ENVIRONMENTAL IMPACT ASSESSMENT

UNION CARBIDE RESEARCH REACTOR (UCNR)

INTRODUCTION

The Union Carbide Research Reactor (UCNR) is a 5-megawatt swimming-pool-type reactor located on an industrial site in the sparsely-settled Sterling Forest development region of Orange County, New York State. The UCNR began operation in September 1961 (first criticality) and has been operating on varying but regular schedules ever since. Current operation is around the clock with a duty cycle of about 97%. The reactor is used principally as a source of neutrons for activating target materials used in producing radioisotopes for medical applications.

This Assessment addresses the possible environmental impacts of continued operation of the reactor in the next 20-year period. The effects of normal operation are treated first, followed by abnormal operation, and concluding with alternatives to continued operation.

ENVIRONMENTAL EFFECTS OF OPERATION

1. Direct Radiation

   Within the reactor restricted area, all zones in which nuclear radiation exists are posted and classified in accordance with 10CFR Part 20 regulations. These zones are surveyed regularly. The nearest reactor Radiation Zone (≥ 2 mR/hr) is about 110 meters from the unrestricted area (public highway). The external radiation dose rate from the reactor at this area is completely negligible.

2. Gaseous Effluents

   a. Wet steam:

      A forced-draft cooling tower in a secondary (non-radioactive) cooling loop is used to dissipate the 5 megawatts of thermal energy generated by the reactor. Approximately 2000 gallons of water per hour is evaporated and discharged to the atmosphere. No adverse effects from this discharge have ever been observed nor are they expected. Whenever fogging from this source has occurred, it has been confined to the cooling tower locality within the site boundary.

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b. Airborne radioactivity:

The principal gaseous radioactive effluent from the reactor is argon-41 formed through neutron-activation of air. Minor amounts of other species may also be formed, but in amounts much less than for argon. The impact of argon-41 in the unrestricted area has been analyzed in the Safety Analysis Report (Reference a, Appendix 2, Section C1). For 5-MW operation at 100% duty cycle, the yearly-averaged dose rate at the site boundary is estimated as 0.4 mR per year, an amount much less than natural background. An estimate of the 50-mile radius population dose from argon-41 (1200 curies/year) utilizing EPA methodology (References b, c) gives a total of only 1.2 man-rem per year. The small magnitude of the environmental impact of airborne radionuclides is confirmed by the results of local environmental monitoring. These results are several orders of magnitude below Part 20 standards for unrestricted areas.

3. Liquid Effluents

a. Radioactive liquids

All aqueous radioactive liquids generated in the reactor are collected and treated by distillation. Included in liquid waste is that from the occasional regeneration of ion exchange resins used for reactor primary water cleanup. The clean distillate (water) is sampled and tested for freedom from radioactive content before discharge to the plant drainage system. The concentrated bottoms containing the radioactive material are solidified and treated as solid waste (see below).

b. Process water

The principal waste water (non-radioactive) effluent is that from cooling-tower blow-down, to remove dissolved salts that would otherwise accumulate as the water is evaporated. This effluent consists of about 40 gallons of water per hour containing a small amount of an EPA-approved additive to retard precipitation. This is discharged into the plant storm sewer that flows into Indian Kill lake. No adverse impact has been observed for this small addition of waste water. This discharge is approved under a N.Y. State Department of Environmental Conservation permit.

c. Sanitary:

The reactor staff (operations and administration) numbers only 30 people out of a total site population of 266. The contribution of reactor and related personnel to this effluent load is only about 10-20%.

4. Solid Wastes

a. Radioactive:

The principal sources of solid, or solidified, radioactive wastes are evaporator bottoms from liquid waste, including liquid waste from regeneration of resins (see above), and spent resins. Included also are other miscellaneous materials incident to the operation of the reactor, for example, sample holders, gloves, and paper. All such material is packaged in accordance with federal regulations and shipped to a licensed burial ground. No disposal of solid waste is permitted on site.

