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25 January 2013

Subject: 2012 Annual Operating Report for the Kansas State University TRIGA Mark II Nuclear Reactor (Facility License # R-88, Facility Docket # 50-188)

To Whom It May Concern:

This document serves as the annual operating report for the Kansas State University (KSU) nuclear reactor. This document satisfies requirements in facility Technical Specifications (TS) 6.11.e.

The report is divided into paragraphs addressing specific items listed as requirements in the Technical Specifications.

Sincerely,

Jeffrey A. Geuther, Ph.D.
Nuclear Reactor Facility Manager
Kansas State University

Attachments:

1. Kansas State University TRIGA Mark II Reactor Annual Report, CY 2012
2. 10CFR50.59 Screening Forms

Cc: Spyros Traiforos, Project Manager, NRC

A020
NRR

Kansas State University TRIGA Mark II Reactor Annual Report, CY 2012

Introduction

The Kansas State University Nuclear Reactor Technical Specifications (TS) require a routine written report to be transmitted to the US Nuclear Regulatory Commission within 60 days after completion of the first calendar year of operating, and at intervals not to exceed twelve months thereafter, providing the following information:

TS.6.11.e.1 - A brief narrative summary of operating experience (including experiments performed), changes in facility design, performance characteristics, and operating procedures related to reactor safety occurring during the reporting period; and results of surveillance tests and inspections.

TS.6.11.e.2 - A tabulation showing the energy generated by the reactor (in megawatt-hours).

TS.6.11.e.3 - The number of emergency shutdowns and inadvertent scrams, including the reason thereof and corrective action, if any, taken.

TS.6.11.e.4 - Discussion of the major maintenance operations performed during the period, including the effects, if any, on the safe operation of the reactor, and the reasons for any corrective maintenance required.

TS.6.11.e.5 - A summary of each change to the facility or procedures, tests, and experiments carried out under the conditions of 10.CFR.50.59.

TS.6.11.e.6 - A summary of the nature and amount of radioactive effluents released or discharged to the environs beyond the effective control of the licensee as measured at or before the point of such release or discharge.

TS.6.11.e.7 - A description of any environmental surveys performed outside the facility.

TS.6.11.e.8 - A summary of radiation exposures received by facility personnel and visitors, including the dates and time of significant exposure, and a brief summary of the results of radiation and contamination surveys performed within the facilty.

This information is transmitted in this report, in sections separated by TS clause. This report covers January 2012 – December 2012.

TS.6.11.e.1 - A brief narrative summary of operating experience (including experiments performed), changes in facility design, performance characteristics, and operating procedures related to reactor safety occurring during the reporting period; and results of surveillance tests and inspections.

Reactor operations during 2012 were typical, with no abnormal occurrences of note. It is worth mentioning that on April 24th the reactor logged its two billionth Watt-hour, and on October 16 the reactor celebrated its 50th anniversary of operation.

Several upgrades were made to the reactor through the year. The reactor control panel had been suffering from push-button switches pushing through the panel, so that they had to be recovered from the rear of the panel. It was not possible to find replacement switches, so a new switch panel was designed featuring modern push-button switches. Another upgrade to the facility was the replacement of the steam still with a reverse osmosis unit to provide pure water for the primary water and bulk shield tank fill system. The secondary coolant pump had a leak which could not be repaired by rebuilding the pump, so the pump was replaced with a new unit of the same specifications. The air monitoring system (AMS) was moved to the top deck of the reactor (22 foot level) from the 12 foot level so that the radial sampling heads would draw air from the exhaust plenum as specified in the facility Technical Specifications.

The operations of the facility during CY2012 were normal, with many hours of class support, tours, training, and research support primarily related to semiconductor neutron detectors. A new experiment was approved to allow the facility to irradiate small amounts of neptunium in the reactor core. Technically, this experiment could have been performed under Experiment 1: Sample Irradiation, but it was judged to be of greater complexity than typical irradiation experiments and therefore warranted a specific procedure.

