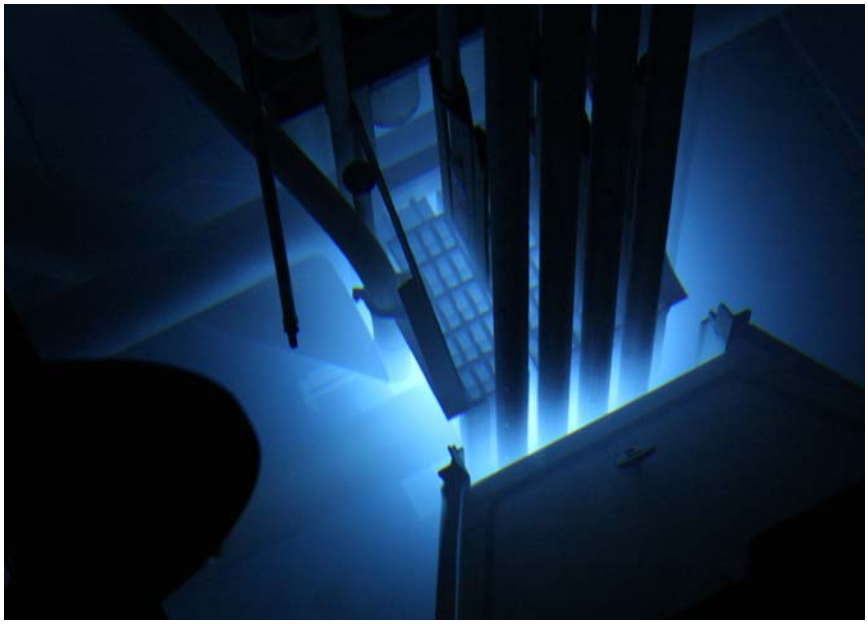
NC STATE UNIVERSITY

PULSTAR REACTOR

EMERGENCY PLAN

NORTH CAROLINA STATE UNIVERSITY

RALEIGH, NORTH CAROLINA 27695



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1. INTRODUCTION

This Emergency Plan applies to the North Carolina State University (NCSU) PULSTAR research reactor licensed pursuant to Title 10 of Code of Federal Regulations Part 50 (10 CFR Part 50). Facility Operating License No. R-120 Docket No. 50-297 has been issued to NCSU for the operation of the PULSTAR reactor. An emergency plan is required by 10 CFR Part 50. Content of the Emergency Plan follows guidance given in NUREG 0849 *Standard Review Plan for the Review and Evaluation of Emergency Plans for Research and Test Reactors*, Regulatory Guide 2.6 *Emergency Planning for Research and Test Reactors*, ANSI/ANS 15.16-2008 *Emergency Planning for Research Reactors*, and ANSI/ANS 15.11-2009 *Radiation Protection at Research Reactor Facilities*.

The objectives of this Emergency Plan are to establish action levels, response plans, and to designate areas of responsibility for the Nuclear Reactor Program (NRP) staff and NCSU support personnel should an emergency occur at the PULSTAR reactor that could present a risk to the health and safety of individuals or result in damage to property. Additionally, the Emergency Plan identifies the offsite support organizations that may be activated.

North Carolina State University has a Radiation Safety Division (RSD) which is part of the Environmental Health & Safety Center that integrates radiological safety and controls at all campus facilities that use radioactive materials or radiation producing devices, including the PULSTAR reactor. The PULSTAR reactor is required to have a radiation protection program and emergency plan. The RSD provides assistance to the Reactor Health Physicist in emergencies.

The NCSU PULSTAR Emergency Plan applies to emergencies which affect the PULSTAR reactor only. The Emergency Plan is implemented by the NRP and supported by both on-campus and off-campus organizations.

1.1. Reactor Facility Description

The PULSTAR reactor is located in the Burlington Engineering Laboratories (BEL) on the campus of North Carolina State University (NCSU), Raleigh, North Carolina. Figure 1 through Figure 4 depict the location of BEL on the NCSU campus. The PULSTAR reactor is used for teaching and research by authorized NCSU faculty, staff, and students and other authorized investigators. In addition, specialized services are provided to industry and governmental agencies. The reactor is available to local high schools, colleges, and universities. The reactor is operated as needed, typically five days per week during business hours.

The North Carolina State University PULSTAR reactor is an open pool, light water reactor that operates with low enriched ^{235}U pin-type fuel assemblies at a maximum steady state thermal power level of 2 MW. The reactor fuel is made of uranium oxide pellets contained by zircaloy clad fuel pins. The reactor fuel pins are loaded into zircaloy boxes to form an assembly. The reactor core consists of a maximum of twenty-five fuel assemblies located on an aluminum grid plate. The reactor is operated at a maximum coolant temperature of 120 °F. High quality demineralized water is used as the primary coolant. The reactor fuel typically is covered by 20 feet of primary coolant. Heat produced by the reactor is removed to a secondary coolant system by a plate type heat exchanger. The heat is then rejected to the environment by a cooling tower. Control rods are used to control reactor power and for shutdown of the reactor. No damage to the fuel occurs from loss of primary coolant. A reactor cooling system diagram is depicted in Figure 5.

2. DEFINITIONS

Assessment Actions: The actions taken during or after an accident to obtain and process information that is necessary to decide when to implement specific emergency procedures.

Burlington Engineering Laboratories (BEL): A three-story building on the campus of NCSU that houses the Department of Nuclear Engineering, their related offices and laboratories, and the PULSTAR reactor building.

Corrective Actions: The measures taken to terminate or mitigate the consequences of an emergency at or near the source of the emergency.

Designated NRP Staff Member: Any member of the NRP staff who holds a Senior Reactor Operator license or who is specifically trained for this Emergency Plan or the Reactor Health Physicist.

Drill: A test of the integrated capability of the Emergency Plan, or a component thereof, and may include periods of instruction to develop and maintain skills in a particular operation.

Emergency: Any situation which activates the PULSTAR reactor Emergency Plan.

Emergency Action Level (EAL): A parameter or criteria used as a basis for emergency classification.

North Carolina Emergency Management (NCEM): NCEM is operated by the State of North Carolina and serves as the central notification point for emergencies which involve multiple state agencies. When notified of an emergency at the PULSTAR reactor, the NCEM would notify the appropriate State agencies and the State Radiation Protection Section.

Operations Boundary: The border that outlines the reactor building (Figure 4).

Protective Actions: Actions taken to avoid or reduce the potential dose to individuals and to prevent damage to property.

Reactor Building: The building that includes the reactor bay, control room, mechanical equipment room, ventilation equipment room, and primary piping vault. It serves to confine the spread of contamination in case of an emergency (Figure 4).

Recovery Actions: The actions taken after the emergency has been terminated to restore the facility to its pre-emergency condition.

Shall, Should, and May: The word "shall" is used to denote a requirement; the word "should" to denote a recommendation; and the word "may" to denote permission, neither a requirement nor a recommendation.

Site Boundary: The area surrounding the BEL between Lampe Drive, Broughton Drive, Stinson Drive, and the north face of BEL (Figure 4).

State Warning Point (SWP): The SWP is operated by the NC Highway Patrol and serves as a backup notification point to NCEM for emergencies which involve multiple state agencies. When notified of an

emergency at the PULSTAR reactor, the SWP would notify the appropriate State agencies which activates North Carolina Emergency Management and the State Radiation Protection Section.

911 Emergency Communication Center: The first contact for the purpose of emergency notification of local off-site responders is the 911 Emergency Communication Center operated by NCSU Campus Police.

3. ORGANIAZTION AND RESPONSIBILITIES

The PULSTAR Emergency Plan is designed to meet the operational demands that are encountered during an emergency situation. To achieve this goal, the PULSTAR Emergency Organization (PEO) is formed in which the normal operating staff is assigned specific authorities, responsibilities, and duties compatible with their routine work assignments. This allows for an effective transition from the normal operating structure when required. Additional resources are provided to the PEO for management of the emergency as necessary through the NCSU Incident Command System (ICS) and NCSU Campus Police.

The PEO is responsible for assessment and response actions involving licensed radioactive materials and PULSTAR reactor operations throughout the emergency and recovery which affect areas inside the PULSTAR operations boundary.

The ICS is responsible for assessment and response actions involving licensed radioactive materials during the emergency and recovery which affect areas outside the PULSTAR operations boundary. The ICS is also responsible for assessment and response actions involving other hazardous substances, fire, or natural disasters during the emergency and recovery which affect areas either inside or outside the PULSTAR operations boundary.

NCSU Campus Police is responsible for assessment and response to security incidents affecting the PULSTAR reactor.

Coordination of resources and actions between the PEO, ICS, and Campus Police is essential for timely and correct response to an emergency. A Technical Advisor is provided to the ICS by the PEO for emergencies which affect the PULSTAR reactor. Upon termination of the emergency, recovery operations are initiated through the Recovery Organization (as described in Section 9).

3.1. Normal Organization Structure

Figure 6 details the operating organization for the NCSU Nuclear Reactor Program (NRP). The NRP organization includes the Director, the Manager of Operations and Engineering, and reactor operators and maintenance personnel. The Reactor Health Physicist (RHP) works with the NRP and reports to the Department Head of Nuclear Engineering. Support to the NRP is provided by a number of NCSU organizations, e.g. Campus Police, Environmental Health and Safety, Facilities Operations.

3.2. PULSTAR Emergency Organization (PEO) Structure

The PEO maintains as many similarities and functional characteristics as possible from the normal NRP organization. This allows a smooth transition into the PEO and for the effective deployment of expertise when evaluating emergencies. Available staff personnel who do not have specific positions in the PEO are assigned to the Emergency Operations Manager for duty on Emergency Teams. The PEO Emergency Director shall have the authority to modify the PEO structure as is necessary during the actual course of an emergency.

Additional resources from support organizations are provided through the NCSU Incident Command System (ICS) and NCSU Campus Police. These organizations include NCSU Campus Police, NCSU Environmental Health & Safety Center, North Carolina Emergency Management, State Radiation Protection Section, Wake County Emergency Management Services Division, City of Raleigh Fire

Department, and the Nuclear Regulatory Commission.

The ICS and PEO coordinate their efforts to respond to emergency situations at the PULSTAR nuclear reactor. The PEO and ICS organizational structures are depicted in Figure 6 and Figure 7.

3.2.1. Emergency Director (ED)

Principal: Manager of Engineering and Operations, NRP

Alternate: Senior Reactor Operator

Interim: Designated NRP Staff Member

A Designated NRP Staff Member may act as the interim ED to initiate the PEO using assessment criteria specified in Section 4 and Section 5. This staff member acts as the interim ED until relieved by the NRP Manager of Engineering and Operations, who is the principal ED, or by a Senior Reactor Operator, who is the alternate ED. The ED is responsible for the performance of actions by the PEO and for the coordination of actions with the ICS in response to emergencies at the PULSTAR reactor.

Basic Function: Ensures the performance and coordination of actions necessary to manage an emergency situation affecting the PULSTAR reactor.

Primary Responsibilities:

a. Coordinate activities of the PEO with those of the ICS.

b. Classify and terminate the emergency in accordance with this Emergency Plan.

c. Ensure notification of all agencies as required by this Emergency Plan.

d. Issue instructions to the PEO and ensure that appropriate actions are taken.

e. Request actions to be taken on campus by the ICS as necessary.

f. Determine the feasibility of re-entry activities during or immediately following an emergency situation, including the authorization of workers to incur emergency radiation exposures with the advice of the Reactor Health Physicist.

g. Serve as Technical Advisor to the ICS for emergencies involving hazardous materials, fire, or natural disasters.

h. Maintain communication with the ICS.

i. Ensure Health Physics activities within the PULSTAR operations boundary are completed.

j. Plan for recovery and initiate the Recovery Organization.

k. Provide engineering assessment/technical support and, where necessary, draw upon the technical resources of the NCSU Department of Nuclear Engineering.