5. Transportation

a. Radioactive waste material:

Solid wastes from reactor operations require about two 55-gallon drums to be shipped to a burial ground each month. Such shipments are made in accordance with appropriate federal regulations.

b. Spent fuel:

At a power level of 5 megawatts and 100% duty cycle, a total of about 36 fuel elements of all types would become spent each year. It can be expected that at intervals of about two years, a series of spent fuel shipments would be made to the Savannah River reprocessing facility. Three shipments, each comprising about 24 elements, would be made over a 2-3 week period. Such shipments are made in a specially-licensed fuel cask and in accordance with DOT and NRC regulations. The precautions taken are such that the environmental impact of such shipments is negligible.

c. Reactor operating personnel:

The number of such people is a small fraction of the total plant staff, many of which are engaged in other activities. The impact of reactor personnel on transportation and access routes is minimal.

6. Abnormal Operations

In Appendix 2, Section C2 of the Safety Analysis Report (SAR), a Design Basis Accident (DBA) is postulated. This accident is one with postulated consequences in excess of any considered credible. The results of the DBA are given in the SAR. The dose results at the boundary of the exclusion area and low population zone are much less than the guidelines of 10CFR Part 100. Specifically, the 2-hour doses are only 1-3% of the Part 100 standards.

7. Non-renewable Resources

The principal non-renewable resource consumed through reactor operation is the uranium-235 contained in the fuel elements. This consumption rate is 2.2 kg per year.

8. Alternatives for Operation

The most important and beneficial result of continued operation of the reactor is to provide irradiated targets from which are extracted the most frequently and widely-used radioisotopes in nuclear medicine. Examples of these are $^{99}Mo/^{99m}Tc$, ^{133}Xe, ^{131}I, ^{125}I. This reactor is the only commercial domestic supplier of the first three of these in the high specific activity grade required.

a. Irradiation of targets might be done in other reactors. There is no domestic commercial reactor available to do this. One government-owned reactor at Oak Ridge National Laboratory does have the capability of providing the required irradiation service. There would be potential environmental impacts involved in the shipment of enriched uranium targets to Oak Ridge and of highly-radioactive irradiated targets back to Sterling Forest for processing. Reliability of radioisotope supply to the medical community would be reduced somewhat, due to the additional transportation steps.

b. Semi-processed radioisotopes might be obtainable from other suppliers and final purification done at Sterling Forest. There is no domestic supplier at present that could fulfil these needs. Unless one could be developed, which would probably involve a government-owned reactor and isotope-processing facility, the supply would have to be imported from foreign sources. It is by no means certain that a foreign supplier would be willing or able to do this.

c. Finished radioisotopes might be obtained by present users (radiopharmaceutical manufacturers, nuclear pharmacies, hospitals, etc.) directly from suppliers of the purified radioisotopes. Again, no domestic supplier exists, but would have to be developed probably at a government-owned facility. Otherwise, all supplies would have to come from foreign sources. Total dependence on the latter could have adverse environmental impacts in the domestic medical and health care field.

d. Each of the above alternatives would also require the decommissioning of the reactor. The cost of decommissioning is estimated elsewhere in this renewal application. There are also potential environmental impacts related to the dismantling, shipment, and burial of the radioactive components and the decontamination of the immediate site.

9. References

a. Safety Analysis Report, Union Carbide Research Reactor (UCNR), May 1980.

b. J. A. Martin, Jr., et al, "A Computer Program for Calculating Doses, Population Doses, and Ground Depositions due to Atmospheric Emissions of Radionuclides", U.S. Environmental Protection Agency, EPA-520/1-74-004 (May 1974).

c. Holzworth, George C., "Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution throughout the Contiguous United States", U.S. Environmental Protection Agency, Office of Air Programs, Report AP-101 (Jan. 1972).

