TRIGA® Reactors

# TRIGA® Mark I Reactor

# ANNUAL REPORT

for

# CALENDAR YEAR 1996

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

**April, 1997**

GENERAL ATOMICS

**TRIGA REACTORS FACILITY**
**TRIGA Mark I Reactor**
**ANNUAL REPORT**
**Calendar Year 1996**

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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, 1996. The Mark I reactor - 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).

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.

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## 1. SUMMARY OF OPERATIONS

### 1.1 *Operating Experience.*

The TRIGA Mark I reactor was operated during calendar year 1996 on an as needed basis, for steady-state irradiations as well as in the pulsing mode. The following represents a summary of reactor operations during this period:

1.1.1 The reactor generated a total of 1,341 Kwh of energy.

1.1.2 The reactor was pulsed 21 times, for a total of 12,395 pulses to date.

1.1.3 The reactor consumed 0.07 grams of U-235.

1.1.4 No irradiation requests were processed during the period.

1.1.5 There were no applications for facility modifications under 10CFR50.59 that were submitted, approved or implemented during this reporting period.

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

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

1.1.8 There were no reportable occurrences during the year.

1.1.9 One licensed senior reactor operator was required to take - and successfully completed - biennial written exams under the requirements of GA's approved operator requalification program..

1.1.11 The following types of operations were conducted:

- steady-state and pulsing operations for operator training and requalification.
- pulsing demonstrations

Table I summarizes pertinent reactor operating parameters for 1996.

# TABLE I
## SUMMARY OF TRIGA MARK I OPERATING DATA

| Operating Parameter | Annual Values January 1, 1996 through December 31, 1996 |
|---|---|
| Kwh of energy produced | 1,341 |
| MWD of energy produced | 0.056 |
| Grams U-235 consumed | 0.07 |
| Number of fuel elements removed from core[1] | 0 |
| Number of fuel elements added to core[2] | 0 |
| Number of pulses | 21 |
| Hours reactor critical (steady state) | 66 |
| Number of start-up and shutdown checks | 29 |
| Number of irradiation requests processed | 0 |
| Number of facility modifications under 10CFR50.59 | 0 |
| Number of Special Experiments approved under R-38 License | 0 |

(1) The number of fuel elements removed from the core represents fuel removed as a result of (a) bending or length changes, (b) otherwise determined to be damaged or otherwise deteriorated or (c) adjustments to core excess reactivity

(2) The number of 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 made in the performance characteristics or mechanical design of the Mark I reactor facility during the reporting period. During the year however, the use of two 500 kW cooling towers, which had been serving as the primary source of heat removal for the Mark I pool, was discontinued permanently, and pool cooling was switched to the 2MW cooling system which had served as the primary cooling system for GA's Mark F (R-67) reactor. No changes to the facility were required to implement this change, since the piping and valving installed already allowed for these systems to be used on an interchangeable basis.

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 was sampled on a continuous basis for conductivity using an on-line sensor installed in the water treatment system flow. Water conductivity was maintained well below the limit of 5 micro-mhos per centimeter averaged over one calendar month as required by the Technical Specifications. Pool water was sampled on a quarterly basis for determination of radionuclide content including the presence of any fission products, as well as the determination of corrosion product concentrations.

Water level sensors with audible and visual alarms were used to ensure that the pool water level was always maintained at acceptable levels. In addition, a visual check of pool water level was made as part of the Daily Start-up Checklist.

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 months of December 1996 and January, 1997, the reactor fuel was inspected visually 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 with an underwater color camera system to observe and document clad deformities or other unusual conditions on the clad surface

There were no fuel elements removed from routine use as a result of this inspection. The inspection process continued to utilize a PC-based records management database utility in lieu of manual data recording, first put in use in 1993.

1.3.3 Control Rods. As part of the routine control rod surveillance procedures, the mechanical components of the central transient 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 1996). 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 January, 1997 as part of the biennial inspection, and were found to be in satisfactory condition.

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 on a routine basis, with the surveillance on power level, fuel temperature measuring channels and manual scram capability performed prior to reactor start-up. Such 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 at least quarterly 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, *no* such adjustments to the power level channels were required. However, it is noted that even where deviations are less than 5%, adjustments may be made regardless because micrometer detector adjustment devices installed in 1988 now give greater precision and sensitivity in setting detector positions, which allows a more accurate indication of power level to be obtained.

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 CAM (Ludlum Model 333-4) alert and alarm set points were checked on a weekly basis by activating them with a check source. 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 at General Atomics. 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 was verified prior to

reactor startup, and alarm set points (50 mR/h and 5 mR/h respectively) were verified on a weekly basis. The monitors were calibrated on an annual basis 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. Its operation was verified prior to reactor startup, and the alarm set point (2.5 mR/h) was verified on a weekly basis. The monitor was calibrated on an annual basis.

