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65 1955–2020 BREAZEALE Nuclear Reactor

US NRC
Document Control Desk
Washington, DC 20555-0001

RE: EMERGENCY PREPAREDNESS PLAN REVISION, PSU BREAZEALE REACTOR (LICENSE R-2, DOCKET 50-005)

23 April 2021

To Whom It May Concern:

A revision to the PSU Breazeale Reactor Emergency Preparedness Plan is hereby submitted. The changes were made following the guidance of ANSI/ANS-15.16-2015, Emergency Planning for Research Reactors, and NUREG-0849, Standard Review Plan for the Review and Evaluation of Emergency Plans for Research and Test Reactors. These changes have been evaluated by facility management and have been determined not to decrease the effectiveness of the Emergency Preparedness Plan and are therefore to be implemented effective April 30, 2021 without prior NRC approval in accordance with 10CFR50.54(q). The revision was necessary in order to update the organization names, building layout, administrator titles, and other changes that have taken place since the last revision to the EPP in 2000. Other minor changes included updates to the conduct of the emergency action drills and decontamination procedures. A full list of changes and a copy of the revised Plan are attached.

Please contact Jeffrey A. Geuther, Associate Director for Operations, at (814) 863-2745 with any questions you may have about this revision.

Sincerely,

J A Geuther

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Attachments: Table of changes to PSU Breazeale Reactor Emergency Preparedness Plan, Rev. 5
PSU Breazeale Reactor Emergency Preparedness Plan, Rev. 5

cc: Lora Weiss, Senior Vice President for Research
Justin Schwartz, Dean, College of Engineering
Anthony Atchley, Associate Dean, College of Engineering
Laura Pauley, Chairperson, Reactor Safeguards Committee
Yuanqing Guo, Radiation Safety Officer
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AX45
AD20
NRR

Table of Changes to PSU Breazeale Reactor Emergency Preparedness Plan, Rev. 5 (2021)

Change	Section	Description
1	1.1, 2.6	Updated reference version of ANSI/ANS 15.16 to reflect the most current guidance and corrected the pertinent section of AEA Section 104 from (b) to (c) .
2	1.2	Included a reference to 50.54(x) guidance to clarify that deviations from the license conditions or technical specifications are allowable when immediately necessary to protect the health and safety of the public.
3	throughout	Minor grammatical / editorial updates
4	1.3	Updated title of Level 1 management in license.
5	Fig 1.2	Updated reactor site figure to include planned changes to building footprint and outbuilding locations.
6	1.3	Updated description of neutron beam lab, which has been modified since the last EPP revision.
7	1.3	Updated description of the Co-60 irradiation facilities
8	3.1	Updated names of organizations in the Emergency Organization section.
9	Fig 3.1	Updated Emergency Organization chart.
10	3.1.1	Changed chain of succession for Emergency Director to start with either Director or Associate Director for Operations instead of Director of PSBR or designee. Functionally this changes nothing, but it is clearer since the ADO would always be the first choice for "designee" as the alternative Level 2 management in the license.
11	3.1.3, 3.1.13, 7.1	Updated office title of University News and Media Relations.
12	4.1.2, 5.1.3	Changed initiating event for Unusual Event from "Report or observation of tornado or hurricane winds that could damage the facility" to "a severe natural phenomenon affecting the reactor site." This description is more general and captures the intent of the original wording but also includes other potentially damaging weather-related events. It is the wording in the most up-to-date version of ANSI/ANS 15.16.
13	4.2.2	Revised threshold for Alert due to radiological effluent at site boundary to be consistent with the wording of the most recent version of ANSI/ANS 15.16.
14	4.2.5	Clarified that "reactor safety system(s)" should include reactor support systems in the reactor bay, pump room, and beam lab.
15	4.2.6	Changed "missiles" to "missiles or aircraft" impacting on reactor facility.
16	5.2.6	Included fires threatening the hot cells or Co-60 facility in Alert criteria.

17	7.1	Added FBI as an outside agency that should be notified depending on the type of emergency.
18	7.4	Clarified that the Emergency Procedures provide for personnel accountability, assessment, and isolating potentially contaminated personnel or areas of the facility.
19	8.1	Added an alternate location for the Emergency Support Center.
20	8.2.1	Removed specification that remote readouts are available on Local Area Network monitors. In the future, remote readouts will still be available, but may access information via alternative methods than LAN.
21	8.3	Updated decontamination guidance to refer to EP6: Medical Emergencies and the use of soap and water as opposed to a decontamination kit.
22	10.2	Changed guidance for the emergency "action" drill to indicate that response from Radiation Protection and University Police will be included if these organizations are available. In the case of the Police in particular, sometimes a heavy workload may preclude the possibility of participating the in the reactor emergency drill.
23	10.2	Included University Health Services as a possible biennial drill participant.

PENN STATE BREAZEALE REACTOR (PSBR)
EMERGENCY PREPAREDNESS PLAN

Docket No: 50-005

NRC License: R-2

THE PENNSYLVANIA STATE UNIVERSITY
UNIVERSITY PARK, PA 16802

APRIL 23, 2021

REVISION 5

PSBR EMERGENCY PREPAREDNESS PLAN
OUTLINE

PSBR EMERGENCY PREPAREDNESS PLAN
OUTLINE (Continued)

PSBR EMERGENCY PREPAREDNESS PLAN

1.0 INTRODUCTION

1.1 Application

This emergency plan applies to The Pennsylvania State University Breazeale Nuclear Reactor (PSBR) facility. The PSBR is licensed pursuant to Title 10 Code of Federal Regulations, Chapter 10, Part 50.21(b)(1), as a research and utilization reactor (Class 104 licensed pursuit to AEA section 104(c), Facility Operating License No. R-2 (Docket No. 50-5).

The emergency plan follows the guidance in ANSI/ANS 15.16-2015 "Emergency Planning for Research Reactors" which is endorsed by Revision 1 to Regulatory Guide 2.6; it is consistent with NUREG-0849 "Standard Review Plan for the Review and Evaluation of Emergency Plans for Research and Test Reactors" as well as 10 CFR 50, Appendix E, "Emergency Planning and Preparedness for Production and Utilization Facilities."

