November 22, 2010

EA-10-234

Dr. Jeffrey Geuther, Manager
Kansas State University Nuclear Reactor Facility
Department of Mechanical and
Nuclear Engineering
112 Ward Hall
Kansas State University
Manhattan, KS 66506-5204

SUBJECT: KANSAS STATE UNIVERSITY - NRC SPECIAL INSPECTION REPORT NO. 50-188/2010-202

Dear Dr. Geuther:

On September 28-30, the U.S. Nuclear Regulatory Commission (NRC, the Commission) conducted a Special Inspection at the Kansas State University Nuclear Reactor Facility. The special inspection included an examination of activities conducted under your license as they relate to safety and compliance with the Commission's rules and regulations. Pursuant to your "10-day" report dated October 1, 2010, later supplemented on October 7, 2010, describing the causes of the event and your corrective actions, the NRC issued a Confirmatory Action Letter (CAL) on October 8, 2010. On October 12, 2010, the NRC conducted a subsequent inspection to confirm your corrective actions. Within these areas, the inspections included selected examinations of procedures and representative records, interviews with personnel, and observations of re-enacted activities. The enclosed report documents the inspections findings, which were discussed in a preliminary debriefing with you, Professor Donald Fenton, Reactor Safeguards Committee Chair, Ronald Bridges, Radiation Safety Officer, and Steven Galitzer, Director, Environmental Health and Safety, on September 30, 2010. A second discussion of inspection findings was conducted on October 12, 2010, with you and the aforementioned individuals.

The event that led to the conduct of this Special Inspection can be summarized as follows. On Wednesday, September 22, 2010, a Senior Reactor Operator (SRO) pulled oil samples out of the well groove around the reflector near the top of the reactor. The samples and holder had been placed in the well groove (also known as the Rotating Sample Ring (RSR) area) to be exposed to radiation. Following an irradiation period of 8 hours and a decay period of 12 hours, the samples and rack were removed from the reactor pool. At that point a survey meter used to monitor the radiation levels in the area pegged high off-scale at 50 rem per hour. At the same time, three radiation monitoring system (RMS) instruments alarmed. The alarms for the two RMS monitors near/by the pool had been anticipated while the third monitor in the Control Room was not expected to alarm. Receipt of the Control Room alarm alerted the SRO that conditions were not as had been expected. At that point the SRO picked up the sample holder with his hands, removed the samples from the rack and placed them behind beta shielding and then positioned the sample holder behind lead shielding located on top of the reactor.

Due to the unplanned high dose rates in excess of 20 rem per hour in the area where the SRO was present, a Special Inspection Team was assigned to review the event. The Special Inspection Team began their review on September 28, 2010. As noted above, this review was completed on October 12, 2010.

In a telephone conversation on November 19, 2010, Mr. Johnny H. Eads, Jr., of my staff informed Mr. Jeff Geuther, Reactor Manager, that the NRC was considering escalated enforcement for Apparent Violations involving failure to develop, document and implement a radiation protection program commensurate with the provisions of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 20. Mr. Eads also informed Mr. Geuther that we had sufficient information regarding the apparent violations and your corrective actions to make an enforcement decision without the need for a predecisional enforcement conference or a written response from you. Mr. Geuther indicated that Kansas State University did not believe that a predecisional enforcement conference or written response was needed.

Based on the results of this inspection, the NRC has determined that one Severity Level III and one non-cited Severity Level IV violation of NRC requirements occurred. The Severity Level III violation, failure to comply with the provisions of 10 CFR 20.1101, is cited in the enclosed Notice of Violation and the circumstances surrounding it are described in detail in the subject inspection report. The violation involved a failure to develop, document, and implement a radiation protection commensurate with the provisions of 10 CFR Part 20.

In evaluating the significance of the violation, the NRC has concluded that although no actual exposures in excess of regulatory limits occurred, the failure to implement a radiation protection program based on sound radiation protection principles created a substantial potential for exposures in excess of applicable NRC regulatory limits. Therefore this violation has been categorized in accordance with the NRC Enforcement Policy at Severity Level III. The current Enforcement Policy is included on the NRC's Web site at www.nrc.gov/about-nrc/regulatory/enforcement/enforce-pol.html.

