DEFENSE NUCLEAR AGENCY
ARMED FORCES RADIOBIOLOGY RESEARCH INSTITUTE
BETHESDA, MARYLAND 20014

DIR

SEP 26 1980

Director
Division of Reactor Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Sir:

The enclosed Environmental Impact Appraisal Data is submitted in accordance with 10 CFR Par 50.51 for USNRC Research Reactor License No. R-84, Docket No. 50-170. This information incorporates all known environmental aspects related to our facility and is submitted in accordance with USNRC guidance for licensing renewal.

Sincerely,

Paul E Tyler

PAUL E. TYLER
Captain, MC, USN
Director

1 Enclosure
as stated

8009290 359 P

ARMED FORCES RADIOBIOLOGY

RESEARCH INSTITUTE

TRIGA MARK-F REACTOR

ENVIRONMENTAL IMPACT APPRAISAL DATA

I. INTRODUCTION

This document is provided as information, reference 10 CFR Part 51.50(c)(3). The data herein deals with those features and operating characteristics of the Armed Forces Radiobiology Research Institute (AFRRI) TRIGA Mark F Research Reactor as related to the local environment. The AFRRI TRIGA Mark F reactor is used for biomedical research, irradiations of electrical components and radioisotope production in support of the Institute's radiobiology research mission. Operation of the facility will generally not exceed a five (5) day week, eight (8) hour day and most operations will occur during daylight hours. The AFRRI reactor will normally operate at steady state power levels not to exceed 1 MW (thermal) and in a pulsing mode with step reactivity insertions up to a maximum of 2.8% $\Delta K/K$.

II. SITE

AFRRI, and the AFRRI TRIGA reactor is located within the confines of the National Naval Medical Center (NNMC), Bethesda, Maryland, which in turn is located approximately three miles north of Washington, D.C. The NNMC is located within an approximate area that is bounded on the north by the Beltway (I-495), on the east by Connecticut Avenue, on the south by Jones Bridge Road, and on the west by Wisconsin Avenue. AFRRI is located on the south side of the NNMC in Building 42.

III. AFRRI FACILITY DESCRIPTION

The AFRRI complex consists of five phases or buildings which are designed to appear as one building or unit. The principle radiation facilities housed within AFRRI are the TRIGA Reactor Facility, the LINEAR Accelerator (LINAC) Facility, the Cobalt-60 Facility, and the Standards Laboratory, which contains a Theratron and a X-ray unit. In addition to these facilities there are included within AFRRI a Computer Center, Research Laboratories, a Hot Cell, Radiochemistry Laboratory, an Animal Facility, related support areas, and office spaces. The AFRRI complex consists of four (4) separate floor levels. The first and fourth levels are the lowest and the highest levels, respectively.

IV. GENERAL DESCRIPTION

A. Reactor Facility

The TRIGA Reactor Facility occupies various areas on the first level, the second level, and the third level of one building of the AFRRI facility. On the first level, the facility consists of Exposure Room 1 (ER1), Exposure Room 2 (ER2), Prep Area, Room 1120, and Room 1121. The heat exchanger for the reactor coolant systems is located in Room 1121. On the second level, the Facility consists of the Hot Cell, the Radiochemistry Laboratory, which contains portions of the Pneumatic Transfer Systems, and the Equipment Room which contains reactor coolant pumps, demineralizers, and the absolute filters for the reactor heating and ventilating system. On the third level, the Facility consists of the Reactor Room which contains the movable reactor core and control rod drive system, the Reactor Control Room which contains the reactor control console and the associated nuclear instrumentation, the Maintenance Shop, the Equipment Room containing the reactor air system and portions of the heating and ventilating system, and offices.

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 for the rest of the AFRRI facility.