1.2 Objective

The objective of this emergency plan is to establish guidelines and designate areas of responsibility for the PSBR staff should an accident or incident occur at the PSBR that may affect the public health and safety. Emergency personnel may deviate from actions described in the plan for unusual or unanticipated conditions. Deviations to license conditions or technical specifications are authorized by code of Federal Regulations , Title 10, "Energy," Part 50, "Domestic Licensing of Production and Utilization Facilities," Sec. 54, "Conditions of Licenses," Paragraph x (10CFR50.54(x)), if immediately needed to protect the public health and safety when equivalent protection within these documents is not apparent. Additionally, the plan identifies the off-site support organizations that may be activated if required.

1.3 The PSBR and Site Description

The PSBR is a 1 megawatt Mark III TRIGA Reactor located on the campus of the Pennsylvania State University, University Park in the town of State College, Pennsylvania. Management of the facility is the responsibility of the Director, Radiation Science & Engineering Center. The Director reports to the Senior Vice President for Research through the office of the Dean of the College of Engineering. The facility is used to support research activities at Penn State, provide equipment for performing nuclear engineering laboratories, train nuclear reactor operators, educate students of all levels and the public on nuclear engineering topics and provide radiation services to the University, the State, and the Nation. Figure 1.1 shows the location of The Pennsylvania State University and the reactor location within the University. Figure 1.2 shows a detailed view of the reactor and surrounding buildings.

