UNION CARBIDE NUCLEAR FACILITY
EMERGENCY PLAN

UNION CARBIDE CORPORATION
TUXEDO, NEW YORK

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CONTENTS

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1. INTRODUCTION

The UCNR Emergency Plan and its associated implementation procedures provide the basis for the emergency response necessary in mitigating the consequences of an emergency. The objective of this emergency plan is to ensure UCNR's operational readiness and emergency preparedness in order to protect the health and safety of site personnel and to prevent property damage in the event of a radiological accident.

Union Carbide owns and operates the Sterling Forest Reactor Facility under Nuclear Regulatory Commission License No. R-81, and possesses and uses special nuclear material under NRC License No. SNM-639. The reactor is a 5 megawatt pool type research reactor utilizing MTR type fuel elements. The reactor and its adjoining hot laboratory facility is used in producing radiochemicals primarily for use in nuclear medicine. The reactor is operated in general on a 24-hour day, 7-day week cycle with refueling shutdowns every 14 days. The energy generated per year by the reactor is approximately 40,000 megawatt hours.

The general process of making radiochemicals involves preparation of targets for irradiation by neutrons in the reactor core, processing the irradiated targets to obtain pure chemicals that are suitable for incorporation into drug products, and processing waste and effluents for safe disposal. The major product from this facility is molybdenum-99 which is chemically separated from the fission products of uranium-235. Currently, this is the only process which utilizes SNM at the facility.

The detailed production process for Mo-99 is proprietary but it can be generally described as follows:

A. Target Preparation - Uranium (93 percent enriched) is deposited in the inner surface of a suitable tubing for safe irradiation in the reactor. The technical specifications for conducting fueled irradiations in the reactor define the limits for this part of the process. Typically the irradiation time and flux is limited to achieve less than 1 percent "burnup" of the original U-235, and therefore relatively small quantities of the long-lived fission products are present when irradiation is discontinued.

After irradiation the targets are held in the reactor pool for a specified minimum period of time to allow the very short-lived isotopes to decay prior to commencement of the chemical separation process. The targets are brought into the hot cells through a water filled canal that is connected to the reactor pool. The uranium is dissolved in acid inside of the irradiation target capsule. Gaseous fission products are condensed at ~ - 200°C inside of a cold trap to which the irradiation target capsule is connected subsequent to the dissolution of the uranium.

Several carriers are added to the uranium and mixed fission product solution to enhance their separation from the Mo-99. The Mo-99 is then precipitated with α-benzoinoxine and it is filtered out of the uranium solution. The filtrate containing the uranium is considered a waste byproduct at this point. It is stored inside the hot cells as uranyl sulfate in aqueous solutions of ~ 15 g of U-235 per batch (~ 135 mL per batch).

Several batches of decayed uranium wash solutions (less than 200 g U-235 per batch) are combined and the uranyl sulfate is converted to uranyl acetate by the addition of stoichiometric amounts of barium acetate. Sulfates are precipitated as barium sulfate and the uranyl acetate stays in solution. The uranyl acetate is decanted, dried, and calcined to form uranium oxide. The uranium oxide is stored for several weeks and shipped to a reprocessing facility to recover the scrap uranium-235. Some uranium is trapped in the barium sulfate precipitate. This is slurried with water, mixed with cement, and shipped to an approved radioactive disposal facility.

The Union Carbide Nuclear Reactor Emergency Plan is based on the requirements of 10CFR50, Appendix E "Emergency Plans for Production and Utilization Facilities", and NUREG 0762, the "Standard Format and Content for Radiological Contingency Plans for Fuel Cycle Facilities." The guidelines of NRC Regulatory Guide 2.6 and ANS 15.16, "Emergency Planning for Research Reactors," were also used.

The Emergency Plan is the basis for adopting procedures to cope with emergencies of several classes. Major events that require the existence of this plan are discussed in the Safety Analysis Report for the Union Carbide Nuclear Reactor, dated May 1980, Section G.5 and G.6.

2. DEFINITIONS

Accountability:	The process used by the emergency organization to assemble personnel with the intention of identifying potentially missing personnel.
Assessment Actions:	Those actions taken during or after an accident to obtain and process information that is necessary to make decisions to implement specific emergency measures.
Continuous Air Monitor: (CAM)	An air sampling and monitoring device which provides a constant analysis of airborne particulate radioactivity. CAM's have a local alarm if the pre-established alarm setpoints are reached.
Corrective Actions:	Those measures taken to ameliorate or terminate an emergency situation at or near the source of the problem in order to prevent an uncontrolled release of radioactive material or to reduce the magnitude of a release.
Emergency:	An emergency is a condition which calls for immediate action, beyond the scope of normal operating procedures, to avoid an accident or to mitigate the consequences of one.
Emergency Actions:	Those measures or steps taken to ensure that an emergency situation is assessed and that the proper corrective and/or protective actions are taken.
Emergency Action Levels:	Specific instrument readings or observations, radiological dose or dose rates, or specific contamination levels of airborne, waterborne, or surface-deposited radioactive materials that may be used as thresholds for establishing emergency classes and initiating appropriate emergency measures.

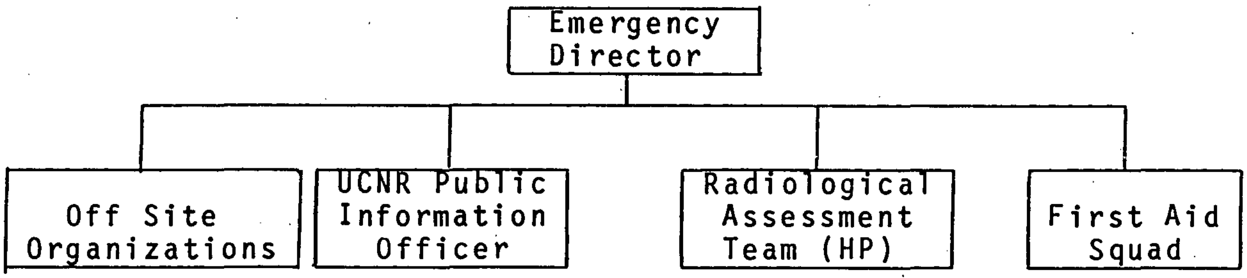
Emergency Classes:	Emergency classes are classes of incidents grouped by level of severity for which predetermined emergency measures should be taken or considered. The three classes of emergencies which have been incorporated into this emergency plan are (1) Notification of Unusual Event; (2) Alert; (3) Site Area Emergency.
Emergency Plan:	An emergency plan is a document that provides the basis for actions to cope with an emergency. It outlines the objectives to be met by the emergency procedures and defines the authority and responsibilities to achieve such objectives.
Emergency Planning Zone (EPZ)	Area for which emergency planning is performed to assure that prompt and effective actions can be taken to protect personnel in the event of an accident. The EPZ size depends on the distance beyond which the Protective Action Guide (PAG) could be exceeded.
Emergency Implementation Procedures:	Emergency procedures are documented instructions that detail the implementation actions and methods required to achieve the objectives of the emergency plan.
Protective Actions:	Those actions taken during or after an emergency for the purpose of preventing or minimizing radiological exposures to persons that would be likely to occur if the actions were not taken.

Protective Action Guides (PAG): Projected radiological dose or dose commitment values to individuals that warrant protective action following a release of radioactive material. Protective actions would be warranted provided the reduction in individual dose expected to be achieved by carrying out the protective action is not offset by excessive risks to individual safety in taking the protective action. The projected dose does not include the dose that has unavoidably occurred prior to the assessment.

Recovery Actions: Those actions taken after the emergency to restore the facility to a safe state.

3. ORGANIZATION AND RESPONSIBILITIES

The UCNR emergency organization is composed of the following groups:



3.1 Emergency Director

The Emergency Director is responsible for coordinating all phases of the emergency response to regain control of the accident condition and to mitigate its consequences. The Emergency Director will be the senior person present from the following list:

a. Business Manager, Radiochemicals
b. Manager, Nuclear Operations
c. Reactor Supervisor
d. Nuclear Facilities Engineer
e. Nuclear Project Engineer
f. Chief Reactor Operator
g. Senior Reactor Operator
h. Lead Reactor Operator
i. Reactor Operator

The Emergency Director will supervise emergency actions and will delegate duties called for in the UCNR Emergency Plan. Reactor Operations, Radiochemical Laboratory, Health Physics, and other site employees will assist the Emergency Director as designated in this plan or as otherwise requested. The Emergency Director will classify the emergency. The Emergency Director is authorized to terminate the emergency and is in charge of recovery operations. The Emergency Director is responsible for informing the emergency organization of planned organizational action, and has the authority to authorize volunteer emergency workers to incur radiation exposures in excess of normal occupational limits. The Emergency Director can authorize a site evacuation and the re-entry into the reactor facility that required evacuation following an incident. Under actual emergency conditions the Emergency Director can authorize deviations from this Emergency Plan and its implementing procedures.

3.2 Radiological Assessment Team

The Manager, Health, Safety, and Environmental Affairs and/or the UCNR Health Physicist will head the Radiological Assessment Team. They and the other members of the Health Physics Group will provide Health Physics' assistance including environmental radiological assessment and recommendations for protective actions to the Emergency Director.

3.3 Emergency Public Information Officer

The Manager of Nuclear Operations and/or Manager of Radiochemical Production will act as the UCNR Emergency Public Information Officer and is responsible for relating information about the emergency situation to the news media and the public.

3.4 First Aid Squad

The site First Aid Squad will assist the Emergency Director as requested and perform first aid and personnel decontamination services as necessary.

3.5 Emergency Planning Coordinator

The Manager of Health, Safety, and Environmental Affairs is in charge of coordinating emergency preparedness, including responsibility and authority for emergency preparedness planning, updating emergency plans and procedures, and coordinating plans with other applicable organizations. The Emergency Planning Coordinator is also responsible for developing emergency training programs, coordinating the development and conduct of emergency drills, and maintaining awareness of emergency planning procedural changes.

3.6 Offsite Emergency Assistance

The support organizations listed below are available on a continuous basis.

3.6.1 Tuxedo Hospital and St. Anthony Community Hospital - Area hospitals prepared to receive injured personnel for treatment.

3.6.2 Tuxedo Police - Local law enforcement agency prepared to provide assistance as requested.

3.6.3 Tuxedo Fire Department - Local fire department prepared to perform fire fighting and rescue work as required.

3.6.4 <u>Tuxedo, and Greenwood Lake Volunteer Ambulance Corps.</u> - Local ambulance squads prepared to provide first aid and transportation of victims to the hospital.

3.6.5 <u>New York State Police</u> - State law enforcement agency prepared to provide assistance as directed by the N.Y.S. Commissioner of Health in commu- nications, traffic control, and public alert and protection.

3.7 The UCNR Reactor Facility is in general operated 7 days a week, 24 hours a day. The minimum staffing on site at anytime unless operations are secured is one lead reactor operator, one reactor operator, one senior reactor operator on call, and one health physics technician on call. (On-call status is defined as being always available to be contacted by phone.)

4. EMERGENCY CLASSIFICATION

The three classes of emergency situations of the UCNR Emergency Plan are described below. These classification descriptions will provide the individuals responsible for declaring an emergency class a guidance criteria. Section 5 lists Emergency Action Levels which are also to be used in establishing which emergency class a particular incident might fall into.

4.1 Notification of Unusual Events - Notification of unusual events may be initiated by either man-made events or natural phenomena that can be recognized as creating a significant hazard potential that was previously nonexistent. There is usually time available to take precautionary and corrective steps to prevent the escalation of the accident or to mitigate the consequences should it occur. No releases of radioactive material requiring offsite responses are expected.

One or more elements of the emergency organization are likely to be activated or notified to increase the state of readiness as warranted by the circumstances.

Although the situation may not have caused damage to the reactor or hot laboratory, it may warrant an immediate shutdown of the reactor or interruption of nonessential routine functions.

Situations that may lead to this class include: (1) threats to or breaches of security, such as bomb threats or civil disturbances directed toward the facility; (2) natural phenomena, such as tornados in the immediate vicinity of the facility, hurricanes, or earthquakes felt in the facility; (3) facility emergencies, such as prolonged fires or fuel damage indicated by high coolant fission product activity or high offgas activity.

4.2 Alert - Events leading to an alert would be of such radiological significance as to require notification of the emergency organization and their response as appropriate for the specific emergency situation. Under this class it is unlikely that offsite response or monitoring would be necessary. Substantial modification of reactor or hot laboratory operating status is a highly probable corrective action.

- Protective evacuations or isolation of certain areas within the operations boundary or within the site boundary may be necessary. Situations that may lead to this class include: (1) severe failure of fuel cladding or of fueled experiments, or (2) significant releases of radioactive materials as a result of experiment or hot cell failures.

4.3 Site Area Emergency - A site area emergency may be initiated when events such as major damage of fuel or cladding and actual or imminent failure of other physical barriers containing fission products in reactor fuel or fueled experiments have occurred and projected offsite radiological consequences exceed Table 5.3 action levels. Monitoring at the site boundary should be conducted to assess the need for offsite protective actions. Protective measures onsite may be necessary.

4.4 General Emergency - A general emergency involving an accident which results in uncontrolled releases of radioactive material into the air, water, or ground, and which would require offsite protective actions, is not credible for the UCNR research reactor or hot laboratory. Because of the design, manufacture, operation, maintenance, and size of the UCNR research reactor and the distance between the reactor and hot laboratory facility and the site boundary, offsite protective actions for the public are not required and have not been formulated.

5. EMERGENCY ACTION LEVELS

Section 4 describes the three classes of emergency situations. Each of these emergency classes is associated with a particular set of emergency action levels and emergency actions to be taken. Tables 5.1, 5.2, and 5.3 list specific action levels and the ap- propriate action to be taken for each emergency class.

TABLE 5.1
EMERGENCY CLASS
NOTIFICATION OF UNUSUAL EVENT

ACTION LEVELS	ACTION TO BE TAKEN
1. Actual or projected radiological effluents at the site boundary exceeding 10 MPC for unrestricted areas when averaged over 24 hours or 15 mrem whole body accumulated in 24 hours.	1. Classify the emergency - assess and respond.
2. Report or observation of severe natural phenomenon that are imminent or existing such as: (1) earthquakes that could adversely affect the reactor or hot laboratory safety systems, (2) high natural water sources that could adversely affect reactor or hot laboratory safety systems and; (3) tornado or hurricane winds that could strike the facility.	2. Follow applicable implementation procedures from procedures manual.
3. Threats to or breaches of security.	3. Call persons in accordance with Emergency Call List. Bring operating staff to a state of readiness.
4. Fuel damage accident as indicated by high CAM or high water activity that could release radionuclides inside containment.	4. Consider evacuation from Buildings 1 and 2 of all unnecessary personnel. Account for all missing or injured personnel.
5. Fire within the facility lasting more than 10 minutes.	5. If necessary dispatch onsite assessment team.
6. Transportation of radiologically contaminated/injured individual from the site to an offsite hospital.	6. As necessary activate the Emergency Control Center.
	7. If the situation warrants it, inform the NRC.
	8. Escalate to a more severe emergency class as necessary.

