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RADIOLOGICAL EMERGENCY RESPONSE PLAN
FOR LOUISIANA STATE UNIVERSITY

A Thesis

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by
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Dedicated to my family

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ABSTRACT

Although the risk for radiation impact is small, institutions using significant quantities of radioactive materials have a mandate to develop emergency response plans to provide reasonable assurance that appropriate measures will be taken to protect the public health and safety. Louisiana State University, which currently has a significant inventory of these materials, can expect a variety of radiation emergencies which could pose risks to students, faculty, and workers. In order for the University to have full preparedness, a Radiological Emergency Response Plan was developed using the criteria in Nuclear Regulatory Commission Report NUREG-0654. Implementation of the Plan would begin with the appointment of a University Committee on Emergencies which would have responsibility for planning to cope with all emergency situations. Emergency Response Teams would be developed with redundant capabilities but specific primary assignments. Five levels of action in response to an emergency have been defined to account for both the radiological hazard and compounding factors; specific actions would be taken on a five-level priority system. Both recovery from an emergency and emergency facilities have been addressed, as has maintenance of the Plan through periodic review and critique after practice exercises. Four hypothetical incidents, ranging from trivial through an airborne plutonium release, when examined in detail lead to the conclusion that full activation of all parts of the Plan are not required for the anticipated increase in radioactive material inventory on the University campus through 1986. The Radiological Emergency Response Plan could be used as a model for other emergency plans with relatively minor changes.

CHAPTER 1

Introduction

Radioactivity was discovered in 1896 by Antoine Henri Becquerel, a French physicist. His discovery led to the important research of Pierre and Marie Curie and others. Radium and other radioactive elements were discovered, and much was learned about the nature and effect of radioactivity. It was not until 1939 that the possibility of releasing large amounts of energy for military or other purposes became known. This discovery led to the atomic bomb.

After the use of the atomic bomb in World War II the public supported the development of the new form of energy. The development of this new form of energy was then placed in the hands of civilians, with the President having ultimate authority. The first legislation related to the development and regulation of nuclear energy was the Atomic Energy Act of 1946, which was greatly expanded by the Atomic Energy Act of 1954. This Act established a five-man commission which spelled out the mandate of the commission in nuclear matters, and it also established an agency called the "Atomic Energy Commission (AEC) to carry out the directives of the five-man commission. The Commission was critized later because it was in the position of being both the promoter and regulator of atomic energy. In order to correct the problem, Congress enacted the Energy Reorganization Act of 1974. This Act (1) abolished the Atomic Energy Commission, (2) consolidated the Energy Research and Development Administration, and (3) transferred all of the licensing and regulatory functions held by the AEC to the Nuclear Regulatory Commission.[1]

In 1979, the Three Mile Island accident and extensive news-media coverage gave momentum to the development of Radiological Emergency Response Plans by the federal government, state, and nuclear material licensees. Such plans had been required previously, but their development and implementation was not given high priority because the risks from nuclear installation are extremely low when compared to risks commonly accepted in other forms of human endeavor. Some of these risks are listed in Tables 1-1, 1-2, and 1-3.[2] In each table, the reduction in life expectancy is given for a particular causal agent by averaging known or theoretical data over the entire United States population. The day of life expectancy lost from occupational activities are listed in Table 1-1, which identifies mining and quarying as having the greatest impact, and radiation use as having the least, even for an assumed dose many times greater than is actually

Table 1-1

Risks from Occupational Accidents

Industry Type	Days of Lost Life Expectancy
Trade	30
Manufacturing	43
Service	47
Government	55
Transportation and Public Utilities	164
Agriculture	277
Construction	302
Mining, Quarrying	328
Radiation (0.5 rem/yr)	40

Table 1-2

Risks from Catastrophic Event

Catastrophic Event	Days of Lost Life Expectancy
Hurricanes	0.5
Tornados	0.5
Earthquakes	0.1
Air crashes (passengers)	1.0
Air crashes (people on ground)	0.1
Major explosions	0.2
Dam failures	0.5
Major fires	0.5
Chemical releases	0.1
Nuclear reactor accidents	0.02

Table 1-3

Risks from Individual Action

Individual Actions	Minutes of Life Expectancy Lost
Smoking a cigarette	10
Calorie-rich dessert	50
Non-diet soft drink	15
Diet soft drink	0.15
Crossing a street	0.4
Coast to coast drive	1,000.0
Coast to coast flight	100.0
Buying a small car	7,000.0
1 mrem of radiation	1.5

experienced. In Table 1-2, airplane crashes are identified as having the greatest effect, and nuclear power as the least effect from catastrophic accidents. The risks associated with various personal actions are compared in Table 1-3. From the data presented in this table, it can be estimated that a standard 50-millirem chest x-ray would lead to a loss-of-life expectancy of 75 minutes, smoking one package of cigarettes would lead to 200 minutes lost, and drinking five non-diet soft drinks a year has the same risk as an annual chest examination.

Although the risk for radiation impact on the public is small, and in fact is less than that used for calculating the assessments in Tables 1-1 and 1-2, the development of radiological emergency response plans for institutions using significant quantities of radioactive materials is mandatory. Because of the increasing and wide-spread use of radioactive materials here on the Louisiana State University campus and the anticipated increase in shipments and storage of these materials for biological research and veterinary medicine, Louisiana State University can expect a variety of radiation emergencies which could pose risks to the welfare of the students, faculty, and workers.

The purpose of this thesis is therefore to develop a Radiological Emergency Response Plan which will describe the actions to be taken toward alleviating the consequences of emergencies involving uncontrolled radioactive materials, and to provide reasonable assurance that the appropriate measures can and will be taken to protect the health and safety of students, faculty, and workers. The Radiological Emergency Response Plan will be developed from the information found in Report NUREG 0654, Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants.[3] Report NUREG 0654 is being implemented by Louisiana Power and Light Utility Company, Gulf States Utilities, and the State of Louisiana. Although Report NUREG 0654 is intended for nuclear power plants, it will be used as an aid in developing the Louisiana State University Emergency Response Plan, mainly because no plan should be developed in a vacuum or in isolation from other emergency response plans. Should an incident occur, the students, faculty, and workers can be best protected when the response by all parties are fully coordinated.

CHAPTER 2

Louisiana State University Radioisotope History

This chapter will develop briefly the growth of radioisotope usage and radiation safety on the Louisiana State University campus from 1947 to 1981, and project these to future needs.

The history on the first uses of radioisotopes at Louisiana State University is sketchy because important information dealing with the earliest uses has not been archived. In 1948, Louisiana State University prepared the foundation for the first radioisotope laboratory. A year later the Atomic Energy Commission granted approval for use of the building as a radioisotope laboratory, under the directorship of Dr. Charles Simons. The Atomic Energy Commission requirements for an institution to obtain radioisotopes were: (1) have trained personnel and (2) have an approved facility.

A photograph of the Louisiana State University Radiochemistry Laboratory is presented in Figure 2-1. Throughout its use, the laboratory housed research workers in the fields of agronomy, bacteriology, biochemistry, and botany.[4] The use of radioisotopes was controlled by a large radioisotope committee, appointed by University

Illustration 2-1

Radiochemistry Building 1948-1955[5]

President Dr. Harold W. Stoke, who said,

> "Any University which is not preparing to introduce its students to the study of atomic energy will be left hopelessly behind."

The first committee governed the use of radioisotopes until April 18, 1955, when it was reconstituted as the Atomic Energy Advisory Committee. The use of radioisotopes was under an AEC General Authorization until August 6, 1958. On August 7, 1958, Louisiana State University received a broad-scope license from the AEC. Regulatory responsibility for the license was assumed by the State of Louisiana in 1967.

In 1955 the Advisory Committee on Atomic Energy was formed; in 1958 it was phased out and reorganized as the Nuclear Energy Committee. The new committee was composed of the central Nuclear Energy Committee and an advisory subcommittee for each college or school. The Nuclear Energy Committee was later revised in 1965 to eliminate the subcommittees, in 1975 to establish campus committees throughout the University system, and in 1981 to consolidate its membership. This committee is now called the LSU System Radiation Protection Committee, and campus uses are under the Baton Rouge Campus Radiation Safety Committee.[6,7,8,9]

Prior to issuance of the first of five AEC licenses in 1958, the University had no formal internal document establishing the responsibilities of radiation safety. The application for the first license included the first such document issued by the Office of the President. After several revisions, this document became identified as PM-30; the latest revision was issued April 1, 1981.

According to Dr. Max Goodrich, Dean-Emeritus of the Graduate School, there was a continuous turnover in personnel in 1955, therefore, some of the individuals working in the radiochemistry building were not fully trained in radioisotope procedures. This lack of training lead to contamination of the radioisotope laboratory with long-lived activity. The decontamination program ended with the radioisotope laboratory being burned and buried in an isolated location on University property near the Mississippi River.[10]

Initial uses of radioisotopes were predominantly in chemistry and physics, which later were joined by zoology, botany, agriculture, and the fine arts. After the radioisotope laboratory was burned, a large-animal metabolism facility, also named the Radioisotope Laboratory, was developed in 1958. The number of isotope users at that time, and the scatter of the laboratories involved, lead to the suggestion of a centralized facility in 1959, and to renovation of the original creamery building into the Nuclear Science Center in 1961. By 1965 the centralized-facility concept had been exceeded, and the number of laboratories where radioisotopes were in use had grown to approximately 18 locations, including several off-campus sites. More recent large research and teaching buildings have been designed specifically for low- and preparative-level isotope usage. These building include Choppin Hall (chemistry), the Life Science Building, the School of Veterinary Medicine, and the Center for Engineering and Business Administration.

Projection of the needs of the University in radiation safety for the next five years is difficult because of changing research interests; however, past experience implies a general increase in radioisotope usage. Receipts of radionuclides, new user projects, and waste generated for the last several years are summarized in Table 2-1.[11] The data in this table suggest a slow upward trend in all categories. By 1986 the number of shipments received are predicted to be at 200 per year. The number of new user projects may be near 22 per year, and the amount of waste generated might approach 100 drums annually. There are now 131 film badges issued to research personnel each month, with an expectation of perhaps 250 badges per month by 1986. Discounting sudden increases in the number of user laboratories with the opening of new major buildings, the number of locations where radioactive materials are in use has increased by

Table 2-1[a]

Radionuclide Activities on the Baton Rouge Campus

Year	Shipments Received	New User Projects	Waste Generation, Equivalent Drums
1978	128	11	25
1979	146	9	35
1980	148	10	45
1981	158*	14*	60*

*Projected for the full calendar year.

[a]Reference 11.

approximately four each year. Currently, 18 buildings housing 32 laboratories are involved with radioisotope usage; by 1986 these are expected to increase to approximately 48 laboratories in 22 buildings.

Although the major permanent hazards have been housed in carefully designed facilities in the Nuclear Science Center, for one period of time a 30,000-Ci ^{60}Co irradiator was operated in a utility building near the sorority-house area, and for another short period a trailer-based 45,000-Ci ^{137}Cs source was located in the parking lot of the Parker Agricultural Center. Recent rulings concerning regulation of irradiated food products could lead to a need for large radiation sources, and possible upgrading of the pool sources in the Nuclear Science Center to as much as 60,000 Curies of ^{137}Cs.

These various projections are necessarily uncertain; however, within the limits of their uncertainties, there is good reason to believe that the number of people working with radioactive materials, the number of places these are used, and the on-hand inventory of these materials will increase significantly within the next five years. These increases bring with them an increased probability of both the number of accidents and the severity of such accidents. The Radiological Emergency Response Plan developed in this thesis is an attempt to prepare the University to deal effectively with the anticipated problems.

CHAPTER 3

Rationales for the Radiological Emergency Response Plan

The development of an Emergency Response Plan is a job which consumes a great deal of time, but is never completed because of the changes in needs, rules and regulations, devices, or personnel. As stated earlier in this thesis, the guidance used to develop the radiological plan is NUREG-0654. An interim version of this document was issued in January, 1980; it was then commented upon by the public, and, based on the public comments in October, 1980, was revised and published in November, 1980.[3]

Chapters 1 and 2 have established the background and historical perspective for the need to develop a radiological emergency response plan for Louisiana State University. The approach chosen for the development was to adopt NUREG-0654 to a university situation, modifying requirements when appropriate, on the assumption that a potential need for the full plan exists. Actual need will be developed later by considering several radiological incidents, which will be used as a basis for recommending what parts of the plan may be required now, and the order of priority for implementing the plan.

This approach to the development of the Radiological Emergency Response Plan has the advantage that additional portions may be activated as potential hazards on the campus become more severe. Another advantage is that all aspects of radiological emergency response planning must be examined as the program is reviewed periodically. Specific emergency plans have been established to meet existing needs in current licensing documents and safety manuals for the University, but they are not integrated into a general response plan.

The complete Radiological Emergency Response Plan is included in Appendix A without interruption. The various parts of the plan will be discussed in this chapter, along with the rationale and supporting comments for the parts.

The Emergency Response Plan detailed in Appendix A is organized to: (1) provide the best protection for the health and safety of the students, faculty, and workers; (2) make sure each party involved has a clear understanding of what the overall level of preparedness is, and what role it will play in the event of a nuclear incident; and (3) provide redundancy in all parties involved so that one party weakness is compensated for by strengths of the other parties.

The emergency measures developed in this thesis include corrective actions for the Louisiana State

University campus; protective measures for students, faculty, and workers on campus; and aid to the affected student, faculty, and workers.

Implementation

In order for the University to translate the Emergency Radiological Response Plan into an official program, formal review and approval will be necessary. An initial step would be the establishment of a Committee on Emergencies by the Chancellor to undertake the task of developing a master emergency response plan. The committee should be composed of the following members:

1) Vice-Chancellor for Administration, Chairman,
2) Campus Safety Officer,
3) Campus Radiation Safety Officer,
4) Head, Office of Physical Plant,
5) Chief of LSU Police
6) Supervisor, Telephone Exchange, and
7) Head of New Services.

These individuals would provide the expertise to meet the needs for direct involvement of the Chancellor's office, both general and radiation safety, maintenance and safe shut-down of facilities and equipment, law and order, internal campus-wide emergency communication, and public information.

The Committee on Emergencies would supervise the development of all emergency response plans, and merge these into a master plan. The Radiological Emergency Response Plan developed in this thesis could be employed as a model for both the other specific response plans and the master emergency response plan.

Organization

Both University personnel and off-campus groups and individuals may be required to respond successfully to a radiological emergency. The Campus Radiation Safety Officer would be the primary responsible individual for all radiological emergencies, initially to assure the safety of emergency personnel and persons involved in the accident, and later to oversee decontamination and recovery of the area or facility. The Radiation Safety Officer would function in a liason capacity for all responding groups, but each group would have responsibility for its own special activity. Either the Radiation Safety Officer or a designated alternate would be on site during the emergency phase at an incident, and remain there until the situation had been stabilized enough to assure limited risk. Limited risk is defined here as a condition in which radioactive contamination is contained within a limited area with little probability of movement, and access to the area can be limited by minimum surveillance.

General security, crowd control, direction of evacuation, and assuring free access by emergency vehicles would be assigned to the Campus Police. The Campus Police also would have responsibility for on-site communications, and could assist in rescue and first aid activities.

Personnel from the Office of Physical Plant would have primary responsibility for controlling utility services to the facility involved in the incident if this is needed. Services involve electricity, gas, water, and air conditioning, all of which may require interruption from a remote control point to reduce the spread of radioactive contamination. The Office of Physical Plant would also be responsible for providing trucks or other vehicles to get emergency gear to the site, and later to transport decontamination supplies and waste to and from the site. These personnel may also assist in rescue and first aid activities.

An incident severe enough to call for a mobilized radiological emergency response probably will involve other hazards related to chemical safety. Procedures necessary to control a radiological hazard should be sufficient to prevent toxic-chemical injury. For this reason, the campus Safety Officer has not been included as a primary emergency-response team member. General safety problems and procedures would be developed by the Committee on Emergencies, which includes the campus Safety Officer. The campus Safety Officer is considered as an important reserve for a radiological emergency; the campus Radiation Safety Officer would hold a similar position for a chemical emergency.