The AFRRI reactor is a TRIGA-Mark F that was designed and manufactured by General Atomic Company and installed at AFRRI in 1962. The thermal reactor has a movable core and is designed to operate up to one megawatt of thermal power in the steady state mode and up to 2500 megawatts in the pulse mode (10 milli-seconds FWHM). The cylindrical core consists of 87 stainless steel clad fuel elements, enriched to 20% in uranium-235, and four aluminum clad borated graphite control rods. The core moderator consists of zirconium hydride and water, and the reactor core is reflected on the top and bottom by graphite, and at the periphery by water. The cylindrical fuel elements are positioned in the core in five rings. The rings are designed as B, C, D, E, and F, and contain 6, 12, 15, 24, and 30 fuel elements, respectively. The four control rods are located in the center core position (1) and the D-ring (3).

The reactor core is positioned in the reactor tank under approximately 16 feet of demineralized water. The reactor core is cooled by the natural convection of the water in the reactor tank. The water, in turn is pumped from the tank by the primary system coolant pump, passed through a heat exchanger and demineralizer, and then retured to the tank. The secondary coolant system pumps industrial raw water from the cooling tower basin, through the heat exchanger, and returned to the cooling tower where the water is cooled by being passed down through the tower to the basin.

There are four principle experimental facilities associated with the AFRRI-TRIGA reactor and these are Exposure Room 1, Exposure Room 2, the Pneumatic Transfer Systems, and the In-Core Experiment Tube (CET). Experiments can also be placed in the reactor tank, but this method of irradiations is not normally used.

B. <u>Reactor Tank</u>

The AFRRI-TRIGA reactor tank is constructed of aluminum and is embedded in concrete. Aluminum was selected as the tank material to improve long term reliability and to minimize problems of corrosion and neutron activation. The reactor tank, which is clover-leaf in shape, is approximately 19-1/2 feet deep with a diameter across the tank lobes of approximately 13 feet. The basic wall thickness of the tank is 3/8-inch, except in two clover-leaf projections that extend into the north and south exposure rooms, and this wall thickness is 1/4-inch. The tank bottom and projection shelf thickness is 1/2-inch.

In addition to containing the reactor core-support structure, reactor core, and tank shield doors, the reactor tank contains approximately 15,000 gallons of demineralized water which serves both as the primary reactor coolant, and as a radiation shield.

C. Shield Doors

Two radiation shield doors are located in the reactor pool and divide the reactor tank into two equal sections. These interlocking doors are constructed of 1/2-inch aluminum plate and 8-inch aluminum Z-sections. The doors are approximately 19 inches thick, 5 feet high and 6 feet wide. Each water-tight door is filled with approximately 18,000 pounds of No. 6 lead shot and approximately 90 gallons of transformer oil to provide cooling for the lead shot. The gap between the shield doors is stepped to prevent radiation streaming through the door. Each door is supported on a low-friction steel thrust bearing mounted at the bottom of the tank.

The shield doors may be rotated 90° to permit the core support carriage to move from one end of the reactor tank to the other. Rotation of the doors is accomplished using a 1/6 HP drive motor located in a small pit at the reactor top. Power for door rotation is transmitted through one 200:1 and two 10:1 reduction gears. Each shield door is connected to a reduction gear, mounted on the side of the carriage track, by a vertical shaft extending from the top of the door to the reduction gear. Operating controls for the doors are located at the control console. Approximately 3 minutes are required to fully open or close the lead shield doors.

Limit switches are used to indicate the fully opened or closed positions of the shield doors. These limit switches, located on top of the reduction gear above each door, are part of an interlock system which prevents movement of the core support carriage and denies power to the control rod magnets unless the shield doors are fully opened or fully closed.

D. Carriage and Core Support Structures

A four-wheeled carriage, traveling on two tracks that span the reactor tank, is used to move the reactor core from one operating position within the tank to another. In addition to supporting the core, the carriage also serves as a support for four control rod drives, a diffuser system, and various electronic control devices.

The carriage consists of a structural steel framework enclosed with removable aluminum covers. The carriage is approximately 64 inches square by 24 inches high. Four control rod drives are attached to a mounting plate elevated above the carriage. Two wheels on one side of the carriage are grooved to match a double beveled track. Engagement of the wheels and track restrains any lateral displacement of the carriage. The two wheels on the opposite side of the carriage are flat faced and roll on a flat track.

