GENERAL ATOMICS

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Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Subject: **Facility License R-38; Docket 50-89**
Submittal of TRIGA Mark I 1993 Annual Report (3 Copies)

Dear Mr. Adams:

Enclosed is the annual report required by the applicable Technical Specifications of General Atomics' Mark I TRIGA reactor (License R-38). This report covers the operation for the calendar year 1993. The sections of the report are numbered consistent with the items of information referred to in Section 9.6e of the Technical Specifications for the Mark I TRIGA reactor.

Should you desire additional information concerning the above, please contact me at (619) 455-2823 or Dr. Junaid Razvi at (619) 455-2441.

Very truly yours,

Keith E. Asmussen

Keith E. Asmussen, Director
Licensing, Safety and Nuclear Compliance

KEA:rmk

Enclosure - as above

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TRIGA REACTORS FACILITY

TRIGA Mark I Reactor

ANNUAL REPORT

for

CALENDAR YEAR 1993

prepared to satisfy the requirements of
U.S. Nuclear Regulatory Commission
Facility License R-38
Docket No. 50-89

February 1994

GENERAL ATOMICS

TRIGA REACTORS FACILITY
TRIGA Mark I Reactor
ANNUAL REPORT for 1993

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INTRODUCTION

This report documents operation of the General Atomics (GA) TRIGA Mark I non-power reactor for the period January 1 - December 31, 1993. The Mark I reactor - one of two reactors operated by GA at its San Diego, California facilities - is a pulsing type reactor with a licensed steady state operating power of 250 kilowatts, and with maximum reactivity insertions during transient operations of $3.00. It is operated by GA under License No. R-38 granted by the U.S. Nuclear Regulatory Commission (Docket No. 50-89). The second reactor is a 1.5 MW(t) TRIGA Mark F reactor operated under License No. R-67; both reactors are housed in GA's reactor building with their own independent reactor rooms and control rooms.

This report is being prepared and submitted to satisfy the requirements of Section 9.6(e) of the R-38 Technical Specifications, as amended. This report is presented in eight parts, consistent with the information required by the applicable Technical Specifications.

1. SUMMARY OF OPERATIONS

1.1 Operating Experience.

The TRIGA Mark I reactor was operated during calendar year 1993 on an as needed basis, for numerous steady-state irradiations as well as pulsing operations. The following represents a summary of reactor operations during this period:

1.1.1 The reactor generated a total of 42,413 Kwh of energy.

1.1.2 The reactor was pulsed 108 times, for a total of 12,250 pulses to date.

1.1.3 The reactor consumed 2.81 grams of U-235.

1.1.4 A total of 244 irradiation requests were processed during the period.

1.1.5 No special experiments, as defined in the R-38 Technical Specifications, were conducted during this period.

1.1.6 No amendments to the facility license were issued during this period.

1.1.7 The following types of operations were conducted to support the various users of the reactor:

- Neutron activation analysis (1656 samples).
- Low power radiation hardness testing of electronic piece parts and hybrid circuits.
- Neutron radiography.
- Irradiation of fresh and previously irriadiated gas cooled reactor fuel rods, including New Production Reactor (NPR) test fuel capsules, at ambient and high temperatures using electrically heated furnaces (in-core and ex-core).
- Testing of research reactor instrumentation.
- Operator training and requalification exercises.

Table I summarizes pertinent reactor operating parameters for 1993.

TABLE I
SUMMARY OF TRIGA MARK I OPERATING DATA

Operating Parameter	Annual Values January 1, 1993 through December 31, 1993
KWh of energy produced	42,413
MWD of energy produced	1.77
Grams U-235 consumed	2.81
Number of fuel elements removed from core[1]	0
Number of fuel elements added to core[2]	0
Number of pulses	108
Hours reactor critical (steady state)	314
Number of start-up and shutdown checks	277
Number of irradiation requests processed	244
Number of facility modifications under 10CFR50.59	0

[1] Fuel elements removed from the core represents fuel removed as a result of bending or length changes, or determined to be damaged or otherwise deteriorated.

[2] Fuel elements added to the core represents fuel added to compensate for loss of reactivity, or to replace fuel removed from the core due to damage or deterioration.

1.2 Facility Changes and Modifications.

There were no changes to the Mark I reactor facility during 1993.