The NRC has concluded that information regarding the reason for the violations, the corrective actions taken to correct the violations and prevent recurrence and the date when full compliance is achieved is already adequately addressed on the docket in the "10-day" report which you submitted on October 1, 2010 and supplemented on October 7, 2010. Therefore, you are not required to respond to this letter unless the description therein does not accurately reflect your corrective actions or your position. In that case, or if you choose to provide additional information, you should follow the instructions specified in the enclosed Notice.

In accordance with the Enforcement Policy, a base civil penalty in the amount of $3,500 is considered for a Severity Level III violation. Because your facility has not been the subject of escalated enforcement actions within the last 2 years, the NRC considered credit was warranted for *Corrective Action* in accordance with the civil penalty assessment process in Section VI.C.2 of the Enforcement Policy. Therefore, no civil penalty is imposed.

In accordance with 10 CFR 2.390 "Exemptions, inspections, requests for withholding," a copy of this letter and its enclosure will be made available electronically for public inspection in the NRC Public Document Room or from the NRC's document system (ADAMS), accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html.

Should you have any questions concerning this inspection, please contact Johnny H. Eads, Jr., Chief, Research and Test Reactors Oversight Branch, at 301-415-1471.

Sincerely,

/RA/

Timothy J. McGinty, Director
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Docket No. 50-188
License No. R-88

Enclosures: Notice of Violation
NRC Special Inspection Report No. 50-188/2010-202

cc w/encls: See next page

Kansas State University Docket No. 50-188

cc:

Office of the Governor
Suite 2415
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Topeka, KS 66612

Thomas A. Conley, RRPJ, CHP,
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Test, Research, and Training
Reactor Newsletter
Purdue University
Office EE B81
400 Central Drive
West Lafayette, IN 47907

Should you have any questions concerning this inspection, please contact Johnny H. Eads, Jr., Chief, Research and Test Reactors Oversight Branch, at 301-415-1471.

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ACCESSION NO.:ML103220298 **TEMPLATE #: NRC-002**

OFFICE	PRTB:RI	PRTB:LA	PRTB:BC	DPR:D
NAME	CBassett, PI for	GLappert	JEads	TMcGinty
DATE	11/22/2010	11/22/2010	11/22/2010	11/22/2010

OFFICIAL RECORD COPY

NOTICE OF VIOLATION

Kansas State University
Nuclear Reactor Facility

Docket No. 50-188
License No. R-88
EA-10-234

During an NRC inspection conducted on September 28-30, and on October 12, 2010, one violation of NRC requirements was identified. In accordance with the NRC Enforcement Policy, the violation is listed below:

Title 10 of the *Code of Federal Regulations* (10 CFR) Section 20.1101(a) requires that each licensee shall develop, document, and implement a radiation protection program commensurate with the scope and extent of licensed activities and sufficient to ensure compliance with the provisions of the regulations in Part 20. In addition, the licensee's Technical Specifications (TS) include Sections for implementing the radiation protection program consistent with the requirements of 10 CFR 20.1101(a). The following are specific provisions of Part 20 and the licensee's TS:

1. 10 CFR 20.1501 requires that each licensee shall make or cause to be made, surveys that may be necessary for the licensee to comply with the regulations in Part 20; and that are reasonable under the circumstances to evaluate the extent of radiation levels; concentrations or quantities of radioactive materials; and the potential radiological hazards that could be present. *Survey* means an evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal, or presence of radioactive material or other sources of radiation. When appropriate, such an evaluation includes a physical survey of the location of radioactive material and measurements or calculations of levels of radiation, or concentrations or quantities of radioactive material present.

2. 10 CFR 20.1502(a)(1) requires that each licensee shall monitor exposures to radiation and radioactive material at levels sufficient to demonstrate compliance with the occupational dose limits of this part. As a minimum--(a) Each licensee shall monitor occupational exposure to radiation from licensed and unlicensed radiation sources under the control of the licensee and shall supply and require the use of individual monitoring devices by--(1) Adults likely to receive, in 1 year from sources external to the body, a dose in excess of 10 percent of the limits in 20.1201(a).