Principal Working Relationships:

a. ICS Incident Commander concerning services, technical options, public information, and advice.

b. Reactor Health Physicist concerning radiation safety inside the PULSTAR operations boundary and radiological releases.

c. Emergency Operations Manager concerning assessment actions, corrective actions, and protective actions inside the PULSTAR operations boundary including reactor core status.

d. ICS concerning implementation of assessment and response actions to control hazardous substances, fire, and natural disasters.

e. Emergency Coordinator concerning radiation safety of the public and ICS personnel outside the PULSTAR operations boundary.

f. Emergency Coordinator concerning communications with support organizations at the NCSU ICS.

3.2.2. Reactor Health Physicist (RHP)

Principal: Reactor Health Physicist

Alternate: NCSU Radiation Safety Officer

Basic Functions: The RHP is responsible for the sampling and analysis of liquid and airborne effluents, radiation safety of personnel inside the PULSTAR operations boundary, and controlling the spread of contamination.

Primary Responsibilities:

a. Sample and analyze liquid and airborne effluent

b. Provide information and recommendations to the ED concerning radiation safety of personnel inside the PULSTAR operations boundary.

c. Supervise decontamination, monitoring, and sampling tasks performed by the PEO Emergency Teams.

d. Consult with ED concerning radiation exposures to personnel inside the PULSTAR operations boundary.

Principal Working Relationships:

a. Emergency Operations Manager regarding the sampling of liquid and airborne effluents, performance of radiation surveys, decontamination services, and other actions performed by PEO Emergency Teams.

b. Emergency Coordinator regarding radioactive effluents and personnel doses.

3.2.3. Emergency Operations Manager (EOM)

Principal: Senior Reactor Operator

Alternate: Senior Reactor Operator

Interim: Designated Senior Reactor Operator

Basic Functions: The EOM is responsible for implementing emergency activities with the objective of taking the reactor to a safe shutdown status and maintaining it in a condition that minimizes or mitigates potential reactor damage.

Primary Responsibilities:

a. Implements preventative and corrective actions as directed by the ED.

b. Provides information and recommendations to the ED concerning emergency conditions and reactor core status.

c. Analyzes conditions and develops guidance for protection and mitigation of potential damage to the reactor core, systems, and components.

d. Provides a central point for the collection, retention, retrieval, and transmittal of reactor data.

Principal Working Relationships:

a. ED concerning the implementation of preventative and corrective actions and mitigation of reactor damage.

b. RHP concerning the release of radioactive effluents and radiation safety during implementation of emergency actions.

c. Emergency Coordinator concerning reactor status.

3.2.4. Emergency Coordinator (EC)

Principal: NCSU Radiation Safety Officer

Alternate: Associate Radiation Safety Officer or Environmental Health Physicist

Basic Functions: Serves as Technical Advisor in the ICS if the ED is not available. Support ICS by coordinating radiological assessment actions outside the PULSTAR Operations Boundary between NCSU and other organizations.

Primary Responsibilities:

a. Establishes and maintains communications with the ICS Incident Commander and ED of the PEO.

b. Obtains information on the diagnosis and prognosis of the emergency, and estimates off-site dose consequences.

c. Organizes and dispatches radiological monitoring teams outside the PULSTAR operations boundary as required.

d. Interprets radiological data from the radiological monitoring teams and updates the PEO and ICS with the results of both real-time measurements, and when possible, projected radiological exposures.

e. Arranges for any further radiological evaluations that are needed.

f. Assists the ICS organization in their information and communication needs with the PEO.

g. Consults with ED concerning radiation safety of the public and ICS.

h. Provides assistance to the RHP.

Principal Working Relationships:

a. ED concerning status of notification, request for assistance, and radiological measurement results.

b. RHP concerning the release of radioactive effluents, PEO personnel dose, and assistance with radiological sample analysis and surveys.

c. ICS Public Information Officer concerning technical data for public information releases.

d. ICS Incident Commander concerning PEO actions and requests for assistance.

3.2.5. ICS Public Information Officer

Principal: Director, News Services

Alternate: Assistant Director, News Services or Campus Police Public Information Officer

Basic Function: Responsible for preparing and making public information releases.

Primary Responsibilities:

a. Coordinates all public information releases with the ICS and PEO.

b. Ensures timely and correct dissemination of public information.

Principal Working Relationships:

a. ICS Incident Commander and PULSTAR EC or ED to answer technical questions for public information releases.

b. Federal, State, and local government public relations officials regarding release of public

information.

c. Media representatives for making information available to the public.

3.2.6. Emergency Team

Emergency Teams, which are under the direction of the Emergency Operations Manager, are comprised of the following qualified personnel: Chief of Reactor Maintenance, Chief Reactor Operator, Licensed Senior Reactor Operators, Licensed Reactor Operators, and individuals trained specifically for this Emergency Plan.

Emergency Teams are assigned specific tasks as dictated by the emergency conditions. Examples of the specific tasks that Emergency Teams may perform include:

a. Determine and report radiological conditions.

b. Assist in search for personnel.

c. Establish access and egress areas which minimize personnel exposure.

d. Provide personnel decontamination.

e. Assess equipment damage.

f. Perform emergency repairs as required.

g. Install emergency systems, structures, or components.

h. Perform other actions necessary to reduce the effect of an emergency or to mitigate a release when repair is not possible.

3.2.7. NCSU Incident Command System (ICS)

The ICS is composed of NCSU and off-campus emergency organizations for the purpose of optimizing resources and coordinating emergency response. NCSU emergency organizations include Campus Police, News Services, and Environmental Health & Safety Center. Additional NCSU organizations, such as Facility Operations, are used if needed. The PEO participates in the ICS for emergencies that affect the PULSTAR reactor. Off-campus emergency organizations include City of Raleigh Fire Department, Wake County Emergency Management Services Division, North Carolina Emergency Management, State Radiation Protection Section, and the Nuclear Regulatory Commission. Those support organizations needed for an emergency meet at a central location outside of the PULSTAR reactor building and establish communication with the PEO. If the PULSTAR reactor building is not habitable or accessible, then the PEO may meet at the ICS location or at another location. Depending on the emergency conditions, either the ED or EC from the PEO serves as a Technical Advisor to the ICS for PULSTAR emergencies. Efforts are coordinated between all emergency organizations to respond to an emergency situation. Administrative documentation is developed, maintained, and implemented by the ICS independent of the PULSTAR Emergency Plan.

ICS has primary responsibility for assessment and response to off-site consequences and to specific on-site consequences from PULSTAR emergencies. If an emergency at the PULSTAR reactor involves fire,

hazardous materials, or natural disasters, then the ICS and PEO coordinate efforts to facilitate access/egress and radiological monitoring. Complete and timely communication between the ICS and the PEO is necessary to ensure that all aspects of an emergency situation are addressed.

3.2.8. NCSU Campus Police

NCSU Campus Police is responsible for providing security measures during an emergency, such as crowd and traffic control, and for responding to security incidents at the PULSTAR reactor. If a security incident occurs, Campus Police would respond and notify the NRP if the incident is valid. Activation of the PEO would then occur in accordance with this Emergency Plan. Campus Police perform assessments and response actions to security incidents with necessary assistance by the PEO in accordance with the PULSTAR Security Plan. Campus Police also is the 911 Emergency Communications Center and contacts local off-campus emergency management agencies.

3.2.9. NCSU Environmental Health and Safety Center (EHSC)

NCSU Environmental Health & Safety Center (EHSC) is responsible for the assessment of and recommending appropriate safety measures from hazardous material. Hazardous material includes radioactive materials which are outside the PULSTAR operations boundary as defined in this plan or other hazardous materials which are either inside or outside the PULSTAR operations boundary. Efforts of the Environmental Health & Safety Center are coordinated with other hazardous material emergency response teams, such as Raleigh Fire Department HAZMAT, for PULSTAR related emergencies through the ICS.

3.3. Off-Campus Support

The ICS coordinates emergency response with off-campus support organizations to support the PEO. The following subsections list the organizations that may be contacted for assistance (i.e., Request for Assistance) during an emergency. Certain organizations are required to be notified, as further detailed in Section 7.2, whether or not their assistance is actually required.

3.3.1. Rex Hospital

Rex Hospital has emergency medical facilities available to render immediate treatment to contaminated and non-contaminated injured personnel. The on-call hospital administrator activates necessary personnel in Rex Hospital for an emergency response.

3.3.2. Wake County Emergency Medical Service

Wake County Emergency Medical Service provides ambulance service for injured personnel approved for transport by the Raleigh Fire Department. Prior to transportation, contaminated injured personnel are decontaminated to the extent feasible by PEO personnel or NCSU Fire Protection or Raleigh Fire Department personnel. Two-way radio communication exists between ambulance personnel and the Rex Hospital Emergency Room staff.

3.3.3. City of Raleigh fire Department

The Raleigh Fire Department provides primary firefighting protection for NCSU, including the PULSTAR reactor. Search and rescue of personnel may also be performed by the Raleigh Fire Department with assistance by the ICS and PEO. Limited emergency medical assistance may also be provided by the

Raleigh Fire Department by their Hazardous Materials (HAZMAT) Team.

3.3.4. North Carolina Department of Public Safety

NC Department of Public Safety includes Emergency Management. NC Emergency Management (NCEM) coordinates emergency response activities for the State of North Carolina and other state government response agencies. NC Emergency Management plans, develops, and updates the State of North Carolina Radiological Emergency Response. NC Emergency Management will be notified and advised upon the activation of the PEO.

The State Warning Point (SWP) is operated by the NC Highway Patrol and serves as a backup notification point to NCEM for emergencies which involve multiple state agencies. When notified of an emergency at the PULSTAR reactor, the SWP would notify the appropriate State agencies which activates NCEM and the State Radiation Protection Section (RPS).

3.3.5. State of North Carolina Radiation Protection Section (RPS)

The State of North Carolina Department Health and Human Services (DHHS) contains the Radiation Protection Section (RPS), which provides specialized services to handle incidents involving radioactive materials. The RPS is notified by North Carolina Emergency Management or the State Warning Point.

3.3.6. Nuclear Regulatory Commission (NRC)

At the request of NCSU, the Nuclear Regulatory Commission (NRC) may provide additional technical advice, assistance, and personnel during and following an emergency. The NRC will be notified and advised upon the activation of the PEO.

3.3.7. Wake County Emergency Management Services Division

In emergency situations within Wake County and the City of Raleigh, the Wake County Emergency Management Services Division supports the ICS by coordinating resources, acting as liaison with outside agencies, and assisting with protective actions for the general public. Wake County will be notified and advised upon the activation of the PEO.

3.4. Staffing

Staffing of the PEO and ICS for around-the-clock response to an emergency for a protracted period of time is possible by rotating primary and alternate personnel and working extended shifts. The MEO and SRO would alternate and the RHP and EC would alternate as needed to maintain the PEO.

On-campus support organizations include Campus Police and Environmental Health and Safety Center. Campus Police are staffed around-the-clock routinely. Both organizations are able to call in staff as needed during off-hours and for emergency support.

Off-campus support organizations include Raleigh Fire Department, Wake County Emergency Management, and North Carolina Emergency Management. These organizations maintain their staffing as needed for emergency support.