1.3 Surveillance Tests and Inspections.

Surveillance tests and inspections were performed as required by Sections 3.0 (Reactor Pool), 4.0 (Reactor Core) and 5.0 (Control and Safety Systems) of the R-38 Technical Specifications. A summary of the results are presented below:

1.3.1 Pool Water. The pool water conductivity was measured continuously using a sensor installed in the input piping of the demineralizer system. Water conductivity was maintained well below the limit of 5 micro-mhos per centimeter averaged over one calendar month required by the Technical Specifications.

Water level sensors were used to ensure that the pool water level always was maintained at acceptable levels. In addition, a visual check of pool water level was made as part of the Daily Startup or Shift Change Checklists.

Redundant pool water temperature monitors were used to ensure that bulk pool water temperature is maintained within acceptable limits.

1.3.2 Reactor Core. During the month of December 1993, the reactor fuel was visually inspected for damage and deterioration, and all uninstrumented fuel elements were inspected for length and bend changes. The growth test measures the elements average growth (which must be less than 0.500-inch for aluminum-clad elements and less than 0.100-inch for stainless steel clad elements). The bend test measures the sagitta of each element over a length of 23-inches along the cladding; the bend must be less than 1/16-inch for the element to be considered satisfactory. All fuel elements passed these inspection criteria.

Additionally, all fuel elements were inspected for clad deformities with an underwater color camera system, initially used during 1991. There were no fuel elements removed from service due to clad deformities.

The inspection process utilized for the first time a PC-based fuel records management database utility in lieu of manual data recording.

It is to be noted here that many older aluminum clad elements continue in routine use in the Mark I reactor; however, all presently manufactured TRIGA fuel now uses stainless steel clads. The present reactor core is a mixture of aluminum and stainless steel clad fuel elements.

1.3.3 Control Rods. The mechanical components of the central transient (pulse) rod (air piston, lip seal, anvil and accumulator) were inspected, cleaned, and lubricated twice during the calendar year as part of the routine surveillance activities (June and December 1993). No deterioration or undue wear were noted on the rod damper assembly itself, which had been completely overhauled in 1987.

All control rods were removed from the core and visually inspected in December 1992, and were found to be in satisfactory condition. The next scheduled inspection of control rods is December 1994.

1.3.4 Reactor Safety Systems. Surveillance and calibration of reactor safety systems was carried out as specified in the R-38 Technical Specifications and reactor operating procedures. The calibrations and checks on the scram functions of the minimum required safety system scrams were verified a routinely, with the surveillance on power level, fuel temperature measuring channels and manual scram capability performed daily prior to reactor start-up. Daily checks ensure that the channels are operating as intended, and that the set points for these channels are within the limits specified in the Technical Specifications.

A calorimetric determination of reactor power was performed monthly to verify the calibration of the three power measuring channels. In conformance with reactor operating procedures, the calibration of the power measuring channels was considered acceptable if the deviation of the measured value from the indicated power was less than five percent; the power measuring channels were adjusted to conform to the calorimetric value if the deviation was greater than five percent. During the reporting period, fourteen such adjustments to the power level channels were made.

However, it is noted that only on five of these adjustments was the deviation actually greater than five percent. For the other eight, where the deviation was less than 5%, the adjustments were made because micrometer detector adjustment devices installed in 1988 allow the detector positions to be adjusted with a greater degree of precision, which allows a more accurate indication of power level.

1.3.5 Radiation Monitoring. The primary instruments utilized during the reporting period for facility radiation monitoring were a continuous beta-gamma air monitor, radiation area monitors, water and air filter monitors, a control console monitor, and a variety of portable survey meters. Their use and calibration is described below:

Continuous Air Monitor (CAM). The Ludlum Model 333-4 CAM was source checked weekly to verify the alert and alarm set points. Calibration of the system was performed annually using two Sr-90/Y-90 sources with a calibration traceable to the National Institute of Standards and Technology (NIST). Two sources were used to allow calibration at low and high count rates.

Radiation Area Monitors (RAM). Two area monitors (Eberline Instrument Corp.) were used for monitoring area radiation levels in the reactor room. The low level monitor was used to provide an alarm when the area radiation levels exceeded 20 mR/h; the high level monitor alarmed at levels exceeding 5000 mR/h. The alarm set points were checked daily, with alarm testing performed biweekly using a check source. Calibration was performed annually using a 4 mCi Cs-137 source on a calibration range. All calibrations were traceable to NIST.