In a severe radiological emergency, particularly one with compounding factors, the University may not have sufficient resources to take care of all the situations that may present themselves. Therefore, it is a necessary part of this thesis to specify arrangements to be made with State and local organizations for such special emergency functions as ambulance, medical, hospital, fire and police services. The Radiological Emergency Response Plan presented in Appendix A cannot be implemented effectively until Louisiana State University enters into legal agreements with the contacts listed below. The contacts listed below have all agreed in principle to help translate the plan into practice:

<u>Baton Rouge Fire Department</u>

Chief Woods
2300 Florida Blvd.
Baton Rouge, LA
Telephone (504) 389-4619 or 389-4662

<u>Medical Center</u>

Robert C. Davidge
Executive Director
Our Lady of the Lake Regional Medical Center
5000 Hennessy Blvd.
Baton Rouge, LA
Telephone (504) 387-8802

Ambulance Service

Guy Moran
Director of Central Ambulance Service
14149 Joor Rd.
Baton Rouge, LA
Telephone (504) 261-4832

Mrs. D. Washington
Director of Gilbert Funeral Home
1900 North Blvd.
Baton Rouge, LA
Telephone (504) 344-1536

Capital Transportation Corporation

Mike McClery
1111 Senca
Baton Rouge, LA
Telephone (504) 343-8331

Shelter

Baton Rouge Centroplex
275 S. River Road
Baton Rouge, LA 70821
Telephone (504) 389-3030

Alex Harrington
American National Red Cross
Director of Safety and Disaster
1165 South Foster Dr.
Baton Rouge, LA
Telephone (504) 926-4533

State Radiological Emergency Reaction Team

L. Hall Bohlinger
Alternate Team Captain
4845 Jamestown Ave.
Baton Rouge, LA 70808
Telephone (504) 925-4518

Louisiana Nuclear Energy Division

Robert Myers
4845 Jamestown Ave.
Baton Rouge, LA 70808
Telephone (504) 925-4518

Table 3-1 is a function summary of the organization of the Radiological Emergency Response Plan. In this table, agencies outside the University, and internal University departments are matched with their responsibilities for each major emergency function.

Emergency Response Team

The functional organization summarized in Table 3-1 forms the basis for development of the Radiological Emergency Response Team. Local Services Support Groups and Participating Government Agencies will assist the emergency team both during and after the crisis stage of an incident. Figure 3-1 is an assignment matrix of primary and support responsibilities for groups and agencies to the task categories associated with effective response in a radiological emergency.

The Emergency Response Team would have to deal with a variety of situations. This is reflected in the Radiological Emergency Response Plan by specifying the following special teams:

Emergency Radiation Team -

On-site Team - evaluate immediate local hazards
Off-site Team - evaluate remote hazards

Emergency Fire Team - extinguish and control fires

Emergency Medical Team - treat and decontaminate injured persons

Table 3-1

Organizational Responsibilities for the Radiological Emergency Response Plan

Emergency Function	Brief Description of Function	Responsible Parties
First Aid	To provide emergency treatment to injured individual.	LSU Police LSU Infirmary Local Ambulance Service American National Red Cross
Fire	To conduct fire operations.	City Fire Department
Law Enforcement	To maintain law and order, and provide traffic control during emergency operations.	LSU Police City Police State Police
Rescue	To conduct rescue operations.	LSU Police Nuclear Science Center Staff City Fire Department LSU Physical Plant
Warning	To develop, operate, and maintain an emergency warning system.	LSU Police Nuclear Science Center Staff
Communications	To develop an adequate communication system to conduct and coordinate emergency operations.	LSU Police LSU Physical Plant Nuclear Science Center Staff City Police State Police Nuclear Energy Division

Table 3-1 (cont'd)

Emergency Function	Brief Description of Function	Responsible Parties
Sheltering	To provide food, clothing and shelter.	Centroplex Facilities American National Red Cross Louisiana State University
Transportation	To provide transportation for hospital care.	Central Ambulance Service Gilbert Funeral Home
Medical Services	To provide care to the injured and contaminated.	Our Lady of the Lake Medical Center
Public Information	To release timely information to the students, faculty, workers, and public by all available media.	Louisiana State University, Public Relations Officer
Equipment Maintenance	To calibrate the equipment.	Nuclear Science Center Technician
Campus Monitor	To provide on-campus monitoring.	Nuclear Science Center Staff Fire Department LSU Police
Off-campus Monitor	To provide off-campus monitoring.	Gulf States Utilities Louisiana Nuclear Safety Division

	LSU Police	LSU Infirmary	LSU Physical Plant	Nuclear Science Center	Local Ambulance Service	City Fire Department	Red Cross	State Police	City Police	Centroplex Facilities	Hospital+	LSU News Service	Gulf States Utilities	LSU Shelter	LA Nuclear Energy Div.
Warning	P		P	S								P			S
Communication	P		P	P				S	S				S		S
Public Information				P*								P*			S*
Traffic Control	P		P					S	S						
Law Enforcement	P							S	S						
First Aid	P	S	P		S	S	S	S	S						
RESCUE	P		P	P		S		S	S						
Fire Protection						P									
Decontamination				P*											S*
Training				P											S
Hospital		S									P				
Transportation					P										
Shelter and Food										S				P	
Campus Monitor				P		S							P		S
Off-Campus Monitor				P		S							P		P

P = Primary
S = Support
* For an extreme emergency, the Governor may direct the Louisiana Nuclear Energy Division to become the lead agency for all public information and all decontamination work.

+ Our Lady of the Lake Medical Center.

Figure 3-1. Radiological Emergency Response Plan Assignment Matrix.

Emergency Evacuation Team - supervise evacuation of hazard area

Emergency Recovery Team - rescue trapped and injured persons

The nature and extent of each incident would be evaluated to determine which special teams, and how many on each team, would be needed to cope with the emergency. However, as described later, certain emergency situations would trigger automatic special-team response prior to on-site evaluation.

Except in extreme radiological emergencies, local service support groups and participating government agencies would be on standby status, and would respond only when specifically notified. Any fire or explosion, however, would invoke immediate response from the fire department. Local service support groups include the fire department, city police, Our Lady of the Lake Regional Medical Center, and local ambulance services for urgent response to a radiological emergency. If evacuation were required, Capital Transportation Corporation would make buses and drivers available, and off-campus housing could be supplied by the Riverside Centroplex. Both off-site and on-site radiation monitoring could be supported by personnel from Gulf States Utilities Company and the Louisiana Nuclear Energy Division. The Louisiana State Police and Louisiana Department of

Transportation and Development would assist in maintaining orderly evacuation of the campus if it became necessary. The American National Red Cross also would assist if an evacuation were necessary by providing shelter, food, clothing, and other temporary services to people displaced from the campus.

Activation of the Radiological Emergency Organization

Any out-of-the-ordinary incident involving radioactive material will require an appropriate response. Classification of an incident as to its severity and the correct response may be approached in several ways. The Nuclear Regulatory Commission has developed formal "Abnormal Occurrence Criteria" for general licensees, commercial power plants, and fuel-cycle licensees; NUREG 0654 in Appendix 1 identifies four classes of emergency-action levels; and the Louisiana Radiation Regulations establish the basis for immediate, 24-hour, and 30-day notification of radiological incidents in Sec.D.403-D.405. For the purpose of this Radiological Emergency Response Plan, the reporting categories for the Louisiana Radiation Regulations and the action classes for NUREG 0654 correspond as follows:

Louisiana Radiation Regulations	NUREG 0654
30-day reportable incident	Unusual event
24-day reportable incident	Alert
Immediately reportable incident (without associated catastrophe)	Site Emergency
Immediately reportable incident (with associated catastrophe)	General Emergency

The terminology of NUREG 0654 has been adopted for the plan because of its simplicity. Sec.D.403-D.405 of the Louisiana Radiation Regulations has been excerpted and included as Attachment I of the Plan in Appendix A.

In the correspondence table above, the distinction between site emergency and general emergency, both of which are immediately reportable incidents, is that of an associated catastrophe. Each of the emergency classes would trigger a different level of response depending upon moditying factors, such as fire or chemical attack on a radiation source, leading to the potential for widespread contamination. Five trigger levels (0, I, II, III, IV, and V) may be defined to establish what response action is appropriate for an emergency involving radioactive materials. The action levels for each of the potential reporting categories from the Louisiana Radiation Regulations, modified by other incident factors, are defined in Table 3-2. The terminology of NUREG 0654 and the action levels defined in Table 3-2 correspond as follows:

NUREG 0654	Action Level
(Trivial)	(0)
Unusual Event	I
Alert	II
Site Emergency	III-IV
General Emergency	V

Although the Radiological Emergency Response Plan deals with only the five Roman-numeral incidents, a sixth zero-level category exists. This level is for trivial incidents, such as a minor spill of low-specific-activity solution, which will be handled by laboratory personnel and reported to the Radiation Safety Officer afterward.

In each action level up to and including IV, the Radiation Safety Officer may elect to upgrade the event to a higher action level following on-site evaluation.

Notification procedures described in the Radiological Emergency Response Plan are designed to identify the nature of an event as quickly as possible. Any unusual situation involving radioactive materials which is more than trivial in the judgement of an individual at the site would prompt a call to the Radiation Safety

Table 3-2

Action Levels for the Radiological Emergency Response Plan

REPORTING POTENTIAL[b] MODIFIER:	EXPLOSION	FIRE	STRUCTURAL FAILURE	CHEMICAL ATTACK	LOSS	NONE
Immediate	V	V	III	III	II	II
24-hr	IV	IV	III	II	II	I
30-D	IV	IV	II	II	I	I
None	IV	IV	II	I	I	0

a. Action Level:

0 Routine assessment and decontamination by radiation safety officer (RSO)

I On-site evaluation by RSO for higher trigger level

II Prompt response by Campus Police and RSO to establish higher trigger level

III Immediate response by Campus Police, RSO, Safety Officer, and Office of Physical Plant to establish higher response level

IV Urgent response by all rescue units

V Emergency activation of rescue units, evacuation plan, public notification

b. Possible maximum release based on known on-site radioactive materials inventory, and Louisiana Radiation Regulations Part D, Sec. D.403-D.405.[12]

officer; if a fire or any other compounding factor is known to be involved, either Campus Police or the University Emergency Number would also be called. In the case of the caller judges the event to be classed as an action-level IV or V, all emergency teams would be activated by the person receiving the call to assure maximum probability of quick control. Off-site support units would be notified and activated by either the Radiation Safety Officer or Campus Police.

Protective Action

All protective actions under the Radiological Emergency Response Plan would be executed on the following order of decreasing priority:

First: Rescue injured individuals

Second: Rescue other individuals

Third: Protect health of the general public

Fourth: Protect health of emergency teams

Fifth: Protect University property

In any incident, the first action would be to search for and rescue anyone in the area. Simultaneously with the search, evaluation of local radiation fields and contamination would be made if possible. Any person who had been contaminated or injured would be cared for by the medical and radiological teams either at the site or at source pre-established location. The autopsy rooms at the School of Veterinary Medicine would be an ideal facility for initial decontamination and treatment of wounded persons before they are moved to Our Lady of the Lake Regional Medical Center. All individuals near the incident at the beginning would be checked for contamination and cleared from the area as quickly as possible.

Effective control of a radiological emergency would be accomplished best by establishing a well-equipped Emergency Control Center at the site. A previously outfitted truck with a full range of emergency and routine equipment could be used as the basic unit in the control center. No such vehicle exists in Louisiana at this time other than Civil Defense vehicles with radiation monitoring instruments.

Radiation monitoring equipment and decontamination supplies currently are available in the Nuclear Science Center and at other locations on the campus. This equipment is listed in Table 3-3, which also is Attachment C of the Radiological Emergency Response Plan.

Because of the priority for dealing with injured persons, early protective action responses are centered on decontamination and first aid. It will be important for all first aid personnel to be trained in basic contamination control to reduce the probability of internal contamination through a wound or ingestion. All individuals who were contaminated initially or become contaminated in controlling the emergency should be decontaminated before leaving the site, at least to the extent that permanent facilities will not be contaminated excessively.

Recovery from an Incident

The Radiological Emergency Response Plan must make provisions for returning the site of an incident to a condition which would permit restoration of the site to normal working status. As the severity of an event increases, the difficulty of recovery, and the length of time required, can be expected to increase also. Normal procedure is to isolate major sources of potential re-contamination, and then decontaminate from minimum hazard zones to the maximum hazard zone. As each zone is cleaned, the exclusion area can be decreased, and normal activities can be resumed.

To assure that there would be no misunderstanding, the Committee on Emergencies would evaluate both radiological and general safety conditions in each zone. When the committee determined that an acceptable level of safety, based on the Baton Rouge campus Radiation Safety Manual, is sufficiently decontaminated and otherwise safe, the University President would be notified. An exclusion zone would be returned to normal or restricted use only by order of the President.

Emergency Facilities

Two primary Radiological Emergency Response Facilities would be developed. The Nuclear Science Center already is equipped with all required emergency response supplies and instruments. However, because the Nuclear Science Center also houses the greatest inventory of radioactive materials and is the most likely building for involvement in a catastrophic radiological emergency. If this happened, all of the emergency equipment would be lost. Establishment of a second location for a major storage and emergency center therefore would be an important part of the Radiological Emergency Response Plan. Because the Plan also calls for the School of Veterinary Medicine to be used for decontamination and first aid of individuals injured in a radiological emergency, establishing the School as the alternate control center would be logical. All radiological emergency equipment, supplies, and instruments would be duplicated at the School of Veterinary Medicine, and would be supervised by the Radiation Safety Officer for the School.

Much of the equipment important for dealing successfully with a radiological emergency is used also for dealing with chemical emergencies. This equipment is available through the Campus Safety Office, and could be used to offset the loss of equipment if the Nuclear Science Center equipment was lost.

Maintenance of the Radiological Plan

A radiological emergency response plan that is written and put in a file is a useless effort. There are three elements necessary to assure that a plan will remain effective: (1) training, (2) practice drills, and (3) review.

Training would involve three different levels to implement the Radiological Emergency Response Plan fully. Emergency team members would have to be trained to the maximum level so that they are knowledgeable to the extent that is required by their activities. Each emergency team would train all other teams in their special skills. Individuals working with radioactive materials would be required to be thoroughly familiar with all emergency notification and initial reaction procedures. All students, staff, and faculty would be familiarized with emergency warning procedures and actions to be taken. These training levels would be accomplished by preparedness courses for emergency teams, coordinated through the Louisiana Nuclear Energy Division, and by local short courses and workshops; by short courses and workshops for radioisotope users; and by seminars, orientations, and publications for the remainder of the campus community.

Refresher training would be important for all radiological emergency response team members, and refresher seminars or other information meetings would be used for other campus groups. Annual briefings sponsored by the Committee on Emergencies would be held for off-campus support groups.

Drills and practice exercises would be an integral part of preparedness training and refresher training for adiological emergency response team members. Radioisotope users and other campus personnel would also be involved to make this activity meaningful. Non-university assistance and support groups would have integral rules in the drills and practice exercises. The senario for each drill or practice exercise would be written, monitored, and reviewed by a qualified non-affiliated organization such as the emergency response group for Louisiana Power and Light Company, the regulatory agency from an adjoining state, or the Nuclear Regulatory Commission.

After each drill or practice exercise, the Radiological Emergency Response Plan and all participating response teams, assistance groups, and support groups would be reviewed and evaluated. Additional training, revisions in training procedures, and the Plan itself would be prepared on the basis of the drill performance. Drill and reviews would be accomplished at least once each year.

Public Information

Effective and honest communication with the various news media and the public must be made an essential part of the Radiological Emergency Response Plan. The head of New Services for the Baton Rouge campus would have lead responsibility for transmitting information about both real emergencies and drills, would include tests of information transfer. Direct communication between new-media personnel and response-team members in any format other than in the presence of University New Service representatives can lead to conflicting interpretations of the recovery progress or origin of an event. In this format, independent observations can be correlated and simultaneously evaluated to present the most accurate, current status of the incident. Local news-media representatives would be invited to participate in and conduct radiological emergency response team training.

