ENVIRONMENTAL IMPACT REPORT

University of Texas

TRIGA MARK I

Nuclear Reactor

March 1981

ENVIRONMENTAL IMPACT REPORT

This report deals with the environmental effects which can be contributed to the operation of the UT TRIGA research reactor since its initial loading on August 2, 1963.

A. Facility, Environmental Effects of Construction

UT's nuclear reactor is housed in an engineering building which is centrally located on the University of Texas at Austin campus. Since the reactor was installed in an existing building there was no significant affect on the terrain, vegetation, wildlife, or nearby waters due to the installation of the facility.

There are no exterior conduits, pipelines, electrical or mechanical structures or transmission lines attached to the reactor facility other than utility service facilities which are similar to those required by other campus facilities, especially laboratories. Utility connections to the laboratory consist of high pressure air, water, steam, chilled water, sanitary sewer, electrical power and communication lines.

The reactor tank cooling system consists of a chilled water heat exchanger and an auxiliary 5 ton chiller located outside the facility exterior wall. Heat rejection by the primary heat exchanger cooling system is an integral part of the University chilled water system while the 5 ton auxiliary cooling system does not represent a significant heat rejection source. Makeup water for the reactor tank is provided by deionized tap water which replaces water loss from evaporation. Radioactive gas effluents are limited to argon-41 whose release is controlled by restricted leakage from the facility, exhaust stack height and exhaust rate. There are no radioactive liquid effluents associated with the operation of the UT TRIGA, but both solid and liquid radioactive wastes are generated through the irradiation of samples to be used on campus either for neutron activation analysis or radioisotopic tracer analysis. These radioactive samples are gathered, packaged and shipped off site for storage at an approved site by the campus Radiation Safety Officer. The transportation of this waste is done in accordance with existing NRC-DOT regulations in approved shipping containers.

The sanitary waste system associated with the reactor laboratory facility is similar to those at other laboratories. Controlled releases of small amounts of liquid radioactive materials to the sanitary system are monitored by the Radiation Safety Officer.

B. Environmental Effects of Facility Operation

The UT TRIGA nuclear reactor has a maximum power output of 250 kW(thermal) in the steady-state mode. Pulse mode operation represents an insignificant quantity of additional heat to the steady-state operation. Environmental effects of thermal effluents of this order of magnitude are negligible. The waste heat is rejected as either a small source from the auxiliary system or as a small component of the University primary cooling system. In either case the rejected heat represents only a small fraction of the effect generated by the University campus cooling system.

Radioactivity of reactor tank water is routinely monitored in the purification loop by a GM monitor and periodic samples for β activity are taken of the pool water. These measurements combined with water conductivity aide in the initial detection of fuel element failure and the degradation of the tank water deionizing system. Proper operation of the water deionizing system controls the water radioactivity hazard to laboratory personnel. Since the only loss mechanism for reactor tank water to the environment is through evaporation, the major potential radioactive effluent to the environment would be tritium. Calculations of the tritium generated from deuterium in the reactor pool water indicate that approximately 400 μCi would be produced annually by 40 hour week, full power operation. Instantaneous release of one third of the total amount to the reactor room atmosphere would not exceed allowable effluent releases to the environment. Actual release rates are substantially less. Measurements at other similar facilities indicate that the annual tritium release by evaporation is orders of magnitude less than the allowable effluent concentration of 2×10^{-7} $\mu Ci/cm^3$.

Air in the room containing the reactor is continuously monitored for radioactive particulates. The particulate monitor is a continuous air monitor which samples air as it is recirculated in the room. Dust particles are trapped on a filter which is held in front of an end window Geiger-Mueller tube. The alarm set point of the air particulate monitor is 5,000 cpm. A 5,000 cpm increase during one hour corresponds to an air concentration of long lived isotopes of approximately 10^{-8} $\mu Ci/cm^3$. Typical background readings range from 100 to 1000 cpm with the variation attributed to atmospheric changes in radon and thoron gas concentrations.

Leakage or exhaust of air from the facility is controlled during operation to limit the release rate of argon-41 produced by the reactor operation.

The argon-41 is generated in air that is in the region of the reactor core and is released from the pool water and experimental facilities. Measurements have shown that argon-41 releases in the reactor facility are, at saturated conditions, about equal to the allowable concentrations for unrestricted areas, 4×10^{-8} $\mu Ci/cm^3$. Therefore, actual releases to the environment by leakage, would be considerably less than allowable limits when averaged over the facility operation time. Exhausted air from a stack would increase the released amount but dilution effects at the stack height assure that allowable concentrations averaged over the annual operation are substantially below allowable concentrations. Conservative calculations support these conclusions for an assumed annual operation of 520 Mw-hrs.

