50-188

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Subject: 2017 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,

A. V. Cebula

Alan Cebula, Ph.D.
Nuclear Reactor Facility Manager
Kansas State University

Attachments:

1. Kansas State University TRIGA Mark II Reactor Annual Report, CY 2017
2. 10CFR50.59 Screening Forms

Cc: Spyros Traiforos, Project Manager, NRC
Johnny Eads, Inspector,NRC

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Kansas State University TRIGA Mark II Reactor Annual Report, CY 2017

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 facility.

This information is transmitted in this report, in sections separated by TS clause. This report covers January 2017 – December 2017.

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.

The KSU reactor operated for its usual purposes in CY2017. One reactor operations laboratory class and a reactor theory laboratory class were directly supported, along with approximately 9 other courses with occasional use of the reactor. Through various outreach activities, classes, and research experiments, the facility hosted 1633 visitors. Compared to CY2016, the number of visitors to facility decreased by about a third.

Typical research experiments included neutron activation analysis (NAA), neutron radiography, neutron detector testing at beam ports, in-core neutron detector testing, and in-core temperature measurement. A total of 35 pulses were performed with all but two occurring between January and May 2017. No new experiments were approved in CY2017.

The NRC routine annual inspection was completed from August 7 – 10, 2017. No violations or inspector follow-up items were reported. (See Inspection Report No. 50-188/2017-201).

A change to the secondary surge tank level monitoring system was performed. Instead of utilizing a mercury switch to indicate low surge level, a transducer utilizing an ultrasonic sensor was installed. The output of the new level sensor was connected to the surge low indicator on the console. The leak repairs made to the thermal column in 2016 remained stable throughout 2017. However, water ingress into the beam port facilities is still being monitored. The repair for the water ingress originally scheduled for July 2017 is still being evaluated.

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 decreased from the prior year, from 42.1 MWh to 36.2 MWh.

Table 1 - Energy generated by the KSU Triga Mark II reactor by month for CY 2017.

Month	MWh Burnup
January	2.37
February	2.26
March	5.70
April	5.37
May	3.31
June	3.72
July	2.31
August	5.22
September	1.17
October	0.91
November	0.75
December	3.06
TOTAL	**36.15**

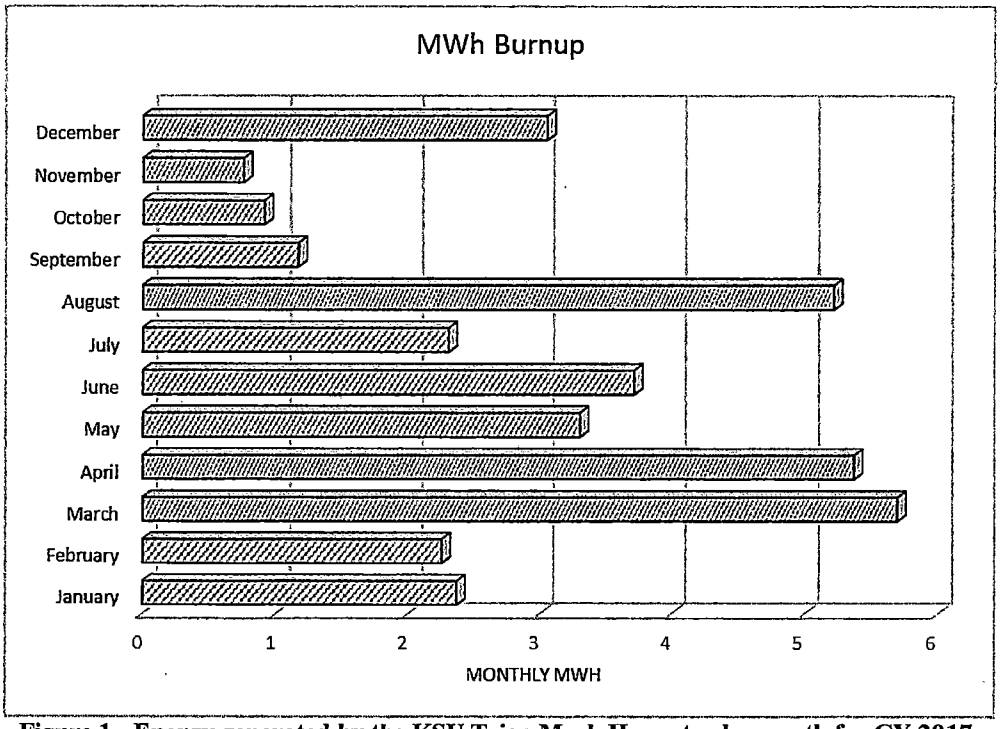

Figure 1 - Energy generated by the KSU Triga Mark II reactor by month for CY 2017.