The NRC routine annual inspection during the summer of 2012 yielded no findings.

TS.6.11.e.2 - A tabulation showing the energy generated by the reactor (in megawatt-hours).

The monthly total energy generated by the KSU reactor is recorded in Table 1. The same data is shown as a bar chart in Figure 1. The total MWh of operation increased from the prior year, from 57 MWh to 70 MWh.

Table 1 - Energy generated by the KSU Triga Mark II reactor by month for CY 2012.

Month	MWh
January	4.1
February	5.6
March	10.2
April	9.0
May	19.5
June	0.0
July	1.6
August	6.7
September	1.4
October	7.5
November	2.5
December	1.8

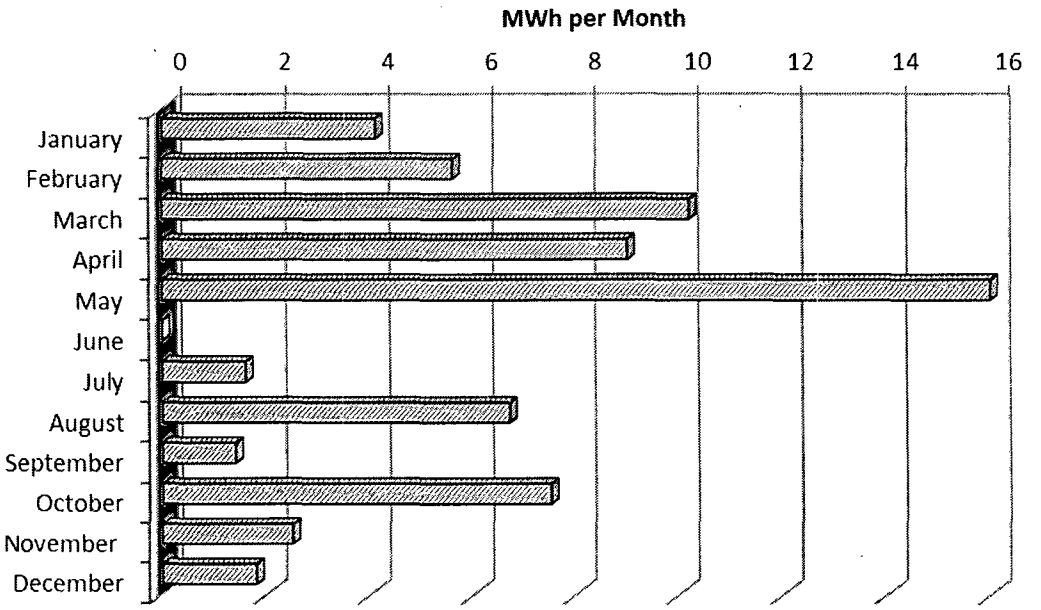

Figure 1 - Energy generated by the KSU Triga Mark II reactor by month for CY 2012.

Figure 2 shows the percentage of hours of reactor operation for various purposes, i.e., research support, training, education, etc. The percentage of hours for training appears small, because operator training was often performed when the reactor was being operated for another purpose, such as research support. The plot demonstrates that the reactor is operated in accordance with our stated primary functions: education; research support (e.g., irradiation); operator training; and demonstration (e.g., tours).