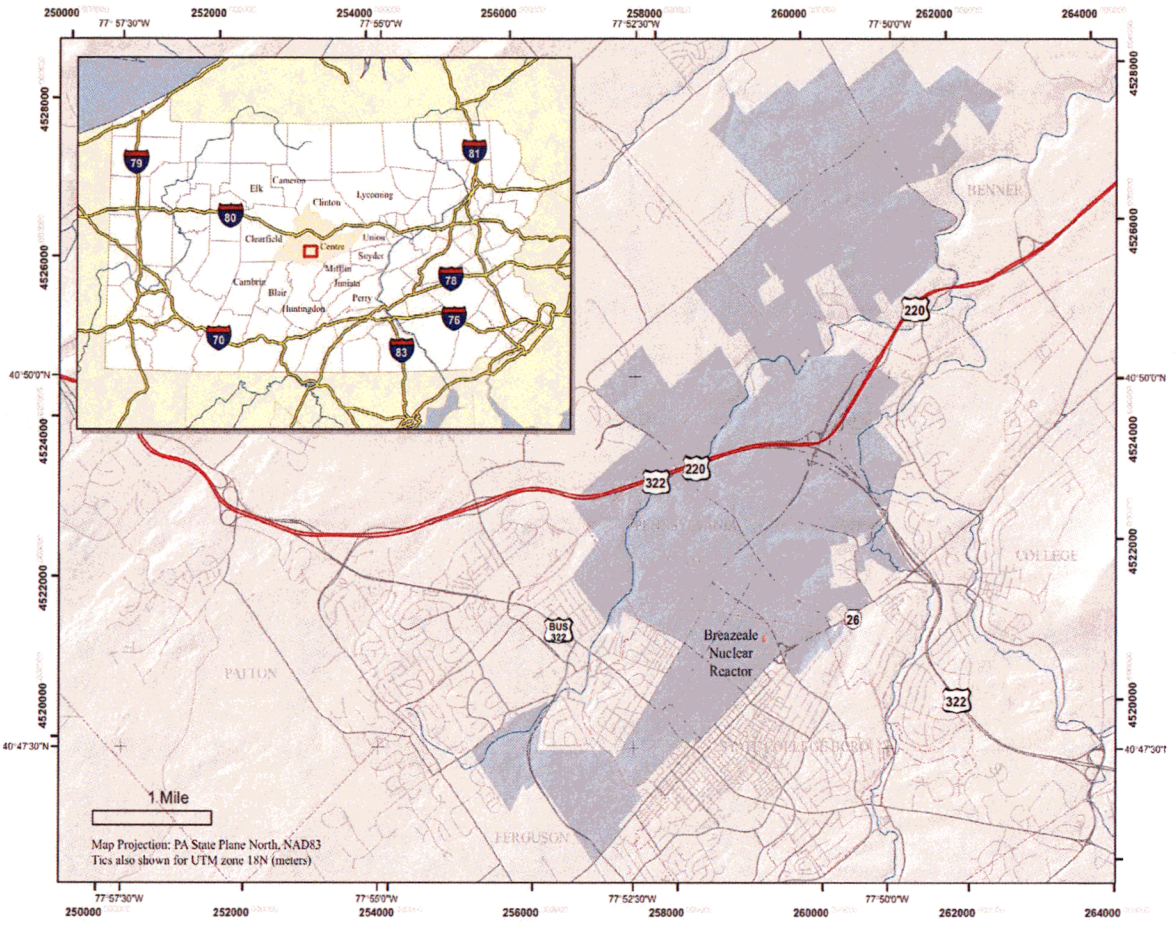

Figure 1-1: PSBR Site Location 1

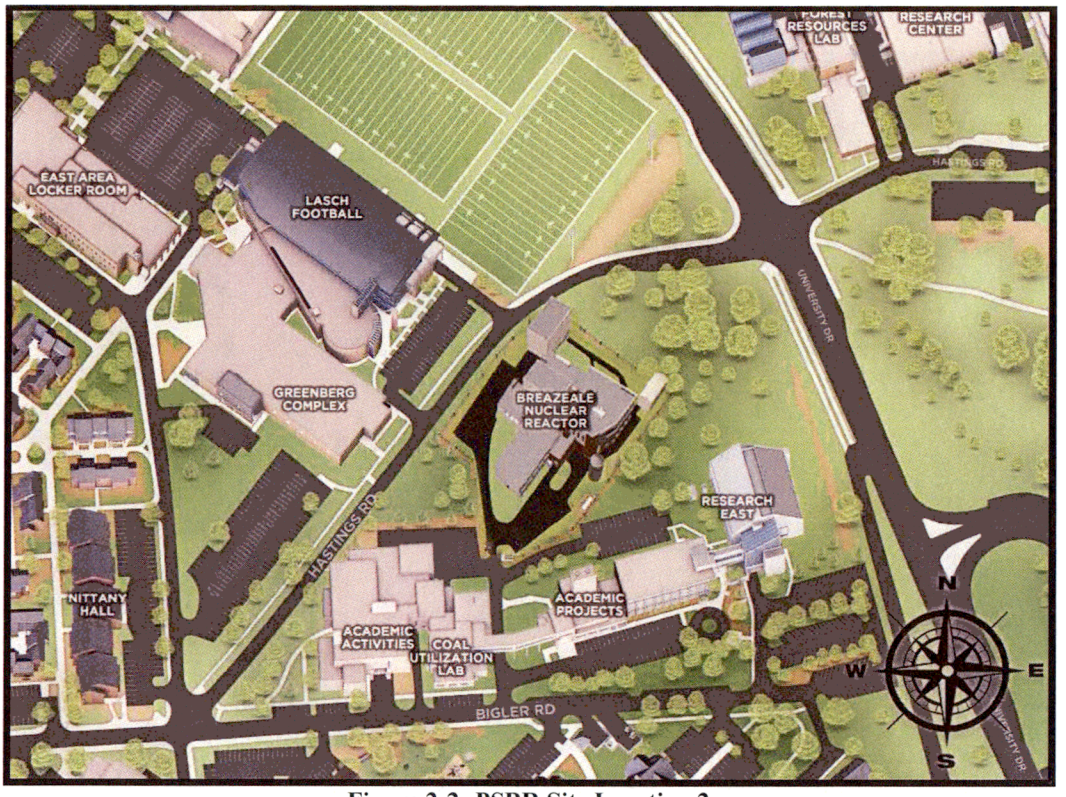

Figure 2-2: PSBR Site Location 2

In addition to the TRIGA Mark III reactor, the PSBR laboratory complex contains the Cobalt-60 (Co-60) irradiation facility, neutron beam laboratory, two hot cells, radiochemistry laboratories, supporting radiation sources, radiation detectors, and counting equipment.

The TRIGA reactor is a light-water cooled and reflected pool type reactor capable of both pulsing and steady state operations. The reactor is operated in a water filled pool, with the centerline of the reactor located about 20 feet beneath the surface of the water. The reactor can be rotated, moved north-south, and moved east-west within the reactor pool for flexibility of operation.

The reactor core has a basic shape of a right hexagonal prism containing approximately six fuel elements per side. The fuel/moderator elements are made up of a fuel region approximately 1.47 inches in diameter and 15 inches long, consisting of a zirconium hydride moderator homogeneously combined with 20 percent enriched uranium fuel.

The reactor is capable of 1000 kW (thermal) operation with natural convection cooling and can be pulsed repetitively and reproducibly at approximately 15 minute intervals to yield a burst having a prompt energy release of up to 24 MW-seconds and a peak power of 2000 MW. Further details regarding the facility are described in the Safety Analysis Report.

The neutron beam laboratory (NBL) has access to ports or openings in the reactor pool wall for beam experiments. Five beam ports, including a cold neutron source, are used to provide collimated neutron beams to the NBL for a variety of experiments. Typical uses of the neutron beams include neutron scattering experiments, attenuation studies, neutron imaging facility and student spectrometer.

The Co-60 irradiation facility is currently licensed by the State for up to 25,000 curies of ^{60}Co in rod form submerged in a 16,000 gallon pool of water. Radioactive ^{60}Co has a 5.2 year half-life and emits two gamma rays with energies of 1.17 MeV and 1.33 MeV. For this reason, the total curie source available in ^{60}Co rod form in this pool varies from year to year due to the ^{60}Co half-life, and the replacement or addition of the present ^{60}Co with new ^{60}Co rods. In addition to the pool irradiation tubes, the facility houses a self-contained dry cell lead-shielded irradiator. The irradiator is about four feet in diameter and five feet in height. This irradiator has an automatic timer to move the sample chamber away from the source and the ability to more easily conduct in-situ testing of components during irradiation.

Two identical, well-equipped hot cells at the PSBR are available for the safe handling of radioactive materials. Each hot cell is a concrete structure, with dimensions of 7.5 ft. x 5 ft. x 13 ft. high, and each is capable of handling 100 curies of 1 MeV gamma emitters. Direct viewing of experiments through lead glass windows, two remote manipulators in each cell, air cleaning equipment, utilities, and special control of waste are additional features of the cells.

The PSBR facility is equipped for maintenance support, radiation handling, and radiation monitoring. A machine shop and electronic shop are provided for maintenance support. Radiation monitoring and detection equipment is accessible throughout the facility. Ventilation hoods are located in labs which require radiation handling.

2.0 DEFINITION

2.1 Reactor Site Boundary

The reactor site boundary is that boundary defined by the fence surrounding the PSBR as shown in Figure 1-2. The Director has direct authority over all activities within this boundary. Entrance to the boundary is through the vehicle or pedestrian entry gate, which can be locked or used as a control point into the area as deemed necessary.

2.2 University Site Boundary

The area defined by University Park is the University site boundary of the Pennsylvania State University. University Park is located within Centre County and encompasses parts of six different municipalities. The reactor is located within the central campus area of the University. According to the Judicial Code Amendments of 1996, University Police have jurisdiction on and adjacent to all University property.

2.3 Reactor Bay

The reactor bay is the structure enclosing the reactor pool, control room, and the region over the hot cells adjacent to the reactor pool.

2.4 Operations Boundary

The operations boundary is the entire reactor building which incorporates the reactor bay, Co-60 facility, hot cells, NBL, and all rooms and laboratories housed therein.

2.5 The Emergency Support Center (ESC)

The Emergency Support Center (ESC) is a located within the Academic Projects Building (APB) (see Figure 1-2). The Emergency Director can use this room as the operations center during an emergency and as the assembly area for reactor personnel during this time. It also contains additional emergency supplies and equipment for use during an emergency.

2.6 State College

State College is the local community adjacent to University Park. The community has its own police force, volunteer fire department, and hospital. The hospital and fire department provide services for a large area surrounding State College, including University Park. The police force provides services to University Park when requested.

2.7 Others

All other definitions, i.e., emergency, emergency action levels, emergency classes, emergency planning zone (EPZ), emergency procedures, off-site, on-site, protection action guides (PAG), research reactor, shall, should, and may are as defined in ANSI/ANS 15.16-2015 "Emergency Planning for Research Reactors."

3.0 ORGANIZATION AND RESPONSIBILITIES

3.1 Emergency Organization

The PSBR's Emergency Organization (shown in Figure 3-1) is designed for emergency response, recovery and maintaining emergency preparedness. The emergency organization consists of the Reactor Staff; Environmental Health and Safety; Office of Radiation Protection; University Health Services; University News and Media Relations; University Police; State College Police Department; Pennsylvania State Police; Alpha Fire Company of State College; Centre LifeLink EMS; and Mount Nittany Medical Center. The latter organizations provide offsite support.

If Penn State University's Emergency Management is needed they will come to the scene and assess the need to open the Emergency Operations Center and call for additional resources and make a declaration if needed.