The reactor operated for a total of 465 hours during 2017, at an average power of 78 kW. Table 2 lists the number of hours operated and Figure 2 shows the percentage of operation for various purposes, i.e., research support, training, education, etc. Training percentage seems low 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). Compared to CY2016, operations shifted from testing to supporting research. The number of operating hours for research more than doubled while testing decreased by almost a factor of ten. In addition to an increase in research operations, time spent conducting maintenance operations also increased. Overall, the total number of hours operated was similar over the past two years.

Table 2 – Operating hours grouped by purpose at the KSU TRIGA Mark II reactor for CY 2017.

Purpose	Operating Time [hr]
Research	190
Tours	51
Classes	99
Maintenance	91
Training	17
Testing	17
TOTAL	**465**

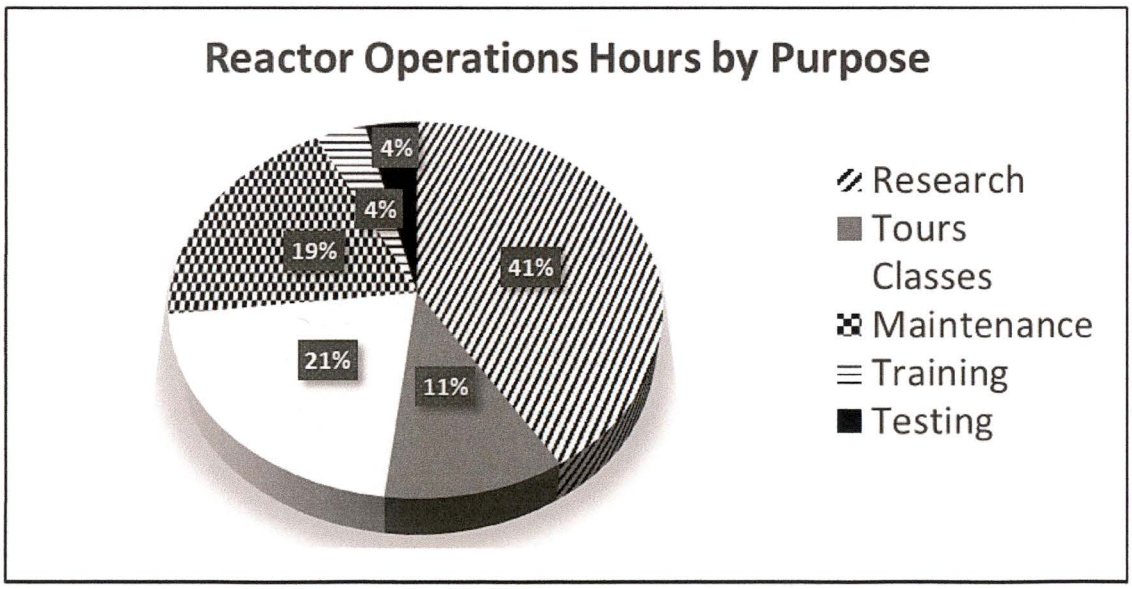

Figure 2 - KSU operations distribution, CY2017, based on purpose of operation.

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

The following table documents the inadvertent SCRAMS for CY 2017 at the KSU reactor. This table does not include single dropped rods. There were occasions when rods dropped, but not due to a reactor trip. There were no emergency shutdowns. Note that the period scram due to transient rod motor noise occurred when the other rods were bottomed. In other words, the reactor is at very low power when the scram occurred.

Table 3 – Inadvertent SCRAMS and Emergency Shutdowns.

Date	Action	Comments
1/24/2017	Period Scram	Operator error
3/3/2017	Scram	Console mode select switch was set to invalid mode
8/28/2017	Fuel Temp Scram	Caused by attempt to fix Fuel TC 1 wires. Fuel temp TC 1 wires re-insulated and reconnected
10/24/2017	Period Scram	Due to transient rod motor noise
12/4/2017	Period Scram	Operator error

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. The following major maintenance activities occurred:

- Replaced bias potentiometer on safety rod
- Replaced surge level mercury switch with ultrasonic transducer level indicator
- Replaced Pool Outlet Temperature thermocouple
- Installed new bias potentiometer on regulating rod
- Replaced transient rod air hose
- Replaced exhaust fan control relay and power transformer

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:

- Replacement of mercury switch with ultrasonic sensor to measure height of second water in surge tank.
- Replacement of regulating rod R901 bias resistor with one of higher resistance.