4. EMERGENCY CLASSIFICATION SYSTEM

Classifications are made based on conditions and situations affecting the reactor facility that require immediate attention. Classification involves a preplanned system of notifications and activation of various emergency response organizations. This system classifies emergencies according to severity.

4.1. Emergency Classification Criteria

Emergency classification is based on Emergency Action Levels (EAL) criteria. The following are considered in determining the class of an emergency:

- **Radioactivity Release**: Status and magnitude of the release is used to determine if an EAL criterion is met. If so, an emergency classification is made.

- **Core/Fuel Damage**: Status of fuel and release of fission products is used to determine if an EAL criteria has been met. Associated radiation levels in the coolant system, reactor building, and potential public exposure to radiation or radioactive materials are considered. If so, an emergency classification is made.

- **Plant Degradation**: Reactor system response to equipment failures or external events is evaluated. If the response is not as expected, the likelihood for a safe recovery is evaluated. Alternatively, if further degradation is likely (e.g., corrective action is not likely to be successful or cannot be accomplished before a release occurs), then an emergency classification is made.

4.2. Emergency Classification

There are four emergency classes. Emergency classes are declared through Emergency Action Levels (EAL). Each EAL has specific conditions (e.g. reactor conditions, instrument readings, and events) that unless promptly corrected meet the criteria requiring an emergency class declaration. Each EAL has been selected so a reasonable amount of time is available to diagnose the specific cause of the emergency and to take immediate corrective actions. Once an emergency is declared, assessments of projected releases and resultant exposures are performed as needed.

Radiation levels, radioactive releases, along with other reactor status assessments are the bases for determining what corrective or protective actions need to be taken. Emergency classes are given below.

4.2.1. Notification of Unusual Event

Manmade events or natural phenomena that are recognized as creating a significant hazard potential that was previously nonexistent have occurred. These events may not have caused damage to the reactor but may warrant an immediate shutdown of the reactor or interruption of routine functions. Situations that may lead to this classification include:

a. threats to or breaches of security such as bomb threats or civil disturbances directed towards the facility

b. natural phenomena such as tornadoes in the immediate vicinity of the reactor, hurricanes,

or earthquakes felt in the facility

c. facility emergencies such as prolonged fires or fuel damage indicated by high coolant fission product activity or fission gas airborne activity, breach of a physical boundary or barrier, high energy missile impact, explosion, uncontrolled release of toxic or flammable gas, vehicle/aircraft crashes into the facility

4.2.2. Alert

Events with a radiological significance requiring notification to and response by emergency organizations have occurred. Off-site response or monitoring would be unlikely. Substantial modification of reactor operating status is a highly probable corrective action. Protective evacuations or isolation of certain areas within the operations boundary or within the site boundary may be necessary. Situations that may lead to this classification include:

a. severe failure of fuel cladding or of fueled experiments where containment boundaries exist or less severe cladding failures where fission products are not well contained

b. significant releases of radioactive materials as a result of experiment failures

4.2.3. Site Area Emergency

Events such as major damage of fuel or cladding and actual or imminent failure of physical barriers containing fission products in reactor fuel or fuel experiments have occurred and projected off-site radiological consequences exceed EAL criteria.

No credible accidents attributable to the reactor or its operations are postulated that can cause emergency conditions at or beyond the site boundary for this classification. However, the Emergency Director retains the right to declare this class if necessary. Monitoring at the reactor site boundary is conducted to assess the need for off-site protective actions. Protective measures on-site may be necessary. An armed attack directed towards or occurring at the reactor facility may result in a Site Area Emergency.

4.2.4. General Emergency

An accident that results in uncontrolled release of radioactive material into the environment (air, water, ground, etc.) to the extent that protective actions off-site may be necessary have occurred. Protective actions, such as sheltering and evacuation, apply to an emergency planning zone (EPZ) may be recommended to off-site authorities. State of NC and local government agencies have the ultimate responsibility for initiating and implementing any recommended off-site protective actions.

No credible accidents attributable to the reactor or its operation are postulated that can cause emergency conditions at or beyond the site boundary for this classification. The EPZ is defined as the operations boundary for this facility (refer to Section 6). However, the Emergency Director retains the right to declare this class if necessary.

Loss of physical control of the reactor facility may result in a General Emergency.

5. EMERGENCY ACTION LEVELS (EALS)

Emergency Action Levels (EAL) may be based on Airborne Effluent Concentration (AEC) fractions at the stack exhaust point and other on-site parameters for which dose rates and radiological effluent releases at the site boundary can be projected.

The following subsections detail the EAL for the four defined classes of emergencies. In situations where an EAL is not applicable, the Emergency Director retains the right to declare an emergency if warranted by other conditions. EAL specified in the following subsections follow guidance given in ANSI/ANS 15.16-2008 and NUREG 0849.

There are two ventilation modes associated with the PULSTAR reactor building; normal and confinement. Normal ventilation recirculates a portion of air through a heating and cooling system and discharges a smaller portion of air to the exhaust stack. Normal ventilation recirculation has a flow rate of 5575 cfm and an exhaust flow rate of 1870 cfm. Confinement ventilation passes air through the two roughing filters, activated charcoal filter, and a High Efficiency Particulate Air (HEPA) filter prior to being discharged by the stack. Confinement ventilation exhaust rate is 600 cfm. Normal or confinement ventilation are each capable of maintaining negative pressure in the reactor building relative to the atmosphere. Additional dilution flow of clean process air is available by the BEL South Wing (R-63) exhaust fans which are rated at 12,500 cfm. Thorough mixing with this clean air is assumed to occur in either ventilation mode.

Atmospheric dilution occurs after the effluent is released to the environment. This dilution depends mainly on weather conditions, such as wind speed and stability. Unstable conditions disperse effluent more readily than stable conditions. Stable conditions result in higher doses for elevated locations while unstable conditions result in higher doses for ground locations.

Under stable weather conditions the limiting location for stack discharges are upper floors on the surrounding buildings at distances greater than 100 m rather than the ground level at the site boundary. Maximum ground concentration occurs at distances greater than 100 m from the stack under various weather conditions. Minimal atmospheric dilution factors are estimated at 130 for elevated levels and 5000 for ground level with a wind speed of 1 m/s. With only atmospheric dilution, EALs are conservatively based on a dilution factor of 130. BEL dilution flow is 12,500 cfm. If BEL dilution is available, a stack dilution factor of 7 in normal ventilation and 20 in confinement mode are applicable:

$$7 \approx \frac{(12{,}500 + 1870)}{1870}$$

$$20 \approx \frac{(12{,}500 + 600)}{600}$$

If stack dilution is available, EALs are conservatively based on the following dilution factors:

In normal ventilation mode:

$$910 = 7 * 130$$

In confinement ventilation mode:

$$2600 = 20 * 130$$

5.1. Action Levels for Notification of Unusual Events

a. Actual or projected airborne radioactive effluent at the site boundary or beyond for an exposure of 24 hours or less exceeding 15 mrem deep dose equivalent (DDE)

b. Actual or projected airborne radioactive effluent at the site boundary or beyond for an exposure of 24 hours or less exceeding:

- For noble gases, 50 Airborne Effluent Concentration (AEC) for 24 h or 1200 AEC·h or 15 mrem DDE
- For radionuclides other than noble gases, 100 AEC for 24 h or 2400 AEC·h or 15 mrem CEDE

c. For this reactor facility, release of radioactivity with the following concentrations at the stack exhaust point averaged over 24 hours meet EAL criteria for a Notification of Unusual Event:

- Without BEL dilution, 6500 and 13,000 AEC fraction for noble gases and for radionuclides other than noble gases, respectively
- With BEL dilution in normal ventilation mode, 45,000 and 90,000 AEC fraction noble gases and for radionuclides other than noble gases, respectively
- With BEL dilution in confinement mode, 130,000 and 260,000 AEC fraction for noble gases and for radionuclides other than noble gases, respectively

d. A leak in the primary system resulting in a loss of pool level at a rate that cannot be replaced by normal pool fill, and/or loss of pool level to the point the core becomes uncovered.

e. Fire within the reactor facility not extinguished within 15 minutes.

f. Credible security threat affecting the reactor facility.

g. Receipt of bomb threat affecting the reactor facility.

h. Reports or observations of severe natural phenomena affecting the reactor facility.

i. Other events that affect the facility.

5.2. Action Levels for an Alert

a. Actual or projected airborne radioactive effluent at the site boundary or beyond for an exposure of 24 hours or less exceeding 75 mrem DDE

b. Actual or projected radioactive Airborne Effluent Concentration (AEC) at the site boundary or beyond for an exposure of 24 hours or less exceeding:

- For noble gases, 250 AEC 24 h or 6000 AEC·h or 75 mrem DDE
- For radionuclides other than noble gases, 500 AEC·24 h or 12,000 AEC·h or 75 mrem CEDE

c. For this reactor facility, release of radioactivity with the following concentrations at the stack exhaust point averaged over 24 hours meet EAL criteria for an Alert:

- Without BEL dilution, 32,500 and 65,000 AEC fraction for noble gases and for radionuclides other than noble gases, respectively
- With BEL dilution in normal ventilation mode, 225,000 and 450,000 AEC fraction for noble gases and for radionuclides other than noble gases, respectively
- With BEL dilution in confinement mode, 650,000 and 1,300,000 AEC fraction for noble gases and for radionuclides other than noble gases, respectively

d. Radiation levels at site boundary of 20 mrem/h for 1 hour DDE or 100 mrem of committed dose equivalent (CDE) to the thyroid.

e. Security breach of the reactor facility.

5.3. Action Levels for a Site Area Emergency

The PULSTAR Safety Analysis Report indicates that no credible accidents attributable to the reactor or its operation are postulated to cause an emergency condition at or beyond the site boundary or beyond in excess of:

a. 375 mrem DDE for an exposure of 24 hours or less

b. 1250 AEC fraction or 30,000 AEC·h for noble gases or 375 mrem DDE for an exposure of 24 hours or less

c. 2500 AEC fraction or 60,000 AEC·h for radionuclides other than noble gases or 375 mrem CEDE for an exposure of 24 hours or less

d. 500 mrem CDE to the thyroid

e. 100 mrem/h DDE for 1 hour

An armed attack directed towards or occurring at the reactor facility may result in a Site Area Emergency and would be declared upon consultation and concurrence with university organizations and off-site authorities.

5.4. Action Levels for a General Emergency

The PULSTAR Safety Analysis Report indicates that no credible accidents attributable to the reactor or its

operation are postulated to cause an emergency condition at or beyond the site boundary or beyond in excess of:

a. 1,000 mrem TEDE

b. 5,000 mrem CDE to the thyroid

c. 500 mrem/h DDE that are sustained

Loss of physical control of the reactor facility may result in a General Emergency and would be declared upon consultation and concurrence with university organizations and off-site authorities.

6. EMERGENCY PLANNING ZONES

The operations boundary (Figure 4) is established as the Emergency Planning Zone (EPZ). Protective Actions for the EPZ are described in Section 7 of this plan. The NCSU PULSTAR Safety Analysis Report (SAR) states that the maximum hypothetical accident (MHA) consists of a loss of reactor pool water due to a ruptured inlet or outlet pipe. The hazard associated with the MHA is related only to the vertical radiation beam emanating from the unshielded shutdown core since the reactor fuel will be air cooled. Corrective measures for the MHA involve plugging the leak and refilling the pool without danger from the vertical radiation beam. Assuming the complete draining of the pool did occur from the MHA, the radiation dose rate in the control room is estimated to be approximately 0.25 rem/h. Considering the MHA, the total inventory of the core and the fact that the core can be air cooled, at no time would the Protective Action Guides (PAG) of 1 rem total effective dose equivalent (TEDE) or 5 rem committed (organ) dose equivalent (CDE) to the thyroid be exceeded. The SAR also indicates that the radiation dose for other events, such as a fuel cladding failure accident, is also within the EAL criteria for an Alert notification. PAG are not exceeded in the event of the MHA or other postulated accidents.