Written agreements between the PSBR and the Alpha Fire Company of State College and the Mount Nittany Medical Center are updated as required by PSBR procedures. The University Police have a mutual aid agreement with the State College Police Department. The Pennsylvania State University in its association with the Commonwealth of Pennsylvania may utilize the Pennsylvania State Police to provide emergency assistance as required. All groups responding to the emergency have the ability to operate around the clock during an emergency.

PSBR Emergency Organization (EPP)

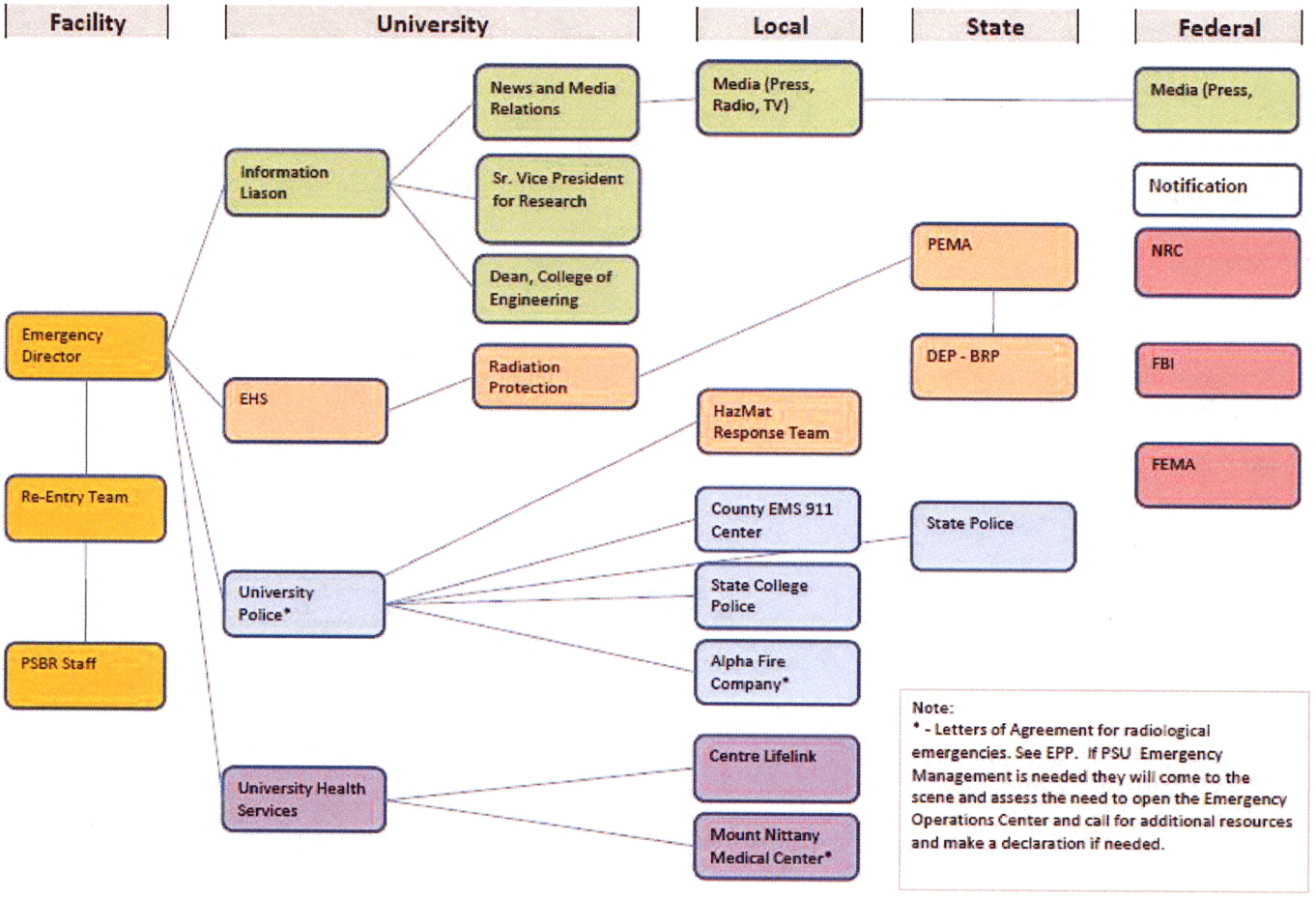

Figure 3.1

3.1.1 Emergency Director

The Emergency Director has ultimate authority over on-site activities and personnel. He/she is responsible for placing the facility in a safe shutdown condition, minimizing releases of radioactive materials, protecting facility personnel and visitors, and for assessing the severity of an emergency event. To fulfill these responsibilities, the Emergency Director shall exercise judgment, and summon medical, ambulance, fire and police assistance as necessary. The Director or Associate Director for Operations (Level 2) shall be the Emergency Director. If neither the Director or ADO is available, a PSBR administrative procedure designates those who may act in his/her place.

3.1.2 Environmental Health and Safety, Radiation Protection Office

The Department of Environmental Health and Safety, Radiation Protection Office is responsible for the radiological assessments both on and off the reactor site and will make recommendations for protective actions. The Radiation Safety Officer (RSO) or designee is responsible for the radiological assessments. He/she will assist the Emergency Director in evaluating emergency conditions. When the RSO is not available, a member of the Radiation Protection staff will assume his/her duties; otherwise, a member of the reactor staff will perform these duties.

3.1.3 The Information Liaison

The Information Liaison is responsible for relating information about the emergency through the University News and Media Relations Office of Strategic Communications to the news media. He/she is also responsible for reporting the event to the offices of the Dean of Engineering and the Vice President for Research and for liaison with them. The Information Liaison is designated by PSBR procedure. If the Information Liaison is not available, the Emergency Director will be responsible for directing the performance of these duties.

3.1.4 Communications Center

The University Police maintain a communications center that is staffed 24 hours every day. During times when the PSBR is unattended, if an emergency condition develops the communications center contacts the appropriate PSBR staff, the Radiation Protection Office staff, the ambulance service, the fire department, and additional Police as required.

3.1.5 University Police

University Police is the primary response force for the PSBR and will be called to provide facility security assistance, ambulance service,

emergency radio communications, traffic control, and riot control as necessary. The University Police maintain a force of armed certified police officers. University Police operate with the same authority as any municipal police department. These police officers undergo specialized training and participate in an ongoing in-service training program. Secondary response forces would be the State College Police Department and the Pennsylvania State Police.