General Summary

In the foregoing discussions, the background information and approaches have been developed for the formal Radiological Emergency Response Plan. A complete text of the Plan is presented in Appendix A. This organization of the thesis, with the major result presented in the appendix, has been chosen to allow both uninterrupted presentation of the Plan, and narrative discussion, development, and evaluation of the Plan and its various parts.

A set of four cases of varying severity will be described in the following chapter, and will be used to evaluate the plan as presented in Appendix A.

CHAPTER 4

Postulates Used to Evaluate the Radiological Emergency Response Plan

The purpose of this chapter is to apply the emergency response plan in Appendix A to several postulated on-campus radiological incidents. The postulated incidents are divided into four cases, each of which will be presented as (1) radiological incident, (2) predict exposure, and (3) procedures for response. The exposure from the first three cases are small because of dispersion in the atmosphere and, in some cases, low release factors for the radioactive materials.

Internal exposure to radiation results when radioactive materials are taken into the body by inhalation, ingestion, or absorption through the skin. Various chemical forms of materials locate for different periods of time in different parts of the body, resulting in some dose to the exposed tissues. Eventually most of the radioactive material is eliminated by radioactive decay and body process. The organ doses from internal exposure by alpha and beta particles, and their associated photons, result from energy imparted to the organs by both contained and distant radioactive materials; however, only gamma radiation can lead to exposure of distant organs.

The dose from inhalation is calculated by

$$D(\text{rem}) = RF \cdot Q \cdot \frac{X}{Q} \cdot BR * DCF * \frac{10^{12}\ \frac{\text{pCi}}{\text{Ci}}}{10^{3}\ \frac{\text{mrem}}{\text{rem}}}, \qquad (4\text{-}1)$$

in which

RF = the release factor,

Q = the number of curies,

$\frac{X}{Q}$ = the relative dispersion in seconds per cubic meter,

BR = the breathing rate in cubic meters per second, and

DCF = the dose commitment factor for adults in mrem in 50 years per picocurie inhaled in one year or less.[13] (See Appendix B)

The basic equation for atmospheric diffusion from a ground level point source, from 0-to-8 hour, is[1]

$$\frac{X}{Q} = \frac{1}{\pi\ \bar{\mu}\ \sigma_y\ \sigma_z}, \qquad (4\text{-}2)$$

in which

π = 3.14159,

$\bar{\mu}$ = the wind speed in meters per second,

σ_y = the horizontal dispersion coefficient in meters, and

σ_z = the vertical dispersion coefficient in meters.

In ground level release, the plume diffuses in both the Z and Y directions as the wind blows in the X direction at $\bar{\mu}$ m/sec. The degree of diffusion depends on the stability of the atmosphere. Stability is determined by the Pasquill stability parameter, σ. The more unstable the atmosphere, the larger the values for σ. The horizontal dispersion coefficient, σ_y, and the vertical dispersion coefficient, σ_z, are shown in Figure 4-1. The variations of the coefficients with distance from the source for various stabilities are shown in Figures 4-2 and 4-3.[1] Each figure includes information for six common atmospheric stability conditions. A seventh stability condition, Type G (extremely stable), may be approximated from the Type F (moderately stable) condition by

$$\sigma_z(G) = \frac{3}{5}\,\sigma_z(F), \qquad (4\text{-}3)$$

and

$$\sigma_y(G) = \frac{2}{5}\,\sigma_y(F). \qquad (4\text{-}4)$$

The values of σ_y and σ_z for the four cases described are listed in Table 4-1.

Dose commitment estimates can be made if one knows how much radioactive material is in the air and the length

Figure 4-1

Plume Diffusion for σ_y and σ_z

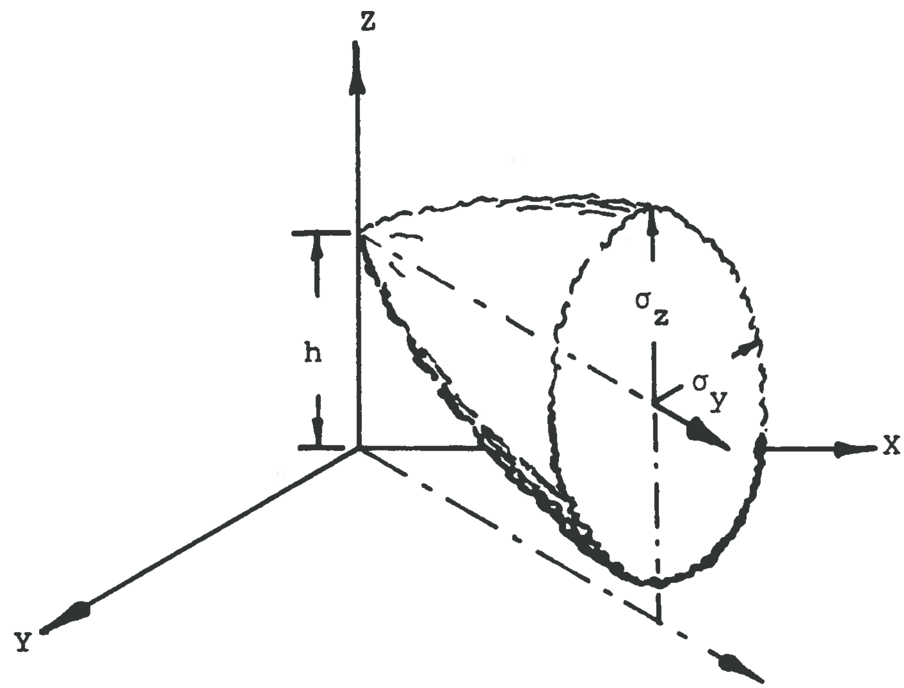


Figure 4-2

Horizontal Dispersion Coefficient, σ_y, as a Function of Distance from Source for the Various Pasquill Conditions.

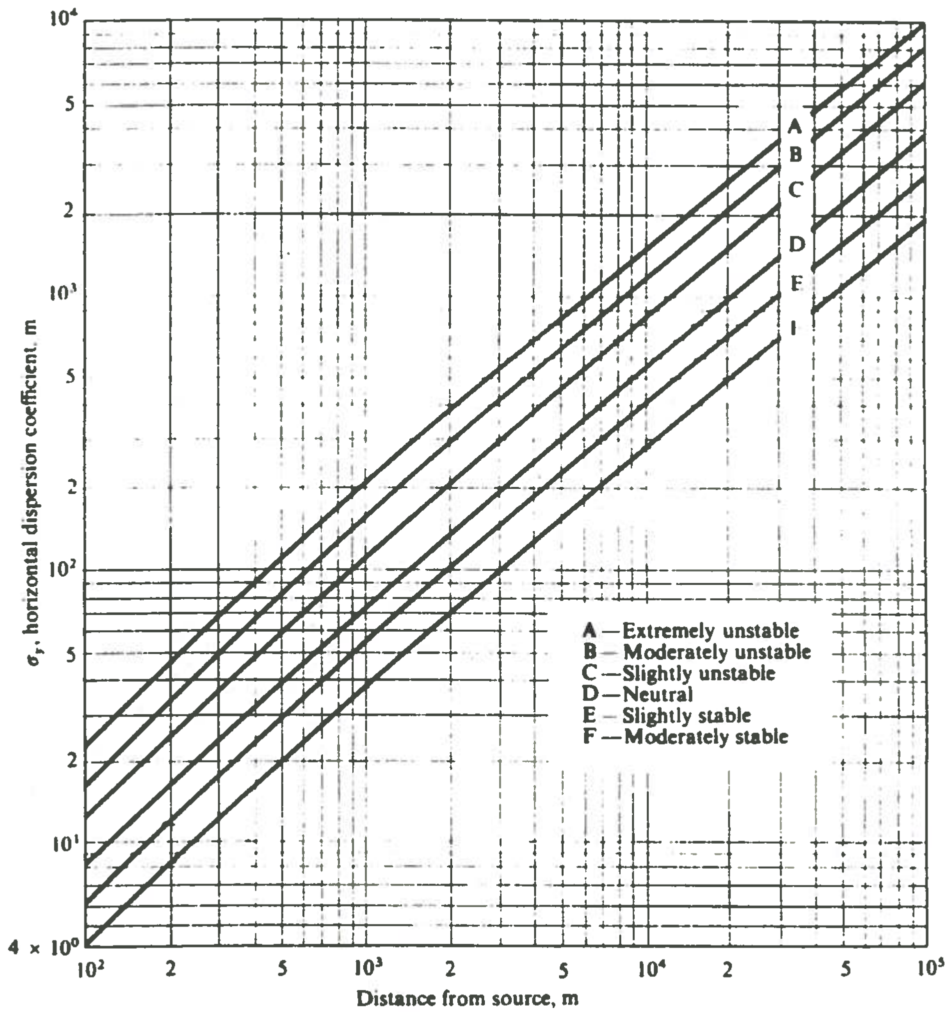
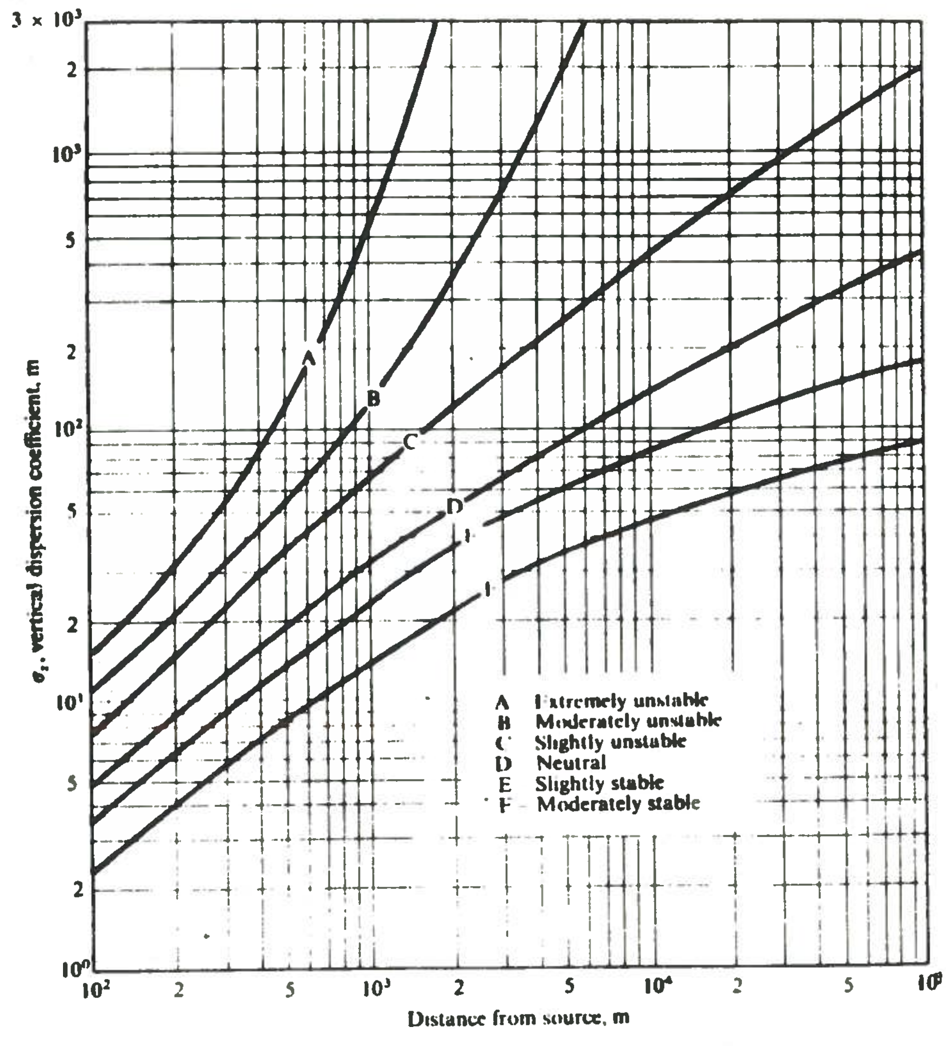


Figure 4-3

Vertical Dispersion Coefficient, σ_z, as a Function of Distance from Source for the Various Pasquill Conditions.



of time during which the air was breathed. Dose commitments are presented in Table 4-1. The dose from inhalation in a specified volume is calculated by

$$D(\text{mrem}) = \frac{Q}{V} * BR * t * DCF * 10^{12}\ \frac{pCi}{Ci}, \qquad (4\text{-}5)$$

in which

Q = the number of curies,

V = the volume of the room in meters,

BR = the breathing rate in cubic meters per second,

t = the time in seconds, and

DCF = the dose commitment factor in mrem per picocuries.

The average breathing rate during an eight hour day for a standard man is taken to be:[1]

$$BR = 10\ m^3/8\ \text{hours} = 3.47 \times 10^{-4}\ \frac{m^3}{sec}.$$

The DCF values are supplied by NUREG 0172 in units of mrem in 50 years per picocurie inhaled.[13]

External exposures (submersion doses) to the skin by alpha, beta and gamma rays in the form of gases or suspended particulate generally do not present significant health problems, but cannot be ignored without evaluation. Submersion doses for beta and gamma radiation for a person standing in a semi-infinite cloud of activity may be obtained by [4]

$$\dot{D}_\beta(\text{rem}) = 0.23 * \bar{E}_\beta * X, \qquad (4\text{-}6)$$

and

$$\dot{D}_\gamma(\text{rem}) = 0.25 * \bar{E}_\gamma * X, \qquad (4\text{-}7)$$

in which

$\bar{E}_\gamma$ = the mean effective gamma energy per disintegration in Mev,

$\bar{E}_\beta$ = the mean effective beta energy per disintegration in MeV, and

X = the concentration of radioactive material in curies per cubic meter of air.

If a puff release of Q' curies occurs, a X' in curie-sec per cubic meter is calculated and the doses from gamma and betas are obtained by replacing X with X' in Equations (4-6) and (4-7).

<u>Case I. Maximum Hypothetical Incident</u>. In this incident, a 5-Ci Pu-Be source is ruptured explosively in the Nuclear Science Center parking lot in the early morning hours. The release factor (RF) is 0.1%. The dose commitments to the lungs have been calculated for inhalation at distances of 200, 500, and 1000 m under Type G conditions. The Type G condition gives

conservative but realistic values for the Louisiana State University campus and is assumed because the release point is at ground level in an essentially enclosed area which would inhibit normal dispersion by diffusion (see Figure 4-4). The dispersion coefficients for this case are listed in Table 4-1.

Case II. Maximum Credible Incident. In this incident, 100 mCi of methyl iodide is released at ground level from the Nuclear Science Center. The release factor is assumed to be 100%. The dose commitments have been calculated for the thyroid at distances of 200, 500, and 1000 m. The results of the calculations are summarized in Table 4-4. The values in Table 4-4 for I-131 are lower than the value in Table 4-2. The procedures for response in this case are listed in Table 4-6.

Case III. Maximum Probable Incident. In this incident, 100% of 100 mCi of C-14 is released uniformly as $^{14}CO_2$ in a 20 ft x 20 ft x 10 ft room. All of the activity remains in the room for 6 minutes. The whole body dose from submersion and inhalation calculated by Equation (4-5) and (4-6) is 0.4717 rem, which is well below the quarterly whole body dose commitment for controlled individuals in restricted areas (Table 4-2). The procedures for response in Case III are listed in Table 4-7.