TABLE 5.2
EMERGENCY CLASS ALERT

ACTION LEVELS	ACTION TO BE TAKEN
1. Actual or projected radiological effluents at the site boundary exceeding 50 MPC for unrestricted areas when averaged over 24 hours or 75 mrem whole body accumulated in 24 hours.	1. Classify emergency - assess and respond.
2. Radiation levels at the site boundary of 20 mrem/hr for 1 hour whole body or five times this level to the thyroid.	2. Follow applicable implementation procedures from Procedures Manual
3. Abnormal loss of water used for shielding and coolant to irradiated reactor fuel at a rate which exceeds makeup capacity.	3. Call persons in accordance with Emergency Call List; bring operating staff to a state of readiness.
4. Loss of radioactive material control that causes radiation dose rates or airborne radionuclides to increase ambient exposure levels by a factor of 1000 throughout the reactor or hot laboratory.	4. Evacuate all unnecessary personnel from Buildings 1 and 2. Account for all missing or injured personnel.
5. Fire that threatens or causes damage to any required reactor or hot laboratory safety system.	5. As necessary dispatch onsite assessment team.
6. Other imminent or existing hazards such as (1) missiles impacting on the reactor or hot laboratory facility, (2) explosion that affects facility operation, and (3) uncontrolled release of toxic or flammable gases into the facility environs.	6. As necessary activate the Emergency Control Center.
7. Radiation dose rates in the reactor or hot laboratory building requiring evacuation of all personnel (e.g., 100 mrem/hr for one hour throughout the reactor or hot laboratory buildings.)	7. Inform the NRC of the status and reason for emergency.
8. Severe failure of fuel cladding or of fueled experiments as indicated on Building 1 CAMs or in pool water activity.	8. Escalate to a more severe class as necessary.
9. Imminent loss of physical control of the reactor or hot laboratory.	

TABLE 5.3
EMERGENCY CLASS
SITE AREA EMERGENCY

ACTION LEVELS	ACTION TO BE TAKEN
1. Actual or projected radiological effluents at the site boundary exceeding 250 MPC for unrestricted areas when averaged over 24 hours or 375 mrem accumulated in 24 hrs.	1. Classify emergency - assess and respond.
2. Actual or projected radiation levels at the site boundary of 100 mrem/hr for 1 hour whole body or five times this level to the thyroid.	2. Follow applicable implementation procedures from the Procedures Manual.
3. Abnormal continuing loss of coolant to the reactor fuel at a rate greater than the capacity of the makeup system.	3. Call persons in accordance with Emergency Call List, bring operating staff to a state of readiness.
4. Severe natural events experienced. Examples include: a. earthquake that is causing observable damage to the reactor or hot laboratory safety equipment within the building. b. high water levels that are affecting the operability of any reactor or hot laboratory safety system; and (c) tornado or hurricane winds that are damaging the facility structure.	4. Evacuate all unnecessary personnel from Buildings 1 and 2. Account for all missing or injured personnel
5. Loss of physical control of reactor or hot laboratory buildings.	5. As necessary dispatch the onsite assessment team.
	6. As necessary activate the Emergency Control Center.
	7. Inform the NRC of the status and reason for the emergency

6. EMERGENCY PLANNING ZONES

The UCNR site boundary is established as the UCNR Emergency Planning Zone. This EPZ falls within the guidance of ANS 15.16 Table II. The size of this EPZ has been established such that in the worst case situation the dose received by individuals beyond this EPZ is not projected to exceed 1 rem whole body or 5 rem thyroid. The size of the site is large enough to provide a response base that would support activities outside this area should this ever be needed.

Predetermined protective actions for this EPZ are described in Section 5.

7. EMERGENCY RESPONSE

7.1 Activation of the Emergency Organization

This Emergency Plan identifies three classes of emergencies. The actions to be taken in the event of these emergencies are listed in Tables 5.1, 5.2, and 5.3 and in their supporting implementation procedures. The Emergency Director as defined in Section 3.1 is responsible for initiating, coordinating, and supervising all response activities.

The UCNR Facility is operated on a continuous basis, unless operations are secured, with a minimum staffing of one lead reactor operator, one reactor operator, one senior reactor operator on call, and one members of the Health Physics staff on call. At all times, unless operations are secured, an Emergency Director is on site and can initiate emergency response.

During normal work hours, emergency support personnel are available on site and they will be contacted via the public address system or site telephone. During off-hours support personnel will be contacted at their homes by telephone or contacted via the use of electronic pagers.

Telephone numbers are available from the Emergency Roster and Telephone Listing. This listing is in each Procedures Manual on site. There are numerous on-site official Procedures Manuals with these manuals spread throughout the site. Several of these manuals would be accessible during any facility emergency.

7.2 Assessment Actions

7.2.1 Assessment Equipment

Initial assessment of radiological hazards shall be made using the stack monitor, radiation monitrons located inside the buildings, portable direct radiation monitoring equipment, and building continuous air monitors.

Follow-up assessment will be implemented by analyzing air samples from environmental monitoring stations, exhaust ventilation, and portable air samples on a multichannel analyzer. Water and soil samples may also be analyzed.

The primary effluent air monitor will be the three unit stack monitor consisting of particulate, gas, and iodine monitors. All three read out locally at the stack monitor and remotely in the control room. Gaseous levels are also available in the Hot Laboratory operating area. Because several areas are available to obtain stack monitor data, a stack data readout location would be accessible to the assessment team during an emergency. In the event the stack monitor is inoperative during an emergency, grab samples will be collected and counted on a multichannel analyzer.

High volume air samplers will be utilized as necessary inside and outside site buildings to determine local airborne concentrations.

Radiation dose rates will be determined inside and outside site buildings via portable survey meters.

Fixed environmental monitoring stations are available for iodine and particulate sampling and dose assessment utilizing TLDs.

Contamination levels will be determined with standard "smear" discs.

Emergency personnel radiation doses will be assessed utilizing personnel film badges and pocket dosimeters issued to all personnel accessing Buildings 1 and 2. TLD dosimeters are also available.

Sufficient equipment in accessible locations is available to the assessment team to provide adequate assessment equipment support in an emergency.

7.2.2 Effluent Dose Projection

The Radiological Assessment Team will use stack monitor release rate data in conjunction with meteorological parameters (wind speed and stability class) to determine effluent airborne release quantities.

Table 7.1 gives specific iodine and gas release rates for <u>average</u> meteorological conditions which are release rate thresholds to be used in classifying emergencies. Table 7.2 lists correction factors for varying conditions of wind speed and wind stability class. Table 7.1 corrected by factors of Table 7.2 will give emergency classification release rate thresholds for various meteorological conditions.

During an emergency the actual effluent stack monitor release rate will be obtained from the stack monitor. These actual release rates are then compared to the thresholds adjusted to the actual meterological conditions (Table 7.1 corrected by Table 7.2) to classify the emergency.

Table 7.1

Stack Monitor Readouts Corresponding to Emergency Class Categories for Average Meteorological Conditions

	Iodine Release	Inert Gas Release
Notification of Unusual Event	Average increase to full scale in 8.6 hours and continuing at this rate for 24 hours on the iodine monitor.	1.0×10^6 cpm persisting for 24 hours on gas monitor.
Alert	Average increase to full scale in 1.7 hrs. continuing at this rate for 24 hours on the iodine monitor. Or increase to full scale in 7 minutes and continuing at this rate for 1 hour on the iodine monitor.	Off-scale on the gas monitor and the iodine monitor average reading is 1.3×10^5 cpm for 1 hour.
Site Area Emergency	Increase to full scale in 1.4 minutes and continuing at this rate for 1 hour on the iodine monitor.	Off-scale on the gas monitor and the reading on the iodine monitor is 6.5×10^5 cpm and continuing at this rate for 1 hour.

- A full scale gas monitor reading corresponds to a concentration in the stack of 1.6×10^{-2} uCi/cc and a release rate of 22.9 Ci/min.
- A full scale particulate monitor reading corresponds to a concentration in the stack of 3.8×10^{-7} uCi/cc and a release rate of 530 uCi/min.
- A full scale iodine monitor reading corresponds to 8.3 Ci of I-131 released or 229 Ci/min. inert gas release rate.
- Full scale on all three monitors is 1×10^6 cpm.

For adverse meteorologcal conditions:
- Table 7.1 Iodine Release Rates to be divided by Table 7.2 correction factors.
- Table 7.1 Inert Gas Release Rates to be multiplied by Table 7.2 correction factors.

Table 7.2

Meteorological Correction Factors

Correction Factors for Use with Effluent Release Rate
(Table 7.1) for Adverse Meteorological Conditions

→ Iodine Release Rate from Table 7.1 to be divided by Table 7.2 factors.
→ Inert Gas Release Rate from Table 7.1 to be multiplied by Table 7.2 factors.

Sigma Theta Degrees	Wind Speed (meters/second)					
	1	2	3	4	5	6
15	0.4	0.8	1.0*	1.0*	1.0*	1.0*
10	0.1	0.3	0.4	0.6	0.7	0.8
5	0.08	0.2	0.2	0.3	0.4	1.0*
2.5	0.03	0.06	0.1	1.0*	1.0*	1.0*

*Denotes conditions which would give greater dispersion than average.

7.2.3 Radiation Dose Rate Projection

Buildings 1 and 2 contain fixed area radiation monitors located throughout both buildings. (See Section 11 for typical locations of fixed area radiation monitors.) These fixed monitors in conjunction with portable survey meters will be utilized in radiation dose projections. Distance and shielding parameters will be used in conjunction with instrument measurements to determine expected onsite radiation dose rates.

Whole body dose rates as listed in Tables 5.1, 5.2, and 5.3 and below in Table 7.3 will be used as action levels to define emergency class levels.

TABLE 7.3

Whole Body Dose Rate/Emergency Class

Emergency Class	Whole Body Dose Rate at Site Boundary
Notification of Unusual Event. . .	> 15 mRem/24 hours
Alert.	> 75 mRem/24 hours or > 20 mRem/01 hour
Site Area Emergency.	>375 mRem/24 hours or >100 mRem/01 hour

7.3 Corrective Actions

Tables 5.1, 5.2, and 5.3 list corrective action to be taken for each of the three emergency classes to correct or mitigate an emergency situation. Detailed implementation procedures exist to provide guidance to the Emergency Director in performing corrective actions. Implementation procedures are in place for radiation situations, fire, injury, and civil disturbance.

All licensed reactor operators have received extensive training in facility systems including system emergency response. This group will be available for repair and damage control of any essential facility equipment.

The objective in any emergency situation involving the release of radioactive material or exposure to radiation is to contain and reduce the hazard as quickly as possible. When reliance on automatic emergency equipment is essential for containment or correction, the proper function of such equipment will be verified as quickly as possible.

Corrective actions which will result in exposure to emergency workers or others will be evaluated in terms of the benefit to be gained. High personnel exposures will be allowed only to gain a great benefit such as saving life and limb, or reducing exposure to workers. Refer to Section 7.4.4 for guidance on emergency personnel exposure.

7.4 Protective Actions

Protective actions are measures taken during or after an uncontrolled release of radioactive material to prevent or mimimize personnel exposure.

7.4.1 Evacuation

Persons in the reactor or hot laboratory buildings will be of two groups 1) those who have authorized access to the buildings 2) those who do not have authorized access to the buildings but are escorted by authorized individuals. All authorized access individuals receive training to recognize emergency evacuation signals and to follow building evacuation routes.

All unnecessary personnel will be evacuated from Building 1 and 2, as the situation requires, to minimize radiation exposure. Typical evacuation button locations are shown in Section 11.

7.4.2 Notification

Buildings 1 and 2 personnel will be notified of reactor or hot laboratory emergencies via the buildings public address system and as necessary by the buildings evacuation horns. Other site and offsite personnel will be notified of an emergency via the telephone as per the Emergency Roster and Telephone Listing. Site emergencies shall also be announced through the site general alarm system as per the Fire/Site Evacuation Alarm Implementation Procedure. Specific alarms are also provided in the event of occurrences requiring special responses other than the general emergency response, e.g., stress, hot cell low pressure, filter bank high temperature, etc. All Building 1 and 2 telephone and public address microphone locations are shown in Section 11.

In the event that the emergency situation requires NRC notification the message shall contain, to the extent known, the following information. Some or all of this information, but at least a, b, and c, shall be forwarded in contacting any of the offsite organizations.

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

b. Description of emergency event and emergency class.

c. Date and time of incident initiation.

d. Type of expected or actual release (airborne, waterborne, surface spill) with estimated duration times.

e. The quantity of radionuclides released or expected to be released.

f. Meteorology data, obtained from meteorological station, which include:

   1) Wind direction and speed from reactor site.

   2) Estimate of atmospheric stability class.

g. Projected (usually by hand calculations) or actual dose rates outside of operations boundary.

h. Impact of releases and recommended offsite emergency actions.

7.4.3 Accountability

The Emergency Director is responsible to account for all individuals within Buildings 1 and 2 within thirty minutes after initiation of an evacuation. The Emergency Director will delegate a person to utilize the "List of Individuals Authorized Access to the Controlled Access Area." This Procedures Manual List will be checked to insure that all persons possibly in the evacuated area are accounted for.

7.4.4 Emergency Personnel Exposure

The Emergency Director has the authority to authorize volunteer emergency workers to incur radiation exposures in excess of normal occupational limits.

If it is determined that a great benefit could be gained by re-entering the facility to save a life, volunteers will be allowed to re-enter the facility and receive a dose of up to 75 rem for such rescue work.

If it is determined that a great benefit could be gained by re-entering the facility to save vital safety equipment, volunteers will be allowed to re-enter and receive a dose of up to 25 rem for such work.

7.4.5 Aid of Affected Personnel

Decontamination of personnel shall be performed under the guidance of the Health Physics staff. Injured personnel shall be decontaminated by members of the site first aid squad or other qualified members of the staff prior to their removal to the hospital. In the event complete decontamination cannot be accomplished in time to render necessary treatment to victims, arrangements have been made with the hospitals to accommodate contaminated victims under the guidance of the UCC Health Physics staff.

Transportation to the hospital(s) shall be performed by the Tuxedo or Greenwood Lake Ambulance Corps. Contaminated or radioactive personnel shall be escorted by an employee trained in contamination control to assist hospital emergency treatment personnel.

7.4.5 Contamination Control

Controlled access shall be established to the following areas:

1) where airborne concentration of radionuclide exceeds ten times the limits specified in 10 CFR 20 Appendix B Tables I.

2) where direct radiation dose rates exceed 100 mRem/hr.

7.5 Health Physics Emergency Program

Emergency equipment such as protective clothing, emergency breathing apparatus, survey instrument, and other necessary emergency equipment is located outside the reactor and hot laboratory buildings for use by emergency squads. The location for this equipment is in the northwest entrance lobby to Building 4.

The emergency equipment specified in Section 8.4 will be maintained by Health Physics and inventoried by Health Physics every six months.

8. EMERGENCY FACILITIES AND EQUIPMENT

8.1 Emergency Control Center

The primary emergency control center for reactor or hot laboratory will be set up in Building 2 just outside the upper personnel air lock to the Reactor Building.

The secondary emergency control center for reactor and hot laboratory or the primary emergency control center for site emergencies will be set up in the lobby of Building 4.

8.2 Communication System

On site communications will be accomplished via site telephones, public address systems, radios, evacuation horns, and alarm and monitoring systems as described in the implementation procedures. Typical telephone, public address microphones, and Building 1 and 2 evacuation button locations are noted in Section 11.

Offsite communications with outside organizations shall be by telephone. This may be augmented by radio through the Tuxedo and State police.

Communication systems operability is assured through constant use of the components. Any operation problems identified are corrected within a short period.

8.3 Dose Assessment Equipment

Effluent Air Monitor	-	Stack Monitor (gas, iodine, particulate).
Local Air Monitor	-	Portable high volume air samplers.
	-	Fixed Continuous Air Monitors (CAM).
	-	Fixed area air filter samples.
Radiation Monitors	-	Fixed area radiation monitors.
	-	Portable survey meters.
	-	Direct reading GM detectors.
Personnel Dosimetry	-	Film badge, TLD, pocket dosimeters.

Contamination	-	Smear Discs.
Isotope Identification	-	Sodium iodide crystal with multichannel analyzer.
Meteorological	-	Meteorological station providing wind speed and direction and data for determining wind stability class.

All portable dose assessment equipment will be checked for operability at least quarterly and calibrated semi-annually.

8.4 Emergency, Medical, and Decontamination Facilities

The primary first aid station is located in Building 2 outside the upper personnel air lock door to the reactor building.

The secondary first aid station is located in Building 4 at the southeast corner on the second level.