Film badge dosimeters have been used to monitor radiation levels at various laboratory locations after the reactor began 250 kW operation in April 2, 1968. Measurements of the gamma radiation doses are tabulated in Table I. GM gamma ray detectors supplement film badge monitors with continuous monitoring of various laboratory areas. Typical radiation levels in specific laboratory areas range from .01 mr/hr to 1 mr/hr, without the reactor operating and increase to .1 mr/hr to 2 mr/hr with the reactor at full power. Alarms are set at 5 mr/hr. Measurements outside exterior walls and doors indicate radiation levels of .05 mr/hr with the reactor operating at full power. Periodic area radiation surveys around the facility are conducted by the Radiation Safety Officer. No excessive radiation levels have been observed.

Environmental measurements of both surface runoff water and air are available. Samples of the local creek water are obtained by the Radiation

TABLE I

Laboratory Area Film Badge Doses

YEAR	NORTH[1]	SOUTH[2]	CEILING[3]
1963	20	30	50
1964	55	100	50
1965	0	15	0
1966	15	0	0
1967	30	0	0
1968	680	560	890
1969	830	130	810
1970	13910	790	3460
1971	4190	620	3740
1972	3060	180	2280
1973	2690	610	1490
1974	710	M	720
1975	650	M	630
1976	570	M	390
1977	250	M	210
1978	280	400	460
1979	180	1990	2200
1980	650	460	420

[1]Located near heat exchanger and reactor console.

[2]Located near deionizer on pneumatic transfer system.

[3]Located above reactor pool (~16 ft.).

Safety Officer to determine gross beta activity on a routine basis. Typical values are in the tens of pCi/ℓ range. Air activity samples are sporadically collected by the State Health Department Radiation Division at various locations in the city. Activities of collection filters after several hours decay indicate activity levels of 1 to 10 pCi/m^3. Allowable releases by the University of up to one curie to the sanitary sewer system are generally less than one fourth the state licensed amount. Dilution with 2.4×10^9 liters of water yields activities of 2.75×10^{-10} Ci/ℓ for .25 curie annual releases. The reactor facility represents a small to negligible amount of this liquid effluent release.

Other radioactive low level wastes are generated by reactor operation as routine products of neutron activation analysis measurements. The main constituents of these wastes are short lived isotopes such as Na^{24}, Mg^{27}, Al^{28}, Cl^{38}, Cr^{51}, Mn^{56}, Ni^{65}, As^{76}, Ag^{108}, I^{128}, W^{187}, and Au^{198} plus a few longer lived products such as Co^{60}. These isotopes are shipped to authorized disposal sites in approved containers. The annual quantity disposed of consists of approximately .5 m^3 which includes samples, containers, gloves, paper, and deionizer resin. The total University waste disposal is typically 28 to 34 m^3/yr.

Storage, reprocessing, or disposal of spent fuel elements is not a major concern at the UT TRIGA reactor because the typical U^{235} burnup is less than one percent of the total core excess reactivity.

C. Environmental Effects of Accidents

Accidents ranging from failure of experiments to the largest core damage and fission product release considered possible result in doses of only a small fraction of 10 CFR Part 100 guidelines and are considered negligible with respect to the environment.

D. Unavoidable Effects of Facility Construction and Operation

The unavoidable effects of construction and operation involves the materials used in construction that cannot be recovered and the fissionable material used in the reactor. No adverse impact on the environment is expected from either of the unavoidable effects.

E. Alternatives to Construction and Operation of the Facility

There are no suitable or more economical alternatives which can accomplish both the educational and the research objectives of this facility. These objectives include the training of students in the operation of nuclear reactors, the production of radioisotopes, its use as a source of neutrons for neutron activation analysis, and also its use as a demonstration tool to familiarize the general public with nuclear reactor operations.

F. Long-Term Effects of Facility Construction and Operation

The long-term effects of a research facility such as the UT Nuclear Engineering Teaching Laboratory are considered to be beneficial as a result of the contribution to scientific knowledge and training. This is especially true in view of the relatively low capital costs involved and the minimal impact on the environment associated with a facility such as the UT Nuclear Engineering Teaching Laboratory.

G. Costs and Benefits of Facility and Alternatives

The cost for a facility such as the UT Nuclear Engineering Teaching Laboratory is on the order of $1 million with very little environmental impact. The benefits include, but are not limited to: training of operating personnel, conduction of activation analyses, production of short-lived radioisotopes, and education of students and public. Some of these activities could be conducted using particle accelerators or radioactive sources, but these alternatives are at once more costly and less efficient. There is no reasonable alternative to a nuclear research reactor of the type presently used at the UT Nuclear Engineering Teaching Laboratory for conducting the broad spectrum of activities previously mentioned.