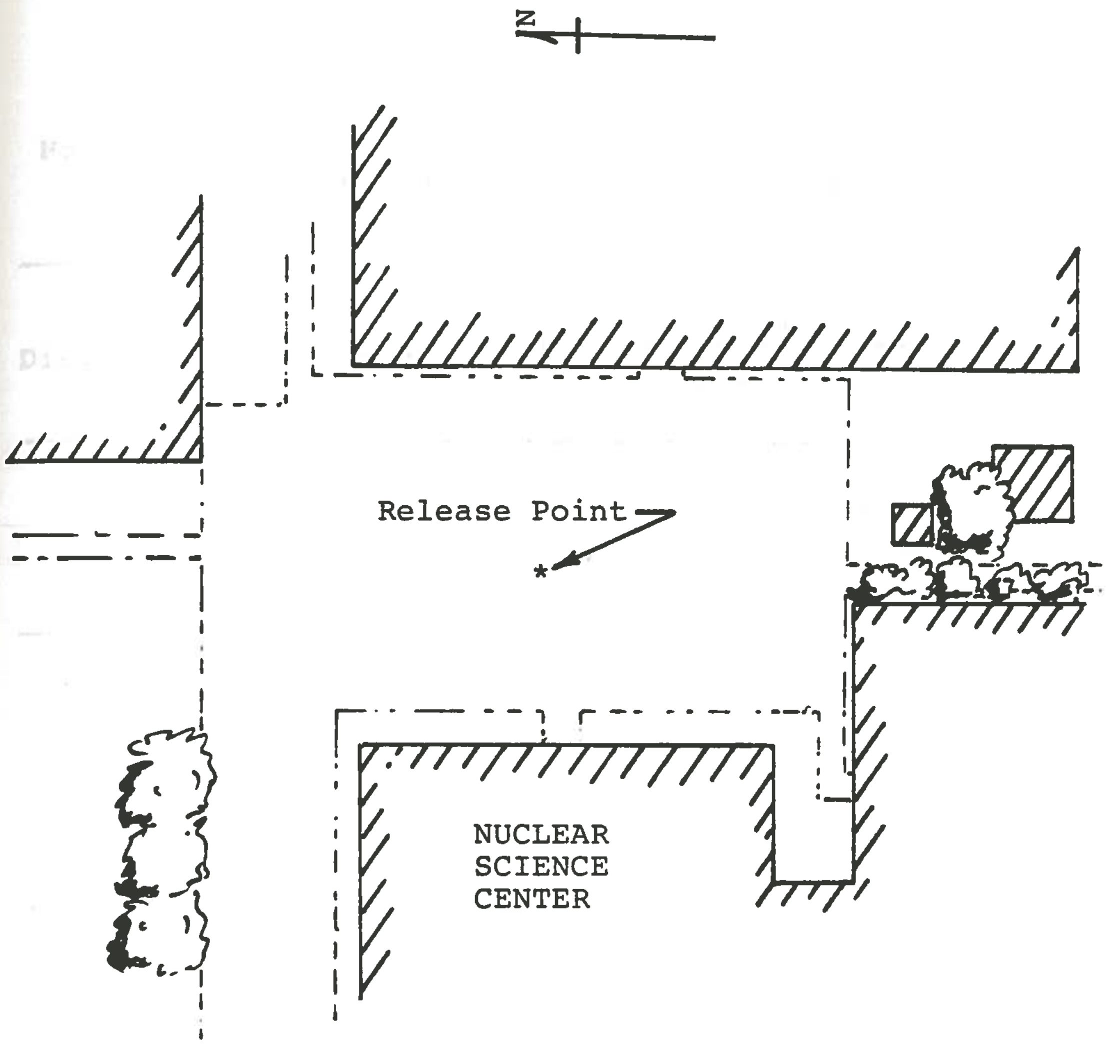


Figure 4-4. Location of the Case I Incident.

Table 4-1

Horizontal and Vertical Dispersion Coefficients at Specified Distances for Type G Conditions

Dispersion Coefficient in meter	Distances		
	200 m	500 m	1000 m
σ_y	5.3	13.3	26.0
σ_z	2.4	5.1	9.0

Table 4-2

RADIATION PROTECTION STANDARDS[c]

for controlled personnel in restricted areas

Type of Exposure	Expos. Per:	Dose Commitment, rem[a] Year	Quarter	Emergency[b]
Whole body; head, trunk, gonads, lens of the eye, red bone marrow, active blood-forming organs		5 (0.5)	1.25 (0.125)	100 (12)
Unlimited areas of the skin (hands and forearms excluded); other organs, tissues and organ systems (bone excluded)		15 (1.5)	7.5 (0.5)	--
Bone		30 (1.5)	10 (0.5)	--
Forearms		30 (1.5)	10 (0.5)	200 (50)
Hands and feet		75 (1.5)	18.75 (0.5)	200 (50)

[a] Values in parentheses represent "as-low-as-practicable" target commitments.

[b] Values for emergency-dose commitments are one-time-only life-saving dose commitments; values in parentheses are target commitments for timed entries.

[c] Reference 15.

Table 4-3

RADIATION PROTECTION STANDARDS [a]

for the general public in unrestricted areas

Type of Exposure	Annual Dose Commitments, rem	
	Individual	Population Avg.
Whole body, gonadal tissue, bone marrow, lens of the eye	0.5	0.17
All other organs	1.5	0.5

[a] Reference 15.

Case IV. Routine Incident. A routine incident consists of a spill of a small amount of activity in a lab. Because the amount involved is small, the individual only has to:

1) Notify the Radiation Safety Officer, and
2) Decontaminate the area where the spill was performed.

In all four cases, the term decontamination implies verification by appropriate measurements that the activity has been removed.

Case and Response Summary

The four hypothetical-incident cases are summarized in Table 4-4. In only the most severe (Case I) situation would a member of the general public be exposed beyond regulatory limits at less than 500 m in from the point of origin; occupational limits would not be exceeded beyond 200 m for this case. The remaining three cases present no hazard to the general public at distances beyond 200m, and no hazard to occupational personnel at much closer distances. However, for the first two cases, extensive contamination above acceptable standards would result, and would require prompt action.

On the basis of the results presented in Table 4-4, and the regulatory limits specified in Tables 4-2 and 4-3, appropriate parts of the Radiological Emergency

Response Plan would be activated. Response to Case IV is trivial. Appropriate responses to the four cases are stated explicitly in Table 4-5. Each of the responses listed in Table 4-5 will be discussed as they pertain to each of the cases.

Response 1

2.2. Notification Procedures

The notification procedures found in the emergency plan instructs individuals on what to do, who to call, what to report, and how to report it. This notification procedure will be used by all campus personnel in the event of a radiological incident, no matter how trivial the incident is.

Response 2

2.4.1. Location and Inventory List of Emergency Supplies and Equipment.

This list is supplied to prevent the loss of valuable time in locating the proper detector. This response is used by the first three cases.

Response 3

2.1. Activation of Emergency Organization.

This part of the radiological emergency response plan tells how to categorize an incident.

Table 4-4

Inhalation and Submersion Doses for the Four Cases

Cases	Isotope	Incident Intensity	Distance Organ Dose Commitment (rem) 200 m	500 m	1000 m	Critical Organ
I	Pu-239	Severe	7.31	1.37	0.40	Lung
II	I-131	Moderate	1.27	0.24	0.067	Thyroid
III	C-14	Minimum	------ Negligible ------			Whole Body
IV	Any License Isotope*	Trivial	------ Negligible ------			

* μCi amount

Table 4-5

The Response Actions Required by Four Cases of Radiological Emergency

Response	Applicable Section of the Radiological Emergency Response Plan*			
	Case I	Case II	Case III	Case IV
1) Notification	2.2	2.2	2.2	2.2
2) Location of Protective Equipment	2.4.1	2.4.1	2.4.1	N/A
3) Classification of Emergency	2.1, 2.1.2	2.1, 2.1.1	2.1, 2.1.1	2.1, 2.1.1
4) Initial Response Organization	1.2	1.2	1.2	1.2
5) Emergency Response Team	1.3, 1.3.1 1.3.2, 1.3.3 1.3.4, 1.3.5	N/A	N/A	N/A
6) Evacuation	2.3.1.A	2.3.1.A	2.3.1.A	N/A
7) Decontamination	2.5.2	2.5.2	2.5.2	2.5.2
8) Transportation	1.4.3.B	1.4.3.B	1.4.3.B	1.4.3.B
9) Medical	1.3.3, 1.4.3.A, 1.5.4	1.3.3, 1.4.3.A, 1.5.4	1.3.3, 1.4.3.A, 1.5.4	N/A
10) Recovery	2.6	2.6	2.6	N/A

* See Appendix A for intact plan.

2.1.1. Notification of unusual event. This is the least severe level of the four emergency action levels. This level poses no harm to the public and is usually brought under control and terminated without the use of the Emergency Response Organization. This level is used to classify Cases II-IV•

2.1.2. Alert. The primary purpose of this level is to ensure that members of the emergency organization are available to respond should the situation become more serious. This level poses no harm to the public. This level is used to classify Case I.

Response 4

1.2. Initial Response Organization.

The Initial Response Organization is the organization that will control the emergency until the Emergency Response Team is called to assist. All four cases use this organization.

Response 5

1.3. Emergency Response Team

The Emergency Response Team is composed of:

1.3.1. Emergency Radiation Team,

1.3.2. Emergency Fire Team,

1.3.3. Emergency Medical Team,

1.3.4. Emergency Evacuation Team, and

1.3.5. Emergency Recovery Team.

After the incident is assessed the teams listed above are called to provide their assistances. Case I is the only case that requires this response.

Response 6

2.3.1.A. Evacuation from Restricted Area.

Protective action taken during an emergency to minimize the hazard to the public. The first three cases undergo either room or area evacuation.

Response 7

2.5.2. Decontamination.

The purpose of decontamination is to remove and control radioactive material and thus prevent it from being inhaled, ingested, or absorbed through the skin. The four cases stated in Chapter 4 calls for some form of decontamination.

Response 8

1.4.3.B. Ambulance Service.

The purpose of this service is to transport radiological injured or contaminated individuals to Our Lady of the Lake Medical Center. The first three cases depend on this service.

Response 9

The three groups listed below will provide first aid or medical to individuals injured or contaminated by radioactive material:

1.3.3. Emergency Medical Team,

1.4.3.A. Physicians and hospital, and

1.5.4. American National Red Cross.

This response applies to the first three cases.

Response 10

2.6. Recovery.

Action used to restore the campus back to normal condition after an emergency. After the campus resumes its normal condition, the University system President notifies the public via the LSU Public Information Officer. This applies only to the first three cases.

CHAPTER 5

Conclusions and Recommendations

The Radiological Emergency Response Plan developed in this thesis is a master plan which gives a description of the overall picture of how the various organizations and personnel will respond in a radiological emergency on Louisiana State University campus.

Conclusions

Based on the arguments presented in Chapter 4, the Radiological Emergency Response Plan was evaluated on a case-by-case basis:

Case IV (Routine incident) - concluded that incidents of this nature are trivial and could be resolved by routine procedures.

Case III (Maximum probable incident) and Case II (Maximum credible incident) - concluded that problems such as these were severe enough to require approximately 75% of the radiological plan.

Case I (Maximum hypothetical incident) - concluded that approximately 80% of the radiological plan would be required to control incidents of this magnitude. The only conceivable mechanism for this case is a deliberate act of sabotage which is very remote.

Only if there were a nuclear reactor incident on the Louisiana State University campus would 100% of the plan have to be implemented. The possibility of a nuclear reactor being installed on Louisiana State University campus is small.

During the development of the radiological emergency response plan, other types of emergencies were examined. With relatively minor changes, the radiological emergency response plan could be adapted into a plan which deals with other extreme situations on campus.

Recommendations

Eleven recommendations can be made from the information obtained in developing this thesis.

• Louisiana State University's departments should work together in developing plans to ensure the safety of the entire University system. A means by which this could be achieved is through the formation of a Committee on Emergencies. This Committee should consist of the following members:

1) Vice-Chancellor for Administration serving as Chairman,
2) Safety Officer for the Baton Rouge Campus,
3) Radiation Safety Officer for the Baton Rouge Campus,
4) Head of the Office of Physical Plant,
5) Chief of LSU Police,
6) Supervisor of the Telephone Exchange, and
7) Head of New Services.

• The University should have some type of warning system so that the entire University campus can be alerted efficiently without causing a panic.

• The University should have a specific area prepared for decontamination of individuals.

• The University should have the medical staff trained for radiological emergency.

• The Nuclear Science Center should offer training in radiological decontamination procedures for minor and major incidents.

• Each department involved with radiological research should have proper detection equipment and a decontamination kit.

• The University should devise a system to account for people working in radiological areas.

• The University should require refresher training to ensure that personnel are familiar with proper laboratory procedures.

• The University should provide the necessary equipment needed by the Nuclear Science Center staff to respond quickly in the event of a radiological emergency. This could be accomplished best by means of a car or truck supplied with radiological emergency equipment and supplies.

- The University sould reassess the plan every two years.
- The plan must be tested by practice exercises simulating major occurrences.

This Radiological Emergency Response Plan exceeds all of the actual and/or conceivable problems that may present themselves now or within the next 5 years. If the radiological plan is accepted, Louisiana State University will be the only nuclear-material licensee in the State to have such a plan. As the leading research and teaching institution in Louisiana, the University has an obligation to remain at the forefront in all areas of activity. Adoption of the Radiological Emergency Response Plan will assure that the University is setting the standard for other institutions to follow.

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Appendix A

RADIOLOGICAL EMERGENCY RESPONSE PLAN

RADIOLOGICAL EMERGENCY RESPONSE PLAN FOR LOUISIANA STATE UNIVERSITY

Nuclear Science Center
Louisiana State University
May, 1981

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RADIOLOGICAL EMERGENCY RESPONSE PLAN
FOR LOUISIANA STATE UNIVERSITY

1.0. Organizational Control of Emergencies

This section of the Emergency Response Plan will describe the initial response organization that will be activated on the Louisiana State University campus in the event of an emergency.

1.1. Campus Organization

1.1.1. Louisiana State University, Nuclear Science Center. During normal weekdays, between the hours of 8:00 a.m. to 4:30 p.m., the entire Louisiana State University Nuclear Science Center staff is available on campus. The entire staff can be reached at home on Saturdays, Sundays, and after 4:30 p.m. during the week. The entire staff is trained in radiological emergency.

1.1.2. Louisiana State University Police. The Louisiana State University Police Department is open 24 hours a day. The entire Police staff is trained in first aid by the American Red Cross. Seven of the officers have completed the Emergency Medical Technician program and the radiological monitoring program. They are not equipped with radiological monitoring equipment.

1.1.3. Louisiana State University Physical Plant. The Louisiana State University Physical Plant staff operate 24 hours a day. The staff is knowledgeable in the mechanics of the campus. The staff is also trained in first aid. They are also one of the three modes of communication on campus.

1.1.4. Louisiana State University Communication Force. The communication force is available 24 hours a day. The communication force will transmit the plans of action whenever the telephone is inefficient or not operational. The communication force consists of the Police Department and the Physical Plant Department.

1.1.5. Louisiana State University System Radiation Protection Officer. The System Radiation Protection Officer is authorized to act immediately in all matters pertaining to radiation protection involving university personnel engaged in university-sponsored activities, or any other individual on university property. His review and approval are required on matters which may alter established practices and procedures for control of radiation hazards within the University, including Campus Radiation Safety Committee policies rules or guidelines that may conflict with those established by the System Radiation Protection Committee. He is also assigned liaison responsibility with all state and federal regulatory agencies with jurisdiction over radiation safety programs and control of radiation sources.

1.1.6. Alternate System Radiation Protection Officer. He has the same responsibility as the System Radiation Protection Officer. He acts only when the System Radiation Protection Officer is temporarily away from the University.

1.1.7. Radiation Safety Officer. The Radiation Safety Officer and the System Radiation Protection Officer is the same person on the Louisiana State University campus. On the other Louisiana State University campuses, the Radiation Safety Officer is vested with the authority to act immediately to assure the well-being of the students, faculty, workers, and the integrity of the facilities within the boundaries of the campus. The Radiation Safety Officer after being notified will determine if an incident is an emergency. If it is an emergency, he will then activate the Initial Response Organization.

1.2. Initial Response Organization

The Initial Response Organization is composed of members of the University Operational staff on duty.