The carriage is propelled using a two-speed electric motor, and a rack and pinion gear system. The gear rack is attached to one side of the double beveled track. The carriage is driven at two speeds, 1-1/2 feet per minute, and 2-1/4 feet per minute. Low speed is used during the first and last foot of travel as the carriage moves from one extreme limit of travel to the other. The intervening distance is traversed at the high speed. Microswitches are employed to automatically change the drive motor's speed depending on the carriage's position on the track. Microswitches are also used to stop the carriage drive motor when the carriage has reached either of its two extreme limits of travel. These switches are part of a facility interlock system. As a safety measure, mechanical stops are mounted at both ends of the carriage track to prevent carriage overtravel at the extreme limits. The carriage position is read on a position indicator at the reactor console. Travel time for the carriage from one extreme position in the reactor tank to the other is approximately 5 minutes.

Power, control circuit wiring, and compressed air are supplied to the carriage through a trail cable and flexible hose. The cable and hose are attached to the carriage control rod drive motor enclosure. The trail cable and hose are supported by a wall-mounted swinging boom.

The core support structure consists of an aluminum cylinder approximately 36 inches in diameter and 12 feet high, and an aluminum adapter 5 feet high and 19-1/2 inches in diameter. Both the cylinder and adapter are formed from 5/16-inch thick aluminum plate. The support structure connects at its top to the carriage, and at its bottom to the adapter. A vertical slot 16-inches wide extends the full height of the aluminum cylinder. This slot provides access to the inside of the support structure permitting the installation and removal of fuel elements from the core without having to raise the above the water-level.

E. Grid Plates

AFRRI-TRIGA fuel elements and other in-core assemblies are spaced and supported in the core by an upper grid and a lower grid plate.

The upper grid plate is 18-3/4 inches in diameter, and contains ninety-one 1-1/2 inch diameter holes. Four of these holes receive the guide tubes for the three standard control rods and the transient rod. The three standard control rods are located in positions D1, D7, and D13. The transient rod is located in position A1. The remaining 87 holes accept in-core elements and assemblies. These holes, or grid spaces, are located in concentric rings. Each ring is designated by the letters (A through F) radially from the center. Spaces in each ring are identified numerically in a clockwise direction from a reference radius which points in the direction of the North Exposure Room (ER1). One-quarter inch diameter holes in between the grid spaces will be used for in-core experiments and dosimetry.

The lower grid plate is 16-5/8 inches in diameter and is gold anodized to reduce grid plate wear and to aid light reflection in the core. The lower grid plate contain eighty-seven 1/4-inch diameter holes to accept the fuel element end fixtures, four 1-1/2-inch diameter holes to accept the control rod guide tubes, and thirty 5/8-inch diameter holes to permit flow of cooling water. Both grid plates are made from 3/4-inch thick aluminum plates. Each plate is bolted to the shroud by four captive screws. Correct positioning of the grid plates is assured by two positioning dowels on the grid plate support pads.

F. Core

The core is enclosed in the aluminum shroud attached to the bottom of the adapter. The core forms a right circular cylinder consisting of a compact array of 87 cylindriical fuel-moderator elements and four control rods, all positioned vertically between two grid plates. The core is positioned within the shroud such that its horizontal center line is approximately 29 inches above the bottom of the reactor tank. Serial numbers are used to identify individual fuel elements and control rods.

G. Reactor Water Systems

The water coolant systems for the AFRRI reactor consists of a primary cooling system, a secondary cooling system (with 1 MW heat exchanger and cooling tower), a demineralized water make-up system for the primary cooling system, and a N-16 diffuser system.

H. Reactor Ventilation System

The Reactor Room contains approximately 1800 square feet of floor space, has a ceiling height of 18 feet, and a volume of 32,400 cubic feet. The doors and hatches leading to the Reactor Room are sealed with compressible rubber garlute to enhance confinement of the Reactor Room air when the dampers are closed. A system of double doors serves as an air lock for entry and exit of the Reactor Room. The air enters primarily through two air supply fans, is circulated then exhausted. It passes through both roughing filter and absolute filter banks before being discharged out the stack which extends approximately 35 feet above the roof of the reactor building.