3.1.6 The Alpha Fire Company

The Alpha Fire Company of State College serves as the primary fire-fighting agency.

3.1.7 University Health Services

The University Health Services-Emergency Medical Services provide ambulance service and emergency medical assistance for the PSBR as needed.

3.1.8 Centre LifeLink EMS

Centre Lifelink Emergency Medical Services provides backup ambulance service and emergency medical assistance as needed.

3.1.9 Mount Nittany Medical Center

The Mount Nittany Medical Center provides medical facilities and care for radiation accident victims who require medical treatment. University personnel from the PSBR and/or the Radiation Protection Office will provide assistance to the Mount Nittany Medical Center staff in radiation monitoring and decontamination. Additional radiation detection equipment will be loaned to the Mount Nittany Medical Center if necessary.

3.1.10 State College Police Department

The State College Police will provide assistance when requested by University Police. Under the incident command system and mutual aid agreement, any assisting police agencies would be subordinate to University Police.

3.1.11 Pennsylvania State Police

The Pennsylvania State Police will provide assistance when requested by University Police. Under the incident command system and mutual aid agreement, any assisting police agencies would be subordinate to University Police.

3.1.12 Emergency Coordinator

The Director of the PSBR shall designate an Emergency Coordinator. The Emergency Coordinator is responsible for reviewing and updating the emergency plan and its implementing procedures. The Emergency Coordinator is also responsible for conducting emergency training, tests, and drills.

3.1.13 University News and Media Relations

The University News and Media Relations office prepares news and information releases concerning emergency conditions or situations of public interest at the PSBR.

3.2 Notification

All emergency communications and notifications are initiated by personnel on duty, activated alarms, or University Police during required patrolling of the area. The postulated credible accidents associated with the operation of the PSBR will not result in a radiological hazard affecting the public health and safety. These emergency events will not require the direct involvement of State and Federal agencies; they will require notification of appropriate on-site and off-site organizations.

Notification of an incident to the U.S. Nuclear Regulatory Commission (NRC) shall be in accordance with the requirements of the reactor license (R-2) and applicable sections of Chapter 10 of the Code of Federal Regulations. PEMA shall also be notified for both emergency classes defined in Sections 4.1 and 4.2. Special forms in the emergency procedures identify the telephone numbers of appropriate offices to contact in the event of an emergency. An emergency notification checklist is available to the Emergency Director to ensure all appropriate organizations are notified.

3.3 Termination of an Emergency

The Emergency Director is responsible for the termination of an emergency. Prior to termination of an emergency the Emergency Director shall:

3.3.1 Determine that there exists no foreseeable subsequent events that could cause damage to the reactor or render its operation unsafe.

3.3.2 Verify that all areas to be reopened to facility personnel or the general public meet the requirements of 10 CFR 20 for occupancy.

3.3.3 Confirm that areas restricted to entry or requiring controlled access are clearly posted.

3.4 Reentry

Authorization and methods for reentry are provided by the PSBR Emergency Procedures.

3.5 Authorization of Radiation Exposures in Excess of 10 CFR 20 Limits

The Emergency Director may authorize exposures to emergency team members and radiation workers in excess of normal occupational limits. The exposure limits are for corrective actions that mitigate the consequences or reduce the severity of the emergency event. Exposures above the limits for a restricted area given in 10 CFR 20 are to be on a voluntary basis without penalty for refusal and restricted to those persons with sufficient knowledge and experience of reactor operations and biological effects of radiation to understand the risks involved.

4.0 EMERGENCY CLASSIFICATION SYSTEMS

The severity of an accident determines the class of the emergency into which it falls and the subsequent actions to be taken. The PSBR is situated on high ground where natural water levels cannot affect the operability of any reactor safety systems. In addition, University Park is located in an area where earthquakes of sufficient intensity to cause observable damage to the reactor safety equipment are highly improbable.[1]
A review of the possible emergency events that can occur shows that they can be classified in two emergency classes:

4.1 Unusual Event

An Unusual Event may be initiated by either man-made events or natural phenomena that can be recognized as creating a significant hazard potential that was previously nonexistent. There will be time available to take precautionary and corrective steps to prevent the escalation of the accident or to mitigate the consequences should it occur. No release of radioactive material requiring off-site responses (outside of the reactor site boundary) is expected.

Although the situation may not have caused damage to the reactor, it may warrant an immediate shutdown of the reactor or an interruption of non-essential routine functions. The accidents or events, which fall into this classification, are as follows:

4.1.1 Actual or projected radiological effluents at the site boundary which are calculated or measured to result in either of the following conditions, both of which are based on an exposure of 24 hours or less:

4.1.1.1 A deep dose equivalent of 15 mrems, or
4.1.1.2 A committed effective dose equivalent of 15 mrems based on the following considerations:

100 EC* x 24 hours = 2,400 EC-hours = 15 mrems (for radionuclides other than noble gases)

50 EC* x 24 hours = 1,200 EC-hours = 15 mrems (for noble gases)

*EC is the effluent concentration listed in 10CFR20, Appendix B, Table 2.

4.1.2 Report or observation of a severe natural phenomenon affecting the reactor site.

4.1.3 Threats to or breaches of security as follows:

4.1.3.1 Bomb threat
4.1.3.2 Threat of theft of special nuclear material
4.1.3.3 Theft of special nuclear material
4.1.3.4 Non-accidental unauthorized intrusion
4.1.3.5 Civil disorder

4.1.4 Fuel damage accident that could release radionuclides from the fuel elements to the reactor bay (confinement).

4.1.5 Fire within certain areas of the facility lasting more than 15 minutes.

4.2 Alert

Alerts are events of such radiological significance as to require notification of the emergency organization and responses appropriate for the specific emergency situation. Under this class, it is unlikely that emergency response efforts, such as radiation monitoring, will need to be conducted beyond the reactor site boundary. Substantial modification of reactor operating status is a highly probable corrective action. Precautionary evacuations or isolation of certain areas within the operations boundary or within the reactor site boundary may be necessary. Situations, which lead to this class, are as follows:

4.2.1 Actual or projected radiological effluents at the site boundary which are calculated or measured to result in either of the following conditions, both of which are based on an exposure of 24 hours or less:

4.2.1.1 A deep dose equivalent of 75 mrems, or
4.2.1.2 A committed effective dose equivalent of 75 mrems based on the following considerations:

500 EC* x 24 hours = 12,000 EC-hours = 75 mrems (for radionuclides other than noble gases)

250 EC* x 24 hours = 6,000 EC-hours = 75 mrems (for noble gases)

*EC is the effluent concentration listed in 10CFR20, Appendix B, Table 2.