7. EMERGENCY RESPONSE

In general, a potential emergency situation is annunciated by the PULSTAR evacuation alarm. This alarm may be activated automatically upon exceeding a radiological set point or manually by a Designated NRP staff member or Reactor Health Physicist (RHP). A Designated NRP staff member or the RHP may act as the Interim Emergency Director (ED) to activate the PULSTAR Emergency Organization (PEO), to notify NCSU Campus Police, and to initiate actions to correct and/or mitigate the situation as necessary. NCSU Campus Police or NCSU Environmental Health & Safety Center may activate the NCSU Incident Command System (ICS). If an event at the reactor facility occurs during off-hours, a Designated NRP staff member or the RHP is notified by NCSU Campus Police. Only a Designated NRP Staff Member or the RHP can declare and classify an emergency at the PULSTAR reactor. After the decision that an emergency condition exists, the PEO and the ICS are assembled. Both the PEO and ICS assess the nature and magnitude of the situation, take corrective actions to terminate the emergency, and exercise all protective actions necessary to ensure the health and safety of emergency responders and the public commensurate with their responsibilities. Organizations which may be present at the ICS have indicated their support to this emergency plan in Letters of Agreement (refer to Appendix A). These letters are renewed every two years and kept on file for five years.

7.1. Activation of the PULSTAR Emergency Organization (PEO)

In general, this emergency plan is implemented by activation of the PEO if actual or imminent conditions meet the criteria of an Emergency Action Level. Upon being informed about a potential emergency situation at the PULSTAR reactor, a Designated NRP Staff Member or the RHP verifies the indication is valid. If an actual emergency condition exists or is imminent, the Designated NRP Staff Member or the RHP acts as the ED and activates the PEO. The PEO is considered functional upon staffing of the ED, RHP, ROM, and EC positions. Once the PEO is assembled, the ED verifies an EAL has been exceeded, classifies the emergency, directs the PEO, and coordinates actions with the ICS and NCSU Campus Police. As soon as possible after the activation of the PEO, pertinent organizations are notified as described below.

7.2. Notification

As referenced in Section 3 of this plan, certain agencies and/or organizations are required to be notified upon activation of the PEO. Emergency procedures identified in Appendix B of this plan provide the specifics of the notification process. The general process of notification is described below.

7.2.1. Organizations Notified

Once an emergency condition is confirmed to exist, the PEO is activated by the ED. If not already notified, the ED ensures the ICS is notified including NCSU Campus Police and the NCSU Environmental Health & Safety Center. Notification of the PEO and ICS may be made by telephone, pager, radio, or other communication methods. When the PEO is activated, the following organizations or agencies are notified in the following order of priority:

- 911 Emergency Communication Center
- North Carolina Emergency Management, if no answer then State Warning Point
- Nuclear Regulatory Commission (NRC)

The above organizations respond to the emergency notification in accordance with their policies and procedures. Requests by the PEO or ICS for emergency assistance by the above organizations are separate from formal notification.

Following notifications to the above listed organizations, other notifications are made to NCSU officials and interested parties, e.g. American Nuclear Insurers (ANI), in accordance with the emergency procedures.

7.2.2. Notification Process

The ED will ensure the notification message format provided in the PULSTAR emergency procedures with the required information is completed and transmitted to those off-site organizations listed in those procedures. The call list for those off-site organizations is located in the NRP emergency lockers. Notification should be made to these off-site organizations in the order of their listing using information provided by the formatted message. Failure to reach any of the organizations should not prevent or delay the transmittal of information to those lower on the list. Requests for assistance early in the emergency do not substitute for required notifications of off-site organizations.

Follow up emergency notification in this format will be authorized by the ED periodically or whenever changing conditions require it. In the case of the initial notification, read back of the message may be performed to verify the message contents.

Notification is typically made by the principal or alternate Emergency Coordinator (EC) at the ICS location. However, if the EC is not available, then a Designated NRP Staff Member or the RHP initiates the notification process as authorized by the ED.

7.2.3. Content of Notification Message

Notification messages include the following information, if known:

a. Name, title, and telephone number of caller and the location of the incident and emergency event

b. Description of the emergency event

c. Date and time of incident

d. Type and quantity of radionuclides released or expected to be released

e. Other information as required by the State of North Carolina emergency notification form.

7.2.4. Release of Information Other than Notification

The NCSU ICS Public Information Officer is identified as the sole official University spokesperson for the emergency. To ensure accuracy, the spokesperson must closely coordinate news releases with the ICS Incident Commander, ED of the PEO, and government public relations officials. The spokesperson is responsible for arranging interviews, issuing press releases and other announcements, and presiding at press conferences (although others may answer detailed questions). Emergency responders other than the ED and ICS Incident Commander are not to make any unauthorized statements.

7.3. Assessment Actions

The ED shall ensure necessary assessments are made to determine the extent of the emergency and the possibility of escalation to a more serious class. Actual or projected events may be used by the ED to change the emergency classification. The ED also makes requests for ICS support groups to address on-site emergencies as necessary.

The Reactor Health Physicist (RHP) has the responsibility for assessing the amount of radioactivity that has or will be released, and reporting the assessment to the ED. Emergency procedures and/or the Safety Analysis Report are used for determining quantities of released radionuclides and off-site dose projections.

The Emergency Operations Manager (EOM) has the responsibility for assessing reactor parameters and assembling and dispatching Emergency Teams to implement approved protective and corrective actions.

The Emergency Coordinator (EC) has the responsibility for assessing off-site radiological consequences of the emergency and serving as a Technical Advisor to the ICS.

The ICS Incident Commander has the responsibility for coordination of off-site emergency response by NCSU and other support groups.

7.3.1. On-Site Radiological Assessment

On-site radiation dose rates will be determined by portable survey instruments and fixed area radiation monitors. On-site contamination surveys will be made by analysis of swipes or by portable survey instruments. Airborne contamination surveys may be made by using fixed process monitors, continuous air monitor (CAM), or grab air samples.

7.3.2. On-Site Personnel Dose Assessment

Permanent, occupationally exposed employees are issued personnel dosimeters in accordance with applicable regulations and procedures. Extra personnel dosimeters, as well as direct reading dosimeters, are contained in emergency lockers. Personnel dosimeters are also available from the RHP and the EHSC. The RHP and EC coordinate distribution and collection of personnel dosimeters and tracking of personnel dose.

7.3.3. Off-Site Dose Assessment

Release rate, total release activity, activity concentration, and off-site dose are determined using data from the radiation monitoring system instrumentation, reactor instrumentation for the ventilation system and meteorological data using the emergency procedures. Instrumentation available for use is listed in Table 1 and Table 2. Detector efficiency for the radionuclides released, ventilation dilution flow, and weather conditions are taken into account. Meteorological data sources are described in Section 8.2.5.

7.3.4. Release Rate Determination when Normal Instruments are Inoperable

If the PULSTAR facility effluent monitoring instrumentation is either inoperable or off-scale, the PEO will obtain air samples or filter media through which air has passed (e.g., ventilation exhaust filters). These samples will be analyzed by gross alpha counters, gross beta counters, and/or gamma spectroscopy to

determine concentration.

Stack release rate is determined using emergency procedures and the stack exhaust flow rate and applicable stack dilution factor. Alternately, accident analysis given in the Safety Analysis Report may be used.

7.3.5. Liquid Radioactive Releases

Sampling and measurement of water in the reactor pool, primary system, and liquid waste system is performed as necessary using facility procedures. The reactor building is capable of holding the entire volume of the primary coolant system.

7.4. Corrective Actions

PEO personnel shall attempt to control a facility emergency with the means available until emergency aid arrives, provided this can be accomplished without serious risk. The ED will coordinate the activities to minimize the uncontrolled releases of radioactive materials. The PULSTAR Operations Manual contains emergency procedures for reactor operator response, including reactor scram, reactor building and BEL evacuation, and initiation of confinement. Corrective actions for emergencies include: reactor shutdown, assessment of reactor parameters, radiological assessment using fixed or portable instruments, initiation of confinement and/or evacuation, and assistance of fire, medical, and/or security personnel. The specifics of the emergency shall dictate the corrective actions.

7.5. Protective Actions

7.5.1. Evacuation

Evacuation of personnel is initiated by the cyclic sounding of alarm horns. There are two groups of alarm horns. One group is located within the reactor building and the other is located throughout the BEL complex. The second group is connected to the alarm system by a BEL/Reactor Building switch on the Radiation Alarm Panel that is under the supervision and control of the licensed reactor operator. This switch is turned to the Reactor Building during periods when a licensed reactor operator is in the BEL (normally during working hours), and is turned to the entire BEL complex after working hours, on weekends, and on holidays when a licensed reactor operator is not on duty. The alarm horns are activated automatically by designated radiation monitoring channel alarms or manually by a Designated NRP Staff Member by using a switch in the control room or by using a switch outside the northwest door of the reactor bay.

Upon activation of the evacuation alarm in the BEL complex:

a. Nonessential personnel in the BEL and control room will evacuate through the nearest exit, assemble outside the North entrance of the BEL, and wait for directions from the NRP.

b. Personnel in the reactor bay will evacuate through the northwest door and assemble in the change room. These personnel will then contact the control room using the intercom or telephone and wait for directions from the NRP.

c. Essential personnel will report to and remain in the control room as long as habitability requirements are met and begin performing preliminary assessment actions to determine if an actual emergency exists.

Upon activation of the evacuation alarm in the reactor building:

a. Nonessential personnel in the BEL may remain.

b. Nonessential personnel in the control room will evacuate to the BEL.

c. Personnel in the reactor bay will evacuate through the northwest door and assemble in the change room. These personnel will then contact the control room using the intercom or telephone and wait for directions from the NRP.

d. Essential personnel will report to and remain in the control room as long as habitability requirements are met and begin performing preliminary assessment actions to determine if an actual emergency exists.

NRP personnel who are members of the PEO are considered essential. As long as habitability requirements are met, the control room may be occupied. However, the control room will be evacuated in the event of a security threat, fire, hazardous materials incident, significant radiation or airborne radioactivity levels, natural disaster, or if it is otherwise not habitable. Radiological habitability requirements shall be established by the PEO and shall be consistent with emergency radiation exposure guides given in this Emergency Plan.

7.5.2. Personnel Accountability

Immediately after evacuating the BEL, it will be necessary to verify that all nonessential occupants have evacuated or are located elsewhere. Essential personnel may be present in the control room. The PEO and ICS will coordinate personnel search and rescue operations.

7.5.3. Re-entry Process

If evacuation of the BEL and control room has occurred, re-entry at a later time is coordinated through the ICS. Re-entry is a deliberate process with defined objectives. Each re-entry shall be conducted by a team of at least two members of the ICS or PEO. The re-entry team will maintain communications with the ICS and use appropriate protective clothing and equipment including dosimeters and survey meters as necessary.