Portable Radiation Monitors. Several types of portable radiation monitors were in use at the facility. Examples are the Eberline RO2 and RO2A beta-gamma survey meters, the Ludlum pancake probes, the Ludlum MicroR meter and the LFE SNOOPY neutron survey meter. All portable radiation monitors were calibrated on a semiannual basis, with the exception of the SNOOPY neutron survey meters, which were calibrated on an annual basis.

## 2. ENERGY GENERATION

The total energy generated during calendar year 1996 as a result of Mark I operations was 1,341 kilowatt-hours. Figure 1 is a bargraph showing energy generated on a monthly basis during the year.

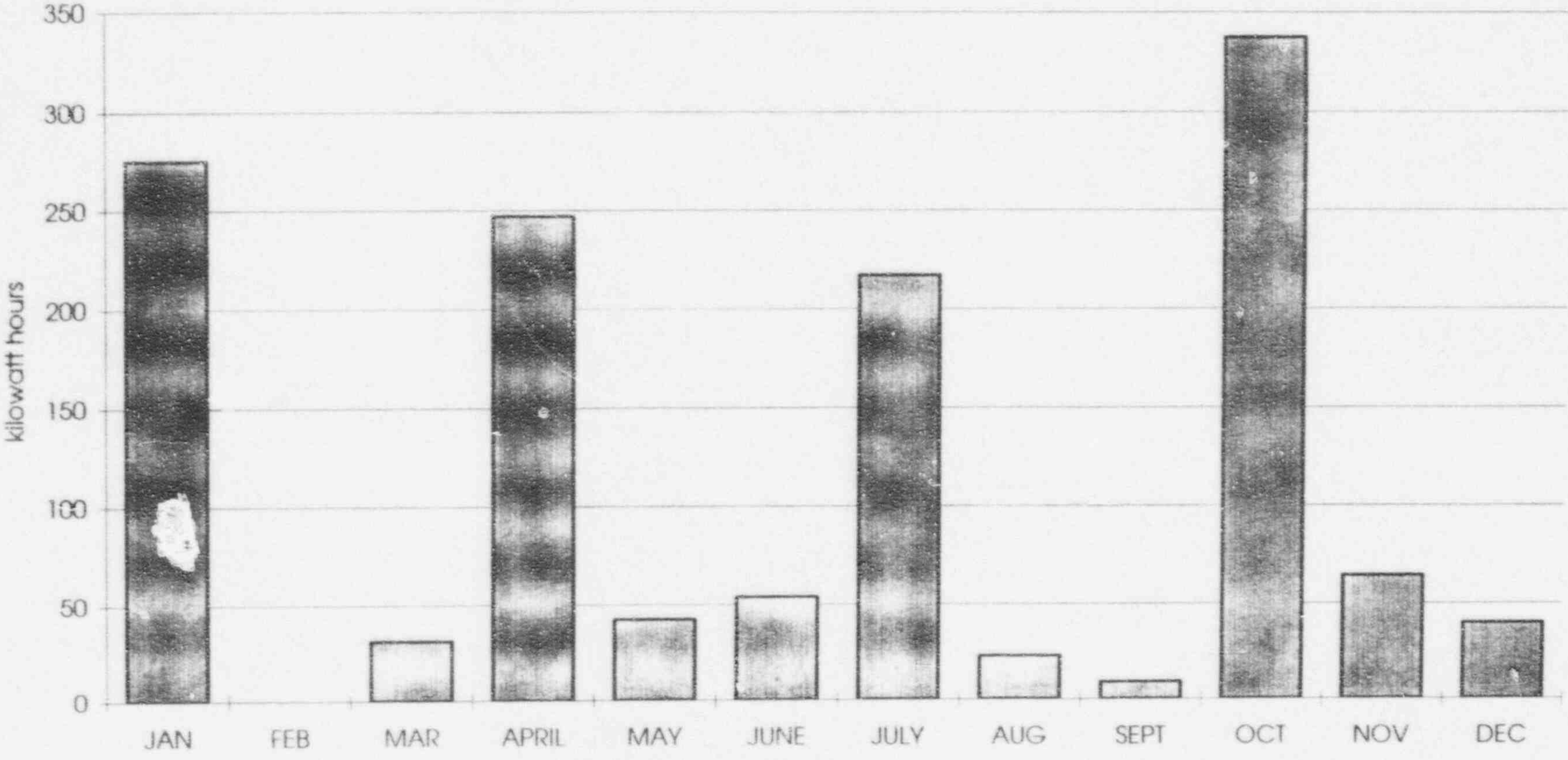


Figure 1. TRIGA Mark I Energy Generation for 1996

## 3. EMERGENCY SHUTDOWNS AND INADVERTENT SCRAMS

The total number of unscheduled scrams during 1996 operations was **three**. *None of the unscheduled scrams experienced in 1996 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 these scrams are grouped into the following general categories:

| Scram Channel | Cause | Number |
|---|---|---|
| Watchdog Timer | Computer lockup caused a watchdog time-out in THE CSC computer | 1 |
| Safety Channel | Scram set point in NM-1000 wide range safety channel was incorrectly set at 250 watts. | 2 |