The 8:00 a.m. to 4:30 p.m. Initial Response Organization will consist of:

1) Louisiana State University, Nuclear Science Center staff;

2) Louisiana State University Police Department;

3) Louisiana State University Physical Plant Department;

The 4:00 p.m. to 8:30 a.m. Initial Response Organization will consist of:

1) Louisiana State University Police Department; and

2) Louisiana State University Physical Plant Department.

The members of the Initial Response Organization who are not on-site at the time of an emergency will be able to augment the University Emergency Response Team within an hour of being notified.

1.3. Emergency Response Team

The Emergency Response Team is composed of: (1) the Nuclear Science Center staff, (2) the Louisiana State University Police Department, (3) the Louisiana State University Physical Plant Department, (4) Gulf States Utilities Radiation Safety Staff, (5) the City Fire Department, (6) the City Police, and (7) State Police and the Louisiana State Nuclear Energy Division staff.

1.3.1. Emergency Radiation Team. This team is responsible for the determination of radiological hazards which results from fires, radioactive spills or unplanned radioactive releases. When activated, the Emergency Radiation Team shall function in two sections, as follows:

A.) On-site Radiological Monitoring Section. This section is responsible for determining on-site radiological hazards, and for conducting the required surveys, monitoring, and sampling. The personnel in this section are trained in the determination of radiological hazards of the Nuclear Science Center staff, Fire Department, City Police and State Police.

B.) Off-site Radiological Monitoring Section. This section is responsible for determining off-site radiological hazards, and for conducting the required surveys, monitoring, and sampling. The personnel assigned to this section are trained in environmental radiological monitoring. This group will be composed of Gulf States Utilities and Louisiana State Nuclear Energy Division staff.

1.3.2. Emergency Fire Response Team. Louisiana State University does not have a Fire Team therefore the Fire Teams from the surrounding areas are responsible for fighting fires within the University boundary. The Fire Department teams are trained by the Civil Defense in fighting radiological fires and radiological emergencies.

1.3.3. Emergency Medical Team. The function of the Emergency Medical Team is to provide first aid and decontamination for injured persons. This team will be composed of the LSU Police Officers who have completed the Emergency Medical Technician program, the Physical Plant individuals with first aid training, and the Nuclear Science Center staff.

1.3.4. Emergency Evacuation Team. This team is responsible for the evacuation of the campus or hazardous area on the campus. This team is composed of the LSU Police with first aid training and the Physical Plant personnel without first aid training.

1.3.5. Emergency Recovery Team. This team is composed of personnel that are familiar with the campus, building operation, maintenance, and/or health physics. The Emergency Recovery Team will be formed as required for the existing emergency conditions under the direction of the System Radiation Protection Officer.

1.4. Local Services Support Groups

The Local Services Support Groups will be required to supplement Louisiana State University Emergency Response Organization. The local services listed below will assist Louisiana State University in the event of an emergency on campus. A Letter of Agreement with these agencies will have to be obtained.

1.4.1. Baton Rouge Fire Department. The Baton Rouge Fire Department will dispatch men and equipment to assist in fighting fires. The Fire Department has training in radiological monitoring and radiological emergency.

1.4.2. Baton Rouge City Police. The Baton Rouge City Police will dispatch men to assist in law enforcement and communication.

1.4.3. Medical Services.

A.) Physicians and Hospital. Our Lady of the Lake will treat individuals who are injured or contaminated with radioactive materials. Individuals who are contaminated internally will receive treatment in an isolated area of the emergency room. Individuals who are contaminated externally (skin and clothing) will be treated in the morgue.

B.) Ambulance Service. Central Ambulance Service and Gilbert's Funeral Home will provide emergency transportation to injured or containinated individuals as requested by the Civil Defense. If not requested by the Civil Defense, Central Ambulance Service will transport only if no other Ambulance Service is available. Special efforts shall be made to minimize contamination of the ambulances.

1.4.2. Capital Transportation Corporation. In the event an incident on the Louisiana State University campus requires evacuation, Capital Transportation Corporation will provide approximately 40 buses and drivers for the transportation of evacuees.

1.4.3. Riverside Centroplex. In the event of an emergency involving Louisiana State University, the downtown Centroplex will be made available for use as a registration center for evacuees.

1.4.4. Gulf States Utilities Radiological Team. Gulf States Utilities will dispatch men and equipment to assist in on-site and off-site radiological monitoring.

1.5. <u>Coordination with Participating Government Agencies</u>

Support from government agencies will be required in the areas of radiological monitoring, health, safety, and communication. The responsibilities of the various participating agencies are described in this section.

1.5.1. Louisiana Department of Natural Resources. The Louisiana Department of Health under state law has the primary responsibility for protecting the health and safety of the general public from radiological incidents.

1.5.2. Louisiana State Police. The State Police Department will interface with the Louisiana State University Police Department, the City Police Department, and the Sheriff's Department. The State will send out a team which is composed of 10 men. This team will help in setting up road blocks, monitoring, and evacuation of the areas.

1.5.3. Department of Transportation and Development. Their primary function will be to (1) assist with debris removal from the roads and highways, and (2) assist in determining which roads and highways should be blocked or closed.

1.5.4. American National Red Cross. When a radiological incident is declared an emergency by the Civil Defense Team, the Red Cross will provide food, clothing, shelter, and first aid for evacuees. It will also provide information to friends and relatives inquiring about sheltered residents.

1.5.5. Louisiana Nuclear Energy Division. Under the authority of the Legislature, the Louisiana Nuclear Energy Division has the overall responsibility for the administration, implementation, application and coordination of radiological emergency procedures in the event of a radiological incident.

1.5.6. State Radiological Emergency Reaction Team. In the event of an incident on the Louisiana State University campus, an Emergency Reaction Team consisting of radiation specialists with broad health physics experience and equipment will be dispatched to the incident after being notified by Louisiana Nuclear Energy Division (LNED). A summary of each organization function is found in Figure A-1.

2.0. Emergency Measures

This section discusses the classification system used to categorize the possible emergency situation here on the Louisiana State University campus. The five Emergency Action Levels in increasing order are:

	LSU Police	LSU Infirmary	LSU Physical Plant	Nuclear Science Center	Local Ambulance Service	City Fire Department	Red Cross	State Police	City Police	Centroplex Facilities	Hospital+	LSU News Service	Gulf States Utilities	LSU Shelter	LA Nuclear Energy Div.
Warning	P		P	S								P			S
Communication	P		P	P				S	S				S		S
Public Information				P*								P*			S*
Traffic Control	P		P					S	S						
Law Enforcement	P							S	S						
First Aid	P	S	P		S	S	S	S	S						
RESCUE	P		P	P		S		S	S						
Fire Protection						P									
Decontamination				P*											S*
Training				P											S
Hospital		S									P				
Transportation					P										
Shelter and Food										S				P	
Campus Monitor				P		S							P		S
Off-Campus Monitor				P		S							P		P

P = Primary

S = Support

* For an extreme emergency, the Governor may direct the Louisiana Nuclear Energy Division to become the lead agency for all public information and all decontamination work.

+ Our Lady of the Lake Medical Center.

Figure A-1. Radiological Emergency Response Plan Priority Assignment Matrix.

Action Level	Nomenclature
I	Notification of unusual events,
II	Alert,
III	Site emergency,
IV	Site emergency with compounding factors, and
V	General emergency.

2.1. Activation of Emergency Organization

The project users and Nuclear Science Center staff monitor the control instruments and alarms for any changes in condition on the campus. Upon noticing any unusual or abnormal change, the Louisiana State University System Radiation Protection Officer will determine if the change or event corresponds to one of the Emergency Action Level categories as defined by Table A-1. If the event or change corresponds to one of the Emergency Action Levels, he will take further action as described below.

2.1.1. Notification of Unusual Event. This is the least severe of the four Emergency Action Levels. It includes those situations which, unless complicated by other factors, pose no harm to the public but for which it is prudent to notify the System Radiation Safety Officer, Campus Safety Officer and the Louisiana Nuclear Energy Division to provide them with current information on unusual events which are occurring or have occurred.

Table A-1

Action Levels for the Radiological Emergency Response Plan

REPORTING POTENTIAL[b]	MODIFIER: EXPLOSION	FIRE	STRUCTURAL FAILURE	CHEMICAL ATTACK	LOSS	NONE
Immediate	V	V	III	III	II	II
24-hr	IV	IV	III	II	II	I
30-D	IV	IV	II	II	I	I
None	IV	IV	II	I	I	0

a. Action Level:

- 0 Routine assessment and decontamination by radiation safety officer (RSO)
- I On-site evaluation by RSO for higher trigger level
- II Prompt response by Campus Police and RSO to establish higher trigger level
- III Immediate response by Campus Police, RSO, Safety Officer, and Office of Physical Plant to establish higher response level
- IV Urgent response by all rescue units
- V Emergency activation of rescue units, evacuation plan, public notification

b. Possible maximum release based on known on-site radioactive materials inventory, and Louisiana Radiation Regulations Part D, Sec. D.403-D.405.[12]

This type of situation is usually brought under control and terminated without the use of the Emergency Response Organization.

If the incident involves a fire, radiological, or medical emergency, the appropriate Emergency Response Team and local support services will be activated as required and will respond as necessary. (See Table A-1).

2.1.2. Alert. This Emergency Action Level includes those situations for with it is crucial to notify the System Radiation Safety Officer, Campus Safety Officer, LSU Police, Physical Plant Department, and the Louisiana Nuclear Energy Division staff in order to assure that the emergency personnel are available to respond should the situation become more serious. This Emergency Action Level also poses no harm to the public but, confirmatory radiological monitoring by the state may be appropriate in order to verify that no harm to the public has occurred.

The primary purpose of this Emergency Action Level is to ensure that members of the emergency organization are available to respond should the situation become more serious. If a fire, radiological or medical emergency is involved, appropriate emergency response teams and local support services will report to the Nuclear Science Center as required. The University Radiation Safety Officer will initiate the notification.

2.1.3. Site Emergency. This Emergency Action Level includes those situations for which it is prudent to notify the System Radiation Safety Officer, the President of the University, the Campus Safety Officer, LSU Police Department, Physical Plant, City Police, State Police, Gulf States Utilities, the Fire Department, and Capital Transportation Corporation. The level requires early warning to the campus and surrounding community so that they may be in a state of readiness should the accident become more serious.

2.1.4. General Emergency. This is the most severe of the four Emergency Action Levels. This Emergency Action Level includes those situations for which it is prudent to notify the System Radiation Safety Officer, the President of the University, the Campus Safety Officer, Louisians State University Police, Physical Plant, the Fire Department, and Capital Transportation Corporation so that they may take predetermined protective actions such as sheltering and/or evacuation of the public, in order to minimize the potential radiological exposure of the public.

If the Nuclear Science Center is under evacuation, another suitable place will be designated by the University Radiation Safety Officer.

The Emergency Response Team, local service groups and Louisiana Emergency Reaction Team will work hand in hand with each other under the leadership of the System Radiation Protection Officer.

2.2. Notification Procedures

Procedures to be used by campus personnel in the event of a radiological incident.

* CLEAR AREA ....

    Go to the closest safe place
    Get everyone out
    Carefully help anyone who is injured

* SEAL OFF AREA ....

    Post guards to keep people away
    Turn hoods and water off before leaving
    Close doors behind you

* CALL FOR HELP ....

Campus Radiation Safety Officer:	Dr. Robert C. McIhenny Nuclear Science Center Room 123 (Business) 388-2163 (Home) 766-4931
Alternate:	Dr. Ronald M. Knaus Nuclear Science Center Room 223 (Business) 388-2163 (Home) 766-0677
Technical Assistant:	Mr. Jack Evans Nuclear Science Center Room 125 (Business) 388-2163 (Home) 343-9794
Campus Safety Office	244 Thomas Boyd Hall (Business) 388-5640

Campus Police	Campus Police Bldg. (Business) 388-3231
University Emergency Number	388-HELP/4357

* TELL WHAT HAPPENED ....

  Major spill
  Exposed surface
  Air-borne contamination
  Fire or explosion
  Badly contaminated major injury

* TELL WHERE ....

* TELL WHO ....

* WAIT CLOSE BY ....

  Tie a handkerchief around your arm for quick identification.

In the event the Nuclear Energy Division has to be notified, the procedures listed below will be used:

A. Advise the individual contacted that a radiological incident has occurred.

B. Provide information to include the following:

   1. WHO: Your name, address, telephone number and any numbers where you may be contacted and any other significant identification.

   2. WHAT: Type of incident (radioactive material release ruptured or lost source, personnel overexposure, etc.), contamination, personnel

injures and magnitude, action or notifications that have been taken at the scene of the accident.

3. WHEN: Give best information available as to time and date of incident.

4. WHERE: Give exact location of incident.

In the event that the Nuclear Energy Division cannot be reached at its 24-hour telephone number (504) 925-4518 notify the Louisiana State Police at (504) 292-8200 and tell them a radiological incident has occurred and that they will relay the message to the Nuclear Energy Division.

2.3. Protective Action

Protective actions are measures taken during or after an emergency situation to minimize or eliminate the hazard to the health and safety of the students, faculty, workers, and surrounding community.

2.3.1. Evacuation and Protection.

A.) Evacuation from a Restricted Area. This is an orderly withdrawal of all individuals from any area in a building or the university grounds where radioactive materials or radiation sources are uncontrolled. This type of evacuation will be used only if the personnel in this area could receive a whole body dose of 0.5 rem or 1.5 rem dose to tissue and organ system (hands and forearms excluded) over a period of twelve months as a result of the incident. These limits are consistent with LSU Radiation Protection Standards in Attachment B.

The following action will be taken to evacuate the area:

1. The Emergency Evacuation Team will evacuate all individuals within the affected area,

2. Individuals evacuated from the affected area will follow marked evacuation routes set up by the Emergency Evacuation Team,

3. All individuals will report to Emergency Control and Pickup Center designated by the Emergency Evacuation Team,

4. All individuals are to remain at the Emergency Control Pickup Center until they are transferred by bus or other means to provided shelter, and

5. All individuals will undergo preliminary monitoring at the designated shelter.

B.) Campus Evacuation. This Plan does not provide for a campus-wide evacuation. Emphasis is placed on facility or local evacuations. In the event of a major accident involving transportation of radioactive material on or near campus, the situation will be managed by off-campus organizations.

2.4. Protective Equipment and Supplies

The use of campus radiological protective equipment and supplies is controlled by the Louisiana State University Nuclear Science Center staff. Individuals and groups requiring access to areas where radiation is in use are trained in the use of dosimeters, protective clothing, and the precautions required to minimize the effects of radiological exposure and contamination problems.

2.4.1. Location and Inventory List of Emergency Supplies and Equipment. A list of available equipment and supplies is included in Attachment C of this plan.

2.5. Aid to Affected Individual

2.5.1. Search and Rescue. Re-entry will be done by individuals who are trained in health physics, first aid, and/or maintenance. Re-entry will be accomplished for one or more of the following reasons:

A.) To rescue injured or trapped individuals,

B.) To search for unaccounted individuals, and

C.) To decrease the hazardous condition.

The individuals used for the re-entry will be briefed regarding their duties, expected dose, and stay time. The guidelines listed below shall be followed upon re-entry.

A.) Under emergency conditions where it is imperative to enter a hazardous area in order to protect students, faculty, and workers, the re-entry individuals may exceed 5 rem whole body exposure within the following guidelines:

1. The individuals must volunteer,
2. Women capable of reproduction shall not take part,
3. Whole body dose shall not exceed 24 rem,
4. Dose to hands and forearms shall not exceed 100 rem,
5. Internal exposure shall be minimized by respiratory protection and controlled by the use of protective clothing, and
6. One person must use a survey meter.

B.) Under conditions not requiring action to prevent serious injury the individuals that re-enter shall not exceed 5 rem whole body exposure within 12 months.

2.5.2. Decontamiation and First Aid. Decontamination will be done by individuals who are trained in health physics except when an injury is involved. Medical assistance will be rendered by individuals who are trained in first aid with the assistance of health physics personnel to reduce radiation exposure to or contamination of emergency medical personnel.