The objectives of the re-entry team(s) shall be:

a. Building Search: To verify the complete evacuation of the BEL of nonessential personnel within 30 minutes after the evacuation is initiated and to report the location of injured personnel. Building search is typically coordinated by the ICS or NCSU Campus Police with support by the PEO.

b. Personnel Rescue: To remove injured personnel only. Personnel rescue is typically coordinated by the ICS or NCSU Campus Police with support by the PEO.

c. Radiation Survey: To perform a radiation survey of specified areas and entry ways into the BEL and reactor building. Radiation surveys are typically performed by the PEO and/or NCSU RSD.

d. Reactor building Re-entry: To obtain additional information to determine the cause of the

incident and to mitigate the consequences within the reactor building. Typically this is performed by the PEO in response to a reactor operational event or by the ICS for other events such as fire, hazardous materials incidents, or natural disaster. Re-entry from security incidents are coordinated by NCSU Campus Police.

e. Recovery Operations: To perform activities or sequences of events necessary to return the reactor to its normal operating condition through the execution of the emergency plan. The Recovery Organization is described in Section 9 of this Emergency Plan.

7.5.4. Reactor Building Re-entry Point

The reactor building re-entry point shall be determined by the ED or ICS Incident Commander on the basis of available information. Re-entry of the reactor building, including the control room, for radiation and reactor system information may be desirable. Re-entry of the reactor building for emergency assessment and actions may be accomplished as soon as habitability requirements are met. Radiological habitability requirements shall be established by the PEO and shall be consistent with emergency radiation exposure guides given in this Emergency Plan. Habitability requirements for other hazards within the reactor building shall be established by the ICS. Appropriate protective clothing will be worn and radiation surveys and monitoring of other hazards will be performed upon re-entry into the reactor building as necessary.

7.5.5. Return of Personnel

Occupants of the BEL who have been evacuated may be permitted to return to normal work areas only with permission by the ICS. Return of recovery personnel into the Reactor Building will depend on all hazards, radiological and others, being within occupational limits given in applicable regulations.

7.5.6. Aid to Affected Personnel

During an emergency, personnel may be required to enter contaminated or hazardous areas to rescue injured or trapped personnel. The ICS, with the advice of the ED, will assess the potential radiation hazards and authorize rescue operations accordingly.

The RHP and PEO Emergency Team will be responsible for controlling the potential spread of radioactive contamination and assisting in the decontamination of individuals involved in an emergency. The Raleigh Fire Department HAZMAT Team, has the capability, training, and equipment to provide limited emergency medical assistance to contaminated patients and to perform personnel decontamination operations. NCSU Fire Protection personnel have also been trained and have the capability of providing emergency medical assistance and performing personnel decontamination. The RHP, EC, or NCSU Radiation Safety personnel may accompany decontaminated patients to Rex Hospital.

The Raleigh Fire Department HAZMAT Team authorizes transport of decontaminated patients. Patients approved for transport are taken to Rex Hospital by Wake County Emergency Medical Services. Rex Hospital shall provide facilities to accept and treat injured patients in accordance with their emergency procedures. Letters of Agreement from the Raleigh Fire Department and Rex Hospital are maintained as part of the Emergency Plan (refer to Appendix A).

7.5.7. Personnel Exposure Guidelines

Personnel involved in any operation under this Emergency Plan should keep their radiation exposure As

Low As Reasonably Achievable (ALARA). Radiation doses will be within 10 CFR Part 20 limits unless permission to exceed these limits is given before the exposure occurs. Emergency radiation doses are limited as follows:

All doses are total effective dose equivalent (TEDE)

a. >25 rem may be authorized for lifesaving actions or for the protection of large populations if lower dose is not practicable and only by volunteers who are fully aware of the risks involved

b. Up to 25 rem may be authorized for lifesaving actions or for the protection of large populations if lower dose is not practicable

c. Up to 10 rem may be authorized for taking corrective actions to protect valuable property if a lower dose is not practicable

d. Up to 5 rem for all other actions

Dose in excess of 5 rem shall not be permitted unless the ED and the affected personnel agree that the circumstances merit this emergency exposure. This dose will be strictly voluntary. Individuals exposed to emergency doses above 10 CFR Part 20 limits are briefed on radiological conditions, ALARA precautions, biological risks, and other special instructions prior to being exposed. Emergency personnel doses are recorded. Planned Special Exposure dose histories for affected individuals are updated to reflect this emergency dose.

8. EMERGENCY FACILITIES AND EQUIPMENT

To facilitate the control of the numerous actions required in an emergency situation, several facilities have been designated as operating centers for the PULSTAR Emergency Organization (PEO) and NCSU Incident Command System (ICS). Specialized equipment has been installed or prepositioned to aid emergency response.

8.1. Emergency Facilities Locations

8.1.1. PULSTAR Control Room

The PULSTAR control room is the central facility from which reactor control is exercised. Instrumentation and controls necessary for operation of the reactor are provided. Equipment is provided to give a warning of a potential emergency and to continuously monitor key reactor parameters. Equipment is available for both on-site and off-site communications. Supply of auxiliary electrical power when off-site electricity is lost is provided to the control room by a natural gas fueled generator.

8.1.2. Emergency Support Center (ESC)

The Emergency Support Center (ESC) is composed of those offices normally occupied by the NRP staff. Intercom, telephone, or portable radio communication capabilities link these offices with the control room. The ESC is directly adjacent to, but outside of, the PULSTAR reactor building and control room. Alternately, the ESC may be located in the BEL conference room on the first floor. The ESC will be activated whenever the PULSTAR Emergency Organization (PEO) is activated. If the ESC cannot be occupied because of BEL evacuation, it will be transferred to the NCSU ICS or to an adjacent building.

8.1.3. Incident Command System (ICS)

Once activated, the Incident Command System (ICS) coordinates NCSU and local support agencies in the event of an emergency. An Incident Command Center is established near the PULSTAR reactor building and serves as the meeting point for all NCSU and off-campus support groups. The Incident Command Center is maintained by NCSU and has telephone, fax, and radio communication equipment, and office supplies.

8.2. Emergency Equipment

8.2.1. Decontamination Supplies and Personnel Rescue Equipment

Decontamination supplies are located in the emergency lockers in the BEL north foyer and change room. The change room also has a shower for personnel decontamination. Stretchers are located in the change room and the BEL north foyer for personnel rescue operations.

8.2.2. Communications

The intercom system provides the primary basis for communications between the control room and remote stations in BEL. The master station located on the control console may select any one or all of the following stations:

a. Manager of Engineering and Operations

b. Reactor Health Physicist

c. Reactor Operations

d. Reactor Bridge

e. Mechanical Equipment Room

f. Primary Piping Vault (inside Reactor Bay)

g. Reactor Bay (NW Door)

h. Change Room

i. Health Physics Laboratory

j. Nuclear Services Laboratory

The public address system is an auxiliary means of communication to the reactor bay and BEL basement laboratories. Should the normal evacuation system fail, this system is used in evacuating the reactor building area, for general announcements, and for directing persons in an emergency. Controls for the public address system are located in the control room. The NCSU Campus Police provides exterior public address using loudspeaker systems. NCSU has a telephone system that allows communication between stations on campus. Commercial lines for both local and long distance dialing are available. Telephone jacks are available in the ESC conference room and in all NRP offices, control room, reactor bay, Health Physics Laboratory, and Nuclear Services Laboratory. Two-way radios are used for emergency communications and for contact between Emergency Teams. These are hand-held devices capable of maintaining communications anywhere near and within the BEL. Portable radios are available in the BEL north foyer emergency locker and in the control room. A radio with a common channel is used to communicate with ICS.

8.2.3. Radiological Assessment Equipment

Radiological assessment equipment provides the PEO with the information necessary to make accurate estimates of the radiological consequences of an emergency. It serves, in part, to supply the information for the initiation of protective actions. The equipment is stored in convenient locations for timely response. This equipment is maintained in emergency lockers. Emergency lockers containing accident assessment and personnel protective equipment and clothing are located in the BEL north foyer and in the change room. In addition, NCSU Environmental Health and Safety Center maintains a locker of emergency equipment. If an item contained in these lockers is missing due to repair and/or calibration, a suitable substitute may be provided.

Table 1 lists the locations and associated alarms for the radiation monitoring system. This system is used for monitoring reactor building areas, airborne radioactivity, and the waste tank vault. Readout modules for these monitors are in the control room. Additionally, these monitors are connected to a multipoint chart recorder which operates continuously to maintain a historical record of radiation levels.

8.2.4. Reactor Instrumentation

Various reactor instruments are used in determining the status of the reactor facility. These include instruments used in the ventilation system and coolant systems. Table 2 lists the instruments, sensor locations, and display locations.

8.2.5. Meteorological Data

The Raleigh Durham airport (RDU) is located approximately 10 miles from the reactor facility. RDU meteorological data is available via the internet and from the National Weather Service (NWS). Additionally, data from other weather stations in the Raleigh area may be available via the internet, NWS, and from broadcast media (radio, television). Data provided includes temperature, wind speed, wind direction, and precipitation. Atmospheric stability class is determined using this data and the emergency procedures.

8.2.6. Fire Alarm System

The Fire Alarm System for the BEL is composed of various thermal and smoke detectors, and manual switches. The sensors or manual switches activate relays in a master control panel, which sounds the building audible alarms and transmits a signal to Campus Police. On receipt of an alarm in the reactor building, a fire alarm is activated within the BEL and annunciation is made on the Fire Alarm Annunciator panel located at the South and North entrances to the BEL. Status of specific sensors is displayed on the Fire Alarm System panel at the South BEL entrance.

8.2.7. Analytical Laboratories

The NRP has a Nuclear Services Laboratory and a Health Physics Laboratory capable of performing various sample analysis for radioactivity in case of an emergency. If the NRP analytical equipment is unavailable or inaccessible, the NCSU RSD will provide laboratory analysis.

8.2.8. Medical Assistance for Personnel

The various aspects of emergency capabilities for assisting injured and/or contaminated individuals are described in Section 7.

8.3. Contingency Planning

In case any emergency facility or equipment is unusable, the following backup facilities are available:

- NCSU RSD for personnel dosimetry, portable radiation survey equipment, air samplers, and radioactive sample analyses
- Adjacent buildings or other spaces with the BEL for the ICS for the PEO, including the ESC
- Medical assistance may be provided by Wake Med in Raleigh NC

9. RECOVERY

After the emergency has been terminated, steps will be taken to initiate recovery. All recovery actions will be planned and executed using approved, written procedures to minimize radiation exposures and other hazards to recovery personnel. The overall goals of the recovery effort are to assess the consequences of the emergency, and to perform clean up and repair operations. This effort includes the marshaling of NCSU resources and interfacing with outside agencies.

The PULSTAR Recovery Organization is identical to the PULSTAR Emergency Organization (PEO) in which the Emergency Director (ED) assumes the role of Recovery Director (RD). Other identified positions of the PEO shall remain available to function with the same line of succession for the particular aspects of the recovery operation. The NCSU Incident Command System (ICS) is disbanded upon termination of the emergency. NCSU support groups, such as Campus Police and Environmental Health and Safety Center, Facilities Operations, Construction Management, and others work in association with the PULSTAR Recovery Organization to complete necessary assessments and repairs.

The incorporation of identical organizations between the emergency and recovery phases yields an efficient and orderly transition to the recovery operation.

10. MAINTAINING EMERGENCY PREPAREDNESS

Emergency preparedness at the PULSTAR reactor is maintained by:

a. Preparing the PULSTAR Emergency Organization (PEO) and NCSU Incident Command System (ICS) members for emergency response action through training and drills,

b. Periodic review and update of the PULSTAR Emergency Plan and the associated emergency procedures, and

c. Periodic inventory and calibration of emergency equipment and instruments.

10.1. Organizational Preparedness

Organizational preparedness is maintained through an integrated training program that includes training of individuals assigned to the PULSTAR Emergency Organization and NCSU Incident Command System.