Water and Air Radiation Monitors. Separate radiation monitors (Eberline RMS II) were used to monitor the radiation levels in the reactor pool water and the reactor room air ventilation system. Their operation and alarm set points (50 mR/h and 5 mR/h respectively) were checked daily with alarm testing performed weekly. The monitors were calibrated annually using the General Atomics calibration range; all calibrations were traceable to NIST.

Console Radiation Monitor. A radiation monitor (Eberline RMS II) monitors dose rates at the reactor console. The alarm set point (2.5 mR/h) was checked daily with alarm testing performed weekly. The monitor was calibrated annually.

Portable Radiation Monitors. Several types of portable radiation monitors were in use at the facility. Examples are the Eberline RO2 and RO2-A beta-gamma survey meters, Ludlum pancake probes, Ludlum MicroR meter and LFE SNOOPY neutron survey meter. All portable radiation monitors were calibrated semiannually, with the exception of the SNOOPY neutron survey meters, which were calibrated annually.

2. ENERGY GENERATION

The total energy generated during calendar year 1993 as a result of Mark I operations was 42,413 kilowatt-hours. Figure 1 is a bargraph showing energy generated on a monthly basis during the year.

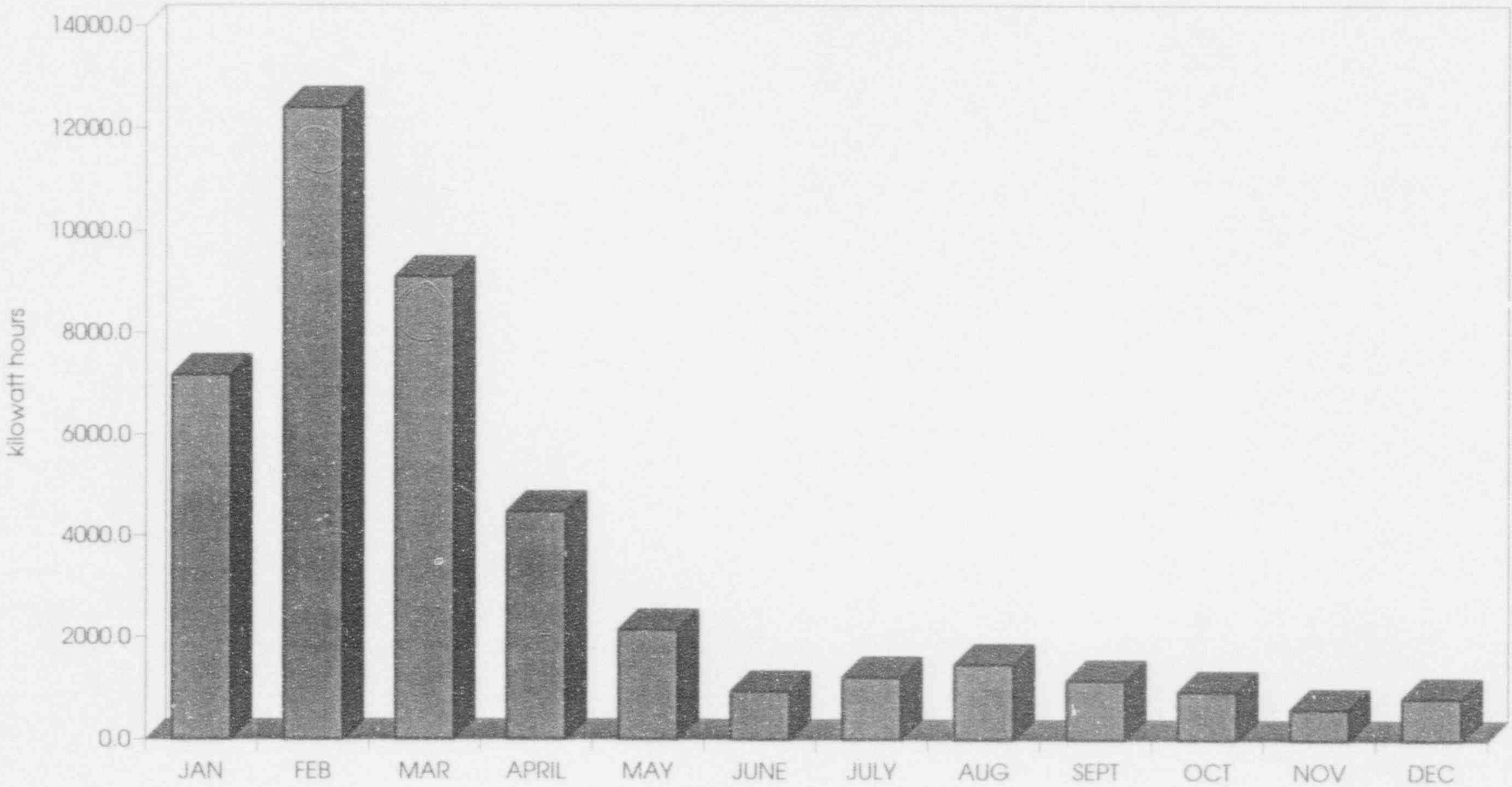

Figure 1. TRIGA Mark I Energy Production for 1993

3. EMERGENCY SHUTDOWNS AND INADVERTENT SCRAMS

The total number of unscheduled scrams during 1993 operations was 13. *None of the unscheduled scram experienced in 1993 had any effect on, or consequence for, the safe operation of the Mark I reactor.* In fact, all safety channels functioned as intended in shutting down the reactor when trip setpoints were reached, or an error condition was otherwise detected in the reactor operating systems. The causes of the scrams are grouped into the following general categories:

Scram Channel	Cause	Number
Percent Power	Operator error	1
Shutdown Timer	Operator error; accidentally activating scram timer	1
Percent Power	Loose AC power cord	1
I&C System	Loss of site power	1
Watchdog Timer	Watchdog timeouts in system computers	6
High Voltage	Instrument glitch	2
DIS064	Digital input scanner timeout	1

4. MAINTENANCE ACTIVITIES

All maintenance activities performed during the year generally fall into three categories: (i) routine preventative maintenance, (ii) routine calibration activities, and (iii) ongoing upgrade activities associated with replacement of older components and systems with state-of-the-art technology, or simply due to wear and tear from the many years of use. Significant activities in this area are described below:

4.1 Reactor, Mechanical, and Auxiliary Systems

February 1993	The regulating rod magnet UP limit switch push rod was removed and reinstalled to correct an intermittent stuck magnet UP limit switch problem.
March 1993	The regulating control rod drive (CRD) was replaced with a spare CRD. The CRD was removed from service to repair a loose spline in the drive shaft which was causing the rod position indicator to slip.