Contaminated/injured personnel will be handled by the site First Aid Squad and as necessary transported to local hospitals.

Decontamination showers are available in Buildings 2, 3, and 4. Decontamination supplies are stored at the northwest entrance to Building 4, and in the Building 2 canal area.

Emergency equipment is stored in the northwest entrance to Building 4. This equipment will consist of at least the following:

a) Protective clothing:
   Coverall and hoods.
   Rubber gloves and boots.

b) Respiratory protection:
   Cartridge type respirators and supplied air masks.

c) Dosimeters:
   Gamma pocket chambers (0-50 R range).
   Film badges (beta-gamma capacity).
   TLDs (beta-gamma capacity).

d) Dose rate monitoring:
Portable survey meter.

e) Radiation Survey:
Site plans to be used to record Health Physics evaluatons.

f) Miscellaneous:
Lighting equipment, controlled access boundary equipment, decontamination supplies.

9. RECOVERY

The emergency action measures outlined in Section 5 and 7 are the preplanned immediate actions to be taken in the event an emergency situation arises. After execution of these actions, additional measures may be required to complete a recovery.

In order for the recovery phase of the emergency to commence, the conditions which caused the emergency to be declared must have been terminated or brought under control. It is the responsibility of the Emergency Director to determine that the facility is safe and that any radioactive releases are terminated.

The Emergency Director will supervise the recovery and reentry operations. Planning for any recovery will vary according to the specific nature of the emergency situation. A recovery plan will be developed and approved by the Emergency Director. This plan will cover specific actions to be accomplished in order to bring the facility to a condition where normal operations can be resumed. This plan may include developing detailed schedules, obtaining specialized equipment, and writing specific recovery procedures for decontamination and the processing of radioactive water.

Radiation exposure to personnel involved in the recovery will be kept to a minimum and within the limits of 10CFR20. Affected radiation areas will be roped off and posted with warning signs indicating radiation levels and permissible entry times based on survey results. Access to radiation areas will be controlled and personnel exposures documented. Shielding will be employed to the greatest extent practicable.

10. MAINTAINING EMERGENCY PREPAREDNESS

The intent of this section of the Emergency Plan is to establish responsibilities and methods for maintaining emergency preparedness.

10.1 Emergency Planning Coordinator

The Manager of Health, Safety, and Environmental Affairs has been designated as the Emergency Planning Coordinator. As described in Section 3.5, this individual is responsible for emergency preparedness planning, updating of emergency plans and procedures, coordination of plans with offsite organizations, developing emergency training programs, coordinating the development and conduct of emergency drills, and maintaining awareness of emergency planning procedural changes.

10.2 Training

The Emergency Planning Coordinator is responsible for coordinating, supervising, and conducting training in emergency preparedness.

a. The following site personnel will receive training on their responsibilities and their probable actions in an emergency situation.

1. Emergency Director.
2. Radiological Assessment Team.
3. Public Information Officer.
4. First Aid Squad.

b. The following offsite emergency response personnel will be offered training and site orientation tours to familiarize them with the site and prepare them for an emergency situation.

1. Local Ambulance Squads.
2. Local Hospital Support Personnel.

10.3 Emergency Drills

Emergency drills are developed and conducted to evaluate the response capabilities of the emergency organization, to test the adequacy of the implementation procedures and emergency test equipment, and to provide ongoing training for the emergency organization.

The Emergency Planning Coordinator is responsible for developing the written accident scenario and for the coordination and performance of the drill.

Onsite emergency drills will be conducted annually as action drills with each required emergency measure being executed as realistically as is reasonably possible, including the use of appropriate emergency equipment. The time interval between annual drills is not to exceed 14 months. Radiological monitoring including contamination control methods and procedures, dose rate measurements and assessments, nonessential personnel evacuation, and recordkeeping shall be performed. At least every two years, these drills shall contain provisions for coordination with local ambulance and hospital organizations and should test, as a minimum, the communication links between the UCNR site and these offsite organizations. This bienniel drill will include a simulated injured and contaminated individual. Offsite ambulance and medical treatment organizations will be invited to participate.

10.4 Drill Evaluation

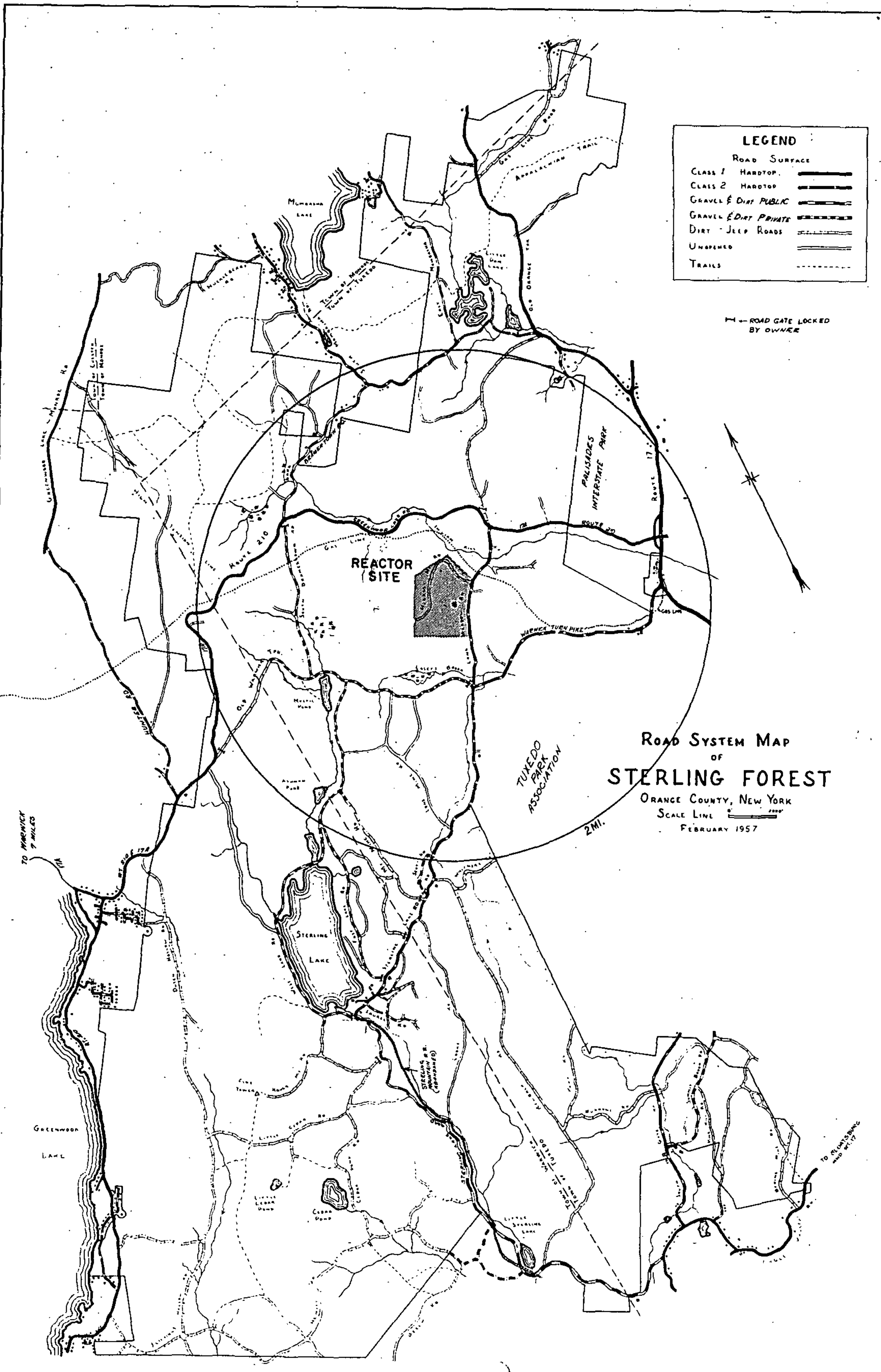
The Emergency Planning Coordinator will designate qualified drill observers. Following each drill, a critique will be conducted, chaired by the lead observer and attended by the major drill participants as designated by the Emergency Planning Coordinator. At this critique, observers and invited participants will report those items which need corrective action and suggest improvements. A report of the critique which describes the drill and the following corrective actions will be issued by the Emergency Planning Coordinator.

10.5 Emergency Plan Review and Update

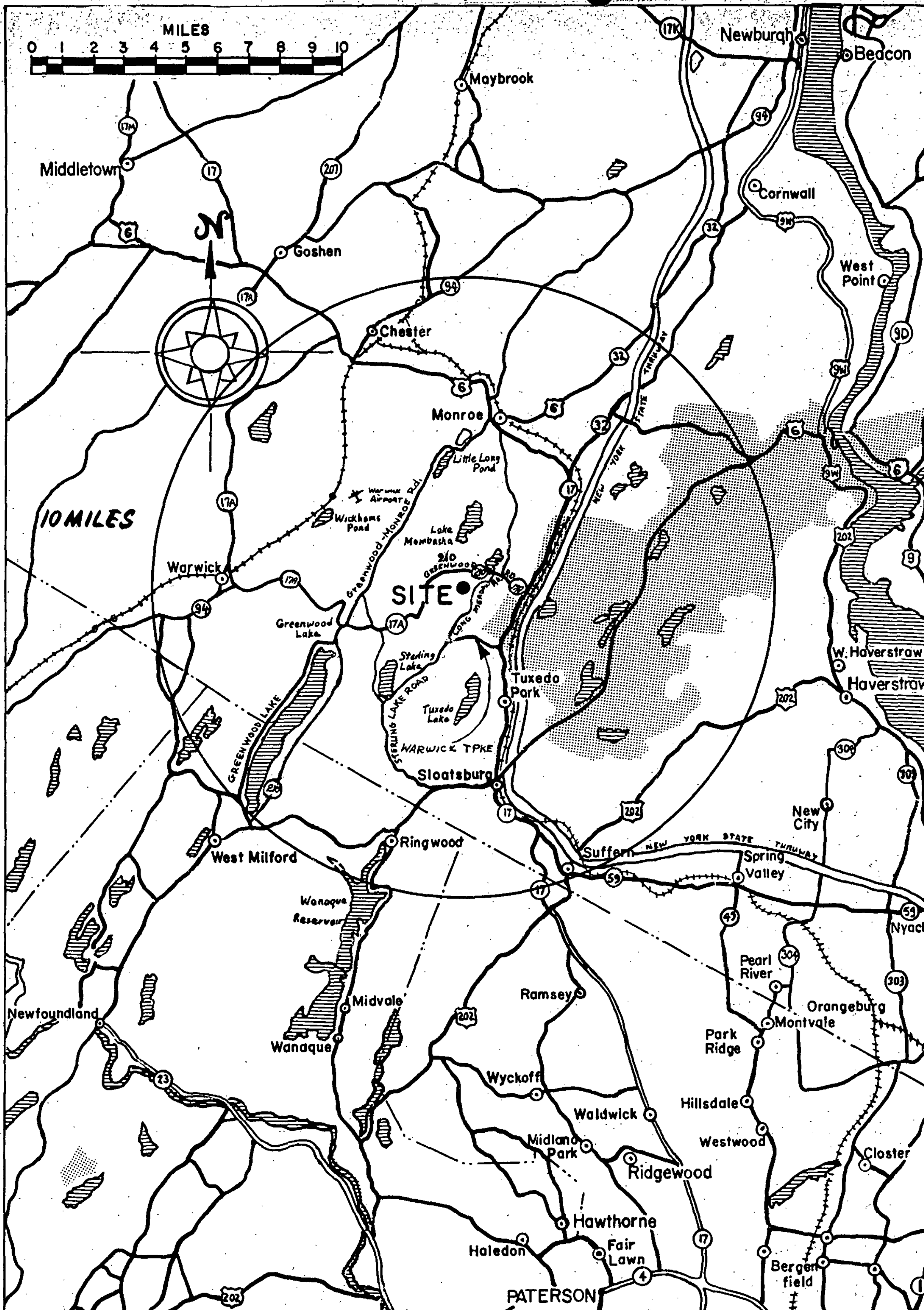
On a biennial basis, the Emergency Planning Coordinator will review and update the emergency plan, implementing procedures, and agreements with offsite support organizations.

On an annual basis, the Emergency Planning Coordinator will review the Emergency Roster and Telephone Listing and verify each individual's or organization's phone number. Any changes will be incorporated into the listing.

Any modification to the emergency plan and its implementing process shall be reviewed and approved via the methods and procedures set down in the Procedures Administration section of the Procedures Manual. All approved changes to the plan shall be distributed to the authorized recipients within 30 days of approval. Any changes which would affect the actions of offsite support groups shall be forwarded to these applicable support organizations.

