4	2	11
Pleasant Gap	0	0	NA	0	0
Child Care UP	0	0	1	0	1

The exposures measured at all points on the facility fence-line were well within historical norms. Licensed operations remain well within the limits for the current fiscal year.