4.2.2 Actual or projected radiological effluent at the site boundary of 0.2 mSv/hour deep dose equivalent (20 mrem/hour) for 1 hour or1.0 mSv (100 mrem) to the thyroid (committed dose equivalent)

4.2.4 Abnormal continuous loss of reactor pool water at a rate that exceeds the combined makeup water capacity of all available refill systems. (Maximum of approximately 475 gpm, if all systems available) A pool water level drop of 1 cm per minute is equivalent to 100 gpm

4.2.5 Fire that may affect any reactor safety system(s) including the reactor support systems in the reactor bay, the pump room, and the NBL

4.2.6 Other imminent or existing hazards such as:

4.2.6.1 Missiles or aircraft impacting on the reactor facility
4.2.6.2 Explosions that affect reactor operation
4.2.6.3 Uncontrolled release of toxic or flammable gases in quantities that pose a threat to the reactor safety systems or personnel

4.2.7 Imminent loss of physical control of the reactor.

4.2.8 Tornado or hurricane winds that are damaging the reactor building.

5.0 EMERGENCY ACTION LEVELS

The emergency preparedness plan shall be activated if the event is determined to be either an Unusual Event or an Alert. The following guidelines will be used to determine whether an event is to be considered an emergency and the emergency class to which it should be assigned Depending on the nature of the situation, an Unusual Event may escalate into an Alert.

5.1 Unusual Event

The following emergency action levels are defined as an Unusual Event. These action levels correspond to the definitions in section 4.1.

5.1.1 Release of particulate beta emitting radionuclides is to be considered an Unusual Event, if the actual or projected radiological effluents at the site boundary are calculated or measured to result in the conditions listed in 4.1.1. Table 5-1[2] shows the activity for a release of several beta emitters that would each result in an airborne activity concentration 100 times the effluent concentration limit. Table 5-1 also shows the approximate time for the continuous air monitor in the reactor bay to alarm after the start of a continuous 24-hour release of that activity. Such a release would

produce an off-scale (high) reading on the air monitor in the reactor bay before the end of the 24-hour release period.

Releases of much less activity than that required to result in an airborne concentration 100 times the effluent concentration limit at the reactor site boundary would also cause an air monitor alarm. An alarm of an air monitor in the reactor bay is assumed to indicate an Unusual Event if it appears that the count rate will go off-scale (high) within 24 hours after the alarm.

Table 5-1
Unusual Event Criteria

Condition	Beta Emitter Activity in millicuries			
	Unknown	Sr-90	Cs-137	Co-60
Total activity released to produce 100 times the effluent concentration limit at the reactor site boundary averaged over 24 hours (15 mrem)	1.7 mCi	10 mCi	346 mCi	86 mCi
Time from start of release to an air monitor count rate level that activates the alarm	22 min.	3.7 min.	0.11 min.	0.44 min.

5.1.2 Actual or projected deep dose equivalent at the reactor site boundary of 15 mrem over a 24-hour period. This could result from direct radiation from within the PSBR building or airborne beta-gamma emitters. The continuous air monitors as noted in 5.1.1 would detect airborne particulate materials. For example, noble gases producing a submersion exposure of 15 mrem in 24 hours (0.63 mrem/hr) would correspond to a reactor bay dose equivalent rate of 85 mrem/hr.[3] This level would be readily apparent in the reactor bay and would be sufficient to activate the *Alert status* of the bridge radiation monitors.

5.1.3 Report or observation a severe natural phenomenon affecting the reactor site.

5.1.4 Threat to or breach of security that could affect reactor systems, such as a bomb threat, threat of theft of special nuclear material, theft of special

nuclear material, threat of violence, vandalism, or non-accidental unauthorized intrusion.

5.1.5 An accident that results in fuel damage such that radionuclides could be released from the fuel. Such damage would be indicated by visual inspection or by high radiation and/or high airborne activity levels in the reactor bay as shown by the bridge radiation monitors or the continuous air monitors, see 5.1.1 and 5.1.2.

5.1.6 A fire within critical areas of the operations boundary lasting more than 15 minutes. Critical areas are the reactor bay, NBL, pump room, hot cells, and the Co-60 facility. Fire in an office or other laboratory area is not an Unusual Event, if it is confined to those areas.

5.2 Alert

The following emergency action levels are defined as an Alert. These action levels correspond to the definitions in section 4.2.

5.2.1 Release of particulate beta emitting radionuclides is to be considered an Alert, if the actual or projected radiological effluents at the site boundary are calculated or measured to result in the conditions listed in 4.2.1. Table 5-2 shows the activity for a release of several beta emitters that would each result in an airborne activity concentration 500 times the effluent concentration limit. Table 5-2 also shows the approximate time for the continuous air monitors in the reactor bay to alarm after the start of a continuous 24-hour release of that activity. Such a release would produce an off-scale (high) reading on the air monitor in the reactor bay before the end of the 24-hour release period.

Releases of much less activity than that required in an airborne concentration 500 times the effluent concentration limit at the reactor site boundary would also cause an air monitor alarm. An alarm of the air monitor in the reactor bay is assumed to indicate an Alert if it appears that the count rate will go off-scale (high) within 5 hours after the alarm.

Table 5-2
Alert Criteria

Condition	Beta Emitter Activity in millicuries			
	Unknown	Sr-90	Cs-137	Co-60
Total activity released to produce 500 times the effluent concentration limit at the reactor site boundary averaged over 24 hours (75 mrem)	8.6 mCi	52 mCi	1728 mCi	432 mCi
Time from start of release to an air monitor count rate that activates the alarm	4.43 min.	0.74 min.	0.02 min.	0.09 min.

5.2.2 Actual or projected deep dose equivalent at the reactor site boundary of 75 mrem over a 24 hour period. This could result from direct radiation from within the reactor facility or airborne beta-gamma emitters. The continuous air monitors as noted in 5.2.1 would detect airborne particulate material. For example, noble gases producing a submersion exposure of 75 mrem in 24 hours would be at a concentration 5 times higher than that in 5.1.2 and the corresponding reactor bay dose equivalent-rate would be approximately 430 mrem/hr. This level would activate alarms for the bridge radiation monitors. Direct radiation can be detectable with portable survey instruments.