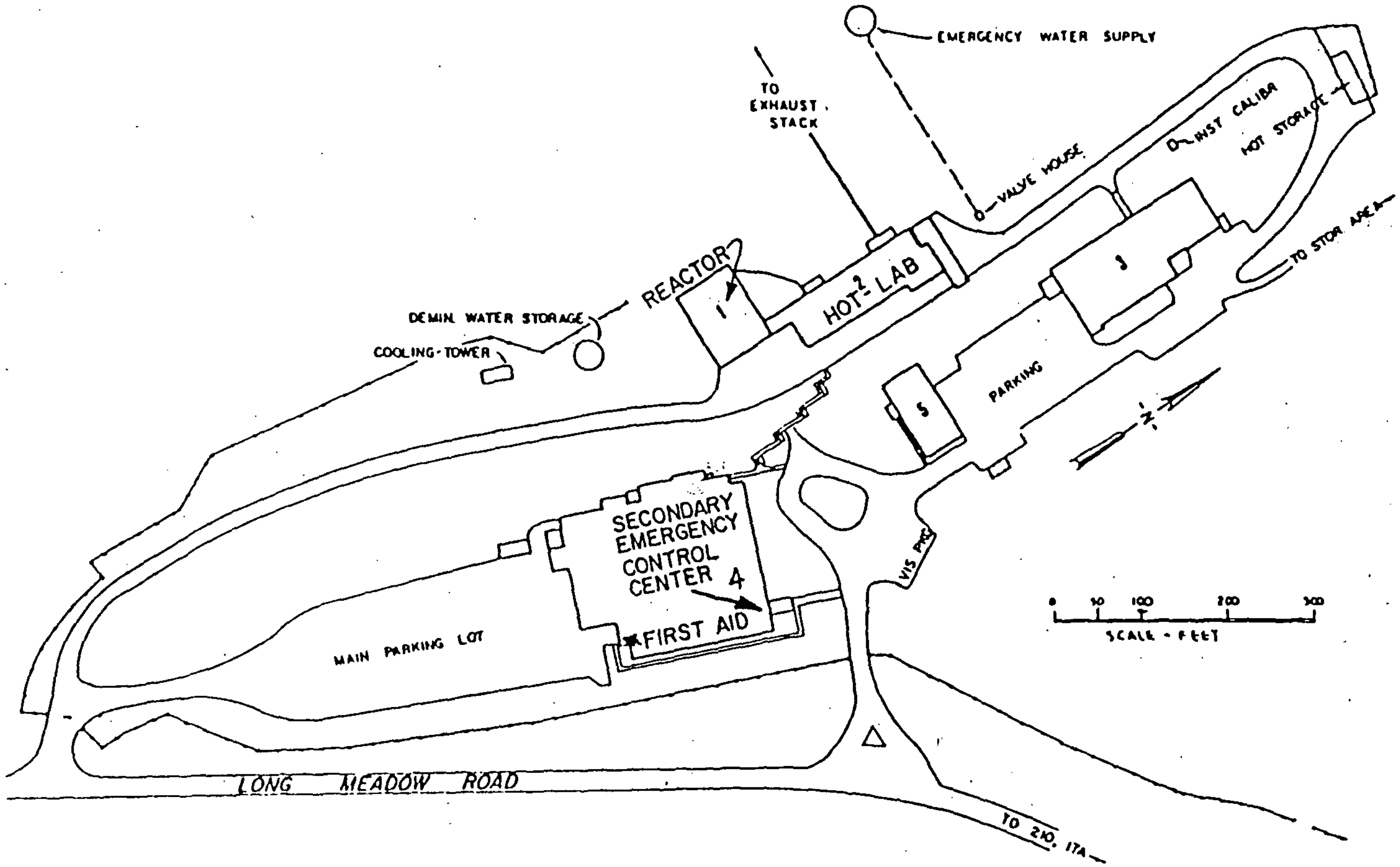


2 MILE RADIUS MAP OF SITE

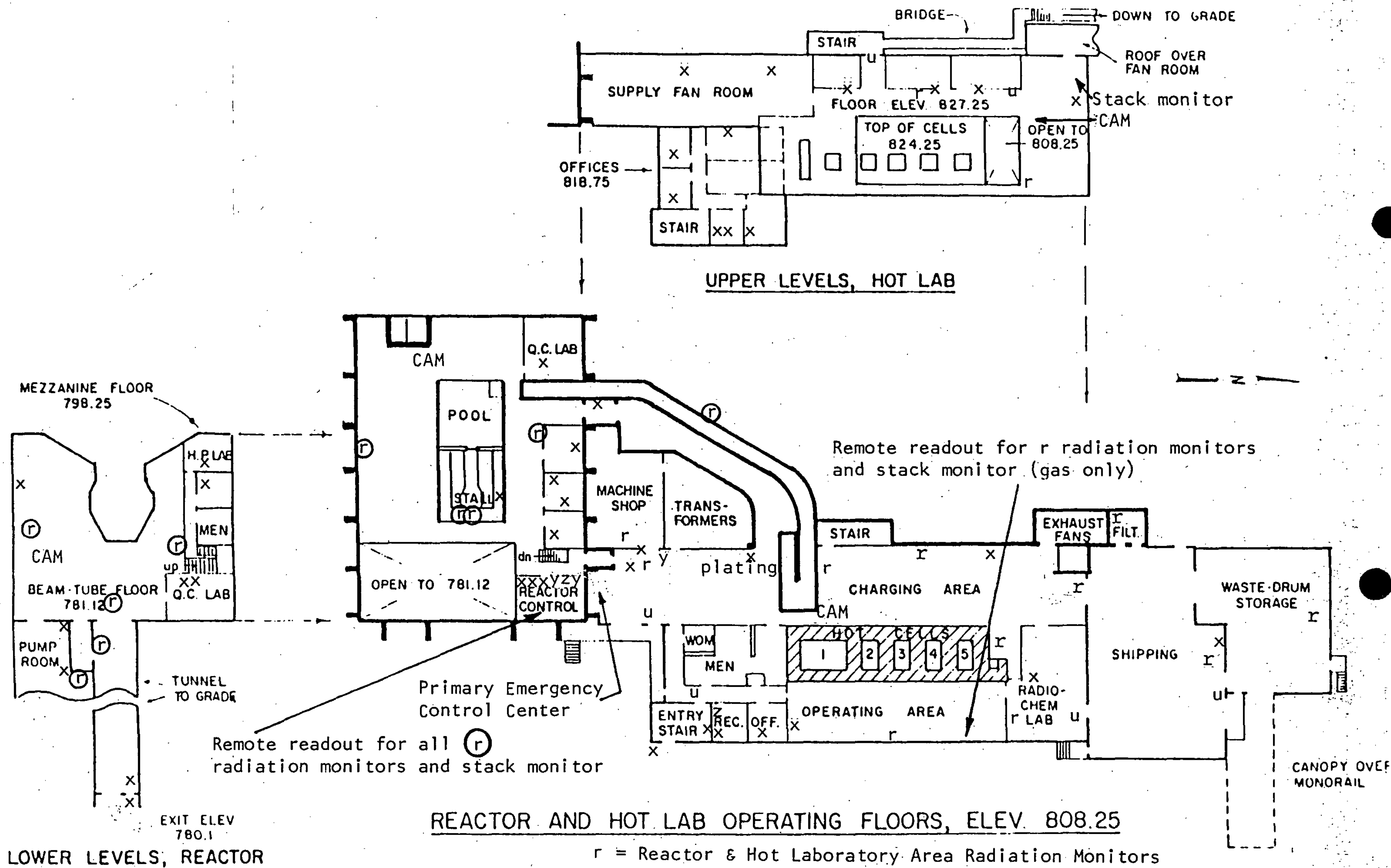


TEN MILE RADIUS MAP OF SITE

SITE PLAN - SECTION 11



PARTIAL SITE PLAN SHOWING LOCATION OF BUILDINGS 1,2,3,4 & 5



r = Reactor & Hot Laboratory Area Radiation Monitors
x = Telephones
z = Public Address Microphone
y = Reactor Bldg Evacuation Button
u = Hot Laboratory Bldg Evacuation Button

Tuxedo Memorial Hospital
Tuxedo Park, New York 10987

August 23, 2976

Mr. C.J. Konnerth, Manager
Health Physics Department
Union Carbide Corporation
P.O. Box 324
Tuxedo, New York 10987

Dear Mr. Konnerth:

Tuxedo Memorial Hospital will cooperate with Union Carbide Corporation in a case contaminated with radioactive material.

Enclosed is a policy and procedure for your approval.

Sincerely,

John H. Beddow
President

JHB:gmc

Enc:

TUXEDO MEMORIAL HOSPITAL
TUXEDO PARK, NEW YORK
10987

914-351-4751

Tuxedo Hospital Policy and Procedure for admitting and treating persons injured and contaminated with radioactive material.

Admission Route and Isolated Area

1. Tuxedo Hospital will be notified in advance of arrival of person injured or contaminated with radioactive material. NOTE: NOTIFY SWITCHBOARD AND ADMINISTRATOR. (914) 351-4751

2. Upon being notified, our plan for treatment of radioactive injured or contaminated persons will activate immediately.

3. All radioactive injured or contaminated persons will enter the hospital through the employee entrance in the rear of the hospital and proceed to the left to the; (a) shower outside the stock room, (b) morgue to the right of the stock room door, (c) to area indicated by sign RADIOACTIVE CONTAMINATED.

4. After showering, all articles will be handled and discarded by escort who is knowledgeable in radioactive materials.

5. Persons requiring treatment will be treated in this area by hospital personnel trained in treating radioactive injured or contaminated.

6. Tuxedo Hospital will provide all the portable equipment required to treat these persons in this isolated area.

7. If radioactive injured or contaminated need further medical treatment they will be provided with an isolated area so as to minimize the spread of radioactive contamination. NOTE: THE DESIGNATED AREA WILL BE AT THE HOSPITAL'S DISCRETION.

8. Union Carbide will provide a knowledgeable consultant to radiologically survey all employees having had contact with contaminated persons or clothing and all areas where contaminated person has been transported through or has been in for more than thirty minutes on a daily basis for duration of stay.

9. Tuxedo Hospital will require patient to remain in his bed or area during his hospitalization.

10. All employees will be urged not to linger in giving patient care longer than necessary even though appropriate precautions are taken and followed.

ST. ANTHONY COMMUNITY HOSPITAL
15-19 Maple Avenue
WARWICK, NEW YORK 10990

May 11, 1979

Mr. Don Scott
Union Carbide
Sterling Forest
New York

Dear Mr. Scott:

Attached please find signed guidelines for obtaining emergency medical treatment for injured employees contaminated with radioactive material as well as guidelines for patients of St. Anthony's.

It is my understanding that you will sign and return a copy for your files.

Sincerely,

James A. Wrynn
Administrator

js
enclosures

cc: Mr. Weber, Safety Chairman

GUIDELINES FOR OBTAINING EMERGENCY MEDICAL TREATMENT FOR INJURED EMPLOYEES CONTAMINATED WITH RADIOACTIVE MATERIAL

1. Union Carbide shall not transport patients to St. Anthony's Hospital before a radiological survey of the individual has been made.

2. Union Carbide shall remove contaminated clothing and decontaminate the patient as completely as possible before allowing transportation to the hospital.

3. Union Carbide shall supply an escort knowledgeable in contamination control procedures to accompany the injured employee to the hospital.

4. Union Carbide shall supply any required contamination control equipment, such as: gloves, shoe covers, lab coats, coveralls, head covers, respirators, etc.

5. Union Carbide shall supply any required radiation monitoring equipment, such as: survey meters, personnel dosimeters, air samplers, etc.

6. Union Carbide shall provide any required waste disposal or decontamination at St. Anthony's.

7. Union Carbide shall provide specialized medical consultation if required.

8. Union Carbide shall provide any technical assistance required in implemeting these guidelines.

St. Anthony Community Hospital

James [signature] Ad

5/7/79

GUIDELINES FOR ST. ANTHONY'S HOSPITAL IN PROVIDING EMERGENCY MEDICAL CARE FOR A PATIENT CONTAMINATED WITH RADIOACTIVE MATERIAL

1. St. Anthony's Hospital shall provide the best possible medical care for the injured patient.

2. St. Anthony's Hospital shall cooperate with contamination control efforts which do not interfere with approved medical practice.

3. St. Anthony's Hospital shall cooperate in providing an admission route and isolated area so as to minimize the spread of radioactive contamination.

4. St. Anthony's Hospital shall provide a communication procedure for initiating the contamination accident plan.

St. Anthony Community Hospital

James [signature]

5/7/79

St. Anthony Community Hospital Policy and Procedure for admitting and tr persons injured and contaminated with radioactive material in condensed as taken from the Master Policy and Procedure Manual:

Admission Route and Isolated Area:

1. St. Anthony Community Hospital will be notified in advance of arriva persons injured or contaminated with radioactive material.

2. Supervisor is to be notified:

   A. Supervisor will notify:
      (1) Administrator
      (2) Chief of X-ray Technician who will notify Radiation Safety O
      (3) Director of Nursing
      (4) Safety Chairman

3. When radioactive injured or contaminated persons are brought in from other than Union Carbide the Nursing Supervisor should call Union Ca (914-351-2131) and ask for the Health Physics Technician and make hi aware of the situation.

4. All radioactive injured or contaminated persons will enter the hospi through the receiving area and proceed to the shower area of the mor

5. After showering, all articles will be handled and discarded by escor is knowledgeable in radioactive material.

6. Persons requiring treatment will be treated in this area by hospital personnel trained in treating radioactive injury or contamination.

7. If radioactive injured or contaminated need further medical treatmen they will be provided with an isolated area so as to minimize the sp of radioactive contamination. The Isolation rooms would be the designated area for this type of injury.

8. St. Anthony Community Hospital will admit and care for no more than two (2) patients simultaneously that have been radioactive injured o contaminated.

9. Union Carbide will provide a knowledgeable consultant to radiologica survey all employees having contact with contaminated persons or clo and all areas where contaminated persons had been transported throug has been in for more than thirty minutes on a daily basis for durati of stay.

10. St. Anthony Community Hospital will require patient to remain in his or area during his hospitalization.

11. All employees will be urged not to linger in giving patient care long than necessary even though appropriate precautions are taken and foll

12. Personnel that are pregnant that would become involved with treating radioactive injured or contaminated should make their condition know the person in charge and not assigned to radioactive exposed patients

ab
January 1, 1979
Rev. April 26, 1979

UNION CARBIDE FACILITY DESCRIPTION

A. REACTOR DESCRIPTION

1. General

This 5 megawatt pool-type research reactor is a light-water moderated, heterogeneous, solid fuel reactor in which water is used for cooling and shielding. The reactor core is immersed in either section of a two-section concrete pool filled with water. One of the sections of the pool contains an experimental stall into which beam tubes and other experimental facilities converge. The other section is an open area permitting bulk irradiation. The reactor can be operated in either section.

Spanning the pool is a manually-operated bridge, from which is suspended an aluminum tower supporting the reactor core. Control of the reactor core is accomplished by the insertion or withdrawal of neutron-absorbing control rods suspended from control drives mounted on the reactor core bridge. Additional control is provided by the temperature coefficient of reactivity.

Heat, created by the nuclear reaction, is dissipated by a forced circulation cooling system. Externally located pumps, storage tanks, water-to-water heat exchangers, a cooling tower, a demineralizer plant, and a filter complete the water handling systems for the reactor.

A plan view of the reactor and hot laboratory facility is shown in Section 11 of the Union Carbide Nuclear Facility Emergency Plan.

REACTOR SPECIFICATIONS

Fuel	93 percent enriched U-235 MTR type, Al clad fuel assemblies
Power	Five megawatt (thermal)
Cold Clean Critical Mass:	
Stall:	3.45 KG U-235
Pool:	3.83 KG U-235
Lattice	54 holes on 6 x 9 pattern
Flux Density	3.1×10^{13} n/cm^2/sec. (average, stall)
Moderator	H_2O
Reflector	H_2O, Graphite
Shielding	H_2O, Lead, Magnetite concrete, and regular concrete
Cooling	Primary Loop - heat exchanger Secondary Loop - cooling tower
Water Purification	Demineralization of a portion of the primary flow
Control	5 Boron-Carbide or Ag/In/Cd safety rods 1 stainless steel regulating rod
Irradiation Facilities	Thermal Column Pneumatic Conveyors Beam Tubes

2. Pool

a. Concrete Pool

The reactor pool is a reinforced concrete enclosure approximately 49 feet long, 23 feet wide and 32 feet high, with the open end embedded in the mountainside. The pool walls support the movable bridge from which is suspended the tower supporting the core. Adequate biological shielding is provided by the depth of water above the core and by the concrete pool walls.

The pool is divided into two sections separated by a four foot wide opening that can be closed by a removable watertight gate. The narrower stall section contains the fixed experimental facilities such as the beam tubes and thermal column. The open end of the pool permits bulk irradiations and provides storage space for irradiated fuel and experiments. A 12-foot deep canal connects the open pool with the hot cells to permit the transfer of irradiated material between the two facilities.

Shielding in the stall area consists of a 5.8 foot thick magnetite concrete wall to a height of 15 feet above the pool floor. The wall thickness is then reduced to three feet to the top of the stall. The lower four feet of the wall above the step is of magnetite concrete and the remainder of regular concrete.

A steel tank is embedded in the concrete walls and floor of the pool. All penetrations are welded to this tank to form a watertight seal.

3. Reactor Building

The Reactor Building is a reinforced rectangular concrete structure set into an excavation in the side of a rock mountain. Shielding and containment are provided on three sides of the building by solid rock against the west wall, and a combination of rock and fill on the north and south sides. The exposed portions of the walls and roof are reinforced concrete.

The building measures about 70 feet wide, 92 feet long, and 57 feet high from the beamhole floor. The walls have a minimum thickness of 12 inches and the roof is a minimum of 8 inches thick. The volume of the Reactor Building is about 285,000 cubic feet. The building is designed to withstand an internal pressure of 3/4 psig.

The experimental area around the reactor is serviced by a 10-ton bridge crane traveling the length of the building. The reactor control room, several offices, and laboratories for low activity work are provided inside of the Reactor Building. Junior hot cells for medium activity work and for opening sample cans are also provided. All personnel entrances to the building are of the double airlock type. Large equipment can be brought into the Reactor Building via a motor-operated, air-tight sliding door. The controls for this door can be locked during periods of reactor operation.

4. Heating and Ventilating

The Reactor Building ventilation system is designed to provide winter heating and summer cooling. Elementary diagrams of the ventilation system flow paths and controls are given in Figure 1.

a. Normal Operation

The supply air fans, coils, and equipment for the reactor chamber are located in a fan room between the Reactor and Hot Laboratory Buildings. The heating boilers, compressors, and refrigeration equipment are located in the central Boiler House which serves the other buildings of the Research Center. The exhaust fans and filters for the system are located in an exhaust fan room in the northwest corner of the Hot Laboratory Building. The system is designed to maintain an inside temperature of 75°F in winter when the outside temperature is 0°F.