The individuals who supply first aid should be trained in health physics to the extent that they understand the basic principles of contamination control and general radiation safety.

On-site first aid and decontamination should be limited to that required to prepare an injured person for transportation to a fully equipped facility. Injured individuals will be taken to a hospital as quickly as possible. The hospital must be notified in advance that a contaminated patient will be sent so that proper receiving precautions may be taken.

General guidelines for personnel decontamination are included as Attachment D of this plan.

2.6. Recovery from an Incident

Recovery action to be taken to restore the campus to normal conditions after an emergency will depend on the actual level of the emergency. The "all-clear" decision will be given by the Louisiana State University System President on the advice of his Committee on Emergency, and will be transmitted to the public via the Louisiana State University Public Information Officer. The decision will be based on the University's radioactive materials license criteria as described in the Baton Rouge campus Radiation Safety Manual, and reproduced as Attachment F of this Plan. An area may be returned to service when it has been decontaminated to the "acceptable" level of Attachment E.

3.0. Emergency Facilities

This section of the Emergency Plan describes the Emergency Facilities to be used in the event of a radiological incident.

3.1. Emergency Response Facilities

3.1.1. Louisiana State University, Nuclear Science Center. The Nuclear Science Center was established in 1960 as a service facility to the entire University community. The Center is equipped with supplies to enable the response organization to follow the course of the incident. In the event the Nuclear Science Center has to be evacuated, the Louisiana State Veterinary Medicine School will be used as the new control center.

3.1.2. Louisiana Veterinary Medicine School. The Louisiana Veterinary Medicine School will serve as the alternate control center. This center will also be equipped with supplies and equipment so that the response organizations will be able to follow the course of an incident.

3.1.3. On-campus Evacuation Centers. Students or other individuals who require temporary housing as the result of evacuating a portion of the campus will be quartered in various buildings on the campus. A list of campus buildings which may be used as evacuation centers is included in Attachment E of this Plan.

3.2. Auxiliary Emergency Housing

In the event of the necessity to evacuate the campus partially, the Mayor's Office will coordinate temporary housing and transportation. The Mayor's Office will be equipped with supplies and equipment to enable the response organization to follow the course of an incident. A list of off-campus evacuation centers is included in Attachment F of this Plan.

4.0. Maintenance of the Emergency Response Plan

This section describes the methods used to ensure that the Radiological Emergency Response Plan remains effective.

4.1. Training

The objectives of the training program are:

A.) To familiarize the students, faculty, and workers with Emergency Response Plan and its implementing procedures.

B.) To give initial orientation to the students, faculty and workers in the basic principles of radiation safety.

C.) To provide refresher training to ensure that personnel are familiar with the duties and responsibilities assigned in the Emergency Plan.

D.) To familiarize all local service groups with the campus procedures and the identity of the individuals involved in the Emergency Organizations.

4.2. Drills

Drills shall be conducted to improve the Emergency Response Plan. The local service groups and the State Nuclear Energy Division will be invited to participate in the drill. The drill will vary from year to year such that all the major parts of the emergency response plan are tested. The drills will vary in the times they are initiated.

The drill scenario will be written and reviewed by a qualified non-affiliated organization to Louisiana State University. The scenario will include the following:

a) Type of emergency such as radiological room or building evacuation, radiological fire emergency and/or radiological medical emergency,

b) Organizations need to control the incident,

c) Time of the incident, and

d) A narrative describing the appropriate action measure to be taken by the appropriate organizations.

4.3. Review and Updating

The Emergency Response Plan will be under continuous review by the University System Radiation Protection Officer and the University Radiation Safety Committee. The University System Radiation Protection Officer will be responsible for the development and updating of the emergency response plan and coordination of this plan with other response organizations.

After each drill, the emergency response plan will be evaluated against the results of the drill and then revised if necessary. The notification list and emergency equipment list will be continually updated. If accepted by the School, Letters of Agreement from service groups will be renewed every year.

5.0. Public Information

Central control over the issuance of public information on an emergency and progress in containing it will be assigned to the Head of the University New Service. News Service personnel will be included on the radiological emergency response teams, and will receive response-team training. Any incident which is classed as reportable to the Louisiana Nuclear Energy Division must be considered for discussion with news media by means of a press conference in which technically knowledgeable individuals are present. All news-media communications should represent the most honest and current assessment of an incident.

Radiological Emergency Response Plan

ATTACHMENTS

ATTACHMENT A

EXCERPTS FROM LOUISIANA RADIATION REGULATIONS

Sec.D.403. NOTIFICATION OF INCIDENTS.

(a) Immediate Notification. Each licensee or registrant shall immediately notify the Division by telephone or telegraph of any incident involving any source of radiation possessed by him and which may have caused, or threatens to cause:

(1) A dose to the whole body of any individual of 25 Rems or more of radiation; a dose to the skin of the whole body of any individual of 150 Rems or more of radiation; or a dose to the feet, ankles, hands or forearms of any individual of 375 Rems or more of radiation; or

(2) The release of radioactive material in concentrations which, if averaged over a period of 24 hours, would exceed 5,000 times the limits specified for such materials in Appendix A, Table II; or

(3) A loss of one working week, or more, of the operation of any facilities affected; or

(4) Damage to property in excess of $200,000.

(b) Twenty-four Hour Notification. Each licensee or registrant shall, within 24 hours, notify the Division by telephone or telegraph of any incident involving any source of radiation possessed by him and which may have caused, or threatens to cause:

(1) A dose to the whole body of any individual of 5 Rems or more of radiation; a dose to the skin of the whole body of any individual of 30 Rems or more of radiation; or a dose to the feet, ankles, hands or forearms of 75 Rems or more of radiation; or

(2) The release of radioactive material on concentrations which, if averaged over a period of 24 hours, would exceed 500 times the limits specified for such materials in Appendix A, Table II; or

(3) A loss of one day or more of the operation of any facilities affected; or

(4) Damage to property in excess of $2,000.

(c) Any report filed with the Division pursuant to this section shall be prepared in such a manner that names of individuals who have received excessive radiation doses shall be stated in a separate part of the report.

Sec.D.404. (Reserved).

Sec.D.405. REPORTS OF OVEREXPOSURES AND EXCESSIVE LEVELS AND CONCENTRATIONS.

(a) In addition to any notification required by Sec.D.403, each licensee or registrant shall make a report, in writing within thirty (30) days, to the Division of:

(1) Each exposure of an individual to radiation in excess of the applicable limits in Sec.D.101 or para. D.104(a) or the license;

(2) Each exposure of an individual to radioactive material in excess of the applicable limits in paragraphs D.103(a)(1), D.103(a)(2), D.104(b) or the license;

(3) Levels of radiation or concentrations of radioactive material in a restricted area in excess of any other applicable limit in the license;

(4) Any incident for which notification is required by Sec.D.403; and

(5) Levels of radiation or concentrations of radioactive material (whether or not involving excessive exposure of any individual) in an unrestricted area in excess of ten (10) times any applicable limit set forth in this part or in the license.

Radiological Emergency Response Plan

ATTACHMENT B

LOUISIANA STATE UNIVERSITY RADIATION PROTECTION STANDARDS

Controlled Personnel are individuals who have been approved for work with radioactive materials and radiation sources, including University employees, students, and visitors, and who have been assigned personnel dosimeters by the Radiation Safety Office. No person under the age of 18 years may be designated in this category.

General Population include all human beings other than those designated as controlled personnel.

Restricted Area includes any area in a building or on the University grounds where radioactive materials or radiation sources are to be used, and entrance is restricted to controlled personnel or the general population only under the surveillance of controlled personnel. Restricted areas must be marked with proper signs.

Unrestricted Area includes all areas which are not qualified as restricted areas.

Dose Commitment is employed here as a general term for both internal- and external-source exposure.

Rem is the special unit of Dose Equivalent, as defined by the International Commission on Radiation Units and Measurements, which is intended to express a scaled value of potential biological consequence from exposure to radiation, independent of the type or quality of the radiation.

Year is any period of 365 consecutive days.

Calendar Quarter is any period of between twelve and fourteen consecutive weeks. One semester is considered equivalent to one calendar quarter because of the scheduling of laboratory periods.

<u>Emergency Exposure</u> is considered to be limited to a situation which potential requires a life-saving mission, and is considered as a once-in-a-lifetime occurrence.

<u>Individual</u> means any single human being or a small group of people exposed simultaneously.

<u>Average</u> implies that the exposure group represents a large number of people.

Table A-2

RADIATION PROTECTION STANDARDS

Controlled Personnel in Restricted Areas

Type of Exposure	Dose Commitment, rem[a/] Expos. Per.: Year	Quarter	Emergency[b/]
Whole body; head, trunk, gonads, lens of the eye, red bone marrow, active blood-forming organs	5 (0.5)	1.25 (0.125)	100 (12)
Unlimited areas of the skin (hands & forearms excluded); other organs, tissues and organ systems (bone excluded)	15 (1.5)	7.5 (0.5)	--
Bone	30 (1.5)	10 (0.5)	--
Forearms	30 (1.5)	10 (0.5)	200 (50)
Hand & feet	75 (1.5)	18.75 (0.5)	200 (50)

[a/] Values in parentheses represent "as-low-as-practicable" target commitments.

[b/] Values for emergency-dose commitments are one-time-only life-saving dose commitments; values in parentheses are target commitments for timed entries.

General Public in Unrestricted Areas

Type of Exposure	Annual Dose Commitments, rem Individual	Population Avg.
Whole body, gonadal tissue, bone marrow, lens of the eye	0.5	0.17
All other organs	1.5	0.5

Radiological Emergency Response Plan

ATTACHMENT C

AVAILABLE RADIOLOGICAL RESPONSE EQUIPMENT ON THE BATON ROUGE CAMPUS

Table A-3

Location and Inventory List of Emergency Supplies and Equipment

Location	Contact	Phone Number	Equipment
1) Biochemistry	Dr. Deutsch	388-1556	Liquid Scintillation Counter (2) Gamma Scintillation Counter (1)
2) Entomology	Dr. T. Sparks	388-1634	Liquid Scintillation Counter (1)
3) Microbiology	Dr. Orlowski	388-2601	Liquid Scintillation Counter (1)
4) Nuclear Science Center	Dr. E. N. Lambremont	388-2163	Liquid Scintillation Counter (2) Gamma Scintillation Counter (1) NaI Detector (3) Geiger-Muller Survey Meter (6) Decontamination Kit Protective Clothing

Table A-3 (cont'd)

Location	Contact	Phone Number	Equipment
5) School of Veterinary Medicine	Dr. King	346-3376	Cutie Pie Survey Meter (1) Geiger-Muller Survey Meter (1) Decontamination Kit (1)
6) Thomas Boyd	Eugene Earp	388-5640	Air Sampler
7) Transportation Research Center	James L. Melancon	342-7874	Geiger-Muller Survey Meter (1) NaI Detector

Radiological Emergency Response Plan

ATTACHMENT D

PERSONNEL DECONTAMINATION GUIDELINES

Personnel Decontamination. General decontamination procedures for exposed personnel are summarized in the table on the following page. The mildest procedure is listed first (soap and water), and the most severe at the bottom of the table. Always begin with the mildest procedure. A soft hand brush is preferable to hand-to-and washing because the brush reaches into crevasses and under fingernails more effectively than hand lathering. Never use a hard brush. Stiff bristles tend to abrade the skin and lead to internal contamination, and recoiling bristles tend to splatter and spread contamination.

If the procedures in the table are not effective, washing with a titanium dioxide paste (a mixture of titanium dioxide powder and lanolin cream) should be tried. This requires caution to avoid unnecessary surface abrasion.

A still more drastic procedure involves dipping the hands into a saturated potassium permanganate solution, rinsing in running water, and then dipping into a five-percent (5%) sodium bisulfite solution to remove the permanganate stain. For very heavy contamination the initial solution should be prepared from equal volumes of saturated potassium permanganate solution and 0.2 N sulfuric acid, and should be applied with a soft brush for not more than two minutes. The sodium bisulfite solution should be freshly prepared to be effective.

If these procedures fail to remove the contamination, there is little risk of it coming off during normal use, and leading to internal contamination. Skin ultimately will decontaminate spontaneously through growth and slow abrasion.

Flooding with water immediately is the most effective emergency procedure for tritium contamination, and washing with an aqueous ammonia solution may prove effective for iodine contamination.

All jewelry must be removed before donctamination of hands is attempted. Rings especially tend to inhibit proper complete decontamination. The jewelry should be decontaminated separately before it is worn again.

Hair is generally difficult to decontaminate because of its surface structure. In extreme cases moustaches or beards may require shaving, and a short hair cut may be advised to bring contamination levels down to acceptable values. These remedial actions should be done only in a controlled area.

If air-borne activity is suspected, the interior of the nose and ears should be cleaned with cotton swabs.

These procedures are best accomplished by a nurse or physician.

Wounds from contaminated sources (e.g., broken glassware) should be allowed to bleed freely for a short while to inhibit internal contamination. If residual activity is detected in a wound, decontamination should be undertaken only by knowledgeable physician.

Table A-4

Personnel Decontamination

Method*	Surface	Action	Technique	Advantages	Disadvantages
Soap and water	Skin and hands	Emulsifies and dissolves contaminate.	Wash 2-3 minutes and monitor. Do not wash more than 3-4 times.	Readily available and effective for most radioactive contamination.	Continued washing will defat the skin. Indiscriminate washing of other than affected parts may spread contamination.
Soap and water	Hair	Same as above	Wash several times. If contamination is not lowered to acceptable levels, shave the head and apply skin decontamination methods.		
Lava soap, soft brush, and water	Skin and hands	Emulsifies, dissolves, and erodes.	Use light pressure with heavy lather. Wash for 2 minutes, 3 times. Rinse and monitor. Use care not to scratch or erode the skin. Apply lanolin or hand cream to prevent chapping.	Same as above	Continued washing will abrade the skin.
Tide or other detergent (plain)	Same as above.	Same as above.	Make into a paste. Use with additional water with a mild scrubbing action. Use care not to erode the skin.	Slightly more effective than washing with soap.	Will defat and abrade skin and must be used with care.

* Begin with the first listed method and then proceed step by step to the more severe methods, as necessary.

Radiological Emergency Response Plan

ATTACHMENT E

LOUISIANA STATE UNIVERSITY CONTAMINATION CRITERIA

Table A-5

Radiation Level/Action Criteria

Situation	Level	Action Required
General radiation at work station	Background	None
	0.5 mR/hr	Acceptable; no action needed
	1 mR/hr	Unnecessary; find source and shield or store elsewhere
	2 mR/hr	Excessive; shield or remove source immediately
	5 mR/hr	Restrict working time if no other remedy is possible
	100 mR/hr	Request assistance from Radiation Safety Office immediately, stop work, control access to the area.
Surface contamination as measured by		
End-window probe[a] -	Background	None
Large-area probe[b] -	Background	
Smear[c]	Background	
End-window probe	120 cpm	Acceptable for all except alpha emitters (reduce by 1/10), but problem is developing.
Large-area probe	300 cpm	
Smear	30 cpm	

Table A-5 (cont'd)

Radiation Level/Action Criteria (cont'd)

Situation	Level	Action Required
Surface contamination as measured by		
End-window probe	400 cpm	Unnecessarily high; cleaning required soon.
Large-area probe	1,000 cpm	
Smear	100	
End-window probe	2,000 cpm	Terminate work immediately; notify Radiation Safety Office; immediate decontamination is imperative.
Large-area probe	5,000 cpm	
Smear	500 cpm	

[a]End-window Geiger-Muller detector, 1.4 mg/cm^2, 7 cm^2 area; for contamination checks probe is held 0.5 cm from surface.

[b]Large-area gas-flow Geiger-Muller detector, 60 cm^2 area; surface contact.