5.2.3 Events that produce actual or projected deep dose equivalent at the reactor site boundary of 20 mrems. This would be detectable with portable survey instruments.

5.2.4 An event that results in airborne radioiodine levels such that the committed dose equivalent to the thyroid is 100 mrem at the reactor site boundary. The reactor bay radiation monitoring equipment would detect this. The release of 134 Ci of ^{131}I into the reactor bay would produce a thyroid committed dose equivalent of approximately 100 mrem at the reactor site boundary.

5.2.5 Loss of adequate shielding pool water at a rate that exceeds the combined makeup water capacity of all available refill systems, (maximum of

approximately 475 gpm, if all systems are available). A pool water level drop of 1 cm per minute is equivalent to 100 gpm.

5.2.6 A fire that threatens any of the reactor safety systems, including the reactor support systems in the reactor bay, pump room, NBL, hot cells, or Co-60 facility.

5.2.7 The impaction of missiles or aircraft within the operations boundary.

5.2.8 An explosion that could impact the operation of the reactor.

5.2.9 A release of toxic or flammable gas into the operations boundary in such quantities that pose an immediate hazard to the reactor safety systems.

5.2.10 Imminent loss of physical control of the reactor.

5.2.11 Tornado or hurricane force winds that are damaging the reactor building.

6.0 EMERGENCY PLANNING ZONE

The emergency planning zone (EPZ) for the PSBR is the same as the operations boundary. This EPZ is consistent with the recommendation for the emergency planning zone given in ANSI/ANS 15.16-2015 "Emergency Planning for Research Reactors" for research reactors with an authorized power level of 2 MW or less. This is adequate to ensure that the dose to individuals beyond the EPZ will not exceed limitations of the Protective Action Guides (PAG). The PAG limits are 1 rem whole body or 5 rem thyroid.

7.0 EMERGENCY RESPONSE

7.1 Notification

When the event has been evaluated and determined to require activating the Emergency Plan, the Emergency Organization shall be notified by telephone and/or two-way radio communication using notification forms designed for this purpose. Copies of the notification forms are stored in the Emergency Support Center. These forms are used during the emergency to ensure applicable organizations are notified about the emergency. These organizations have communication centers and other means for 24 hour notification. University organizations include; University Police, Environmental Health and Safety, Radiation Protection Office, The Office of University News and Media Relations. The NRC Operations Center and the Pennsylvania Emergency Management Agency (PEMA) are to be notified upon activation of the Emergency Plan. The Pennsylvania Department of Environmental Protection Bureau of Radiation Protection office is notified of events of Public Interest and other facility related events. Other organizations to be notified depending upon emergency response needs include: University Health Services, Centre LifeLink EMS, the Alpha Fire Company of State

College, the State College Police Department, the Mount Nittany Medical Center, the Pennsylvania State Police, and the FBI.

7.2 Assessment

Sections 5.1 and 5.2 provide readings of the continuous air monitors and area monitors in the reactor bay that determine releases that would be classified as an Unusual Event or Alert. These instruments are tested and calibrated for proper operation as required by PSBR Technical Specifications.

If the radiation detection instruments are inoperable or off-scale, portable survey instruments would be used to obtain radiation readings. Additional equipment and assay facilities are available in the Radiation Protection Office. For emergencies involving the release of radioactive material from the PSBR, a survey of the reactor site boundary documenting radiation levels and air samples would be made as soon as possible. Air samples from the operations area or reactor site boundary would be assayed in the Radiation Protection Office laboratory or the radiation counting laboratory located in the Academic Projects Building to determine airborne activity. The criteria from Section 5 would then be used to evaluate and predict level of exposures and/or release of radioactive material from the PSBR. All survey and dosimeter records will be delivered to the Radiation Protection Office.

Reactor and Radiation Protection personnel are normally supplied with personnel dosimeters, which require a considerable amount of time for processing amounts of exposure received. Self-reading dosimeters are available for special monitoring and emergencies where extra dosimeters or immediate readout is needed.

Assessment of events such as civil disorder, bomb threats, fire, pool water level, tornado or hurricane force winds, etc., will be made on the basis of direct observation and/or verbal reports.

7.3 Corrective Actions

The release of radioactive material from the PSBR in an amount sufficient to be classified as an emergency would produce an alarm of a continuous air and/or reactor bridge monitor. This would shutdown the reactor, sound the building evacuation alarm, and start the emergency ventilation system. The PSBR Emergency Procedures shall then be followed.

In the event of a radiation release that may have contaminated personnel with radioactive material, the personnel will be isolated and surveyed for contamination and decontaminated as necessary by Radiation Protection and/or reactor staff personnel.

In the event of a pool water leak, civil disorder, bomb threat, or report of a possible hurricane or tornado, the Emergency Director shall determine whether the reactor should be shutdown and/or secured. The PSBR Emergency Procedures shall be followed.

The facility fire detection system communicates directly with the University Police communications center. In the event of the activation of the fire alarm system or if any fires are detected, the PSBR Emergency Procedures for fires will be followed.

7.4 Protective Actions

Upon evacuation from the reactor building following an evacuation alarm or announcement over the page system, personnel shall follow the PSBR Emergency Procedures. The Emergency Procedures provide for personnel accountability and assessment of the situation including isolating potentially contaminated personnel or areas of the facility.

The guidelines for personnel exposure during an emergency are listed in Table 7-1. Exposures above the limits for a restricted area given in 10 CFR 20 are to be on a voluntary basis without penalty for refusal and restricted to those persons with sufficient knowledge and experience of reactor operations and biological effects of radiation to understand the risks involved.

Table 7-1
Guidelines for Personnel Exposure

Dose Limit	Activity	Condition
5 rem	All	Annual dose limit
10 rem	Protecting valuable property	Lower dose not practicable
25 rem	Life saving or protection of large populations	Lower dose not practicable
>25 rem	Life saving or protection of large populations	Only on a voluntary basis to persons fully aware of the risks involved

Source: ANSI/ANS 15.11 (1993) and EPA 400-92-001 (1991).

8.0 EMERGENCY FACILITIES AND EQUIPMENT

8.1 Emergency Support Center

The Emergency Support Center (ESC), used during an emergency evacuation, is equipped with a phone tied to the regular PSBR phone line and is the storage location for emergency radiation monitoring equipment and protective clothing. Laboratory equipment and staff offices under the Radiation Protection office are located on the second floor of the Academic Projects Building (APB). The radiation counting laboratory under the direction of the PSBR Director is located on the first floor of the APB. The ESC is in close proximity to both the reactor facility and laboratories equipped to analyze samples taken during an emergency evacuation. In the event that the ESC is not accessible there is an alternate location for an Emergency Support Center with the University Police.