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED

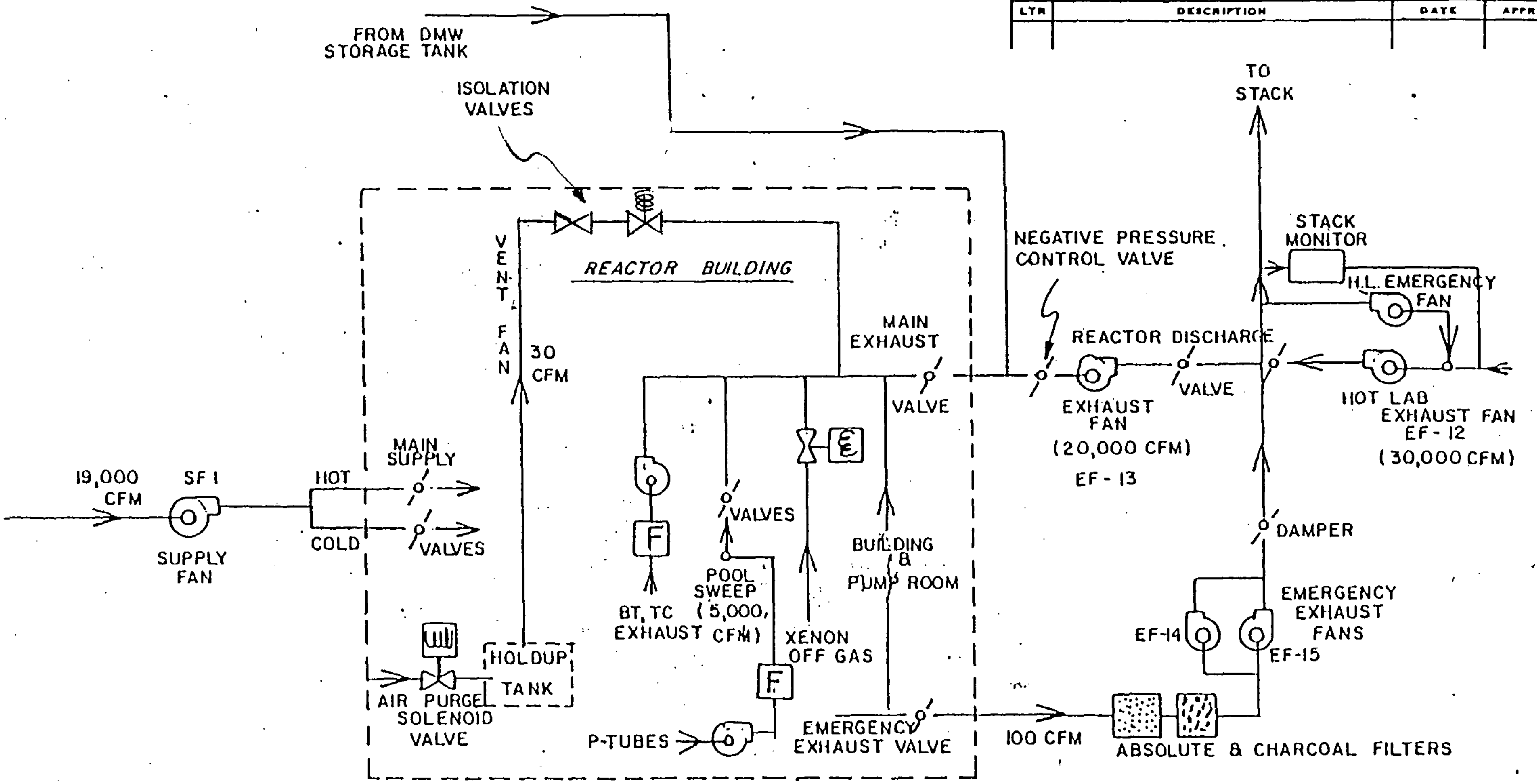


Fig. 16

TOLERANCES ±	UNION CARBIDE CORPORATION CORPORATE RESEARCH LABORATORY TUXEDO, NEW YORK
DRAWN: CF	
CHECKED:	REACTOR VENTILATION SYSTEM ELEMENTARY FLOW DIAGRAM
DATE: 6 MAY 75	SCALE: — - — SIZE: A DRAWING NO.: SK - 1151

In summer the system will cool the chamber to 80°F with a maximum relative humidity of 60 percent. A duct system distributes air throughout the chamber. Fresh air is drawn through intakes in the fan house, heated or cooled, filtered, and circulated through the duct system. No air is recirculated. The entire chamber experiences about 4 air changes per hour.

The reactor exhaust fan gathers air from the reactor building via a main exhaust duct and exhausts it via a 4-foot diameter duct to the exhaust stack located on the ridge at a high elevation northwest of the building. This stack, discharges the air above the tree tops at an elevation of 188 feet above main floor level. There is a special air duct manifold which attaches beneath the reactor bridge and sweeps air across the reactor pool water surface above the reactor core. This 5000 cfm air sweep enters the main exhaust duct and discharges out of the stack with the building exhaust for a total exhaust flow of 19,000 cfm.

The Reactor Building tunnel is ventilated by a jet-type nozzle which discharges heated or cooled air into the tunnel.

b. <u>Emergency Conditions</u>

In the event of a release of radioactive gas or particulate matter into the reactor building's atmosphere, the emergency ventilation system is put into operation. The effect of this system on the overall ventilation system is as follows:

<u>Immediately</u>

1. The Reactor Building supply fan shuts down.
2. The holdup tank isolation valve and air purge valves close.
3. The supply duct dampers close.
4. The beam tube ventilation fan shuts down.
5. The damper in the 5000 cfm pool sweep closes.

<u>After 7 Seconds</u> (or when building pressure reaches 1" w.g. negative)

1. The main exhaust duct damper closes.
2. The main exhaust fan shuts down.
3. The emergency ventilation fan starts.
4. The damper in the emergency exhaust line opens.

The emergency exhaust duct is an auxiliary duct connecting the Reactor Building to the charcoal filter and the roughing and absolute filters in the fan room. The fan, at the discharge side of the filters, vents into the duct leading to the stack. The building and ventilation system is so designed that under emergency conditions building air leakage will be inward.

c. Stack Monitor

The effluent in the 4-foot duct is continosly sampled to provide indication of abnormal levels of airborne radioactive material. This is accomplished by withdrawing a 5 cfm side stream from the duct, passing this through particulate, iodine and gaseous radioactivity detectors and returning it to the suction side of the exhaust fans. The outputs of these detectors are indicated on chart recorders equipped with alarm set-points. The three outputs are also repeated on chart recorders in the reactor control room. Gaseous level is also repeated in the hot laboratory operating area. The particulate detector is a moving paper filter passing in front of an anthracene scintillation crystal. The iodine detector is a charcoal filter monitored with a scintillation detector. The gas detector is a shielded vessel containing a sodium iodide scintillation detector.

5. Reactor Building Waste Collection Systems

Reactor Building waste collection is performed by three systems:

a. Ground Water Removal System
b. Sanitary Waste System
c. Process Waste System

a. Ground Water Removal System

Due to water seepage from the fractured rock against which the Reactor Building is constructed, it is necessary to collect the water in a system of perforated drains located around the building and pool structures. These drains collect into a single drain that releases effluent to the Research Center storm water system. Samples of this water can be analyzed routinely.

The T1 room which is the basement of the hot laboratory is below the level of the perforated drain tile network. During periods of expectionally heavy rainfall water will collect under the foundation. It rises in a sump at the east end of the T1 room that is equipped with an alarm and 2 sump pumps with operating indicators in the reactor control room. The water is pumped to the process waste tanks in the central mall where it is held, sampled, and analyzed before it is released.

b. Sanitary Waste System

Sanitary wastes collect into a main sanitary drain and pass through a deep trap before draining from the Reactor Building. The deep trap is designed to maintain air containment of the building even when the sanitary facilities are drained. The Reactor Building sanitary waste system drains to the Research Center sanitary waste system.

c. Process Waste System

The process waste system discharges effluent to either the Research Center non-radioactive and chemical waste system or the radioactive waste system, depending on the activity level of the waste. The system works as follows:

All Reactor Building liquid wastes other than ground water and sanitary wastes drain to two 500-gallon sumps located on the lower level of the Reactor Building pump room. From these sumps, liquid waste is pumped to the radioactive waste treatment facility storage tank located in the Hot Lab.

6. Waste Disposal

The following waste disposal systems are provided for the Research Center:

a. Storm Water System
b. Sanitary Waste System
c. Non-radioactive and Chemical Waste System
d. Radioactive Waste System

a. Storm Water System

The storm water system is a gravity drainage system discharging to Indian Kill Pond. Maximum use is made of existing natural drainage for ground run-off. A storm sewer main collects storm water from building roof drains and paved area collection scuppers.

There is a damn that can be closed to stop surface run off before it flows into Indian Kill Pond. If necessary or desirable surface runoff from the site can be interrupted.

b. Sanitary Waste System

The sanitary waste system is a gravity drainage system discharging directly to the Sterling Forest sanitary sewage disposal system. This system handles all wastes from the sanitary plumbing in the various buildings on the site.

c. Non-radioactive and Chemical Waste System

The non-radioactive and chemical waste system is a gravity drainage system discharging to Indian Kill Creek downstream from Indian Kill Pond. This system handles waste water from laboratory sinks, cup sinks, benches, and process equipment in from all buildings.

Non-radioactive waste, i.e., cooling water, steam condensate, and decontaminated process waste from the Reactor and Hot Laboratory Buildings discharges into either of two 5000-gallon capacity tanks located underground in the center mall. These tanks are operated on a collect-hold-sample philosophy. Such a system provides a positive method of preventing accidental discharge to the off-site stream because the liquid collected in the tanks is sampled and analyzed prior to discharge to the non-radioactive waste system. If the activity level is higher than can be tolerated, the liquid is pumped to the 7200-gallon waste storage tank.

d. Radioactive Liquid Waste Handling System

The system is described under the Hot Lab description.

7. Emergency Power and Motor Control Center

a. Emergency Power

A gasoline motor driven electrical generator of 50 kw capacity provides emergency power automatically in the event of an electrical power failure.

The following Reactor Building equipment receives electrical power from this generator:

1. Portions of the Reactor Building lighting
2. Reactor control console
3. Reactor Building exhaust fan, 1/2 speed
4. Reactor Building supply fan, 1/2 speed
5. Reactor Building motor-operated doors
6. Emergency ventilation system
7. Beam tube ventilation fan
8. Beam tube flushing pump
9. Swing-type airlock door controls
10. Gasoline pump from storage tank to emergency generator
11. Hot Lab exhaust fan at 1/2 speed or stand-by Hot Lab fan
12. Certain electrical receptacles for mobile equipment (radiation monitors, etc.)

The purpose of this generator is to supply emergency power for minimal operation of critical systems in the Reactor Building. The Reactor will never be operated, even at low power levels, on emergency electrical power. Sufficient gasoline storage has been installed to guarantee a six day supply for the emergency generator. The storage tank is 2000 gallon capacity. A second 45 kw emergency generator, which is fueled with natural gas, serves as an alternate power source for the emergency vent fans in the event the 50 kw emergency generator fails.

b. Motor Control Center

The main motor control center, in addition to controlling the numerous functions of equipment under normal operation, controls the operations and sequences necessary for the use of the emergency ventilation system and the transfer of power loads from the normal supply to the emergency generator supply. The functions of the motor control center that are of interest in this section are those required to control the latter two emergency operations. Operation of the emergency ventilation system was previously described in subsection 4b.

The situations described here are those in which a power failure occurs during the following operating conditions:

1. Simultaneously with the start-up of the emergency ventilation system.
2. After the initial timing sequence of the emergency ventilation system has been completed.
3. Restoration of normal line power after the emergency ventilation system has started.

Condition 1

If a power failure occurs in the same instant that the emergency ventilation system is put into operation, either automatically or manually, the loss of electrical power for the few seconds required to start the generator (approximately 5) will completely close the dampers in the air ducts of the entire ventilation system. These dampers have all been designed to be fail-safe, air-tight dampers so that on loss of either electrical power or pneumatic power, they will close. The closing time for these dampers is less than 3 seconds. After the emergency electrical generator has come up to speed and the automatic transfer switch in the motor control center has transferred power from the normal bus to the emergency bus, the emergency ventilation system will then be energized. The signals which initiate the emergency ventilation system are of a type that will not reset automatically after recovery of electrical power. There is no possibility that a power failure, coinciding with a need for the use of the emergency ventilation system, could return the ventilation system to normal, and thus exhaust large quantities of untreated air into the general atmosphere.

Condition 2

If electrical power from the local power company should fail after the initial 7-second timing sequence for the emergency ventilation system has been completed, it might be possible for the system to reset itself when the emergency electrical generators assume the load, and thus repeat the 7-second cycle. To eliminate this possibility, a manually reset relay is connected to the timer which controls the initial operation of the main exhaust fan for the 7 second period. In this way, the additional operation of the main exhaust fan is prohibited once the timer has cycled through its planned sequence. Loss of normal power and its subsequent replacement by emergency power would have the following effect:

1. The entire system including the dampers would stay shut down for the period of time necessary for the emergency generator to assume the load.
2. Once the load is assumed by the emergency generator, the system would continue to function as it had immediately prior to the power failure, i.e., the main dampers stay shut.

Condition 3

The emergency electrical generator and its associated automatic transfer switch are interconnected in such a way that, upon resumption of normal power from the local power company, the electrical load is switched back to the normal bus automatically. The possibility of the emergency ventilation system being programmed automatically through the initial 7-second phase described previously, with the resultant exhaustion of large quanitites of untreated air, is prevented by the need to reset the emergency ventilation system manually.

8. Fuel Storage

New and "cold" fuel elements are stored in a vault-type room in criticality-safe storage racks. This vault is of concrete block construction with a locked hollow metal door providing the only access.

The storage vault measures approximately 12 ft. long x 9 ft. wide x 13 ft. high. Fuel elements are stored upright in two separate metal racks located on opposite walls of the vault. The racks are fixed in place and separated by a minimum distance of 6 ft. Each rack will hold 50 elements in two rows, with 25 elements in each row. The rows are separated by a minimum distance of 6 inches. Rack separators maintain a minimum spacing of 2 inches between elements.

The vault is so located that flooding by water is not credible, however, if water should enter the vault, it would drain out through the vault ventilators which are located only a few inches above floor level. Futhermore, the storage spacing and geometry described above will guarantee that criticality could not be achieved. This spacing and geometry is based on ORNL criticality safety data given below.

ORNL measurements[1] have shown that two-row slab shaped arrays of ORR and BSR fuel elements remain subcritical under conditions of complete moderation and reflection by water. During these tests, the individual fuel elements and the rows were spaced at an optimum distance of 0.2 inches. Step additions of elements were made to the two-row array and increases in the source neutron multiplication were observed for all additions up to 17 elements per row; however, further additions to this 34-element array had no appreciable effect. The final array had twenty-four, 200-gram elements in the center and fourteen, 168-gram elements on each end. Other ORNL measurements have shown that a completely water-moderated and reflected square array of ORR elements, at a spacing of 1.25 inches between elements, requires twenty-eight, 168-gram elements with six, 200-gram elements in the center of the array and twenty-seven, 140-gram elements on the outside edge of the array to become critical.

Thus, the fixed fuel element spacing maintained by the vault storage racks is, from a criticality standpoint, conservative and will be safe under all credible conditions. The possibility of interaction between elements stored in the two racks is ruled out because of the large (6 feet) distance between the racks.

Irradiated Fuel

Irradiated and spent fuel is stored, prior to shipment for reprocessing, in underwater racks located in the floor of the pool. Each rack is rectangular with spaces for 16 elements. The 6-inch center-to-center spacing of element receptacles guarantees subcriticality. Holes in the bottom of the receptacle allow natural circulation of water through the elements.