10.1.1. NRP PULSTAR Emergency Organization

NRP staff members that function in the PULSTAR Emergency Organization are trained in the following areas:

a. PULSTAR Emergency Organization and NCSU Incident Command System,

b. Emergency classes and action levels,

c. Emergency communication procedures,

d. Capabilities and services to be provided by support organization and agencies,

e. Emergency radiation exposure control and limits,

f. Record keeping, and

g. PULSTAR Emergency Plan and procedures

10.1.2. NCSU Environmental Health and Safety Center

Personnel assigned to the NCSU Environmental Health & Safety Center, including the RSD, that would be mobilized during an emergency are trained in:

a. PULSTAR Emergency Organization and Incident Command System,

b. Emergency classes and action levels,

c. Capabilities and services to be provided by support organizations and agencies, and

d. Emergency radiation exposure controls and limits.

10.1.3. NCSU Campus Police

Campus Police training includes:

a. PULSTAR Emergency Organization and Incident Command System,

b. Facility familiarization,

c. Principles of radiological safety and the effects of radiation, and

d. Emergency communication procedures.

10.1.4. Off-Site Organization/Agencies

For those organizations which provide emergency services (i.e., Wake County Department of Public Safety which includes the Wake County Emergency Management Services Division and Wake County Emergency Medical Services, State Radiation Protection Section, Raleigh Fire Department, and Rex Healthcare[1] (hospital) training is offered and includes:

a. PULSTAR Emergency Organization and Incident Command System,

b. Facility familiarization,

c. Emergency radiation exposure control and limits,

d. Principles of contamination and decontamination, and

e. Drills with off-site responders in cooperation with Wake County Emergency Management

[1]NOTE: Training may be conducted by Rex Healthcare staff with no tour of the reactor facility. Training is focused on treatment and handling of radioactive patients since Rex Healthcare would not respond to the reactor site.

10.2. Drills

On-site emergency drills shall be conducted annually, but not to exceed 15 months, to test the integrated capability of the Emergency Plan, or a component thereof, and may include actions and simulations. Instruction may also be included in emergency drills to develop and maintain skills in a particular operation.

At least every two years, emergency drills shall contain provisions for coordination with on campus and off-site support organizations, including communication links and notification procedures.

10.2.1. Development of Written Scenario for Emergency Drills

Each emergency drill shall have a documented, written scenario that includes the following information:

a. Objectives

b. Date, time, place, and participating organizations

c. Simulated events

d. Time schedule of real and simulated events

e. Narrative summary describing the conduct of the drill, e.g. actions, simulated events, on-campus and off-site support organization assistance, rescue of personnel, radiological monitoring equipment and personnel, and public information

f. Arrangements for controllers and observers.

10.2.2. Critique of Emergency Drills

A critique of the emergency drill will be held by the NRP to identify any deficiencies observed during execution of the emergency drill and to recommend corrective actions. Controller, observer, and participant comments shall be considered during this critique. The critique is held at a convenient time following the emergency drill, but not later than one month.

10.3. Emergency Planning Coordinator

The Reactor Health Physicist is the NCSU PULSTAR Emergency Planning Coordinator. This person is responsible for coordinating on-site and off-site radiological emergency response planning and requesting review and comments from the Wake County Emergency Management Services Division, State of North Carolina, and NCSU support organizations. The Reactor Health Physicist requests the relevant individuals to prepare and maintain the applicable emergency procedures. This person is also responsible for the following planning functions:

a. Interfacing with federal, state, county, and local planners

b. Reviewing and updating the plan biennially and in response to new federal regulations, modifications identified during drills, and changes in hardware and personnel

c. Maintaining agreements for state and county response agencies, federal assistance agencies, and medical and fire support agencies.

The PULSTAR Manager of Engineering and Operators (Emergency Director) is responsible for implementing corrective actions needed following a drill, assigning responsibility for implementing these actions, specifying a schedule for completion of these actions, and evaluating the adequacy of the actions taken.

10.4. Review of the PULSTAR Emergency Plan and Procedures

The PULSTAR Emergency Plan and procedures provide for continuous emergency preparedness. In addition to training and drills, regular reviews and audits are performed. Emergency Plan and procedure reviews and updates are described in the following subsection.

10.4.1. Plan and Procedure Revision and Update

The Reactor Health Physicist is responsible for coordinating the updating of the PULSTAR Emergency Plan and procedures. Biennial reviews are performed by the Reactor Safety and Audit Committee (RSAC). Any changes to the PULSTAR Emergency Plan and procedures due to regulatory revisions, experience

gained from drills, RSAC review comments, or other requirements are reviewed by the RSAC and the NCSU Radiation Safety Committee. Revisions to the PULSTAR Emergency Plan and procedures will be distributed to all pertinent organizations and responsible individuals, and implemented within 30 days of approval. Revised sections will be either summarized or marked to indicate changes.

10.4.2. Off-Site Agreements

Agreements with support organizations are revised and updated by off-site organizations every two years.

10.5. Equipment Readiness

10.5.1. Inventory

An inventory of all emergency equipment and supplies is held quarterly and after use in an emergency or drill. Appropriate emergency locker contents are described below and are specifically listed in the PULSTAR emergency procedures.

Inventory lockers are located in the BEL Lobby, BEL basement, and at the EHSC. Necessary items in sufficient quantities are maintained in the emergency lockers include the following:

a. Protective clothing and personnel protective equipment; e.g. coveralls, shoe covers and boots, caps and hoods, gloves, respirators

b. Radiological supplies; e.g. survey meters, personnel dosimetry, air sampler, various items for radiological controls and sampling

c. Decontamination supplies; e.g. various cleaning materials for people and items

d. Communications equipment; e.g. hand held radios, telephone

e. Documents; Emergency Plan, Emergency Procedures, Operations Manual, blank procedure forms and official notification forms

f. Miscellaneous equipment; e.g. keys for access to emergency lockers and equipment, electrical supplies and lighting, cutting utensils, office supplies

10.5.2. Maintenance and Calibration

Preventative maintenance on portable survey meters is performed monthly. Calibrations are performed annually, but not to exceed fifteen months. Calibration is also performed whenever an instrument is suspected of faulty operation.

10.5.3. Functional Testing

Survey instruments and communications equipment are functionally tested monthly.

Table 1 – Radiation Monitoring System

Monitor	Detector Location	Set Point Bases		Automatic Action
		Warning	Alarm	
Control Room	Control Console	Restricted area dose rate limit	Radiation Area	WARN causes Radiation Alert Annunciation on Reactor Console ALARM causes Evacuation
Pool	Over Pool	Radiation Area	High Radiation Area	
West Wall	Reactor Bay West Wall	Radiation Area	High Radiation Area	
Primary Demineralizer	PPV Demineralizer	Abnormal level	High Radiation Area	WARN causes Radiation Alert Annunciation on Reactor Console
Stack Gas	Stack Sampling Unit	TS limit	TS limit	WARN causes Radiation Alert Annunciation on Reactor Console ALARM causes Evacuation
Stack Particulate		TS limit	TS limit	
Stack Exhaust	Exhaust Duct	TS limit	TS limit	
Recirculation Air Monitor [(a)]	Normal Ventilation Recirculation Duct	3 Derived Air Concentration (DAC) Fraction	10 DAC fractions	WARN causes Radiation Alert Annunciation
CAM [(a)]	Reactor Bridge	0.3 DAC fraction	1 DAC Fraction	Local Audible & Visual Alarm at Alarm set point
[Optional] Experiment Area Monitor	At experiment facility	Abnormal level	Abnormal level	None or may have local audible & visual alarms

(a) Derived Air Concentration (DAC) as listed in 10 CFR Part 20 Appendix B

Table 2 – Reactor Instrumentation

Instrument	Location	Readout	Remote Display	Notes
Ventilation Flow Meter	Exhaust duct	Control Room	Optional via internet	This is an optional instrument
Reactor Building dP	Reactor Bay	Control Room		
Reactor Pool Water Level	Reactor Pool	Control Room	Optional via internet	
Reactor Pool Temperature	Reactor Pool	Control Room	Optional via internet	
Reactor Pool pH	Reactor Pool	Control Room	Optional via internet	This is an optional instrument
Reactor Power	Reactor Pool	Control Room	Optional via internet	
Reactor Pool Resistivity	Reactor Pool	Control Room	Optional via internet	This is an optional instrument
Primary System Flow	Primary Piping Vault	Control Room	Optional via internet	
Primary Coolant Pump	Mechanical Equipment Room	Control Room		
Secondary Coolant Pump	Mechanical Equipment Room	Control Room		
Video Cameras	Various	Control Room	Optional via internet	