Radiological Emergency Response Plan

ATTACHMENT F

AVAILABLE SHELTERS

A) On-campus Shelters

1. Louisiana State University Assembly Center
2. Pleasant Hall
3. Parker Agricultural Center
4. Nelson Memorial Building

B) Off-Campus Shelters

Building/Location/Phone Number

1. CATHOLIC LIFE CENTER; 1800 Acadian Thwy, Baton Rouge; 387-0561
2. ISTROUMA SENIOR HIGH; 3730 Winbourne Ave., Baton Rouge; 355-7701
3. KENILWORTH JUNIOR HIGH; 7600 Boone Dr., Baton Rouge; 766-8111
4. ST. ANTHONY ELEMENTARY; 2305 Choctaw Dr., Baton Rouge; 357-2825
5. ST. GEORGE; 7880 Seigen Lane, Baton Rouge; 293-1298
6. ST. GERARD ELEMENTARY; 3655 St. Gerard Ave., Baton Rouge; 355-1437
7. BELAIRE SENIOR HIGH; 12121 Tams Dr., Baton Rouge; 272-1860
8. HOWELL PARK ELEMENTARY; 6125 Winbourne Ave., Baton Rouge; 356-0104
9. JEFFERSON TERRACE ELEMENTARY; 9902 Cal Rd., Baton Rouge; 293-3210

10. OUR LADY OF MERCY; 400 Marquette, Baton Rouge; 924-1054

11. VALLEY PARK MIDDLE SCHOOL; 4510 Barwell, Baton Rouge; 927-0500

12. WESTDALE ELEMENTARY; 2000 College Dr., Baton Rouge; 926-4107

13. WESTIMINISTER ELEMENTARY; 8935 Westiminister Dr., Baton Rouge; 927-2930

14. BELFAIR ELEMENTARY; 4451 Fairfields Ave., Baton Rouge; 356-6191

15. BELLINGRATH HILLS ELEMENTARY; 6612 Audusson Dr., Greenwell Springs; 261-4093

16. BROOKSTOWN ELEMENTARY; 4375 E. Brookstown, Baton Rouge; 355-0382

17. CAPITOL MIDDLE SCHOOL; 4200 Gus Young Ave., Baton Rouge; 344-6799

18. CEDARCREST-SOUTHMORE ELEMENTARY; 10187 Twin Cedars, Baton Rouge; 293-9950

19. CENTRAL HIGH SCHOOL; 10200 E. Brookside Dr., Baton Rouge; 261-3438

20. CHOCTAW VOCATIONAL CENTER; 2875 Michelli Dr., Baton Rouge; 356-4591

21. DELMONT ELEMENTARY; 5300 Douglas, Baton Rouge; 355-2106

22. GLEN OAKS JUNIOR HIGH; 5300 Monarch, Baton Rouge; 357-3790

23. GREENBRIER ELEMENTARY; 12203 Canterbury Dr., Baton Rouge; 275-2635

24. MCKINLEY JUNIOR HIGH; 1557 McCalop, Baton Rouge; 344-9040

25. MELROSE ELEMENTARY; 1348 Valcour, Baton Rouge; 926-2353

26. NORTHWESTERN ELEMENTARY; Rollins and Pope Rd., Zachary; 654-2786

27. PARK FOREST MIDDLE SCHOOL; 3760 Aletha Dr., Baton Rouge; 275-6650

28. POLK ELEMENTARY; 408 E. Polk St., Baton Rouge; 383-2611

29. PRIDE HIGH SCHOOL; Pride; 654-5113

30. PROGRESS ELEMENTARY; 855 Progress Rd., Baton Rouge; 775-4986

31. REDDY ELEMENTARY; 720 Terrace St., Baton Rouge; 343-7806

32. RIVER OAKS ELEMENTARY; 950 Fountainbleau, Baton Rouge; 275-4600

33. SACRED HEART; 2251 Main, Baton Rouge; 383-7481

34. SHARON HILLS ELEMENTARY; 6450 Guynell Dr., Baton Rouge; 355-6522

35. SHENDANDOAH ELEMENTARY; 1655 Appomatox, Baton Rouge; 293-3560

36. SOUTH BOULEVARD ELEMENTARY; 802 Mayflower, Baton Rouge; 343-6630

37. SOUTHEAST MIDDLE SCHOOL; 1500 Harrell's Ferry Rd., Baton Rouge; 293-5930

38. TANGLEWOOD ELEMENTARY; 9352 Rustling Oaks, Baton Rouge; 261-3454

39. TWIN OAKS ELEMENTARY; 819 Trammel Dr., Baton Rouge; 275-6620

40. VILLA DEL RAY ELEMENTARY; 9765 Cuyhanga Pkwy., Baton Rouge; 924-1606

41. WINBOURNE ELEMENTARY; 4501 Winbourne, Baton Rouge; 355-4446

42. ZACHARY HIGH; 4104 Church St., Zachary; 654-2776

43. ZION CITY ELEMENTARY; 5959 Cadillac St., Baton Rouge; 356-0256

APPENDIX B

Dose Commitment Factors for
Adults Inhaling Radionuclides

DOSE COMMITMENT FACTORS FOR ADULTS INHALING RADIONUCLIDES
REFERENCE NUREG-0172 NOV 1977 HONES & SELBY

UNITS ARE MREM IN 50 YEARS PER PICOCURIE INHALED IN ONE YEAR OR LESS

ID	ISOTOPE	BONE	LIVER	WHOLE BODY	THYROID	KIDNEY	LUNG	GI-LLI	ISOTOPE
1	H 3	0.0	1.58E-07	1.58E-07	1.58E-07	1.58E-07	1.58E-07	1.58E-07	H 3
2	BE 10	1.98E-04	3.06E-05	4.96E-06	0.0	0.0	2.22E-04	1.67E-05	BE 10
3	C 14	2.27E-06	4.26E-07	4.26E-07	4.26E-07	4.26E-07	4.26E-07	4.26E-07	C 14
4	N 13	6.27E-09	6.27E-09	6.27E-09	6.27E-09	6.27E-09	6.27E-09	6.27E-09	N 13
5	F 18	4.71E-07	0.0	5.19E-08	0.0	0.0	0.0	9.24E-09	F 18
6	NA 22	1.30E-05	1.30E-05	1.30E-05	1.30E-05	1.30E-05	1.30E-05	1.30E-05	NA 22
7	NA 24	1.28E-06	1.28E-06	1.28E-06	1.28E-06	1.28E-06	1.28E-06	1.28E-06	NA 24
8	P 32	1.65E-04	9.64E-06	6.26E-06	0.0	0.0	0.0	1.08E-05	P 32
9	AR 39	0.0	0.0	0.0	0.0	0.0	2.08E-09	0.0	AR 39
10	AR 41	0.0	0.0	0.0	0.0	0.0	8.06E-09	0.0	AR 41
11	CA 41	3.83E-05	0.0	4.13E-06	0.0	0.0	3.83E-06	2.86E-07	CA 41
12	SC 46	5.51E-05	1.07E-04	3.11E-05	0.0	9.99E-05	0.0	3.23E-05	SC 46
13	CR 51	0.0	0.0	1.25E-08	7.44E-09	2.85E-09	1.80E-06	4.15E-07	CR 51
14	MN 54	0.0	4.95E-06	7.87E-07	0.0	1.23E-06	1.75E-04	9.67E-06	MN 54
15	MN 56	0.0	1.55E-10	2.29E-11	0.0	1.63E-10	1.18E-06	2.53E-06	MN 56
16	FE 55	3.07E-06	2.12E-06	4.93E-07	0.0	0.0	9.01E-06	7.54E-07	FE 55
17	FE 59	1.47E-06	3.47E-06	1.32E-06	0.0	0.0	1.27E-04	2.35E-05	FE 59
18	CO 57	0.0	8.65E-08	8.39E-08	0.0	0.0	4.62E-05	3.93E-06	CO 57
19	CO 58	0.0	1.98E-07	2.59E-07	0.0	0.0	1.16E-04	1.33E-05	CO 58
20	CO 60	0.0	1.44E-06	1.85E-06	0.0	0.0	7.46E-04	3.56E-05	CO 60
21	NI 59	4.06E-06	1.46E-06	6.77E-07	0.0	0.0	8.20E-06	6.11E-07	NI 59
22	NI 63	5.40E-05	3.93E-06	1.81E-06	0.0	0.0	2.23E-05	1.67E-06	NI 63
23	NI 65	1.92E-10	2.62E-11	1.14E-11	0.0	0.0	7.00E-07	1.54E-06	NI 65
24	CU 64	0.0	1.83E-10	7.69E-11	0.0	5.78E-10	8.48E-07	6.12E-06	CU 64
25	ZN 65	4.05E-06	1.29E-05	5.82E-06	0.0	8.62E-06	1.08E-04	6.68E-06	ZN 65
26	ZN 69M+D	1.02E-09	2.45E-09	2.24E-10	0.0	1.48E-09	2.38E-06	1.71E-05	ZN 69M+D
27	ZN 69	4.23E-12	8.14E-12	5.65E-13	0.0	5.27E-12	1.15E-07	2.04E-09	ZN 69
28	SE 79	0.0	3.83E-07	6.09E-08	0.0	5.69E-07	4.47E-05	3.33E-06	SE 79
29	BR 82	0.0	0.0	1.69E-06	0.0	0.0	0.0	1.30E-06	BR 82
30	BR 83+D	0.0	0.0	3.01E-08	0.0	0.0	0.0	2.90E-08	BR 83+D
31	BR 84	0.0	0.0	3.91E-08	0.0	0.0	0.0	2.05E-13	BR 84
32	BR 85	0.0	0.0	1.60E-09	0.0	0.0	0.0	0.0	BR 85
33	KR 83M	0.0	0.0	0.0	0.0	0.0	5.19E-10	0.0	KR 83M
34	KR 85M	0.0	0.0	0.0	0.0	0.0	2.91E-09	0.0	KR 85M
35	KR 85	0.0	0.0	0.0	0.0	0.0	2.41E-09	0.0	KR 85
36	KR 87	0.0	0.0	0.0	0.0	0.0	1.53E-08	0.0	KR 87
37	KR 88+D	0.0	0.0	0.0	0.0	0.0	3.13E-08	0.0	KR 88+D
38	KR 89	0.0	0.0	0.0	0.0	0.0	2.13E-08	0.0	KR 89
39	RB 86	0.0	1.69E-05	7.37E-06	0.0	0.0	0.0	2.08E-06	RB 86
40	RB 87	0.0	9.86E-06	3.21E-06	0.0	0.0	0.0	2.88E-07	RB 87
41	RB 88	0.0	4.84E-08	2.41E-08	0.0	0.0	0.0	4.18E-19	RB 88
42	RB 89+D	0.0	3.20E-08	2.12E-08	0.0	0.0	0.0	1.16E-21	RB 89+D
43	SR 89+D	3.80E-05	0.0	1.09E-06	0.0	0.0	1.75E-04	4.37E-05	SR 89+D
44	SR 90+D	1.24E-02	0.0	7.62E-04	0.0	0.0	1.20E-03	9.02E-05	SR 90+D
45	SR 91+D	7.74E-09	0.0	3.13E-10	0.0	0.0	4.56E-06	2.39E-05	SR 91+D
46	SR 92+D	8.43E-10	0.0	3.64E-11	0.0	0.0	2.06E-06	5.38E-06	SR 92+D
47	Y 90	2.61E-07	0.0	7.01E-09	0.0	0.0	2.12E-05	6.32E-05	Y 90
48	Y 91M+D	3.26E-11	0.0	1.27E-12	0.0	0.0	2.40E-07	1.66E-10	Y 91M+D
49	Y 91	5.78E-05	0.0	1.55E-06	0.0	0.0	2.13E-04	4.81E-05	Y 91
50	Y 92	1.29E-09	0.0	3.77E-11	0.0	0.0	1.96E-06	9.19E-06	Y 92
51	Y 93	1.18E-08	0.0	3.26E-10	0.0	0.0	6.06E-06	5.27E-05	Y 93
52	ZR 93+D	5.22E-05	2.92E-06	1.37E-06	0.0	1.11E-05	2.13E-05	1.51E-06	ZR 93+D
53	ZR 95+D	1.34E-05	4.30E-06	2.91E-06	0.0	6.77E-06	2.21E-04	1.88E-05	ZR 95+D

