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

K-STATE
Kansas State University
Department of Mechanical and Nuclear Engineering
3002 Rathbone Hall
Manhattan, KS 66506-5205
785-532-5610
Fax: 785-532-7057

US NRC
Attn: Document Control Desk
Washington, DC 20555-0001

17 February 2011

Subject: 2010 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 2010
2. 10CFR50.59 Screening Forms

Cc: Cindy Montgomery, Project Manager, NRC

A020
NRR

Kansas State University TRIGA Mark II Reactor Annual Report, CY 2010

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 2010 – December 2010.

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 TRIGA Mark II reactor operates for research, training, and demonstration purposes. The reactor staff consists almost entirely of undergraduate students. The only full-time staff member is the Reactor Manager. For this reason, new operator training is a very important duty of the facility. The demonstration purpose of the reactor is very important as well, and the reactor staff endeavors to make our facility accessible to visitors from K-State and outside organizations. The KSU reactor was host to approximately 1800 visitors through the course of the year.

There were several significant personnel changes in 2010. Two student Senior Reactor Operators held the titles of Reactor Manager and Reactor Supervisor following the departure of Paul Whaley, the previous Reactor Manager and Supervisor. On January 11, 2010, Jeff Geuther took over as Reactor Manager. After Dr. Geuther received his SRO license, the Reactor Safeguards Committee installed him as Reactor Supervisor as well. In addition to the change in management, the following changes to licensed staff took place in 2010:

John Porter	SRO	Departed
Joshua Smith	SRO / Acting Manager	Departed
Brandi Walborn	SRO	Departed
Caleb Whitten	SRO	Departed
Jeffrey Geuther	SRO / Mgr. / Supervisor	Received License
Kaity Jordan	RO	Received License
Michael Marietta	RO	Received License
Derrick Neufeld	RO	Received License
Robert Rogers	RO	Received License
Jeffrey Saddler	RO	Received License
Neal Strathman	RO	Received License

The primary experiments performed at the reactor were neutron activation analysis and neutron detector testing. The reactor operated for fewer hours in its research support role than in 2009, primarily due to one of its primary customers, a semiconductor detector lab within KSU, being off-line for approximately six months for a clean room installation.

The automatic flux control mode of operation, which uses the regulating rod to maintain power at a certain percent of scale, ceased to operate properly. A new flux controller will be installed in early 2011 by General Atomics. It is expected that this will restore automatic flux control mode.

The reactor completed a series of security upgrades as part of a GTRI-sponsored voluntary security enhancement program.

No significant or unanticipated findings resulted from either the NRC annual routine facility inspection or the surveillances performed by the reactor staff. However, on September 22, 2010, a staff member was exposed to an unanticipated high dose rate of radiation from an irradiated sample holder. The staff member received 147 mrem of whole-body dose, and 13 rem of extremity dose (to the hands). The NRC conducted a special inspection and issued a Level III violation to the facility (EA-10-234), citing weaknesses in the facility radiation protection program. In response to the incident, the facility is conducting an ongoing review of all facility procedures, with procedures suspended until they have been reviewed to ensure that they adequately protect personnel and the public from radiological and other emergencies. The procedure review has resulted in revisions to several operating and experimental procedures during 2010:

1. Experimental Procedure EP1 – Isotope Production (including associated Radioactive Byproduct Logs)
2. Management Order SOM4 – Access and Visitor Controls
3. Operating Procedure 10 – Fuel Element Inspection (pending Reactor Safeguards Committee approval)
4. Operating Procedure 13 – Portable Radiation Survey Meter Calibration (in process of revision)
5. Operating Procedure 21 – Alpha Particle Assay of Reactor Liquids

Thirty-seven additional procedures are suspended pending a safety review. However, most are old or unimportant procedures, and they are not needed in the near future. Operating Procured 2, Annual Power Level Calibration, was revised allow a lower starting moderator temperature for winter execution. This change was not safety-related.