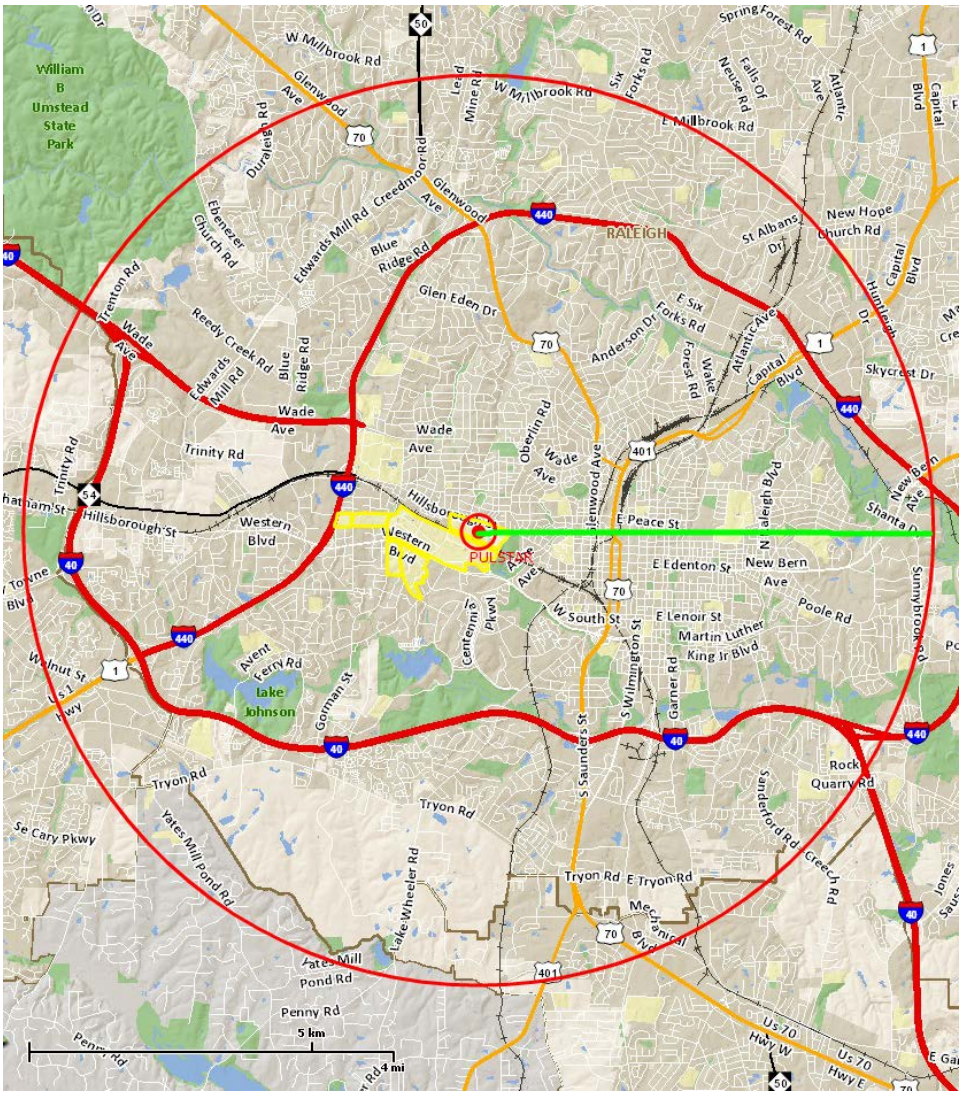


Figure 1 – Raleigh City Map

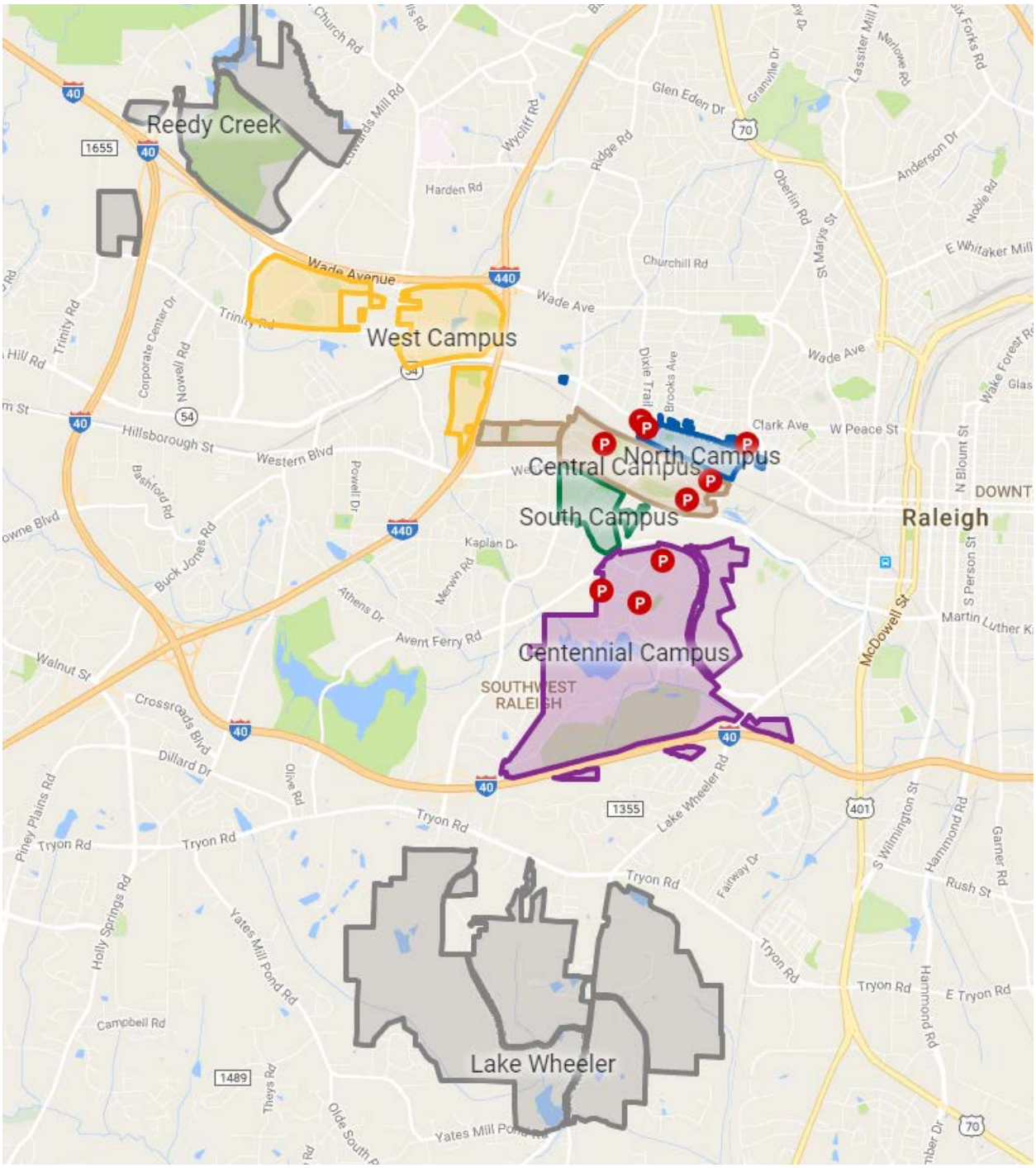


Figure 2 – North Carolina State University Campus

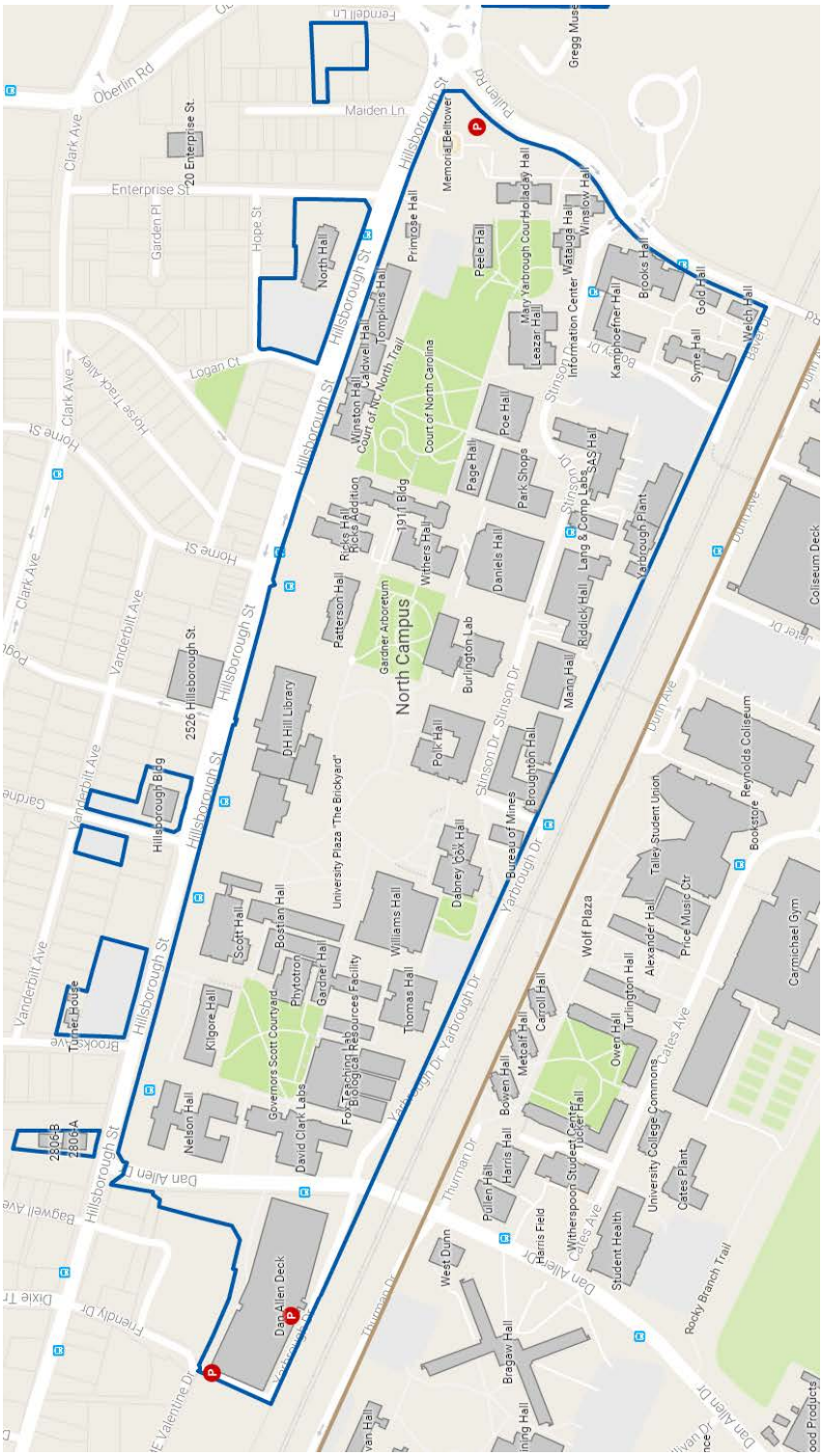


Figure 3 – North Carolina State University North Campus

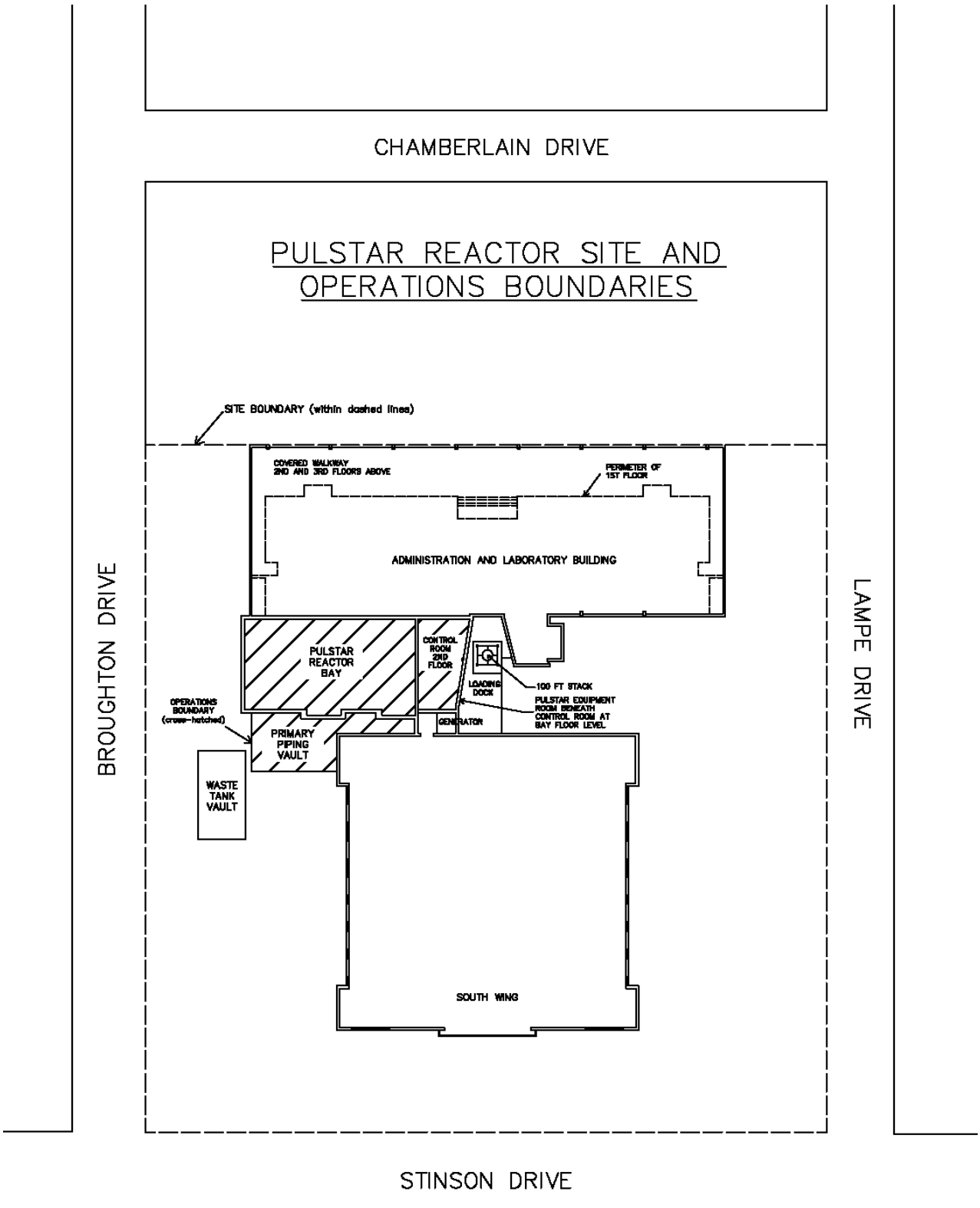


Figure 4 – Burlington Engineering Laboratory Site Map

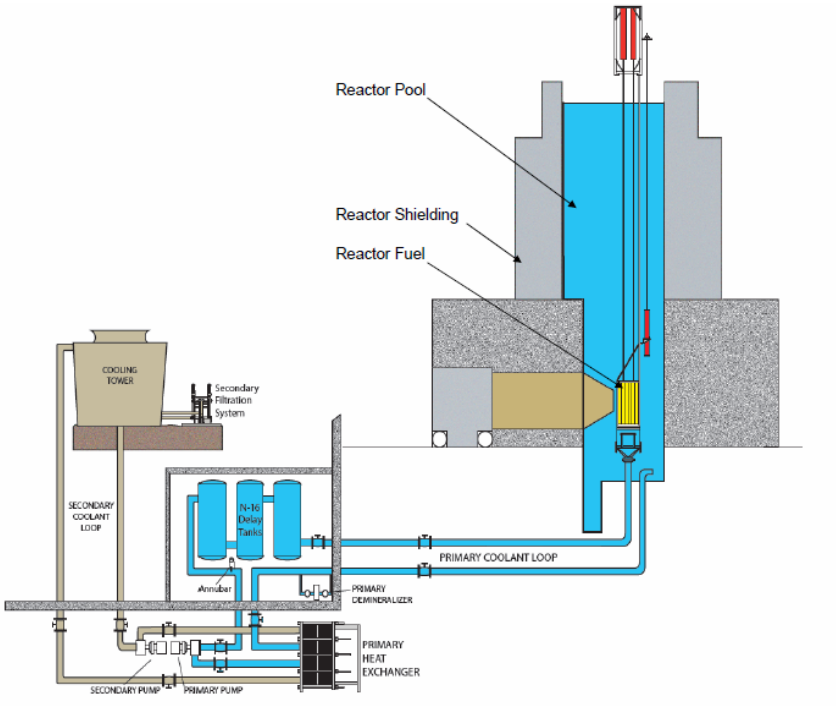
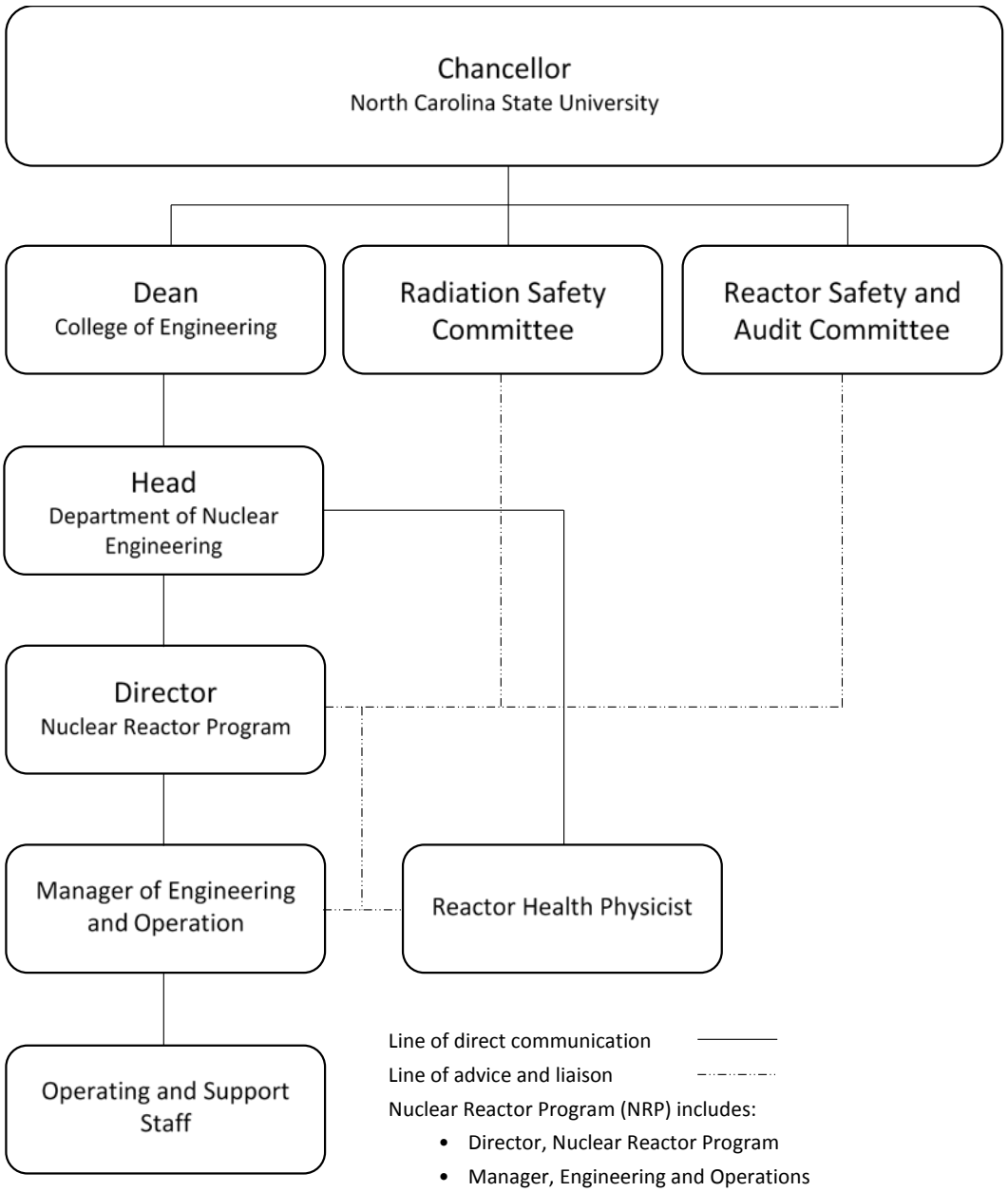


Figure 5 – Reactor Plan View



Line of direct communication ————

Line of advice and liaison – · – · –

Nuclear Reactor Program (NRP) includes:

- Director, Nuclear Reactor Program
- Manager, Engineering and Operations
- Operating and Support Staff

Reactor Health Physicist (RHP) reports to the Head, Department of Nuclear Engineering and serves both the NRP and Department of Nuclear Engineering.