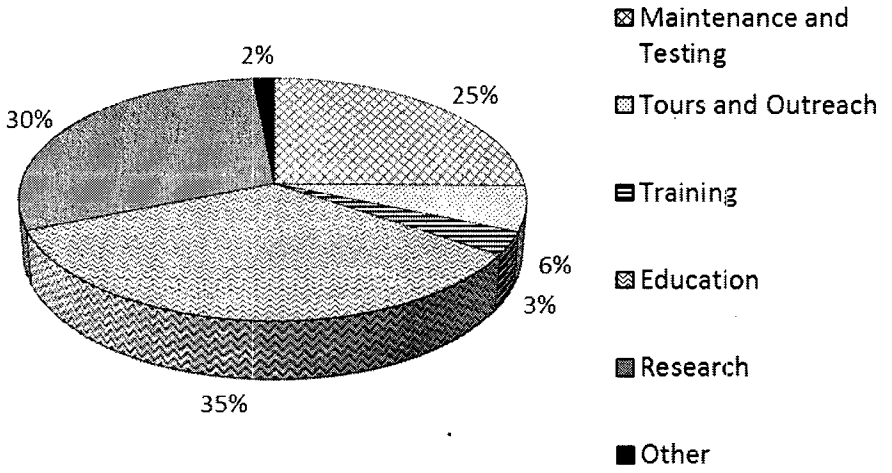

Figure 2 - KSU reactor hours, based on purpose of operation.

TS.6.11.e.3 - The number of emergency shutdowns and inadvertent scrams, including the reason thereof and corrective action, if any, taken.

Inadvertent SCRAMS and Emergency Shutdowns

Date	Action	Comments
3/2/12	Period scram	The scram was caused by a wire connection to the log-range power channel breaking loose. The period was not abnormal. The wire was soldered back into place and operations were resumed.
3/6/12	Linear power scram	The scram was caused by operator error. The power was not above the scram setpoint, but the multirange power channel was locked into low range. The scram occurred when the power went out of range.
4/24/12	Period scram	This scram occurred at low power and was due to operator error.
5/1/12	Linear power scram	The scram was caused by operator error. The power was not above the scram setpoint, but the multirange power channel was locked into low range. The scram occurred when the power went out of range.
5/2/12	Period scram	This scram occurred at low power and was due to operator error.
11/6/12	Spurious scram	There was no known cause for this scram. Power and temperature were steady prior to the scram.
12/19/12	Percent power scram	This scram occurred at a power of 840 kW, which is below the setpoint of 1040 kW.

TS.6.11.e.4 - Discussion of the major maintenance operations performed during the period, including the effects, if any, on the safe operation of the reactor, and the reasons for any corrective maintenance required.

No major maintenance operations affected the safe operation of the reactor. Three maintenance operations which may be considered major are the replacement of the steam still will a reverse osmosis system, the replacement of the secondary water pump, and the replacement of the auxiliary switch panel on the reactor console with a more modern equivalent. Note that none of the switches that were replaced operate safety equipment, and none of the indicator lights on the panel are for scrams or temperature alarms.

TS.6.11.e.5 - A summary of each change to the facility or procedures, tests, and experiments carried out under the conditions of 10CFR-50.59.

The following changes were carried out under 10CFR-50.59.

- The primary fill system was replaced with a reverse osmosis unit.
- The auxiliary switch / indicator light panel on the console was replaced with a more modern version due to obsolescence of the existing system and the breakage of several switches.
- The air monitoring system (AMS) was moved from the 12 foot level of the reactor bay to the 22 foot level.
- The secondary cooling pump was replaced with an equivalent unit.

None of the above changes were determined to have a significant impact on the safety analysis. Copies of the 10CFR-50.59 screening checklists that were performed to accept the changes are attached to this report.

TS.6.11.e.6 - A summary of the nature and amount of radioactive effluents released or discharged to the environs beyond the effective control of the licensee as measured at or before the point of such release or discharge.

On two occasions the contents of the reactor bay sump were discharged to the secondary surge tank. Per procedure, the radioisotope inventory and concentration were calculated prior to discharge, showing both to be well below the limits in 10CFR-20:

Isotope	Avg. Concentration (μCi / mL)	Limit* (μCi / mL)	Total Volume (mL)	Total Activity Released (μCi)
^{3}H	3.32E-11	1.00E-02	6.69E6	2.22E-4
^{14}C	5.64E-13	3.00E-04		3.77E-6
^{32}P	6.71E-13	9.00E-05		4.49E-6

*10CFR-20, App.B

The only other discharges beyond the facility boundary were HVAC condensate discharges to the sanitary sewer. Since the Kansas State University average water usage is 750,000 gallons per day, it is nearly impossible to exceed 10CFR20 limits for effluent concentration at the KSU reactor. The HVAC condensate measured concentration levels

were all approximately at background levels, which is expected, since the HVAC condensate water is never circulated through or near the reactor core.