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UNIVERSITY OF WISCONSIN NUCLEAR REACTOR EMERGENCY PLAN

Introduction: This emergency plan outlines essential items of the plan for protecting health and safety and minimizing damage under emergency situations. Emergency procedures are established to indicate action levels, personnel responsibilities, and appropriate responses to emergency conditions.

1. Organization

The reactor operating staff also constitutes the on-site emergency organization. The Reactor Supervisor is responsible for coping with emergency situations. In his absence, the most senior staff member present has both the responsibility and the authority to take emergency actions.

The established system of review and approval of procedures (UWNR 001 and 005) will ensure that the emergency plan and procedures are reviewed at least annually. The operator proficiency maintenance program (UWNR 004) assures that personnel will remain informed of current status of the plan and procedures, and that proficiency is tested through oral and written examinations, and that periodic drills are held for on-site personnel (UWNR 100).

2. Coordination With Other Authorities

The University has provided the Department of Protection and Security and the Safety Department, and the normal duties of these departments provide backup to the UWNR emergency organization without need for specific response agreements.

The University Department of Protection and Security provides law enforcement, plant security, traffic control, access control, and radio communications with other police agencies and the Fire Department.

The University Safety Department provides assistance in radiological control, health physics services, and fire protection.

The Madison Fire Department provides fire fighting and ambulance service in accordance with city ordinance and Fire Department Rules. (See appendix.) A written response agreement with University Hospitals for treatment of injuries and other medical problems, including injuries which involve radioactive materials or radiation exposure, is in force. (See appendix.)

Backup support for all of these services, making the resources of the State of Wisconsin available without specific response agreements, are available through the State of Wisconsin Division of Emergency Government (24 hour phone--266-3232). See appendix for copy of circular.)

3. Types of Emergencies

The following emergency procedures are in effect:

UWNR 150	Reactor Accident Fission Product Release or Major Spill of Radioactive Materials
UWNR 151	Leak Resulting in Draining of Pool
UWNR 152	Suspected Fission Product Leak
UWNR 153	Threat to Security of Reactor Laboratory
UWNR 157	Fire, Radioactive Material Spills, Radioactive Dust, Fumes, and Gases; Personnel Injuries Involving Radioactivity, Personnel Overexposures

Accidents postulated in the SAR (Ch 6) are briefly described here in the context of the emergency plan requirements and emergency procedures.

a. Production and Release of Gaseous Radioactivity

As explained in SAR (Ch 6), the maximum ^{41}Ar release rate would correspond to a personnel exposure of about 3×10^{-8} µCi/ml. This level does not constitute an emergency.

b. Spillage of Radioactive Material

The induced radioactivity of volatile or powdered samples is limited (SAR CH 6) so that if the contents of the sample are "dispersed in the air within the Reactor Laboratory, the concentration discharged through the stack, when averaged over one week, will be within the maximum concentration of 10 CFR Part 20." Samples approaching this activity must have special approval before irradiation. "These approvals will consider all other activity discharged, and will insure that the total stack discharge lies within permissible limits should the sample rupture." This type of accident should it nevertheless occur, would be annunciated by the remote area radiation monitoring system, or the installed air activity monitor, and emergency response is indicated in UWNR 150.

c. Reactivity Accident

The most severe postulated reactivity accident is a transient rod ejection while at maximum steady state power. The analysis shows that no fuel damage or radioactivity release results from this accident, therefore, this accident does not constitute an emergency.

d. Fuel Element Cladding Failure

The SAR (Ch 6) analyzes exposures to personnel in the Reactor Laboratory and in unrestricted areas following a fuel element cladding failure. The analysis shows that Reactor Lab personnel could receive a thyroid dose due to Iodine as high as 18.9 rad, although actual dose is expected to be a factor of 10 less than this. The analysis also shows that for zero discharge stack height, and no area evacuation, the dose in unrestricted areas, averaged over one year, is 0.635 MPC.