	The rotary specimen rack drive system was realigned.
May 1993	Pressure gages used to measure the demineralizer system ΔP were replaced.
June 1993	The ventilation system was upgraded: a new intake louver and filter were installed; magnehelic pressure gages were replaced with manometers; and, a wire screen was added to the outside discharge louvre.
October 1993	The compressed air supply moisture separator gasket was replaced.
December 1993	The continuous air monitor air pump was replaced.
	Semiannual maintenance on the CTR drive was performed. The CTR air supply system and shock absorber were inspected and found to be satisfactory.

4.2 Instrumentation and Control System

January 1993	Semiannual instrument calibrations were performed.
	A faulty watchdog board was replaced in the DAC computer.
	New read-only memory modules (ROM cards) were programmed and installed in the Mark I I&C System computers. ROM cards allow operation of the I&C system from pre-programmed Read-Only-Memory IC chips as opposed to operation from the hard disk drives in the I&C system. The new ROMs reflect changes or additions to status window information.
February 1993	The SCRAM loop monitor time delay relay was replaced with a standard relay which is reset from the console RESET keyswitch.
	Local high voltage and percent power meters were added to the NP-1000 and NPP-1000 percent power channels.
March 1993	The NPP-1000 +15 VDC regulator was found to be out of specification and was replaced.
April 1993	The servo system power demand switch was replaced.
May 1993	New ROM cards were programmed and installed in the Mark I console. The new ROMs reflected changes or additions to status window information.
June 1993	Fuel temperature #2 scram check relay was replaced.
July 1993	Semiannual instrument calibrations were performed.
	Fuel temperature #3 scram check relay was replaced.
	The uninterrupted power supply batteries were replaced.
	The transient rod FIRE pushbutton was replaced.

August 1993	Fuel temperature #1 was recalibrated due to a 20° C offset in the displayed information.
November 1993	The high voltage power supply for an experimental linear channel ionization chamber was replaced with a dual high voltage/compensation voltage power supply.
	A spare set of network boards were obtained. The spare set was installed in the console for evaluation.
	The console radiation monitor was replaced with a unit which provided readouts in the lower detection ranges. This monitor now covers the 0.01 to 100 mR/hr range.
December 1993	Semiannual instrument calibrations were performed.
	The console high resolution monitor was replaced due to excessive "burn-in" on the old monitor.
	The PA-15 preamp was modified to a eliminate an unstable calibrate condition. The change was performed to the specifications of a General Atomics Engineering Change Order.
	A spare hard disk drive was configured and installed in the CSC.