TS.6.11.e.7 - A description of any environmental surveys performed outside the facility.

Monthly radiation surveys are performed within the facility to verify that radiation levels remain safe when at full-power operation. These surveys indicate that the dose rate at the inside surface of the reactor dome does not exceed the hourly dose limit to members of the public of 2 mR / h, as set forth in 10CFR-20, which indicates that the outside dose cannot exceed this limit.

TS.6.11.e.8 - A summary of radiation exposures received by facility personnel and visitors, including the dates and time of significant exposure, and a brief summary of the results of radiation and contamination surveys performed within the facilty.

A table showing the number of workers receiving given amounts of dose is presented below. Note that no worker received a shallow dose equivalent, deep dose equivalent, or lens dose equivalent in excess of 50 mrem. This shows that the facility radiation protection program has continued to be successful in keeping occupational doses as low as reasonably achievable.

Table 2 - Summary of total occupational dose received by KSU reactor workers from 1/1/2012 - 12/31/2012.

mrem	DDE	LDE	SDE
(0, 10]	1	1	1
(10, 20]	3	2	1
(20, 30]	6	5	3
(30, 40]	1	1	4
(40, 50]	1	2	2
>50	0	0	0

Visitor dose at the KSU TRIGA reactor facility is measured using Civil Defense self-indicating pocket dosimeters, with an indication range from 0-200 mR. Self-indicated pocket dosimeter readings suffer from imprecision due to parallax error, sometimes resulting in negative values or readings above the true value. Aberrant results were checked against visitor dose records from the same tour, and were not included in these data if it appeared that the unusual values were from improper data entry or a dropped dosimeter.

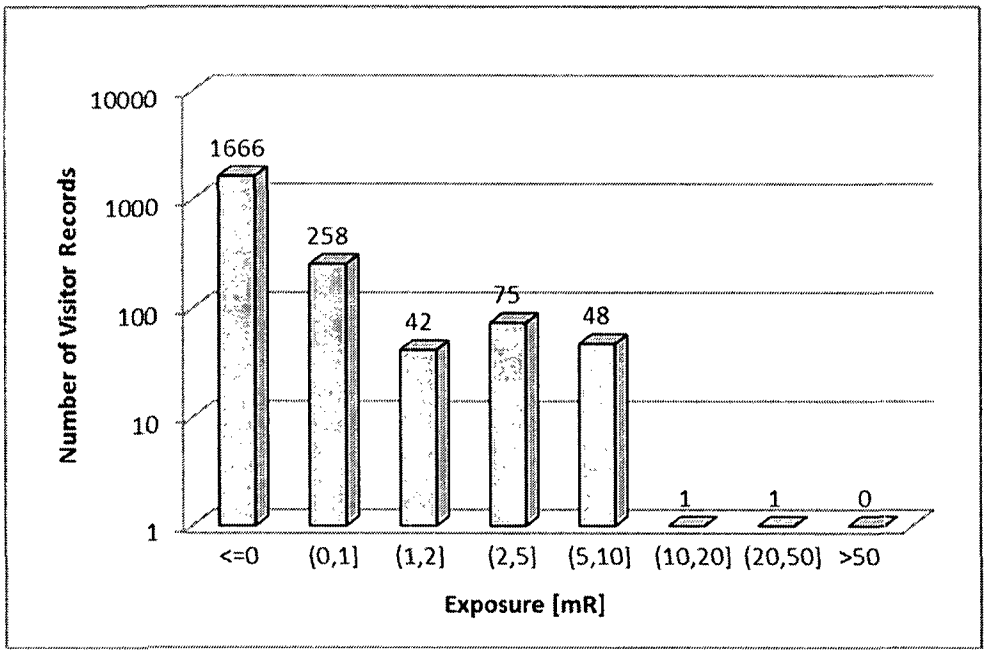

Figure 3 - Visitor dose records from CY 2012.