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.

Table 1 - Energy generated by the KSU Triga Mark II reactor by month for CY 2010.

Month	MWh
January	14.44
February	4.64
March	2.59
April	5.96
May	3.16
June	5.17
July	0.98
August	0.14
September	5.45
October	3.23
November	5.38
December	5.74

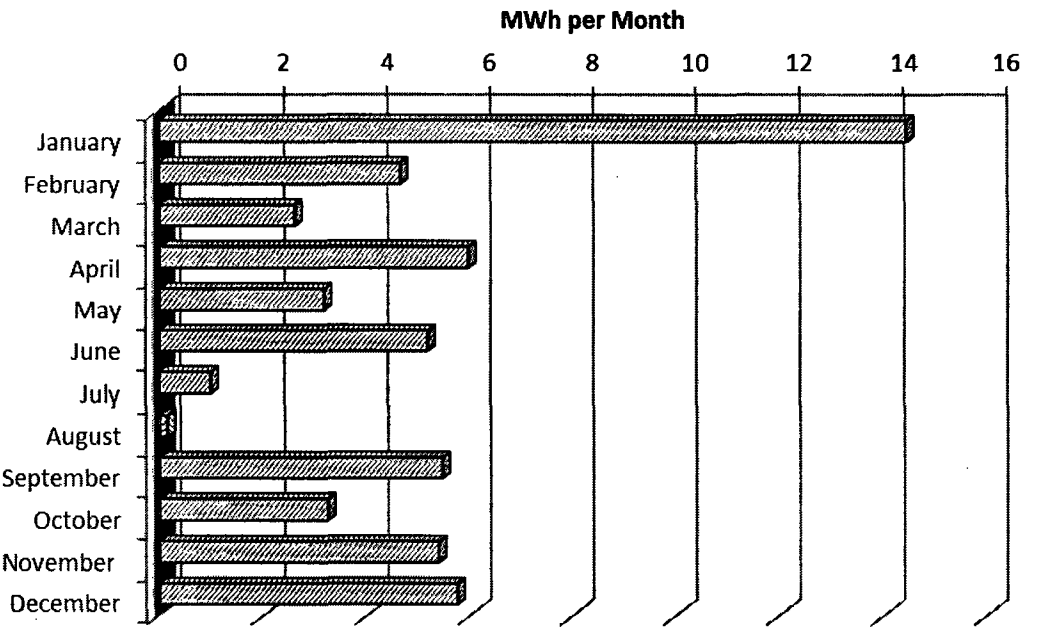

Figure 1 - Energy generated by the KSU Triga Mark II reactor by month for CY 2010.

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).

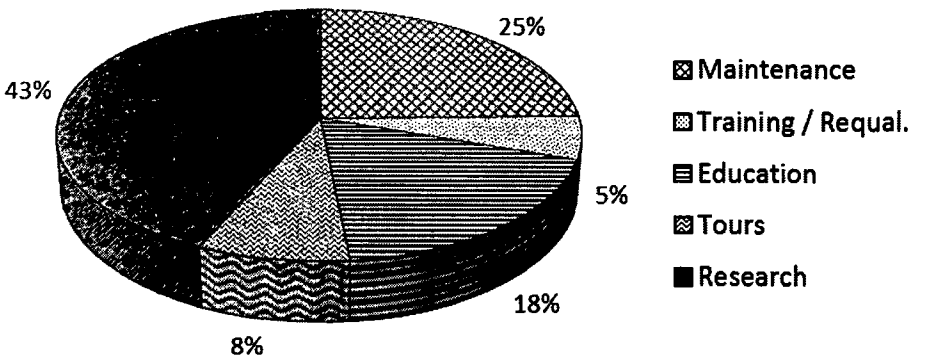

Figure 2 - KSU reactor hours charged, based on purpose of operation.