V. ENVIRONMENTAL EFFECTS OF FACILITY OPERATION

A. Thermal Effluents

The AFRRI Reactor has a maximum thermal power output of 1 MW in the steady state mode. The environmental effects of thermal effluents of this order of magnitude are considered to be negligible. During prolonged operations at the upper range of power levels the secondary cooling system is activated and waste heat is rejected to the atmosphere through the facility's cooling tower. The efficiency of this cooling tower is determined by the temperature and humidity of the outside ambient air.

B. Radioactive Effluents

Enclosure 1 summarizes the gaseous, liquid and solid radioactive wastes for the AFRRI facility, which are considered to have minimal effect on the surrounding environment.

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.

VI. 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.

VII. ALTERNATIVES TO CONSTRUCTION AND OPERATION OF THE FACILITY

There are no suitable or more economical alternatives which can accomplish the diversity of research objectives at this facility. These objectives include radiobiology research, radioisotope production, neutron activation and irradiation of electronic equipment.

VIII. LONG TERM EFFECTS OF FACILITY CONSTRUCTION AND OPERATION

The long-term effects of a research facility such as the AFRRI are considered to be beneficial as a result of the contribution to scientific and medical knowledge. This is especially true in view of the relatively low capital cost involved and the minimal impact on the environment associated with such facilities.

IX. COST AND BENEFITS OF FACILITY AND ALTERNATIVES

The cost for a facility such as the AFRRI Reactor Facility is in the order of four (4) million dollars with very little environmental impact. The benefits of this facility are in the field of biomedical research in support of our national defense posture and provide additional data and findings in the scientific and medical fields for international use. Some of the activities conducted with this facility could be accomplished using particle accelerators or radioactive sources, however, these alternatives are more costly, less efficient and cannot totally replace the existing capabilities associated with this facility. There is no reasonable alternative to the AFRRI Reactor for conducting the broad spectrum of research previously mentioned.

DISPOSITION FORM

For use of this form, see AR 340-15, the proponent agency is TAGCEN.

REFERENCE OR OFFICE SYMBOL	SUBJECT
SAF	Summary: Reactor Environmental Data

THRU: SAHP FROM SAF DATE 24 Sep 80 CMT 1
TO: SSD Dr arras/bsm/50411

1. Summary of Gaseous Radioeffluent, 1 Jan 71 to 30 Jun 80:

a. Total Release - Radionuclide(s):

		Ar-41	N-13,O-15	I-125	Xe-133
Source of activity:		Reactor	LINAC	Other	Other
Released activity (mCi):	1971	26900	1460	0	0
" "	1972	11040	3760	<1	120
" "	1973	11310	3850	0	1380
" "	1974	16690	20740	0	40
" "	1975	7190	20180	<1	340
" "	1976	2750	1040	0	2100
" "	1977	2370	640	<1	1590
" "	1978	9410	15840	<1	340
" "	1979	18930	0	<1	1280
" "	1980(½y)	1940	5	<1	260

b. Dose Assessment Notes:

(1) Environmental doses from Xe-133 and I-125 are less than 10% of the doses from Ar-41, N-13 and O-15, and are clearly the result of biochemical and biomedical procedures not reactor operations, and are not evaluated in detail. For example, the greatest single annual releases and the corresponding calculated environmental concentrations are (from HPP 2-5, $X_{max} \cong 0.12\ Q/U\ \sigma_y\sigma_z \cong 3E\text{-}4Q$):

(a) I-125, 342 µCi, 3.3 E-15 Ci/m^3, (4E-5 x MPC).

(b) Xe-133, 2100 mCi, 2.0 E-11 Ci/m^3 (1E-4 x MPC).