All radiation surveys and contamination surveys conducted at the facility in 2012 were nominal.

This concludes the 2012 Annual Report for the Kansas State University TRIGA Mark II Nuclear Reactor.

TITLE	*Air Monitoring System*	DATE	8/7/2012
DESCRIPTION	Move AMS-4 system to 22' level, with all sampling heads in exhaust Plenum.		

SCREENING: The following guidance provides criteria to screen the proposed change from further assessing need for NRC review. If the change does not affect (1) a design function of SSC, (2) a method of performing or controlling design function, (3) evaluation for demonstrating the design function will be accomplished, then it is not necessary to continue the evaluation.

SSC Affected	SSC Design function	Failure Mode(s)	Accident scenario(s)
NA	NA	NA	NA

SAFETY ANALYSIS & ACCIDENT RESPONSE/MITIGATION	YES	NO
Decrease SSC design function reliability when failure would initiate an accident		X
Decrease SSC design function reliability when failure would mitigate accident		X
Reduce redundancy, reliability or defense in depth		X
Add or delete an automatic or manual design function of an SSC		X

HUMAN INTERFACE	YES	NO
Convert an automatic feature to manual or vice versa		X
Adversely affect ability to perform required actions		X
Adversely affect time response of required actions		X

INTERFACE OUTSIDE THE PROPOSED CHANGE	YES	NO
Degrade seismic or environmental qualification		X
Affect method of evaluation used to establish design basis or safety analysis		X
Introduce an unwanted or previously unreveiwed system or material interaction		X
(Not described in SAR) indirect effects on electrical distribution		X
(Not described in SAR) indirect effects structural integrity		X
(Not described in SAR) indirect effects on environmental conditions		X
(Not described in SAR) indirect effects on other SAR design functions		X

COMMENTS: The AMS will be located in the exhaust plenum as defined by the TS, which is the optimum position for detecting damage to fuel. The human response time could be adversely affected if the visual alarms are in a location that is difficult to see. For this reason, the readout modules will be located on the control room side of the 22' level.

PERFORMED BY: J A Geuther DATE: 8/7/2012

If any of the above answers are YES, then proceed to the EVALUATION section.

TITLE	*Secondary Pump*	DATE	9/4/2012
DESCRIPTION	Replace Griswold 10 HP, 3 in. inlet, 4 in. outlet, 220 V centrifugal pump with Gould 10 HP, 3 in. inlet, 4 in. outlet, 220 V centrifugal pump		

SCREENING: The following guidance provides criteria to screen the proposed change from further assessing need for NRC review. If the change does not affect (1) a design function of SSC, (2) a method of performing or controlling design function, (3) evaluation for demonstrating the design function will be accomplished, then it is not necessary to continue the evaluation.

SSC Affected	SSC Design function	Failure Mode(s)	Accident scenario(s)
NA	NA	NA	NA

SAFETY ANALYSIS & ACCIDENT RESPONSE/MITIGATION	YES	NO
Decrease SSC design function reliability when failure would initiate an accident		X
Decrease SSC design function reliability when failure would mitigate accident		X
Reduce redundancy, reliability or defense in depth		X
Add or delete an automatic or manual design function of an SSC		X

HUMAN INTERFACE	YES	NO
Convert an automatic feature to manual or vice versa		X
Adversely affect ability to perform required actions		X
Adversely affect time response of required actions		X

INTERFACE OUTSIDE THE PROPOSED CHANGE	YES	NO
Degrade seismic or environmental qualification		X
Affect method of evaluation used to establish design basis or safety analysis		X
Introduce an unwanted or previously unreveiwed system or material interaction		X
(Not described in SAR) indirect effects on electrical distribution		X
(Not described in SAR) indirect effects structural integrity		X
(Not described in SAR) indirect effects on environmental conditions		X
(Not described in SAR) indirect effects on other SAR design functions		X

COMMENTS:

PERFORMED BY: J A Geuther DATE: 9/4/2012

If any of the above answers are YES, then proceed to the EVALUATION section.