Communication on reactor operations, experiments, radiation safety, and regulatory compliance occurs between the NRP, RHP, Reactor Safety and Audit Committee, Radiation Safety Committee, and campus Radiation Safety Division as described in the Technical Specifications and facility procedures.

Figure 6 – Nuclear Reactor Program Organizational Chart

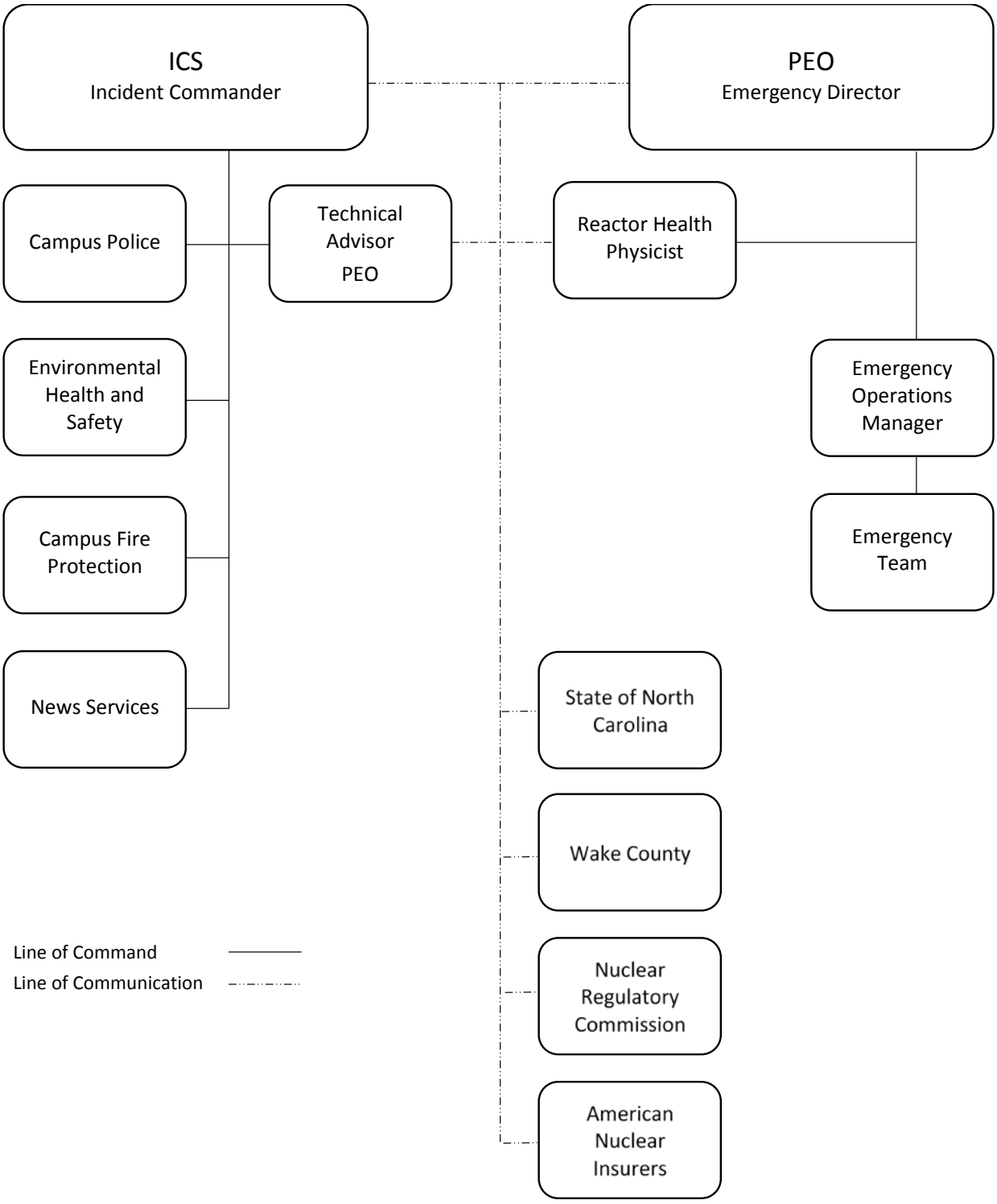


Figure 7 – PULSTAR Emergency Organization (PEO)

APPENDIX A – LETTERS OF AGREEMENT

Written letters of agreement from the agencies listed below are kept on current and on file:

- North Carolina Emergency Management
- Wake County Department of Public Safety
- City of Raleigh Fire Department
- Rex Healthcare

APPENDIX B – LIST OF EMERGENCY PROCEDURES

The following list of emergency procedures is maintained to support the Emergency Plan:

- Emergency Plan Activation and Response
- Notification
- Release of Information
- Emergency Classification
- Recovery
- Emergency Preparedness; Training, Drills, and Inventory
- Determination of Concentration, Release Rate, and Off-Site Dose from Airborne Effluent