[1] J. K. Fox and L. W. Gilley, Critical Experiments with Arrays of ORR and BSF Fuel Elements, O.R.N.L. CF-58-9-40.

B. HOT LAB DESCRIPTION

1. Hot Laboratory Building

The Hot Laboratory is a concrete structure 225 feet long by 57 feet wide by 37 feet high. There are five hot cells, each having 4-foot thick walls of high density concrete (240 lbs/ft^3). The cells are separated from each other by 4-foot thick, high density concrete walls. A plan view of the Hot Lab is shown in Section 11, page 3 of 3.

2. Hot Cells

The cells are general purpose units designed to accommodate a variety of operations including chemical experiments, radiochemical separations of isotopes, physical testing for evaluation of irradiated material, solid state investigations and metallurgical work. A general description of the cells is presented below.

Cell 1 is 16 feet wide by 10 feet long by 15 feet in height. This cell is equipped with a PAR Remote Handling Arm (750 lb. capacity), one pair of Heavy Duty Model 8 manipulators, and one pair of Standard Duty Model 8 manipulators. Two Corning 4-foot thick glass shielding windows are located in the front shielding wall of Cell 1. These viewing windows consist of Corning's "Radiation Shield Standard Assembly 1480", which is their standard unit for 4-foot shielding walls. The windows are constructed from five sections of 3.3 density lead glass each 9-1/2 inches thick.

A Kollmorgan periscope, currently in use in Cell 1, can be relocated to any of the other cells. With auxiliary attachments on the periscope it is possible to do in-cell microscopy and to take photographs of specimens in the cell.

Cells 2, 3 and 4 are 6 feet wide by 10 feet long by 12.5 feet in height, while Cell 5 is 6 feet wide by 10 feet long by 25 feet in height. Cells 2, 3, 4 and 5 are each equipped with a Corning 4-foot thick glass shielding window and all cells are equipped with one pair of Model 8 Master Slave Manipulators.

Major access to all the cells is possible through the rear doors (7 feet wide by 6 feet high by 4 feet thick) which can be withdrawn utilizing electrical drives. The electrical connection and power supply to drive these doors are kept locked to prevent unauthorized entrance. An alarm sounds when any of these rear access doors are opened. The access doors for the cells are motor driven through a 1200:1 reduction worm gear and move on steel rails located in the floor of the charging area.

Access to all cells is also possible via top roof openings containing removable plugs. The roof and roof plugs of all cells are 3-1/4 foot thick magnetite concrete with a density of 240 lbs/ft^3. The roof plug is made up of three 14-inch thick concrete slabs which must be removed individually with a 10-ton capacity overhead crane. A 6-inch diameter charging sleeve located in the center of the roof plug is fitted with an 8-inch long lead filled steel plug. Two 4-inch diameter charging sleeves also are provided through the roof. They have magnetite plugs 6 inches in diameter at the exterior surface and are stepped to 4 inches in diameter 18 inches from the interior surface. There are laboratories and a solution make-up room above the charging area, but no occupied areas directly above the cells.

A canal containing water 12 feet deep connects Cell 1 with the reactor pool. Radioactive samples, specimens, isotopes, etc., are transferred through this canal and brought into Cell 1 via an automatic elevator mechanism.

3. Operating Area

The area on the front side of the cells is the operating zone and is maintained as a clean area. The viewing windows, manipulator controls, intercell conveyor controls, in-cell service controls (air, water, vacuum, gas) and periscope are located in this area.

Eight radiation monitors serving the Hot Lab are linked to a master panel which is located in the operating area. Both audio and visual alarms are activated at this master panel. They are normally set to alarm at 5.0 mr/hr., and can be set to alarm at any level from 1 to 10,000 mr/hr.

In the front shielding wall of each cell there are twelve removable 2-inch diameter stepped pipe sleeves, one 8-1/2 inch diameter sleeve (to accommodate the periscope) and two 10-inch diameter sleeves (to accommodate the Model 8 manipulators). When the sleeves are not in use, magnetite shielding plugs are placed in the sleeves. Special services not available within the cell (such as inert gas, high pressure air, natural gas) can be led into the cells through special plugs which can be inserted in place of the standard 2-inch diameter stepped pipe sleeves. Locking bars are used to prevent accidental removal of any of these plugs.

4. Charging Area

The charging area is located to the rear of the cells. Controls for the rear access doors to the cells are located in the call operating area. Access to the decontamination room, exhaust fan room, waste treatment facility and conveyor loading station are from the charging area.

The north loading dock is separated from the charging area by swinging doors. At the south end of the charging area, swinging and sliding doors separate this area from the canal and the south loading dock.

In the rear shielding wall of each cell, there are five 2-inch diameter stepped pipe sleeves. Each rear cell door also contains one 8-inch diameter stepped sleeve. These sleeves provide additional access ports from the charging area to the cells. They contain magnetite shielding plugs when not in use.

A fifteen ton capacity monorail hoist travels through this area from the north to the south loading dock. Heavy lifts can be manuevered by this hoist throughout the charging area. This hoist can be operated remotely from the operating area.

5. Radiochemical Laboratory

Low level radioactive specimens or samples are handled in the Radiochemical Laboratory. Equipment available in the laboratory includes standard laboratory benches with stainless steel tops, glove boxes and hoods.

Operations in this laboratory involving higher level radioactive gases will be conducted within special hoods. There are three hoods and three glove boxes in the lab. The hoods, with all interior surfaces of stainless steel, are 6 feet wide and are designed for work with radioactive materials. The glove boxes are of stainless steel and some are equipped with shielding. All flow from these hoods and glove boxes passes through roughing filters, and absolute filters and where necessary charcoal filters prior to passage to an exhaust fan and monitoring system. The exhaust air flows to a 50 foot stack which also receives exhaust air from the reactor area.

Supporting non-radioactive analytical work is also done in this laboratory.

6. Second Floor

Laboratories

Three laboratories are located in this area. These labs are currently used for the uranium target preparation. They can also be used for work similar to that described for the Radiochemical Lab. All operations involving radioactive materials will be carried out in hoods or glove boxes of the type used in the Radiochemical Lab.

7. Maintenance Shop

A shop 29 feet by 25 feet is available in the Hot Lab. This shop contains a drill press, lathe, milling machine, band saw, electric and gas welding equipment, and a variety of hand tools.

8. Personnel Facilities

Six offices, a conference room, a change room (17 feet by 9 feet), a locker room (30 lockers), and rest rooms are in the Hot Lab.

9. Waste Drum Storage

One hundred individual storage cells, each sized to hold one 55 gallon drum, are located at the north end of the hot laboratory building. The cells are arranged similar to a honey-comb with 4 feet of concrete shielding around the outer perimeter. Each cell has a concrete shield plug 4 feet deep and is vented to the cell exhaust ventilation filter room. High concentration waste from in-cell processing is stored in this facility prior to disposal.

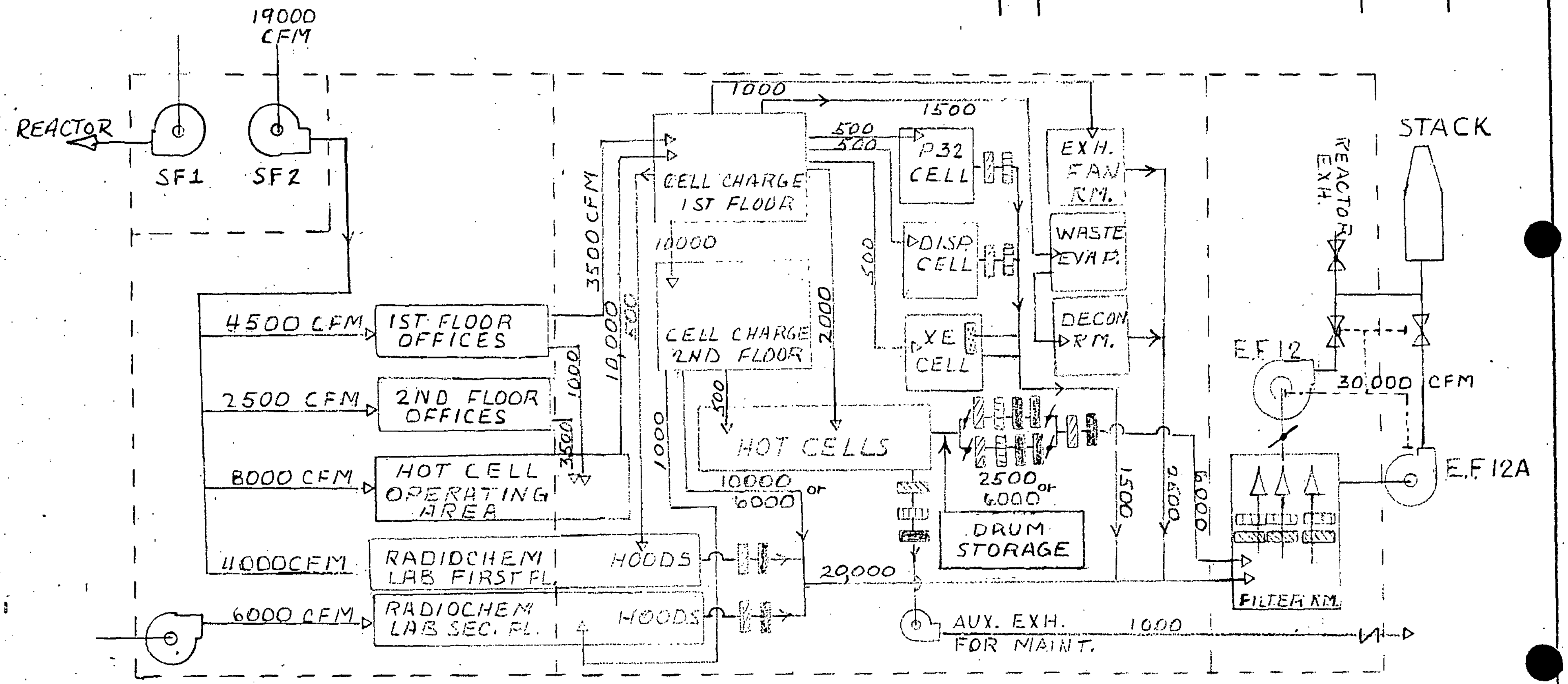
10. Ventilation System (Refer to Figure 2)

The Hot Laboratory ventilation system is designed to assure a continuous, positive flow of air from non-radioactive areas to contaminated or radiation areas. There are two major supply fans. One fan supplies 19,000 cu.ft/min of air to the first floor offices, loading dock, second floor offices, operating area, and the Radiochemical Lab. A second fan supplies 6,000 cu.ft/min of air to three laboratories on the second floor.

The cells are maintained at a negative pressure with respect to the operating area and the charging area.

All exhaust air from the Hot Lab passes through roughing filters and absolute filters in the main filter bank prior to discharge, via an exhaust fan, to the stack. The exhaust air from the hot cells is prefiltered through roughing, HEPA, 2 ea. 2" charcoal filters and 1 ea. 3/4" charcoal filter before it goes into the main filter bank. Exhaust air from all hoods or glove boxes is prefiltered through roughing and HEPA filters before it passes into the main filter bank. Charcoal filters are provided for hoods or glove boxes in which radioactive iodine is processed. The 50 horsepower exhaust fan, operating on normal power, has a capacity of 30,000 cu.ft/min against a head of 7.5" of water. In the event of a power failure, the fan is automatically switched onto an emergency power system (gasoline driven generator) and operates at 1/2 speed on this emergency power supply. (The emergency power supply is described in the reactor description.)

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED



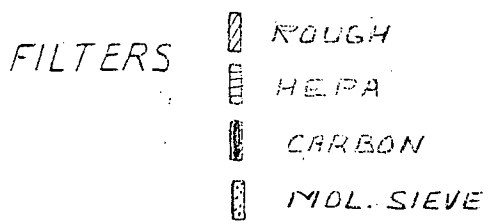


Fig. 2

TOLERANCES ±	UNION CARBIDE CORPORATION CORPORATE RESEARCH LABORATORY TUXEDO, NEW YORK		
DRAWN: JMcG	HOT LAB VENTILATION		
CHECKED:			
DATE: 8/82	SCALE:	SIZE:	DRAWING NO.:

An emergency fan (5 horsepower) with a capacity of 8,000 cu.ft/min against a head of 3.0" of water is provided as backup for the 50 horsepower fan. This fan can be operated on either normal or emergency power.

If a rear door of any cell or the door to the decontamination room is opened, the flow of air is inward from the charging area to the cell. This air comes from the charging area.

Exhaust air from the Hot Lab is added to the exhaust air from the reactor area and the combined flow discharges into a 4-foot diameter vent header which leads to a stack. Its base is located on a ridge at an elevation of 945 feet. The stack is 50 feet high and the top is at an elevation of 995 feet, about 187 feet above the main floor of the Hot Lab. All exhaust air entering the stack is continuously monitored for iodine, gaseous and particulate radioactivity. The stack monitor is described in the reactor description.

10. Radioactive Waste Water Treatment System

The radioactive Waste Water Treatment System is utilized to treat wastes containing isotopes higher than the levels prescribed by Sec. 20.106 10 CFR Part 20. The bulk of the waste water, after treatment, is suitable for discharge from the site. The handling and treatment facilities combine storage, evaporation, ion exchange, and recycle if it is required, to accomplish this objective.

All radioactive waste water resulting from Reactor or Hot Laboratory operations are collected in a 7200 gallon stainless steel tank located in a separate cell under the main floor of the Hot Laboratory. All hot drains in the Hot Lab and drains from vent and off-gas headers also tie into this tank. There is access to this cell via a shielded 3-foot square by 3-foot thick plug in the charging area. The following units are located in a separate area adjacent to the 7200 storage tank:

Evaporator Feed Tank	500 gallon capacity
Evaporator	500 gal/day capacity
Ion Exchange Column	containing cation and anion resin. Maximum operating capacity = 5 gal/ ft^2/min.
Hold Tank	One 800 gal. capacity, for receiving decontaminated liquid following ion exchange.
Concentrate	500 gal evaporated feed also holds the concentrated radioactive liquid wastes from evaporator.
Instrumentation	All tanks equipped with liquid level and density indicators with audio and visual alarms.

Contaminated liquid waste is evaporated at a rate of between 10 and 20 GPH depending on the cooling water temperature. The decontaminated wastes are collected in either of two clean, hold-up tanks. When one tank is full, flow from the ion exchange column will be directed to the other tank. Samples are taken of the contents of these hold-up tanks. If the activity level is satisfactory for discharge, the tank contents will be pumped to the chemical waste header. If the activity level is too high for discharge, the liquid is recycled through the evaporatorion exchange circuit.

The ion exchange columns, 4" diameter by 2' long, are continuously monitored. They are connected into the system by snap-tite quick disconnect units, and they are replaced prior to exhaustion. The spent columns (with resin) are placed in a suitable container for shipment to an approved burial ground.

The converted, low volume radioactive waste water is converted into a solid form by using such wastes to prepare concrete. This solid material is placed in containers which conform to DOT regulations governing the packaging and shielding of radioactive materials for shipment. After packaging, these containers are shipped to an approved burial site.

High concentration radioactive waste liquids produced as a result of research, development, or isotope production inside the hot cells, or other operations, are processed to a solid and packaged within a hot cell. An example of this would be fission product wastes resulting from Mo-99 production. Such wastes are shipped, in approved containers, to an approved disposal facility.

11. <u>Non-Radioactive Waste Water</u>

All other waste water from the Reactor and Hot Lab, with the exception of sanitary wastes and storm water, are collected in two 5000-gallon hold-tanks. These two 5000-gallon tanks were incorporated in the waste system to prevent the accidental discharge of contaminated water from the site.