The screening forms for these changes are attached.

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.

Per procedure, the radioisotope inventory and concentration were calculated prior to discharge, showing both to be well below the limits in 10CFR-20. Table 4 summarizes the average concentration and total activity released.

Table 4 – Summary of radioactive effluent

Isotope	Avg. Concentration (Ci / mL)	Total Volume (mL)	Total Activity Released (Ci)
Alpha-emitters	1.18E-15	3.74E+06	4.40E-09
Beta-emitters	3.82E-11	9.43E+06	3.60E-04

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. HVAC condensate water is never circulated through or near the reactor core and historically radiation levels in HVAC condensate are near background levels.

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

Semi-annual 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 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 facility.

Table 5 shows on the next page the number of workers receiving given amounts of dose. The maximum dose for a staff member was less than 150 mrem deep dose equivalent.

Table 5 - Summary of total occupational dose received by KSU reactor workers from 1/1/2017 - 12/31/2017.

mrem	DDE	LDE	SDE
(0, 10]	2	2	1
(10, 20]	1	0	1
(20, 30]	1	2	1
(30, 40]	3	3	3
(40, 50]	3	1	2
(50,100]	3	5	5
(100,150]	2	2	1
(150,200]	0	0	1

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.

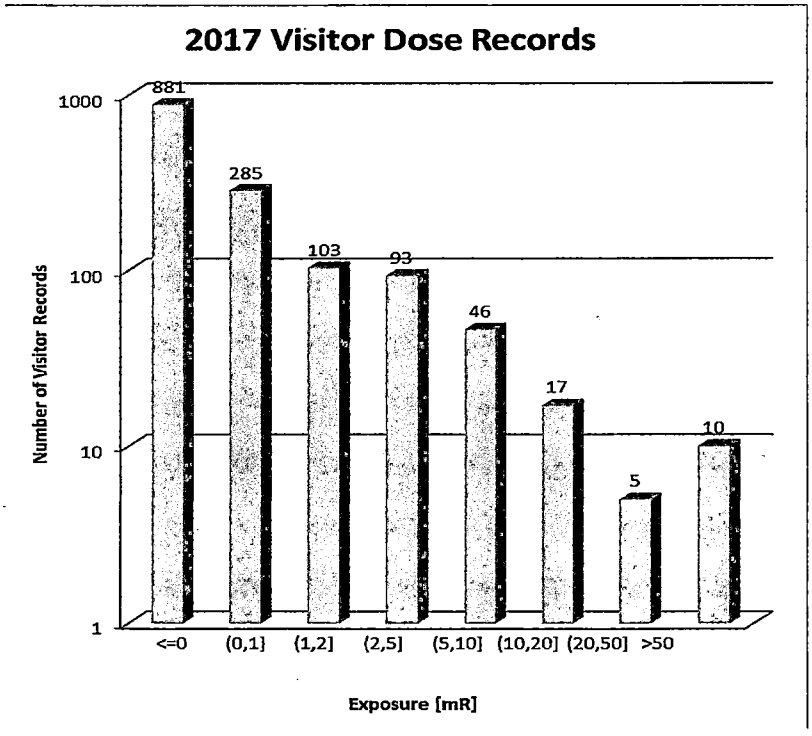

Figure 3 - Visitor exposure records from CY 2017.

All radiation surveys and contamination surveys conducted at the facility in 2017 were nominal.

This concludes the 2017 Annual Report for the Kansas State University TRIGA Mark II Nuclear Reactor.

TITLE	Surge Level Indicator Replacement DATE 2/28/17
DESCRIPTION	Replacement of MAYCO switch with Ultrasonic sensor to measure height of spondex water in surge tank. The signal is sent to the surge low indicator on the console.

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)
None	None	None	None

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

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

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

COMMENTS: Surge Level Indicator ~~is~~ is in the Safety Analysis Report, but has no Safety function

PERFORMED BY: [signature] DATE: 2/28/17

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

Date: 8/17/2017

Title: Replacement of Standard Rod R901 Bias Resistor with one of higher resistance.