54	ZR 97+D	1.21E-08	2.45E-09	1.13E-09	0.0	3.71E-09	9.84E-06	6.54E-05	ZR 97+D
55	NB 93M	1.10E-05	1.01E-05	2.49E-06	0.0	1.10E-05	3.11E-05	2.38E-06	NB 93M
56	NB 95	1.76E-06	9.77E-07	5.26E-07	0.0	9.67E-07	6.31E-05	1.30E-05	NB 95
57	NB 97	2.78E-11	7.03E-12	2.56E-12	0.0	8.18E-12	3.00E-07	3.02E-08	NB 97
58	MO 93	0.0	1.17E-06	3.17E-08	0.0	3.55E-07	5.11E-05	3.79E-06	MO 93
59	MO 99+D	0.0	1.51E-08	2.87E-09	0.0	3.64E-08	1.14E-05	3.10E-05	MO 99+D
60	TC 99M	1.29E-13	3.64E-13	4.63E-12	0.0	5.52E-12	9.55E-08	5.20E-07	TC 99M
61	TC 99	3.13E-08	4.64E-08	1.75E-08	0.0	5.85E-07	1.01E-04	7.54E-06	TC 99
62	TC 101	5.22E-15	7.52E-15	7.38E-14	0.0	1.35E-13	4.99E-08	1.36E-21	TC 101
63	RU 103+D	1.91E-07	0.0	8.73E-08	0.0	7.29E-07	6.31E-05	1.31E-05	RU 103+D
64	RU 105+D	9.88E-11	0.0	3.89E-11	0.0	1.27E-10	1.37E-06	6.02E-06	RU 105+D
65	RU 106+D	8.64E-06	0.0	1.09E-06	0.0	1.67E-05	1.17E-03	1.14E-04	RU 106+D
66	RH 105	9.24E-10	6.73E-10	4.43E-10	0.0	2.86E-09	2.41E-06	1.09E-05	RH 105
67	PD 107	0.0	8.27E-08	5.87E-09	0.0	6.57E-07	9.47E-06	7.06E-07	PD 107
68	PD 109	0.0	4.63E-10	1.16E-10	0.0	2.35E-09	1.85E-06	1.52E-05	PD 109
69	AG 110MD	1.35E-06	1.25E-06	7.43E-07	0.0	2.46E-06	5.79E-04	3.78E-05	AG 110MD
70	AG 111	4.25E-08	1.78E-08	8.87E-09	0.0	5.74E-08	2.33E-05	2.79E-05	AG 111
71	CD 113M	0.0	1.54E-04	4.79E-06	0.0	1.71E-04	2.08E-04	1.59E-05	CD 113M
72	CD 115M	0.0	2.46E-05	7.95E-07	0.0	1.98E-05	1.76E-04	4.80E-05	CD 115M
73	SN 123	3.02E-05	6.67E-07	9.82E-07	5.67E-07	0.0	2.88E-04	3.97E-05	SN 123
74	SN 125+D	1.16E-06	3.12E-08	7.08E-08	2.59E-08	0.0	7.37E-05	6.81E-05	SN 125+D
75	SN 126+D	1.58E-04	4.18E-06	6.00E-06	1.23E-06	0.0	1.17E-03	1.59E-05	SN 126+D
76	SB 124	3.90E-06	7.36E-08	1.55E-06	9.44E-09	0.0	3.10E-04	5.08E-05	SB 124
77	SB 125+D	6.67E-06	7.44E-08	1.58E-06	6.75E-09	0.0	2.18E-04	1.26E-05	SB 125+D
78	SB 126	4.50E-07	9.13E-09	1.52E-07	2.75E-09	0.0	9.57E-05	6.01E-05	SB 126
79	SB 127	3.30E-08	7.22E-10	1.27E-08	3.97E-10	0.0	2.05E-05	3.77E-05	SB 127
80	TE 125M	4.27E-07	1.98E-07	5.84E-08	1.31E-07	1.59E-06	3.92E-05	8.83E-06	TE 125M
81	TE 127MD	1.58E-06	7.21E-07	1.96E-07	4.11E-07	5.72E-06	1.20E-04	1.87E-05	TE 127MD
82	TE 127	1.75E-10	8.03E-11	3.87E-11	1.27E-10	6.37E-10	8.14E-07	7.17E-06	TE 127
83	TE 129MD	1.22E-06	5.84E-07	1.98E-07	4.30E-07	4.57E-06	1.45E-04	4.79E-05	TE 129MD
84	TE 129	6.22E-12	2.99E-12	1.55E-12	4.87E-12	2.34E-11	2.42E-07	1.96E-08	TE 129
85	TE 131MD	8.74E-09	5.45E-09	3.63E-09	6.88E-09	3.86E-08	1.82E-05	6.95E-05	TE 131MD
86	TE 131+D	1.39E-12	7.44E-13	4.49E-13	1.17E-12	5.46E-12	1.74E-07	2.30E-09	TE 131+D
87	TE 132+D	3.25E-08	2.69E-08	2.02E-08	2.37E-08	1.82E-07	3.60E-05	6.37E-05	TE 132+D
88	TE 133MD	7.24E-12	5.04E-12	4.17E-12	6.27E-12	3.74E-11	5.51E-07	5.49E-08	TE 133MD
89	TE 134+D	3.84E-12	3.22E-12	1.57E-12	3.44E-12	2.18E-11	4.34E-07	2.79E-11	TE 134+D
90	I 129	2.48E-06	2.11E-06	6.91E-06	5.54E-03	4.53E-06	0.0	2.22E-07	I 129
91	I 130	5.72E-07	1.68E-06	6.60E-07	1.42E-04	2.61E-06	0.0	9.61E-07	I 130
92	I 131+D	3.15E-06	4.47E-06	2.56E-06	1.49E-03	7.66E-06	0.0	7.85E-07	I 131+D
93	I 132	1.45E-07	4.07E-07	1.45E-07	1.43E-05	6.48E-07	0.0	5.08E-08	I 132
94	I 133+D	1.08E-06	1.85E-06	5.65E-07	2.69E-04	3.23E-06	0.0	1.11E-06	I 133+D
95	I 134	8.09E-08	2.16E-07	7.69E-08	3.73E-06	3.44E-07	0.0	1.26E-10	I 134
96	I 135+D	3.35E-07	8.73E-07	3.21E-07	5.60E-05	1.39E-06	0.0	6.56E-07	I 135+D
97	XE 131M	0.0	0.0	0.0	0.0	0.0	1.40E-09	0.0	XE 131M
98	XE 133M	0.0	0.0	0.0	0.0	0.0	1.89E-09	0.0	XE 133M
99	XE 133	0.0	0.0	0.0	0.0	0.0	1.57E-09	0.0	XE 133
100	XE 135M	0.0	0.0	0.0	0.0	0.0	2.22E-09	0.0	XE 135M
101	XE 135	0.0	0.0	0.0	0.0	0.0	4.05E-09	0.0	XE 135
102	XE 137	0.0	0.0	0.0	0.0	0.0	1.74E-08	0.0	XE 137
103	XE 138+D	0.0	0.0	0.0	0.0	0.0	2.44E-08	0.0	XE 138+D
104	CS 134MD	1.59E-08	3.20E-08	1.72E-08	0.0	1.83E-08	2.93E-09	7.92E-09	CS 134MD
105	CS 134	4.66E-05	1.08E-04	9.10E-05	0.0	3.59E-05	1.22E-05	1.30E-06	CS 134
106	CS 135	1.46E-05	1.29E-05	5.99E-06	0.0	5.11E-06	1.57E-06	2.11E-07	CS 135
107	CS 136	4.88E-06	1.83E-05	1.38E-05	0.0	1.07E-05	1.50E-06	1.46E-06	CS 136
108	CS 137+D	5.98E-05	7.76E-05	5.35E-05	0.0	2.78E-05	9.40E-06	1.05E-06	CS 137+D
109	CS 138	4.14E-08	7.76E-08	4.05E-08	0.0	6.00E-08	6.07E-09	2.33E-13	CS 138
110	CS 139+D	2.56E-08	3.63E-08	1.19E-08	0.0	3.05E-08	2.84E-09	5.49E-31	CS 139+D
111	BA 139	1.17E-10	8.32E-14	3.42E-12	0.0	7.78E-14	4.70E-07	1.12E-07	BA 139
112	BA 140+D	4.88E-06	6.13E-09	3.21E-07	0.0	2.09E-09	1.59E-04	2.73E-05	BA 140+D
113	BA 141+D	1.25E-11	9.41E-15	4.20E-13	0.0	8.75E-15	2.42E-07	1.45E-17	BA 141+D
114	BA 142+D	3.29E-12	3.18E-15	2.07E-13	0.0	2.86E-15	1.49E-07	1.96E-20	BA 142+D

115	LA 140	4.30E-08	2.17E-08	5.73E-09	0.0	0.0	0.0	1.70E-05	5.73E-05	LA 140
116	LA 141	5.34E-10	1.66E-10	2.71E-11	0.0	0.0	0.0	1.35E-06	7.31E-06	LA 141
117	LA 142	8.54E-11	3.88E-11	9.65E-12	0.0	0.0	0.0	7.91E-07	2.64E-07	LA 142
118	CE 141	2.49E-06	1.69E-06	1.91E-07	0.0	0.0	7.83E-07	4.92E-05	1.50E-05	CE 141
119	CE 143+D	2.33E-08	1.72E-08	1.91E-09	0.0	0.0	7.60E-09	9.97E-06	2.81E-05	CE 143+D
120	CE 144+D	4.29E-04	1.79E-04	2.30E-05	0.0	0.0	1.06E-04	9.72E-04	1.02E-04	CE 144+D
121	PR 143	1.17E-06	4.69E-07	5.80E-08	0.0	0.0	2.70E-07	3.51E-05	2.50E-05	PR 143
122	PR 144	3.76E-12	1.56E-12	1.91E-13	0.0	0.0	8.81E-13	1.27E-07	2.69E-18	PR 144
123	ND 147+D	6.59E-07	7.62E-07	4.56E-08	0.0	0.0	4.45E-07	2.76E-05	2.16E-05	ND 147+D
124	PM 147	8.37E-05	7.87E-06	3.19E-06	0.0	0.0	1.49E-05	6.60E-05	5.54E-06	PM 147
125	PM 148MD	9.82E-06	2.54E-06	1.94E-06	0.0	0.0	3.85E-06	2.14E-04	4.18E-05	PM 148MD
126	PM 148	3.84E-07	6.37E-08	3.20E-08	0.0	0.0	1.70E-07	3.91E-05	5.80E-05	PM 148
127	PM 149	3.44E-08	4.87E-09	1.99E-09	0.0	0.0	9.19E-09	7.21E-06	2.50E-05	PM 149
128	PM 151	8.50E-09	1.42E-09	7.21E-10	0.0	0.0	2.59E-09	3.94E-06	2.00E-05	PM 151
129	SM 151	8.59E-05	1.48E-05	3.55E-06	0.0	0.0	1.66E-05	4.45E-05	3.29E-06	SM 151
130	SM 153	1.70E-08	1.42E-08	1.04E-09	0.0	0.0	4.59E-09	4.14E-06	1.58E-05	SM 153
131	EU 152	2.38E-04	5.41E-05	4.76E-05	0.0	0.0	3.35E-04	3.43E-04	1.59E-05	EU 152
132	EU 154	7.40E-04	9.10E-05	6.48E-05	0.0	0.0	4.36E-04	5.84E-04	3.40E-05	EU 154
133	EU 155	1.01E-04	1.43E-05	9.21E-06	0.0	0.0	6.59E-05	9.40E-05	5.95E-06	EU 155
134	EU 156	1.93E-06	1.48E-06	2.40E-07	0.0	0.0	9.95E-07	8.56E-05	4.50E-05	EU 156
135	TB 160	2.21E-05	0.0	2.75E-06	0.0	0.0	9.10E-06	1.92E-04	2.68E-05	TB 160
136	HO 166M	3.37E-04	1.05E-04	8.00E-05	0.0	0.0	1.57E-04	3.54E-04	1.59E-05	HO 166M
137	W 181	6.23E-09	2.03E-09	2.17E-10	0.0	0.0	0.0	1.71E-06	2.53E-07	W 181
138	W 185	1.95E-07	6.47E-08	6.81E-09	0.0	0.0	0.0	5.57E-05	1.07E-05	W 185
139	W 187	1.00E-09	8.85E-10	3.10E-10	0.0	0.0	0.0	3.43E-06	1.94E-05	W 187
140	PB 210+D	2.64E-02	6.73E-03	8.37E-04	0.0	0.0	2.12E-02	2.62E-02	3.05E-05	PB 210+D
141	BI 210+D	0.0	1.54E-06	1.32E-07	0.0	0.0	1.92E-05	1.11E-03	2.95E-05	BI 210+D
142	PO 210	3.97E-04	8.60E-04	9.58E-05	0.0	0.0	2.95E-03	3.14E-02	4.19E-05	PO 210
143	RN 222+D	0.0	0.0	0.0	0.0	0.0	0.0	2.05E-06	0.0	RN 222+D
144	RA 223+D	1.80E-04	2.77E-07	3.60E-05	0.0	0.0	7.08E-06	2.55E-02	2.84E-04	RA 223+D
145	RA 224+D	1.98E-05	4.78E-08	3.96E-06	0.0	0.0	1.35E-06	8.77E-03	3.01E-04	RA 224+D
146	RA 225+D	3.00E-04	3.56E-07	5.99E-05	0.0	0.0	1.01E-05	2.92E-02	2.71E-04	RA 225+D
147	RA 226+D	1.25E-01	2.39E-06	9.14E-02	0.0	0.0	6.77E-05	1.17E-01	2.94E-04	RA 226+D
148	RA 228+D	4.41E-02	1.23E-06	4.78E-02	0.0	0.0	3.48E-05	1.41E-01	5.00E-05	RA 228+D
149	AC 225	4.23E-04	9.82E-04	2.84E-05	0.0	0.0	6.63E-05	2.21E-02	2.52E-04	AC 225
150	AC 227+D	2.30E+00	3.05E-01	1.36E-01	0.0	0.0	9.82E-02	2.41E-01	5.08E-05	AC 227+D
151	TH 227+D	2.17E-04	3.92E-06	6.25E-06	0.0	0.0	2.22E-05	3.77E-02	3.34E-04	TH 227+D
152	TH 228+D	2.00E-01	3.39E-03	6.77E-03	0.0	0.0	1.89E-02	1.01E+00	3.49E-04	TH 228+D
153	TH 229	8.88E+00	1.33E-01	4.36E-01	0.0	0.0	6.52E-01	3.49E+00	3.17E-04	TH 229
154	TH 230	2.29E+00	1.31E-01	6.16E-02	0.0	0.0	6.40E-01	6.21E-01	3.73E-05	TH 230
155	TH 232+D	2.56E+00	1.12E-01	9.04E-02	0.0	0.0	5.47E-01	5.96E-01	3.17E-05	TH 232+D
156	TH 234	1.63E-06	9.56E-08	4.70E-08	0.0	0.0	5.41E-07	1.89E-04	7.03E-05	TH 234
157	PA 231+D	5.08E+00	1.91E-01	1.98E-01	0.0	0.0	1.07E+00	5.75E-02	4.44E-05	PA 231+D
158	PA 233	1.21E-06	2.42E-07	2.09E-07	0.0	0.0	9.15E-07	3.82E-05	1.02E-05	PA 233
159	U 232+D	5.14E-02	0.0	3.66E-03	0.0	0.0	5.56E-03	2.22E-01	4.21E-05	U 232+D
160	U 233+D	1.09E-02	0.0	6.60E-04	0.0	0.0	2.54E-03	5.32E-02	3.09E-05	U 233+D
161	U 234	1.04E-02	0.0	6.46E-04	0.0	0.0	2.49E-03	5.22E-02	3.81E-05	U 234
162	U 235+D	1.00E-02	0.0	6.07E-04	0.0	0.0	2.34E-03	4.90E-02	4.84E-05	U 235+D
163	U 236	1.00E-02	0.0	6.20E-04	0.0	0.0	2.39E-03	5.00E-02	3.57E-05	U 236
164	U 237	3.67E-08	0.0	9.77E-09	0.0	0.0	1.51E-07	1.02E-05	1.20E-05	U 237
165	U 238+D	9.58E-03	0.0	5.67E-04	0.0	0.0	2.18E-03	4.58E-02	3.41E-05	U 238+D
166	NP 237+D	1.69E+00	1.47E-01	6.87E-02	0.0	0.0	5.10E-01	5.22E-02	4.92E-05	NP 237+D
167	NP 238	2.96E-07	8.00E-09	4.61E-09	0.0	0.0	2.72E-08	1.02E-05	2.13E-05	NP 238
168	NP 239	2.87E-08	2.82E-09	1.55E-09	0.0	0.0	8.75E-09	4.70E-06	1.49E-05	NP 239
169	PU 238	2.74E+00	3.87E-01	6.90E-02	0.0	0.0	2.96E-01	1.82E-01	4.52E-05	PU 238
170	PU 239	3.19E+00	4.31E-01	7.75E-02	0.0	0.0	3.30E-01	1.72E-01	4.13E-05	PU 239
171	PU 240	3.18E+00	4.30E-01	7.73E-02	0.0	0.0	3.29E-01	1.72E-01	4.21E-05	PU 240
172	PU 241+D	6.41E-02	3.78E-03	1.29E-03	0.0	0.0	5.93E-03	1.52E-04	8.65E-07	PU 241+D
173	PU 242	2.95E+00	4.15E-01	7.46E-02	0.0	0.0	3.17E-01	1.65E-01	4.05E-05	PU 242
174	PU 244	3.45E+00	4.76E-01	8.54E-02	0.0	0.0	3.64E-01	1.89E-01	6.03E-05	PU 244
175	AM 241	1.01E+00	3.59E-01	6.71E-02	0.0	0.0	5.04E-01	6.60E-02	4.60E-05	AM 241

176	AM 242M	1.02E+00	3.40E-01	6.37E-02	0.0	5.01E-01	2.44E-02	5.79E-05	AM 242M
177	AM 243	1.01E+00	3.47E-01	6.57E-02	0.0	4.95E-01	5.75E-02	5.40E-05	AM 243
178	CM 242	1.48E-02	1.51E-02	9.84E-04	0.0	4.48E-03	3.92E-02	4.91E-05	CM 242
179	CM 243	7.86E-01	2.97E-01	4.61E-02	0.0	2.15E-01	6.31E-02	4.84E-05	CM 243
180	CM 244	5.90E-01	2.54E-01	3.51E-02	0.0	1.64E-01	6.06E-02	4.68E-05	CM 244
181	CM 245	1.26E+00	3.59E-01	7.14E-02	0.0	3.33E-01	5.85E-02	4.30E-05	CM 245
182	CM 246	1.25E+00	3.59E-01	7.13E-02	0.0	3.33E-01	5.96E-02	4.29E-05	CM 246
183	CM 247+D	1.22E+00	3.53E-01	7.03E-02	0.0	3.28E-01	5.85E-02	5.63E-05	CM 247+D
184	CM 248	1.01E+01	2.91E+00	5.79E-01	0.0	2.70E+00	4.82E-01	9.09E-04	CM 248
185	CF 252	9.78E-01	0.0	2.33E-02	0.0	0.0	1.99E-01	1.78E-04	CF 252

VITA

Charley Albert Cheney, Jr., son of Mr. and Mrs. Charley Albert Cheney, Sr., was born on April 16, 1956, in Alexandria, Louisiana. He graduated from Alexandria Senior High School in May, 1974. He was nominated by Representative Gillis Long to the Air Force Academy in 1973. In the fall of 1974, he entered Louisiana College in Pineville, Louisiana where he received a Bachelor of Science degree in Biology in 1978. After working for the U. S. Forest Research Center in Pineville, Louisiana for three months, he entered Louisiana State University's graduate school of zoology. In 1979 he began his graduate study in nuclear engineering at Louisiana State University. He is now a candidate for the degree of Master of Science in Nuclear Engineering.