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

- Linear power scram due to NMP-1000 multi-range power channel being locked into a low range, no corrective action, 3 occurrences.
- Scram when switching from STEADY STATE mode into PULSE mode. Operator error in execution of switch-over presumed. No corrective action. 1 occurrence.
- Period scram when operating with source removed and low count rate interlock bypassed. 2 occurrences in quick succession. Source was re-inserted and low count rate interlock was reengaged as corrective action. 3 total occurrences.
- Period scram due to increase in reactivity during transient rod out-shim. No corrective action. 1 total occurrence.
- Percent power scram (1), period scrams (2), unknown cause. Scrams occurred during two days of artillery practice at Fort Riley, although it is not known whether this had an effect or why artillery practice would have caused scrams. No corrective action. Problem ceased after artillery practice ended. Scrams were initiated by the NLW-1000 channel, which later was sent to General Atomics for repair after two voltage regulators and an integrated circuit failed. It is possible that these scrams were early signs of failure in the NLW-1000. 3 total occurrences.

Emergency Shutdowns
None.

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 procedures were performed aside from the potentiometer replacement and hand rail installation reported per TS.66.1.5 (next section).

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.

1. Experimental Procedure EP-1, Isotope Production, was re-written with the addition of an extensive set of safety measures and revisions to the Radioactive Byproduct Log.

2. Management Order SOM-4, Access Controls, was re-written with additional orders restricting access to unshielded beams with the reactor at power.
3. Operating Procedure OP-21, Alpha Particle Assay of Reactor Liquids, was revised to contain fire safety precautions.
4. The railing on the 12' level which extended back to the reactor structure along the edges of the bulk shield tank was removed, and a new railing was constructed to enclose the entire 12' level around the reactor structure. This modification allows workers to access the air monitoring system and other equipment without fall protection.
5. The potentiometer for the automatic flux controller was replaced with an equivalent unit, except with an odometer-like indicator instead of a dial indicator.

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 May 5th, the contents of the sump were discharged to sanitary sewer. Per Procedure, the radioisotope inventory and concentration were calculated prior to discharge, showing both to be well below the limits in 10CFR-20:

Isotope	Concentration (μCi / mL)	Limit* (μCi / mL)	Volume (mL)	Total Activity Released (μCi)
^{3}H	4.73E-05	1.00E-02	3.28E+06	1.55E+02
^{14}C	1.04E-05	3.00E-04		3.41E+01
^{32}P	5.41E-06	9.00E-05		1.77E+01
^{137}Cs	9.86E-07	1.00E-05		3.23E+00

*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.

On 9/22/10, a worker received approximately 13 rem of extremity dose and 147 mrem of whole-body dose due to a higher than expected exposure rate from an irradiated sample. This represents the only significant exposure at the KSU reactor for 2010. While significant and unfortunate, this exposure did not cause injury or result in the worker receiving a dose in excess of the limits set forth in 10CFR-20. The highest annual dose received by any worker was 223 mrem (deep dose equivalent). Last year, the highest dose was 210 mrem, so despite the exposure on 9/22/10, there was not a significant increase in the whole body dose received by the staff. A table showing the number of workers receiving given amounts of dose is presented below.

Table 2 - Summary of total occupational dose received by KSU reactor workers from 1/1/2010 - 12/31/2010. Only workers with more than three months of employment are included.

mrem	DDE	LDE	SDE
(0, 50]	6	5	3
(50, 100]	2	2	4
(100, 150]	3	4	4
(150, 200]	0	0	0
(200, 250]	1	1	1
>250	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. Records from 2010 demonstrate that no visitor received an excessive radiation dose (Figure 3).