The waste water collected in these tanks is sampled and checked for radioactivity. If the activity is low enough, the waste water is discharged. If the contents of either of the 5000 gallon vessels require treatment to remove radioactivity, the water is pumped to the 7200 gallon storage tank in the Radioactive Waste Water Treatment System. A record is kept of the amount and concentration of waste water leaving the site.

12. Radiation Monitoring Program and Equipment

A senior Health Physicist is responsible for all phases of Health Physics procedures for the Reactor and Hot Lab. He supervises the activities of Health Physics technicians.

a. Health Physics Training

All personnel working with radioactive material receive basic radiation safety training. This initial radiation safety instruction is supplemented by on-the-job training during each new operation.

b. Personnel Monitoring

All personnel wear a film badge and two pocket ionization chambers. The pocket chambers are read daily and the film badges are evaluated bi-weekly by an approved commercial laboratory. Urinalyses on all personnel working with radioactive materials are made on a routine basis at least once each year. Additional samples will be taken as recommended by the Health Physicist.

c. Instruments and Equipment

All radiation detection and monitoring equipment is calibrated and kept in proper operating condition by the Health Physicist.

(a) Radiation Detection and Monitoring

Radiation detection instruments available for monitoring include at least (5) Ion Chamber Meters with range up to 50,000 mr/hr. (2) Geiger Detectors with range up to 20 mr/hr, (1) Alpha Scintillation Counter, (1) End Window GM Counter, (1) Gas-Flow Proportional Counter, (2) Multi-channel gamma spectrum analyzers and TLD detectors and analyzers.

Portable radiation detection equipment such as cutie-pies, and G-M survey meters are located at various points in the area and Hand and Foot Counters are near the main exits from the controlled area. They are used by visitors and personnel before going to lunch or leaving the building. An alpha hand and foot counter is located outside the uranium target preparation area on the second floor of the Hot Laboratory.

(b) Area Monitrons (Refer to Section 11, p. 3 of 3)

Area radiation monitrons are located in 13 different positions throughout the Hot Lab. These monitors have audio and visual alarms at the local point and at the main monitron control panel in the operating area of the Hot Lab. These monitrons are checked on a weekly basis. Eight of these are interlocked with the criticality monitoring system.

Area radiation monitors are located in eight different places throughout the reactor. These have audio and visual alarms locally and in the reactor control room. Five of these are interlocked with the criticality monitoring system.

The area monitors are normally set to alarm between 5 and 20 mr/h for normal radiation monitoring. The monitrons serving the dual purpose of criticality monitoring have a second high level alarm set point. Criticality monitors are designed to fail in the alarm condition. The criticality alarm in each building is a distinctive audible alarm that specifically indicates evacuation of the building.

(c) Constant Air Monitors

Four constant air monitrons are located (2 each) in the Hot Lab and Reactor. The monitors can be set to draw air (via a vacuum pump) past filter paper at a flow rate ranging from 1 to 10 cu. ft/min. A G-M tube is located above the filter paper and measured activities are continually recorded.

(d) Stack Monitors

The exhaust air from both the Reactor and Hot Laboratory is continuously monitored for radioactive particulate matter and for gaseous activity. This monitor is equipped with recorders and alarm circuits to indicate high activity or equipment failure. It is checked on a routine basis at least once a day. A cumulative weekly sample is analyzed for alpha activity. (See Reactor Description for more details.)

(e) Wipe Tests

Wipe tests are made of the floors daily and analyzed for beta, gamma, or alpha activity as appropriate. Wipe tests are made on all sealed sources at intervals not to exceed 6 months. All equipment and materials require Health Physics approval before being removed from a controlled area. All materials packaged for off-site shipments are checked to insure that all appropriate shipping regulations have been followed.

UNION CARBIDE NUCLEAR FACILITY

RANGE OF POSTULATED ACCIDENTS

1. General

The hazards which may be associated with the operation of the 5 MW UCNR pool type research reactor and the hot laboratory are discussed below. A number of accidents and their consequent hazards are considered.

The accidents discussed are as follows:

1. Natural phenomena - the effects of windstorms, earthquakes, etc.
2. Minor accidents - the effects of faulty operation by personnel, or equipment malfunction.
3. Maximum reactor start-up accident - the worst accident resulting from malfunction and misoperation at the time of startup.
4. Credible serious accidents - severe accidents which can be postulated as occurring under foreseeable circumstances.

2. Natural Hazards

a. Windstorm

Since the buildings are built into the side of a hill, and are ruggedly built, windstorm damage to it can be precluded. The reactor, hot cells, and all auxiliary process equipment that is vital to radiation protection are housed in reinforced concrete structures. A strong windstorm could damage the reactor cooling tower, but this would not introduce a radiation hazard. An unusual event may be declared under the emergency plan.

b. Lightning

Lightning could interrupt the power to the site, or cause a fire in the surrounding forest. In case of power failure, the reactor will automatically shut down. An emergency power system will supply power to critical equipment. Normal work ceases during power outages. If it could be anticipated, an unusual event may be declared under the emergency plan.

c. Fire

The location of the building, and its concrete and steel construction, should protect the reactor from damage due to a forest fire in the area. It is not likely that a radiation hazard would result from a forest fire. A fire inside the facility may be cause of declaring an unusual event class emergency under the plan.

d. Flood Hazard

The only probable type of flood in the area is a flash flood. The buildings are situated on the side of a hill that provides excellent runoff of surface water. Some ground water has entered the waste liquid treatment room in the basement of the hot laboratory during very heavy rain. Alarms and sump pumps are installed to prevent flooding. If water enters the sump, it is sampled and analyzed for radioactivity before it is released. Such an event would not be cause for activating the emergency plan.

e. Earthquake

This area has a long record of freedom from violent earthquakes; no strong earthquakes have occurred since 1878. The reactor pool is placed in very firm, hard rock. A violent shock would cause the reactor to fail safe from power failure or cause the rods to fall from their magnets. The worst hazard from an earthquake would be loss of pool water through a crack in the concrete and a simultaneous break in the pool water seal. Because of the structural strength of the pool wall, this occurrence is doubtful. The reinforced concrete pool walls should retain their integrity at least up through an intensity VII shock. The combination of earthquake rarity, rock foundations, and structural design of the pool renders this hazard remote. The hot cells are also constructed of steel reinforced concrete, and such construction is known to withstand the most credible seismic event in this area. Further discussion is given in Appendix 5 of the R-81 SAR.

A shock of severity VII could conceivably cause a leak or break in one or more of the four primary cooling system pipes, leading to draining of the pool if there were no intervening valves. The shortest time to drain the pool entirely is 8 minutes.

After this time, the decay power in the fuel would be only one percent of the operating power. Work done by Wett[1, 2] on temperatures of irradiated ORR fuel elements in both stagnant air and partially submerged in water indicates the maximum core temperature considering minimum drainage time would be about 950°F. The exposure of the core would not result in fuel melting. An added safety feature to reduce the temperature of the exposed core is the existence of two manually operated spray nozzles located at the top of the pool at both reactor operating positions which will direct about 100 gpm of water on the core. The manually controlled valve for the nozzles can be operated from outside the reactor building.

If all primary cooling water were to be released from the pool via severed coolant lines, the depth of water, after filling the underground pump room and holdup tank, would be only about one foot on the reactor building ground floor, and therefore would be expected to be retained within the building. As fuel melting is absent, this water would be only mildly contaminated with short half-life radioactive material. An unusual event class of emergency would be declared under the plan.

3. Minor Accidents

Accidents are considered minor if their results are less severe than those identified under "Credible Serious Accidents."

a. Loss of Ventilation in Reactor Beam Tubes

Normally, the beam tubes and access hole in the thermal column are ventilated to prevent the buildup of air containing radioactive gases. If the ventilation system fails, radioactive gases may contaminate the room atmosphere.

1 J.F. Wett, Jr., Surface Temperatures of Irradiated ORR Fuel Elements Cooled in Stagnant Air, ORNL-2892, March 23, 1960.

2 Final Hazards Summary Report, UCNC Research Reactor, Nov. 1960.

The major contribution to air activity in the beam tubes is the A^{40} (n, γ) A^{41} reactor. The A^{41} activity reaches its saturation level after periods much longer than the A^{41} half life (110 minutes).

If the thermal neutron flux at the end of the beam tubes is 3 x 10^{13} neutrons/cm^2-sec. and is assumed constant over the entire length of the tube, the activity of the air in the beam tubes due to A^{41} is calculated to be 1.26 x 10^{-4} curies/cc of air. The volume of the air in an eight inch beam tube, plugged except for 26 inches of its length, is 21,400 cc. This yields a saturation activity of 2.70 curies in the beam tube air. If the cover were removed from the beam tube and the activity were uniformly dispersed in the building atmosphere (volume = 7700 meters[1]), an A^{41} activity of 3.5 x 10^{-4} uc/cc of air would be produced. This would be over the permissible limit of 2 x 10^{-6} uc/cc listed in Table 1 of Appendix B of 10 CFR 20. If the most conservative dilution factor[3] (340) were applied to this concentration for estimating the offsite exposure, the concentration would be half the allowable MPC.

To reduce the possibility of contamination of the building air, the reactor is equipped with a warning light that operates whenever the beam tube ventilation system fails. If such a failure occurs, the beam port will be kept closed until sufficient time has been allowed for the decay of the A^{41} to safe levels, after the reactor is shut down. An unusual event class of emergency may be called under the plan.

c. Loss of Reactor Ventilation over Pool

Failure of the special pool-top ventilating system should not be a health hazard. The two sources of airborne activity in this zone under normal conditions are water-dispersed activity released as the pool water evaporates, and radioactive gases dissolved in the pool which come out of solution. No emergency would be declared.

1 A dilution factor of 340 would be applied to the effluent from the stack under the most stable meteorological conditions at the site to estimate the exposure to the closest residents offsite. The average annual dilution factor is 8 x 10^4.

d. Loss of Reactor Fuel Cladding

A defective or damaged fuel element could be loaded into the core, or cladding could be corroded or eroded from an element during reactor operation. This would cause an increase in water activity by fission products ejected by recoil from the bare fuel alloy during reactor operation, and a relatively minor and slow additional increase in activity by fission products released as the fuel alloy corrodes. This activity, while still low, will be detected by regularly scheduled water sampling. In addition, there is continuous monitoring of the building air and of the exhaust from the stack. An unusual event class of emergency may be declared for such an event depending upon the severity of the leak.

e. Loss of Reactor Pool Water

Pool water can be lost accidentally through several channels with varying results:

1. Accidental Draining

The pool water can drain into the hold-up tank through a faulty valve, or through a valve accidentally left open. Since the core is normally cooled by water flowing into the hold-up tank by gravity, and the tank is normally one-third full of water, this will drop the pool water approximately 3.7 feet. This is not dangerous. If the reactor is operat- ing, it will be scrammed automatically when the water level drops. No emergency will be declared for this event.

2. Damaged Beam Tube

If an empty beam tube were sheared by a falling object, the water level could drop, possibly exposing the core, and resulting in high radiation levels inside the building. This accident can occur only with unplugged and unbolted cover plates, since a plugged and bolted tube can easily withstand pool water pressure, with some minor leakage occurring around the outer plug. To prevent this type of accident, the reactor is moved to the open end of the pool whenever the beam tubes are unplugged and unbolted. The reactor is not returned to the stall until the beam tubes are bolted.

If a beam tube should leak unnoticed, a six-inch drop in pool water level will actuate the pool water low-level alarm. It takes less than ten minutes to move the reactor to the open end of the pool and lower the gate, during which time the water level will drop a negligible amount. An unusual event class of emergency would be declared only if the water level were to drop within 10 feet of the top of the core.

3. Pumping

The water can be pumped from the hold-up tank, and therefore from the pool, into the storage tank. This cannot be done accidentally, since it requires that several valves and the pump be operated. An alarm will sound when the pool water drops six inches, and the reactor will shut down automatically if the level drops one foot. No emergency would be declared for this event.

f. Reactor Coolant System Failure

Power failure to the coolant pump will scram the reactor. Should water returning to the pool be accidentally shut off, water will flow from the pool into the hold-up tank for between five and ten minutes. This will cause the water level in the pool to drop. When it drops one foot, the reactor will shut down automatically. After the hold-up tank is full, the safety flapper will automatically open, allowing convection cooling and protecting the core from thermal damage. Low flow in the water exit line to the hold-up tank will cause the reactor to scram. This safety feature is independent of others discussed above. No emergency would be declared for this event.

g. Minor Power Excursions

The main hazard associated with a minor power excursion is the high instantaneous radiation level outside the biological shield. With a BORAX reactivity insertion of 1.2 percent $\Delta K/K$, the energy release was 19.5 MW-seconds[4]. The above excursion corresponds to an integrated dose of approximately 0.0001 mr at the outer surface of the stall shield which is negligible. The concrete stall shield is reinforced to withstand, conservatively, heating from continuous reactor operation at five times the maximum normal power level or 25 MW. Therefore, the concrete should withstand short radiation bursts having much higher intensities than this without cracking. No emergency would be declared for this event.

4 J. R. Dietrich, Experimental Investigation of the Self-Limitation of Power During Reactivity Transients in a Sub-Cooled Water-Moderated Reactor, AECD-3668, BORAX I Experiments, 1954.

h. <u>Explosions</u>

The reactor shield, hot cell, and filter room walls are extremely efficient explosion barriers. It is not credible that an explosion external to the shield could damage the core. An unusual event class of emergency would be declared in the event of an explosion in the reactor or hot laboratory until an assessment of damages and hazards could be made.

i. <u>Accidental Spill of Radioactive Material</u>

Operations with radiochemical products in liquid and gaseous form are common in the hot laboratory. It is credible that a container loaded with 10's or 100's of curies of a radioisotope could accidentally become separated from its shielding. If this were to occur in either the reactor or hot laboratory facility, the area monitors, which are placed to cover all areas routinely inhabited, would sound at least one local and remote alarm. This would warn people in the locale of the spill and they would vacate the immediate vicinity. Alarms would continue to sound until the source was removed or shielded. The radiation level at the monitor remote readout, either in the reactor control room or the hot lab operating area, would show the actual radiation dose at the locale of the exposed source. Corrective action could then be planned and implemented by the emergency crew. There would be time to gather shielding, remote handling tools, remote TV equipment, or whatever was necessary to correct the problem without exposing the workers. An unusual event class of emergency would be declared.

j. <u>Loss of Hot Cell Ventilation</u>

The probability of having airborne contamination in the hot cell exhaust ventilation is very high. It is imperative to maintain exhaust ventilation through proper filters, and also to keep the air pressure inside the cell at a lower level than the pressure outside of the cell. The loss of normal ventilation for any reason is sensed by a ΔP switch in the suction plenum of the main exhaust fan (EF12). If this pressure goes above -1" H_2O column, the exhaust vent load is automatically switched to a standby fan (EF12A). The standby fan will exhaust all cells and hoods until normal ventilation can be restored.

In the event both fans fail, another blower that is used for maintenance work will be put on the line when the cell pressure rises to -.1" W.G. This blower (1000 cfm capacity) is sufficient to maintain a slight negative pressure in the cells as long as all access ports are kept closed. The blower discharge is filtered through HEPA and charcoal filters. This blower can also be powered from a portable auxiliary generator. An unusual event class of emergency would be declared under the emergency plan for such an accident.

4. Maximum Startup Accident

In this accident, it is postulated that, due to circuit malfunctions, all control rods are withdrawn simultaneously with the reactor initially shut down at a very low (source) power level. It is further assumed that no rod inhibits are operative, and that at criticality the rods are in their most effective region (50 percent withdrawn). The total rod bank worth is taken at its upper range (11.6 percent ΔK). These assumptions maximize the accident.