Performer: Max Nager

Description: The R901 Bias Resistor provides the phase difference that holds the rod drive in place when the motor is at rest. Occasionally, with the console is energized, the rod drive attempts drive out, even in the absence of an "UP" signal. This condition is thought to be caused by the phase difference overcompensating for the weight of the connecting rod system. The R901 Bias Resistor, as currently configured, is therefore introducing an unwanted condition that negatively affects its safety function. Replacing the R901 Bias Resistor with one that possesses a higher maximum resistance will restore the intended function of holding the rod in place. Potential negative conditions and/or failures that could result from this change are a reduction in rod drive speed and rod dropping. These conditions are conservative with respect to the current condition.

SCREENING – The following guidance provides criteria to screen the proposed change from further assessing the need for NRC review.

SSC Affected	**SSC Design Function**	**Failure Mode(s)**	**Accident Scenario(s)**
Control Rod Drive	Control Rod Drive Withdrawal	None/See Below	None/See Below

Safety Analysis and Accident Response/Mitigation	YES	NO
Decrease SSC design function reliability when failure would initiate accident		x
Decrease SSC design function reliability when failure would affect accident mitigation		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 of 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 unwanted or previously unreviewed system or material interaction		x

(Not described in SAR) indirect effects on electrical distribution	x	
(Not described in SAR) indirect effects on 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 R901 Bias Resistor is not cited in the Technical Specifications, but it is cited in the Safety Analysis Report (SAR). The SAR does not specify a resistance value, but does describe the ability to adjust it. The TRIGA Instrumentation Manual specifies R901 as having a resistance of 300 ohms and includes procedures for its adjustment.

EVALUATION - If the change does affects (1) a design function of SSC, (2) a method of performing or controlling design function, or (3) evaluation for demonstrating the design function will be accomplished, as indicated by one or more YES answers in the "Screening" section, complete the applicable tables below.

Does the change result in more than a minimal increase in the frequency of occurrence of an accident previously evaluated in the final SAR (as updated)?	YES	NO
		x

Accident	***Potential Impact on Accident Frequency***
Reactivity Addition	N/A
LOCA	N/A
Fuel Handling	N/A

Does the change result in more than a minimal increase in the likelihood of occurrence of a malfunction of an SSC important to safety previously evaluated in the final SAR (as updated)?	YES	NO
		x

Affected SSC	***Potential Impact on Likelihood of Malfunction***
N/A	N/A

Does the change result in more than a minimal increase in the consequences of an accident previously evaluated in the final SAR (as updated)?	YES	NO
		x

Accident	***Potential Impact on Accident Consequences***
Reactivity Addition	N/A
LOCA	N/A
Fuel Handling	N/A

Does the change result in more than a minimal increase in the consequences of a malfunction of an SSC important to safety previously evaluated in the final SAR (as updated)?	YES	NO
		x

Affected SSC	***Potential Impact on Consequences of Malfunction***
N/A	N/A

EVALUATION – continued

Does the change create a possibility for an accident of a different type than previously evaluated in the final SAR (as updated)?	YES	NO
		x

Accident Description (Including Likelihood and Consequences)
N/A

Does the change create a possibility for a malfunction of an SSC important to safety with a different result than any previously evaluated in the final SAR (as updated)?	YES	NO
		x

Accident	***Affected SSC***	***Result***
Reactivity Addition	N/A	N/A
LOCA	N/A	N/A
Fuel Handling	N/A	N/A
Other	N/A	N/A

Does the change result in exceedance or alteration of a design basis limit for a fission product barrier as described in the SAR (as updated)?	YES	NO
		x

Category	***Reference/Text***	***Value***
Design Basis Limit	N/A	N/A
Analysis	N/A	N/A
Approach to Limit	N/A	N/A

Does the change result in departure from a method of evaluation described in the final SAR (as updated) used to establish design bases or in the safety analysis?	YES	NO
		x

Category	***Reference/Text***	***Value***
Design Basis	N/A	N/A
New Analysis	N/A	N/A
Comparison	N/A	N/A

APPROVAL – According to Technical Specifications, Section 6.2(b)4, the Reactor Safeguards Committee is responsible for determining "whether changes in the facility as described in the safety analysis report (as updated), changes in the procedures as described in the final safety analysis report (as updated), and the conduct of tests or experiments not described in the safety analysis report (as updated) may be accomplished in accordance with 10 CFR 50.59 without obtaining prior NRC approval via license amendment pursuant to 10 CFR Sec. 50.90."

Date of RSC approval:
8/22/2017
Method of RSC approval:
Email Poll