TITLE	*Auxiliary Switch Panel*	DATE	3/21/2012
DESCRIPTION	Replace Micro push-button switches and indicator lamps on auxiliary panel to upper-right of console with modern switches and LEDs, due to obsolescence of Micro switches in use.		

SCREENING: The following guidance provides criteria to screen the proposed change from further assessing need for NRC review. If the change does not affect (1) a design function of SSC, (2) a method of performing or controlling design function, (3) evaluation for demonstrating the design function will be accomplished, then it is not necessary to continue the evaluation.

SSC Affected	SSC Design function	Failure Mode(s)	Accident scenario(s)
NA	NA	NA	NA

SAFETY ANALYSIS & ACCIDENT RESPONSE/MITIGATION	YES	NO
Decrease SSC design function reliability when failure would initiate an accident		X
Decrease SSC design function reliability when failure would mitigate accident		X
Reduce redundancy, reliability or defense in depth		X
Add or delete an automatic or manual design function of an SSC		X

HUMAN INTERFACE	YES	NO
Convert an automatic feature to manual or vice versa		X
Adversely affect ability to perform required actions		X
Adversely affect time response of required actions		X

INTERFACE OUTSIDE THE PROPOSED CHANGE	YES	NO
Degrade seismic or environmental qualification		X
Affect method of evaluation used to establish design basis or safety analysis		X
Introduce an unwanted or previously unreveiwed system or material interaction		X
(Not described in SAR) indirect effects on electrical distribution		X
(Not described in SAR) indirect effects structural integrity		X
(Not described in SAR) indirect effects on environmental conditions		X
(Not described in SAR) indirect effects on other SAR design functions		X

COMMENTS:

PERFORMED BY: J A Geuther DATE: 3/21/2012

If any of the above answers are YES, then proceed to the EVALUATION section.

TITLE	***Primary Fill System***	DATE	3/14/2012
DESCRIPTION	Replace steam still with reverse osmosis unit for primary water fill.		
Purity of RO water meets or exceeds purity from steam still. Makeup capacity exceeds Capacity of steam still.			

SCREENING: The following guidance provides criteria to screen the proposed change from further assessing need for NRC review. If the change does not affect (1) a design function of SSC, (2) a method of performing or controlling design function, (3) evaluation for demonstrating the design function will be accomplished, then it is not necessary to continue the evaluation.

SSC Affected	**SSC Design function**	**Failure Mode(s)**	**Accident scenario(s)**
NA	NA	NA	NA

SAFETY ANALYSIS & ACCIDENT RESPONSE/MITIGATION	YES	NO
Decrease SSC design function reliability when failure would initiate an accident		X
Decrease SSC design function reliability when failure would mitigate accident		X
Reduce redundancy, reliability or defense in depth		X
Add or delete an automatic or manual design function of an SSC		X

HUMAN INTERFACE	YES	NO
Convert an automatic feature to manual or vice versa		X
Adversely affect ability to perform required actions		X
Adversely affect time response of required actions		X

INTERFACE OUTSIDE THE PROPOSED CHANGE	YES	NO
Degrade seismic or environmental qualification		X
Affect method of evaluation used to establish design basis or safety analysis		X
Introduce an unwanted or previously unreveiwed system or material interaction		X
(Not described in SAR) indirect effects on electrical distribution		X
(Not described in SAR) indirect effects structural integrity		X
(Not described in SAR) indirect effects on environmental conditions		X
(Not described in SAR) indirect effects on other SAR design functions		X

COMMENTS:

PERFORMED BY: J A Geuther DATE: 03/14/2012

If any of the above answers are YES, then proceed to the EVALUATION section.