Emergency response is indicated in UWNR 152.

e. Loss of Pool Water

As described in SAR (Ch 6), this accident does not result in fuel damage or radioactivity release, whether or not action is taken to correct the problem and restore water to the Reactor pool. Direct radiation could, in the worst case, result in unacceptable dose rates in some unrestricted areas. Procedure UWNR 151 advises action levels and emergency responses to this accident.

f. Threat to Laboratory Security

Although not considered in the SAR, the eventuality of a threat to the physical security of the Reactor Laboratory could have possible radiological consequences to the public, and procedure UWNR 153 treats this threat.

g. Other Emergencies, Including Fires, Spills, Overexposure and Personnel Injuries Involving Radioactivity

University Radiation Safety Regulations include emergency procedures for a number of situations which are not specifically reactor associated. These procedures are integrated into the UWNR procedure series of follow-up actions to UWNR 157.

4. Instrumentation and Special Equipment

The referenced emergency procedures make reference to equipment and instruments which indicate the presence of emergency conditions or are needed in carrying out the emergency procedure. All those items which are components of the reactor instrumentation system are maintained, checked, and tested in accordance with technical specifications and normal operating procedures UWNR 100-129 and 160-180. Health physics instruments are checked and calibrated periodically as provided by UWNR 100. Equipment is located in appropriate areas for emergency use, and survey equipment, signs, and decontamination supplies for emergency use only are located in the Reactor Supervisor's office and through the University Safety Department.

No provision is made for emergency power sources, since implementing procedures do not require emergency power.

5. Action Levels

Emergency procedures indicate action levels, limits, and alarm points as appropriate.

None of the emergencies considered has any significant effect on persons outside the area controlled by the University, so that action levels for requesting aid from off-site personnel are not specifically stated. Should the operating staff, the Safety Department, or Protection and Security determine that outside aid is needed, each group may request aid without further approval from higher authority.

6. Emergency Communications

Primary communication means considered in emergency procedures are commercial telephone system (2 lines) and the laboratory intercommunication system. Several important alarms (high radiation level, low pool water level, fire, and intrusion alarms) annunciate at the Dispatcher's location at Protection and Security Headquarters. The Dispatcher's location is the emergency control center, and this location has radio contact as well as telephone communications. These systems are in normal day-to-day use by the University Police service which provides adequate testing of the communications systems. The alarms from the Reactor Laboratory to Protection and Security Headquarters are periodically tested in accordance with existing UWNR operating procedures.

7. Protective Measures

Evacuation of affected areas is covered in procedures UWNR 150. No evacuation of personnel outside the area controlled by the University is considered necessary even for the most severe accident considered.

8. Medical Assistance

Rudimentary capabilities for emergency first aid treatment, personnel monitoring, and personnel decontamination are provided in the basement hallway west of the Reactor Laboratory. In addition, a written agreement with University Hospitals (see appendix) provides for emergency room and other hospitalization and medical services as needed.

9. Public Information

The University News Service is the authorized release agent for University news, and would also be the release agency for public information following an emergency. (See appendix for letter indicating this service is available.)

10. Re-entry Planning

Appendix A of UWNR 150 provides for re-entry into the area after evacuation, while an emergency dose limit of 25 Rem for a rescue in a life-or-death situation is established in UWNR 157 (based on University Radiation Safety Regulations). The decision for re-entry is delegated to the Reactor Director or the Reactor Supervisor.

11. Training

The Operator Proficiency Maintenance Program (UWNR 004) includes training of personnel for participation in the Emergency Plan. Emergency procedure drills are held twice each year, and oral and written examinations also include questions to assure adequate knowledge of emergency procedure. In addition, this retraining program covers subjects such as fire fighting equipment, decontamination, use of respiratory protective equipment, and first aid subjects on a periodic basis.

The periodic emergency procedure drills are specifically required by UWNR 100 as well as by UWNR 004. A practice evacuation of the affected portions of the Mechanical Engineering Building is held in conjunction with the drills at least once per year. Each emergency procedure drill ends with a critique period in which adequacy of the procedures, equipment, and personnel are considered, and which leads to correction of any weakness revealed.