(2) Doses from Ar-41, N-13 and O-15 are assessed by the concentric cylinder set model, as given in HPP 2-5; this is a departure from the unrealistic semi-infinite cloud model used in previous years. Highest average (annual) unrestricted area exposure rates corresponding to given releases are:

Radionuclide(s):	Ar-41	N-13,O-15	Xe-133
Average mR/h, with Q=1 Ci/s*:	4.1	4.3	0.5

* averaged over the year.

Enclosure 1

c. Based upon the above the dose assessment for the above annual releases is:

Year:		1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Ar-41	Ci/s:	8.5E-7	3.5E-7	3.6E-7	5.3E-7	2.3E-7	8.7E-8	7.5E-8	3.0E-7	6.0E-7	1.2E-7
"	mR/h:	3.5E-6	1.4E-6	1.5E-6	2.2E-6	9.3E-7	3.6E-7	3.1E-7	1.2E-6	2.5E-6	5.1E-7
"	mrem:	0.031	0.012	0.013	0.019	0.008	0.003	0.003	0.011	0.022	.002
N,O	Ci/s:	4.6E-8	1.2E-7	1.2E-7	6.5E-7	6.4E-7	3.3E-8	2.0E-8	5.0E-7	0	1.6E-10
"	mR/h:	2.0E-7	5.2E-7	5.2E-7	2.8E-6	2.8E-6	1.4E-7	8.6E-8	2.2E-6	0	7E-10
"	mrem:	0.002	0.005	0.005	0.024	0.024	0.002	0.001	0.019	0	10^{-5}

2. <u>Environmental Film Dosimeters</u>: 1971-1980.

a. This is a summary of environmental dosimetry data representing possible reactor-produced radioeffluent doses to the environment. Statistical analyses of these results show no correlation to AFRRI operations or meteorological conditions. These results are judged to reflect normal variation in ambient background and the statistical uncertainty of the dosimetry.

b. Summary (all doses in millirem):

Year	Envir. Dosimeter Avg.*	Highest Dosimeter Reading*
1971	1.4	8
1972	7.7	16
1973	1.7	12
1974	2.2	10
1975	2.4	14
1976	0.3	13
1977	3.3	20
1978	1.5	30
1979	5.1	9
1980(½y)	-2.5	

* All are net readings, with background station doses (located miles from AFRRI) subtracted. Individual dosimeter readings have 2σ uncertainties of 8 millirem.

3. <u>Liquid Effluent</u>: 1971-1980.

a. During this period there were no measurable releases of radioactive liquids from the reactor; in fact there were no releases of water to the environment from the reactor, in any measurable quantities.

b. Radioactivity was released to the sanitary sewerage system, from the AFRRI waste tanks, but the amount was well below all applicable limits of 10 CFR 20. The sources of liquid radioeffluent are:

(1) Radionuclide laboratory low-level liquid waste, and

(2) Animal care facility excreta, including those injected with radionuclides due to biomedical experiments.

4. Solid Waste Disposal: 1971-1980.

a. With the exceptions noted below, there are no solid waste shipments of reactor-produced materials.

b. Low-level solid waste from reactor operations, including possible contaminated paper, gloves, disposable smocks, and animal bedding constitute a volume of 1-5 55 gallon drums (depending on workload), with less than 1 mCi per year, essentially all short-lived radionuclides; e.g., Na-24, Mn-56, Cu-64.

c. Reactor resins, and cuno filters are changed at intervals of 6 to 18 months. These are disposed of as solid waste. Typical activities observed in these materials in the past have been:

Cr-51 up to 7.6 µCi,
Co-60 " " 8.1 " ,
Co-58 " " 25.7 " ,
K-40 " " 7.6 " ,
Mn-56 " " 1.8 " ,
Zn-65 " " 4.1 " ,
Na-24 " " 1.4 " , and smaller amounts of other radionuclides

5. Environmental Sampling: 1971-1980.

a. Quarterly environmental samples are taken of water, soil and vegetation. All sample results have been below action levels specified in Health Physics Procedure 2-5 and in fact generally are indistinguishable from normal environmental background activity levels.

LESTER A. SLABACK, Jr.
Head, Radiation Safety Department

cf:
DNA/BAO
RRFSC