8.2 Monitoring and Sampling Equipment

8.2.1 Fixed Monitoring Equipment

The reactor bay contains at least one particulate continuous air monitor and at least one area radiation monitor that must be operating whenever the reactor is operating. There is also an area radiation monitor in the neutron beam laboratory which is required to be operating when using the beam port. Remote readouts from these monitors and reactor instrumentation are available in the RSEC facility and the ESC.

8.2.2 Portable Monitoring Equipment

Portable radiation monitors and portable air sampling equipment are available at the ESC and the Radiation Protection Office.

8.2.3 Laboratory Assay Equipment

Equipment for analyzing smear samples and air samples is available in close proximity to the reactor site boundary in the Academic Projects Building.

8.3 Decontamination and Medical Treatment of Personnel

Radiation Protection staff will decontaminate personnel with relatively minor skin contamination at the work location or at the Radiation Protection Office. Severe or life-threatening radioactive contamination of personnel is not expected in any postulated accident at the RSEC. Decontamination would be coordinated with the Radiation Safety Office according to procedure EP-6: Medical Emergencies. In most cases, decontamination would be performed using soap and water. Personnel with injuries

and/or serious contamination will be handled according to PSBR Emergency Procedures. University Health Services is equipped to handle minor medical emergencies. For major medical emergencies, the Mount Nittany Medical Center has agreed to accept patients from radiation accidents at the University.

8.4 Emergency Communications

The University telephone system and a public address system in the reactor building are available for communications. The reactor building has a telephone system with multiple telephones readily available at locations throughout the facility.

One phone in the University telephone system is located in the ESC. There is an additional unlisted telephone located in the ESC. Other telephone lines are available in offices located nearby in the Academic Projects Building.

Two-way hand held radios provide communication between the Emergency Director and response personnel during an event. The public address system in the PSBR provides coverage to all areas within the operations boundary. The PSBR evacuation signal is audible at all locations inside the reactor building. The evacuation signal is channel tested and channel checked according to PSBR technical specifications.

8.5 Inventory

The material available for emergency response includes all the resources of the PSBR facility, with additional resources at the ESC, and the Environmental Health and Safety/Radiation Protection Office. Some equipment that is normally stored inside the PSBR facility may not be immediately available for an emergency which requires evacuation of the building. Therefore, a minimum inventory of equipment is kept at the ESC, if the PSBR facility becomes inaccessible. This equipment is inspected, checked for operability, and inventoried according to PSBR procedures. The calibration of reactor and Radiation Protection office radiation survey instrumentation is conducted in accordance with procedures. These items are available for normal day-to-day use to help ensure that they are in operating condition when needed, but are to be stored at the ESC. The inventory is described in the PSBR Procedures.

9.0 RECOVERY OPERATION

Restoring the PSBR to a safe operating condition after an emergency shall be the responsibility of the Emergency Director. Operations necessary to restore the PSBR will be under his/her direction and recovery procedures will be written and approved as necessary.

After corrective action has been taken, the emergency may be terminated. Prior to termination of an emergency the Emergency Director shall:

9.0.1 Determine there are no foreseeable subsequent events that could cause damage to the reactor or render its operation unsafe.

9.0.2 Verify that all areas to be reopened to personnel or the general public meet the requirements of 10 CFR 20 for occupancy.

9.0.3 Confirm that areas restricted to entry or requiring controlled access are clearly posted.

The Radiation Protection staff will survey and ascertain that contamination and radiation levels within the affected areas are safe. The Emergency Director, with the support of the reactor staff and Radiation Protection personnel, will assess resultant damages, direct repairs, decontamination, and review the emergency.

10.0 MAINTAINING EMERGENCY PREPAREDNESS

The Emergency Plan shall be maintained in a state of preparedness by the following actions:

10.1 Training and Emergency Plan Review

The reactor operator and senior reactor operator requalification program keeps the operating staff cognizant of features of facility design, safety and emergency systems, emergency and standard operating procedures, radiation control and safety concepts, and other facility information needed to respond to an emergency situation. Competency of the reactor staff to respond appropriately to an Emergency will be maintained by having an annual review of the Emergency Plan and/or implementing procedures with the reactor staff. The review will study where improvements can be made in the plan and/or implementing procedures. The Emergency Plan will then be revised accordingly and the revised pages properly dated and forwarded to the appropriate organizations. PSBR Emergency Procedures are reviewed at a frequency according to the PSBR Procedures.

University Police officers undergo an annual training program. This program includes a review of the role and response of University Police in event of an emergency.

10.2 Emergency Drills

An on-site emergency drill shall be conducted annually that requires the use of appropriate emergency equipment. The drill will be conducted as an action drill with required emergency measures executed as realistically as practicable and involving response from Radiation Protection personnel and University Police if available..

An emergency drill shall take place biennially that tests communication links and notification procedures with off-site organizations. It will activate response from the Radiation Protection personnel, University Police, and University News and

Media Relations. In addition, the drill may also include participation by one or more off-site organizations such as University Health Services, Mount Nittany Medical Center, or the Alpha Fire Company of State College.

Following the annual or biennial emergency drill, the Emergency Coordinator will meet with the operations staff and Radiation Protection personnel to critique performance during the drill. University Police, University Health Services and others that participated in the drill will be invited to the critique session and/or to provide comments. This critique will be documented in a timely manner.

10.3 Operational Readiness

Surveillance of emergency supplies and equipment ensures availability and proper condition for immediate use. The PSBR reactor staff and Radiation Protection staff are responsible for surveillance of their respective emergency supplies and equipment. Emergency supplies at the ESC are verified to be operational and complete on a periodic basis according to PSBR procedures. Fire extinguishers located throughout the facility are maintained by University Physical Plant personnel and are inspected and maintained according to their program.

Radiation alarms and pool level alarm signals are sent to the University Communications Center, and the telephone at the ESC is verified to be operational as specified in the PSBR procedures. Portable radiation detectors, including direct reading pocket dosimeters for emergency use, shall also be maintained as described in the PSBR procedures.

References:

[1]PSBR SAR (Safety Analysis Report)

[2]R. W. Granlund, "Changes to PSBR Emergency Plan," Internal memo to Candace Davison, Penn State University, June 1996.