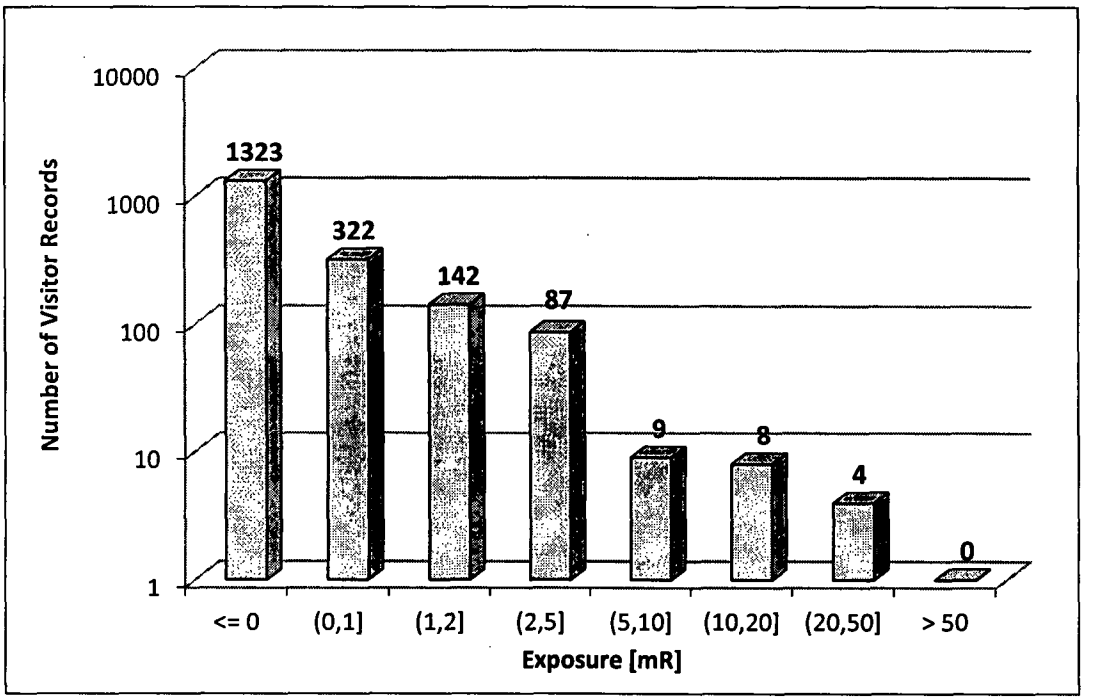

Figure 3 - Histogram of recorded dose for reactor visitors, CY 2010.

All radiation surveys and contamination surveys conducted at the facility in 2010 were nominal.

This concludes the 2010 Annual Report for the Kansas State University TRIGA Mark II Nuclear Reactor.

Jeffrey A. Geuther, Ph.D.
Nuclear Reactor Facility Manager

TITLE	*Experiment Procedure 1*	DATE	10/4/2010
DESCRIPTION	Re-write EP1 with additional safety measures		

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: 10/4/2010

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

TITLE	*SOM-4, Access Controls*	DATE	10/8/2010
DESCRIPTION	Include orders restricting access to unshielded beams		

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: 10/8/2010

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

TITLE	*Operating Procedure 21*	DATE	11/23/10
DESCRIPTION	Re-write OP21 (Liquid sample evaporation) with fire safety precautions		

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: 11/23/2010

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

TITLE	*Fence*	DATE	4/28/2010
DESCRIPTION	Install a railing around the entire 12' level, replacing the railing which surrounds the BST only.		

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 railing on the 12' level appears in a drawing in the SAR (Fig. 1.1), but is not credited in any accident analysis. The replacement is for reasons of personnel safety, and will prevent falls from the previously unprotected areas around the 12' level.

PERFORMED BY: J. A. Geuther DATE: 4/27/2010

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

TITLE	***Flux Control Potentiometer***	DATE	10/8/2010
DESCRIPTION	Replace automatic flux control potentiometer with equivalent. Unit is identical except for odometer-type indicator instead of dial, and some physical differences (i.e., size and shape).		

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: 10/8/2010

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