# 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) upgrade activities associated with replacement of older or obsolete 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*

| | |
|---|---|
| December, 1996 | The pump on the secondary side of the 2 MW pool ccooling system was replaced. |

## 4.2 *Instrumentation and Control System*

| | |
|---|---|
| January, 1996 | Semiannual instrument calibrations were performed. |
| June, 1996 | Semiannual instrument calibrations were performed. |

## 5. 10CFR50.59 FACILITY MODIFICATIONS AND SPECIAL EXPERIMENTS

There were *no* new applications for facility modifications under the provisions of 10CFR50.59 that were approved for the R-38 facility during the 1996 reporting period.

There were *no* new Special Experiments that were approved for the R-38 facility during 1996.

When facility modifications or Special Experiments at the R-38 facility are proposed, the applications for the proposed changes or experiments are reviewed prior to implementation by the Physicist-in-Charge and by the TRIGA Reactors Facility Safety Committee, among others, and approved only after making the determination that the proposals for the changes do not:

(a) involve a change to the R-38 Technical Specifications, or
(b) create any unreviewed safety questions as defined in 10CFR50.59.

## 6. RADIOACTIVE EFFLUENTS AND WASTE GENERATION

During the calendar year 1996, *0.05 microcuries* of Argon-41 were discharged at the Mark I reactor facility stack to the atmosphere.

All low level radioactive and radioactive mixed 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 wastes are measured at the facility for specific radionuclide activity using high resolution gamma-ray spectroscopy prior to the transfer. Solid wastes are then repackaged as necessary and shipped to an authorized disposal facility by GA's waste processing facility. Liquid waste is 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 1996, the GA TRIGA Reactors Facility (R-38 and R-67 licenses) transferred 25 cu. ft. of noncompactable low level radioactive waste (activated and contaminated lead) to GA's waste facility for storage and final disposal.

## 7. ENVIRONMENTAL MONITORING

GA's appropriately modified and implemented its Environmental Surveillance Program and procedures during 1996 to meet the revised regulations of 10CFR20.

The environmental monitoring program during 1996 for the TRIGA Reactors Facility remained unchanged from prior years and included the following:

- Five (5) emergency air samplers situated on the roof and around the reactor building.

- Fifteen (15) 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 (16) stations on the GA site, including stations around the GA reactor building.

- External radiation monitoring of the reactor facilities using thirteen (13) area dosimeters 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 1996.

8.1 *TRIGA Reactors Facility Staff Whole Body Exposures*[1]

| | |
|---|---|
| Number of employees monitored: | 17 |
| High Exposure: | 0.110 |
| Low Exposure: | 0.000 |
| Average Exposure: | 0.020 |

8.2 *Nonfacility GA Staff Whole Body Exposures*[2]

| | |
|---|---|
| Number of employees monitored: | 1 |
| High Exposure: | 0.000 |
| Low Exposure: | 0.000 |
| Average Exposure: | 0.000 |

8.3 *Contractor and Reactor Users Whole Body Exposures*[3]

| | |
|---|---|
| Number of persons monitored: | 6 |
| High Exposure: | 0.515 |
| Low Exposure: | 0.000 |
| Average Exposure: | 0.095 |

8.4 *Visitor Whole Body Exposures*[4]

| | |
|---|---|
| Number of persons monitored: | 9 |
| High Exposure: | 0.000 |
| Low Exposure: | 0.000 |
| Average Exposure: | 0.000 |

8.5 *Routine Wipe Surveys of Mark I Reactor Facility*

| | |
|---|---|
| High Wipe: | 27 β dpm/100 $cm^2$ |
| Low Wipe: | < 1 β dpm/100 $cm^2$ |
| Average Wipe | < 1 β dpm/100 $cm^2$ |

8.6 *Routine Radiation Measurements of Mark I Reactor Facility*

| | |
|---|---|
| High Measurement: | 10 mRem/hr @ 1 foot |
| Low Measurement: | <0.2 mRem/hr @ 1 foot |
| Average Level: | <0.2 mRem/hr @ 1 foot |

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

(2) Includes GA support staff and experimenters who were granted periodic access, under a GA radiological work permit (RWP), to the reactor facility for the performance of work. These personnel may also work routinely at other GA radiation facilities; therefore, this dose represents *cumulative* exposure at all GA facilities.

(3) Includes non-GA personnel who were granted periodic access to the facility for the performance of work under a RWP. These personnel may also work routinely at other GA radiation facilities; therefore, this dose represents *cumulative* exposure at all GA facilities.

(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 from work performed at these other radiation facilities.