This accident was analyzed in the original Final Hazards Safety Analysis, and has been updated with current values of reactor parameters in the current approved technical specifications. It is shown that even with a 200 percent scram trip level, the total energy of the excursion is only 15 MW-sec. or some 2 1/2 times less than the "Borax threshold." An additional analysis is then made of the self-limited excursion that would result if no safety system were present. The results of SPERT-I and SPERT-IV tests are utilized in this analysis. It is found that the self-shutdown characteristics of the core are such as to limit further the power and energy generated in the excursion. In particular, the all important parameter, fuel-plate surface temperature, for the reactor period corresponding to a 200 percent scram level, is shown to be several hundred degrees below the melting temperature. An emergency alert would be declared for this accident.

5. Credible Serious Accidents

Accidents which are credible and which could have serious implications include fuel element mishandling, improper fuel element loading, and experimental facility accidents.

a. Fuel Element Mishandling

Radiation hazards can result from faulty handling of irradiated fuel elements or experimental radioactive samples. The reactor fuel elements are the greatest potential hazard.

No danger of overexposure to personnel exists in the normal handling procedure, but it is conceivable that some malfunction of equipment would result in a fuel element being removed from all shielding, as in the following examples. The building crane will often be used to transport elements either across or along the length of the pool. This would be done by hanging the fuel element handling tool, with the element attached, from the lift hook of the crane. Operations involving the use of the building crane to move fuel elements underwater will be performed by persons manipulating the crane controls while standing on the reactor bridge or at the side of the pools. These positions place the crane operators not more than 90 feet from the crane disconnect switch. A fault in the crane control circuit during such an operation might cause the crane hook to rise to its maximum height of 22 feet above the water surface.

Because of the depth of the reactor pool, any fuel element handling tool used for work in the core would have to be a minimum of 25 feet long. Therefore, an element could be raised to within three feet of the pool water surface. An element removed from the core immediately after extended operation of the reactor at power would, under the above conditions, produce a radiation field at the water surface of less than 20 r/h. It would require about one minute for the element to be raised to this height. This would enable the crane operator to reach and throw the crane disconnect switch located on the wall by the west airlock chamber of the reactor building.

It is also conceivable that an element would be moved during a similar operation using a handling tool less than 25 feet long. In the event the crane controls malfunction, the building evacuation alarm would sound when exposed to a radiation field of 5 r/h. This corresponds to an element about 4.5 feet from the pool water surface. This would warn other people in the reactor building and hot laboratory to evacuate while the operator went to disconnect electrical power to the crane. (Operator has 12 additional seconds between time alarm sounds and element is exposed.) In the event that he failed to disconnect power to the crane and left the building instead, a freshly run element suspended in the center of the reactor building would create a radiation field of less than 160 r/h outside the building wall. If the operator fails to leave the building before the element is exposed, and he takes an additional minute to a tolerable radiation level zone, he would have absorbed less than 3 rads.

With the building emptied, time would be available to establish an exclusion area and to carefully plan procedures to be used in correcting the situation.

There does not exist the possibility of a similar accident occurring with lifting the entire pool bridge. Engagement of the core support bridge by the crane hook would not cause the sudden removal of part or all of the shim rods from the reactor core. The support bridge, the control rods, and the core are tied together as a unit and would move as such. Moreover, such a dislodging force would undoubtedly cause release of the shim rods during operation. Lifting of the bridge would not expose the core unless the crane hook engaged a lower portion of the reactor core support tower. This potential hazard is eliminated by clamping the bridge structure to the bridge rails.

If a fuel element, just removed from the core, were suspended above the pool, an alert class of emergency would be declared.

b. Fuel Element Loading Accidents

The possibilities of a loading accident are extremely remote. In order to evaluate the magnitude and probability of a loading accident, the technique employed during loading fuel must be considered, along with each of the four separate loading conditions.

The UCNR reactor has five shim safety rods with a total worth of approximately 10 percent $\Delta K/K$ and a regulating rod worth not more than 0.6 percent $\Delta K/K$. Whenever fuel is added to the core, it will be done with the shim rods fully inserted.

1. The First Loading Condition to be considered is the approach to criticality on a new core configuration. During such a loading, elements are added at the outer faces of those elements already in place. This is done with the shim rods fully inserted. After the addition of a maximum of two elements, the rods are withdrawn to check for criticality. If the core does not go critical, the sub-critical count rate is recorded and plotted on a graph of reciprocal count rate versus total mass of fuel in the core at the time of count. This aids in estimating the mass at which the core will achieve criticality. At completion of the count, the rods are reinserted and an additional one or two elements added. This process is repeated until criticality is attained. As the core size builds up, it is possible that two additional elements could be added to a core that is almost critical with rods fully withdrawn. The addition would, of course, be made with the rods fully inserted.

These two additional elements, when added to an outer face, would not add more than 5 percent ΔK/K. It would be extremely improbable that a loading accident would occur during the buildup of a new core because this would require the insertion of a minimum of four additional elements without a criticality check, to just compensate for the negative reactivity value of the inserted rods.

2. The Second Loading Condition to be considered is routine refueling at the end of a run without a change in core configuration. In reloading such a core, the shim rods will be fully inserted and elements from the core will be replaced with elements which have a mass within + 10 percent of the weight of the exchanged elements at the beginning of the previous cycle. Neither the core size nor the geometry would change for such a core. The largest loading error readily conceivable would involve a net increase of core which is mass by 10 percent or a maximum of 540 grams U-235 equivalent to a reactivity increase of 8 percent, which is approaching the negative-reactivity effect of the inserted shim rods.

   The total number of elements that can be changed without a criticality check is therefore limited to 15, or roughly half the core. This restricts the possible reactivity increase to a safe value of about 4 percent.

(3) The Third Loading Condition to be considered is the replacement of sufficient elements to allow a restart after the reactor has been "caught" by xenon. This, at its worst, would involve a loading error of less magnitude than that listed in (2) above since that case considers a change of all elements, a case which would not occur during a xenon reload. Again, restricting the number of elements to 15 (before a criticality check need be made), reduces the reactivity change to a safe value.

(4) The Fourth Loading Condition involves the placing of an element into a central core position. This operation would be required for removal of a central flux trap. The procedure for loading a central element into such a core is to remove a minimum of six outside elements for each central element to be inserted. After addition of the central

element, a criticality check is made to determine how many of the removed elements are to be returned to the outer faces of the core. These elements are then reloaded as described for the first loading condition.

An operational misjudgment could allow the loading of the central element without first removing elements from the outer face of the core. The worth of a new fuel element when inserted into the center of a core could be as much as 6 percent $\Delta K/K$. As this is a large fraction of the total worth of the inserted control rods, the removal of enough outer elements to approximately total 6 percent $\Delta K/K$ is desirable. A total of six elements would be adequate.

If any of the above accidents were to occur, it is doubtful that core damage would occur to the extent that fuel cladding could be breached. However, an emergency alert would be declared under the plan.

c. Experimental Facility Accidents

Fast reactivity steps are considered to furnish the most credible serious accidents. For these reactivity steps to achieve such effects, they must take place in less than 50 milliseconds. Reactivity changes that require longer periods than the response time of the safety system require coincident failure of the safety system to achieve serious consequences.

Reactor power response to various reactivity transients is given in Appendix 2, Sect. B of the R-81 SAR. The reactivity worth of experiments and experiment facilities (beam tubes) is limited, either by Technical Specifications or by design, to safe values. Misjudgment of reactivity worth could cause unanticipated transients similar to fuel loading mistakes. If an excursion were to occur an emergency alert would be declared under the plan.

d. Release of a Fission Product Dissolver Batch in Mo-99 Separation Process.

The maximum credible accidents in the Mo-99 production process is assumed to be the result of leakage from the target can during dissolution. At that time the fission products are in solution under ~ 100 psig pressure. As a result of this leakage it is assumed the following activities are released into the hot cell exhaust system:

(a) all of the fission product iodine in the form of a vapor.

(b) all of the noble gases.

(c) all of the fission product solution in the form of a fine spray which results in the formation of five cubic meters of a fog-like aerosol.

Under these assumptions the maximum credible accident could result in a release of radioactivity which, when averaged over one week, would represent the following percentages of our off-site MPC.

	Per Cent of Wks. MPC
Fission Product Iodine	31
Noble Gases	17
Fission Product Aerosol	84
TOTAL Release	132

This represents 1.32 weeks release at the maximum permissible rate. It represents a maximum release since we have assumed iodine collection efficiencies which will only exist at the end of the useful life of a filter.

The collection efficiencies of all carbon filters will be determined routinely by our Health Physics Department. Filters will be replaced when the effective iodine collection efficiency of the system falls below that claimed in the hazards analysis (99.5 percent)

An unusual event class of emergency would be declared under the plan if the released activity were more than the above anticipated amount as indicated by monitoring equipment.

e. Release of Mixed Fission Product Particulate from Uranium Waste Form Process

As discussed in the license hazards summary, a loss of temperature control during the heat treatment step would result in uncontrolled decomposition of uranyl acetate with subsequent discharge of some portion of the dry uranium as a cloud of dust. Such a batch could contain up to 200 gms of irradiated U-235 with a significant fraction of the fission product inventory.

Even though the risk is low, it is postulated that a complete failure of all control devices would lead to a condition that would be considered the maximum credible accident because of the resulting dust cloud.

This accident will be defined as the release of the entire contents of an aluminum waste container into the cell as a cloud of dust since all of the volatile fission products are removed prior to this step. It is assumed that the process solutions are at least 10 days old.

The entire mixed fission product inventory to be expected from one FP-Mo-99 target capsule after 10 days decay and two cycle irradiation (320 hrs.) is 829 Cis assuming a production yield of 300 Cis of Mo-99 per can at reactor out-time. As previously discussed, the volatile fission products are effectively removed early in the process, reducing this inventory by 164 Cis. Removal of the Mo-99 and its daughter Tc-99m effects a further reduction of 48 Cis. The barium sulfate precipitate entrains or co-precipitates at least 60 percent of the remaining activity causing a final reduction of 370 Cis, resulting in a net fission product inventory of approximately 247 Cis per target at the time of processing. This figure is conservative since it is based on an average irradiation time of 320 hours, and a decay of 10 days. Our current production scheduling allows an average actual irradiation period of only 210 hours. The minimum decay period is 10 days prior to processing, while the average is at least 12 days. For this calculation, we will assume that for a 10 target run there will be 2470 Cis present.

Since this operation will be conducted within the cell bank, in the event that all of this material were dispersed in the form of dust, it would pass through two banks of HEPA filters and activated charcoal. Each bank of filters is claimed as 99.97 percent effective to particles larger than 0.3 μ. Even if all the 2470 Cis of radioactive fission products were to reach the filter bank (i.e., none of this material settles out before reaching the filters), the maximum activity released to the atmosphere from the series filters would be 2.22×10^2 μCi.

Released To Filter 2

$2470 \times 3 \times 10^{-4} \times 10^{6} = 7.41 \times 10^{5}\ \mu Ci$

Released To The Atmosphere

$7.41 \times 10^{5} \times 3 \times 10^{-4} = 2.22 \times 10^{2}\ \mu Ci$

Using an environmental MPC of $1.33 \times 10^{-9}\ \mu Ci/cc$ for 10 day old fission products in air, no dilution factor, and a flow rate of 50,000 cfm for air exhausted from the facility, a release of $2.22 \times 10^{2}\ \mu Ci$ would amount to 8.2×10^{-2} MPC days/incident.

An unusual event emergency would be declared for this incident under the emergency plan if the stack monitoring equipment indicated a release higher than this anticipated amount.

f. Fire in Hot Cell

There is a significant inventory of radioactive material in the cell bank and on the filters of the exhaust ventilation system that is a cause of concern in the event of a fire inside the cells. A primary precaution against such an occurrence is an established policy and standing procedures to keep the amount of combustible material placed into the cell at a minimum. Without sufficient fuel, combustion will not be sustained.

In the unlikely event a fire were started, contaminated smoke would be filtered by two stages of HEPA filters. The first roughing and HEPA filters are located at least 35' downstream, through the 24" exhaust duct, from the nearest source of combustion in the cell bank. The filters and housing are noncombustible and would arrest cinders or flaming material that would reach this point.

The hot cell filter bank is also equipped with high temperature alarms to indicate a potential fire problem in the bank. A second high temperature alarm will automatically shut down the exhaust vent system, close the inlet and outlet dampers on the cell filter bank and activate a CO_2 flooding system to the filter bank. It is not credible that a fire in the cell could cause damage to the exhaust filter and cause a release of radioactivity to off-site areas.

An emergency alert would be declared under the plan if a fire were to start in a hot cell.

(g) <u>Criticality Incident In The Hot Laboratory</u>.

Enriched U-235 solutions (350 g/l, 1 liter/batch or 5 g/l, ~ 16 liters/batch) are processed in the second level plating labs of the Hot Laboratory. Administrative and process controls are established to keep individual plating batches of material at 1/2 the single-parameter mass limit for solutions. Vessels that contain plating solution batches are of limited size. Accidental criticality is not likely to occur but, since the total quantity possessed in the entire Hot Laboratory exceeds the single-parameter limit, it is postulated that enough material could be brought together to cause a criticality incident. The plating labs are the only areas where solutions of uranium (other than assay samples) are handled and it is the most likely location for an accidental excursion to occur.

Regulatory Guide 3.34 states that the magnitude of accidental criticality incidents ranged from 10^{15} to 10^{20} fissions depending upon the circumstances involved in each. The median magnitude was 10^{17}. The regulatory position states that a criticality event may be assumed as follows:

1. An initial excursion of 1×10^{18} fissions of 1/2 second duration.

2. 47 subsequent excursions of 1.9×10^{17} fissions at 10 minute intervals continuing for 8 hours.

3. 1×10^{19} total fissions over the course of the entire event.

A less conservative assumption may be made if it can be rationalized when considering the particular plant and process conditions.

The solutions of uranium that are processed under SNM-639 are of limited quantity and they are contained in open vessels of limited size. The initial excursion of 1×10^{18} fissions in 1/2 second will yield 64 MW of energy. This is enough energy to evaporate most of the largest volume of solution (16 L) that is routinely in use. It is assumed that the initial burst will be the only excursion possible. The instantaneous evaporation or expulsion of the uranium solution out of its container will rendered the system subcritical.

The fission products are dispersed throughout the upper level of the Hot Laboratory and they mix with the air in the building. Most will be exhausted through the hoods in the plating lab and pass through two stages of HEPA filters. All of the air will pass through the main filter bank and will be filtered at least once through HEPA filters before it goes to the stack.

The following assumptions are made to assess exposures as a result of the above described accident:

a. The least favorable atmospheric condition exists. (Wind speed, 1 m/sec.; sigma theta, 2.5°; wind direction toward the closest offsite resident (and road).)
b. Dispersion factor based on measurement data.
c. The main exhaust fan operates at normal capacity and the mean residence time of air in the building is 12.5 minutes.
d. The plume transit time to the site boundary (275 meters) is 4.6 minutes.
e. No credit is taken for iodine plate-out or holdup on building surfaces, filters, or ducts.
f. MPC's for isotopes not listed in Part 20 are estimated based on relative whole body exposure hazard from gamma (relative to the most conservative limit for other similar gaseous isotopes that are listed).

The resultant offsite exposure from this postulated criticality is estimated[1] to be as follows:

1.	Prompt gamma dose outside building	= 1.45 rem
2.	Prompt gamma dose at closest point to building along road	= .02 rem
3.	Prompt neutron dose outside building	= 1.4 rem
4.	Prompt neutron dose at closest point to building along road	= .02 rem
5.	Projected airborne release to the nearest point on site boundary (closest point of approach on road)	= 23 weeks MPC

It should be noted here that if the average measured dispersion factor for the site were applied in this postulated accident, the projected airborne release would amount to 1.07 weeks MPC.

A criticality accident occurring inside the hot cell bank has been analyzed and found to be insignificant by comparison because of the additional shielding and exhaust filtration available in the cell bank.

If an accidental criticality occurred, an alert emergency status would be declared under the plan.

1 Reg. Guide 3.34, p. 5, Sec. 3