5. 10CFR50.59 FACILITY MODIFICATIONS AND SPECIAL EXPERIMENTS

No new Special Experiments or 10CFR50.59 applications were submitted for the R-38 facility during 1993.

6. RADIOACTIVE EFFLUENTS DISCHARGED TO THE ENVIRONMENT

During the calendar year 1993, 3 millicuries of Argon-41 were discharged from the Mark I reactor facility to the atmosphere.

All low level radioactive wastes were transferred to GA's Nuclear Waste Processing Facility - which operates under NRC license SNM696 and GA's California Radioactive Materials License - for disposal. All waste was measured at the facility for specific radionuclide activity using high resolution gamma-ray spectroscopy prior to the transfer. Solid wastes were then repackaged as necessary and shipped to an authorized disposal facility by GA's waste processing facility. Liquid waste was first subjected to volume reduction by evaporation, and the residue waste was packaged for disposal as solid waste. Trace quantities of liquid low level waste may also be released into the municipal sewer system, if such waste is found to be within the limits and criteria specified by applicable local, state and NRC regulations.

During calendar year 1993, GA's TRIGA Reactors Facility (R-38 and R-67 licenses) shipped 150 cu. ft. of compacted as well as noncompactable low level radioactive waste to an authorized disposal facility.

7. ENVIRONMENTAL MONITORING

There were no significant changes in the GA Environmental Surveillance Program during 1993.

The environmental monitoring program for the TRIGA Reactors Facility included the following:

- Five emergency air samplers situated on the roof and around the reactor building.
- Fifteen environmental air samples adjacent to, and near the GA site in accordance with GA's SNM-696 license.
- Daily liquid effluent monitoring from GA's main pump house, for gross alpha and beta concentrations.
- Annual soil, vegetation, and water sampling at sixteen stations on the GA site, including stations around the GA reactor building.
- External radiation monitoring of the reactor facilities using four area dosimeters (26 locations around the entire GA site), as well as radiation meter surveys conducted periodically.
- Air samplers located in the reactor room to routinely sample room air for airborne radioactivity.
- Additional radiation monitors as described in Section 1.3.5 of this report.

8. SUMMARY OF RADIATION EXPOSURES AND RADIOLOGICAL SURVEYS

The following data summarizes personnel radiation exposures (rem) and radiological surveys of the facility during 1993.

8.1 TRIGA Reactors Facility Staff Whole Body Exposures[1]

Number of employees monitored:	20
High Exposure:	0.180
Low Exposure:	0.000
Average Exposure:	0.031

8.2 Nonfacility GA Staff Whole Body Exposures[2]

Number of employees monitored:	19
High Exposure:	0.325
Low Exposure:	0.000
Average Exposure:	0.034

8.3 Contractor and Reactor Users Whole Body Exposures[3]

Number of persons monitored:	61
High Exposure:	0.230
Low Exposure:	0.000
Average Exposure:	0.010

8.4 Visitor Whole Body Exposures[4]

Number of persons monitored:	124
High Exposure:	0.170
Low Exposure:	0.000
Average Exposure:	0.003

8.5 Routine Wipe Surveys of Mark I Reactor Facility

High Wipe:	45 Beta dpm/100 cm^2
Low Wipe:	<1 Beta dpm/100 cm^2
Average Wipe	1.5 Beta dpm/100 cm^2

8.6 Routine Radiation Measurements of Mark I Reactor Facility

High Measurement:	35 mRem/hr @ 1 foot
Low Measurement:	<0.1 mRem/hr @ 1 foot
Average Level:	0.6 mRem/hr @ 1 foot

(1) Includes reactor operations staff facility support staff and experimenters assigned to work full-time or near full-time at the reactor facility.

(2) Includes GA support staff and experimenters who were granted periodic access to the reactor facility for the performance of work.

(3) Includes non-GA personnel who were granted periodic access to the facility for the performance of work.

(4) Includes GA staff who routinely work in other GA radiation facilities, and who were granted visitor access to the reactor facility. Most if not all, of the radiation exposure received by the GA staff was from these other radiation facilities.

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