   10 CFR 20.1201(a) requires that the licensee shall control the occupational dose to individual adults, except for planned special exposures under 20.1206, to the following dose limits: (1) An annual limit, which is the more limiting of--(i) The total effective dose equivalent being equal to 5 rems (0.05 Sv); or (ii) The sum of the deep-dose equivalent and the committed dose equivalent to any individual organ or tissue other than the lens of the eye being equal to 50 rems (0.5 Sv). (2) The annual limits to the lens of the eye, to the skin of the whole body, and to the skin of the extremities, which are: (i) A lens dose equivalent of 15 rems (0.15 Sv), and (ii) A shallow-dose equivalent of 50 rem (0.5 Sv) to the skin of the whole body or to the skin of any extremity.

3. TS Section 6.3 requires that the licensee will have written procedures, reviewed and approved by the Reactor Safeguards Committee that are adequate to assure the safety of the reactor, persons within the Laboratory, and the public.

Contrary to the above, on or prior to September 22, 2010, the licensee did not implement a radiation protection program commensurate with the scope and extent of licensed activities and sufficient to ensure compliance with the provisions of the regulations in Part 20 in that:

On or prior to September 22, 2010, the licensee did not make surveys as required by 10 CFR 20.1501 when the licensee failed to determine the magnitude and extent of radiation levels that would be caused by irradiating oil samples on September 21, 2010 that subsequently resulted in an unexpected high shallow-dose equivalent of 12.5 rem to the skin of the extremities (hands) of the operator handling the experiment and an unexpected change in the restricted area dose rates that exceeded 50 rem per hour.

On September 22, 2010, the licensee failed to supply and require the use of extremity monitoring devices to personnel who were likely to receive in 1 year, from sources external to the body, a dose in excess of 10 percent of the limits in 20.1201(a) in that, a person handling oil samples and a sample holder, which read in excess of 50 rem per hour, was not wearing, and had not been issued, extremity monitoring.

On or prior to September 22, 2010, the licensee did not have an adequate written procedure that would assure the safety of personnel within the Laboratory for conducting sample irradiations, in that, Experiment Procedure 1, “Isotope Production,” was very general in nature and contained only one paragraph of instructions concerning the actual conduct of irradiating materials. The procedure was inadequate in that it did not require extremity dosimetry – finger rings – for those handling samples, it did not have a maximum sample withdrawal rate, and it did not specify threshold exposure/dose rates (hold points) to clearly indicate at what dose rate a sample should not be withdrawn from the pool.

This is a Severity Level III violation.

The NRC has concluded that information regarding the reason for the violation, the corrective actions taken to correct the violation and prevent recurrence, and the date when full compliance will be achieved is already adequately addressed on the docket in the “10-day” report which you submitted on October 1, 2010 and supplemented on October 7, 2010. However, you are required to submit a written statement or explanation pursuant to 10 CFR 2.201 if the description therein does not accurately reflect your corrective actions or your position. In that case, or if you choose to respond, clearly mark your response as a "Reply to a Notice of Violation," include the EA number, and send it to the U.S. Nuclear Regulatory Commission, ATTN: Document Control Desk, Washington, DC 20555-0001 with a copy to the Director, Office of Nuclear Reactor Regulation within 30 days of the date of the letter transmitting this Notice of Violation (Notice).

If you choose to respond, your response will be made available electronically for public inspection in the NRC Public Document Room or from the NRC’s document system (ADAMS), accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html. Therefore, to

the extent possible, the response should not include any personal privacy, proprietary, or safeguards information so that it can be made available to the Public without redaction."

In accordance with 10 CFR 19.11, you may be required to post this Notice within two working days.

Dated at Rockville, Maryland this 22nd day of November, 2010

U. S. NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION

Docket No:	50-188
License No:	R-88
Report No:	50-188/2010-202
Licensee:	Kansas State University
Facility:	TRIGA Mark II Research Reactor
Location:	Manhattan, Kansas
Dates:	September 28-30, and October 12, 2010
Inspectors:	Craig Bassett Gary (Mike) Morlang
Approved by:	Johnny H. Eads, Jr., Chief Research and Test Reactors Oversight Branch Division of Policy and Rulemaking Office of Nuclear Reactor Regulation

SUMMARY OF FINDINGS

Kansas State University
TRIGA Mark II Research Reactor Facility
NRC Inspection Report No. 50-188/2010-202

The report covered a period of one day of in-office document review by one inspector, three days of on-site inspection by two inspectors, and one additional day on-site inspection by one inspector. The NRC's program for overseeing the safe operation of research and test reactors is described in Manual Chapter 2545, "Research and Test Reactor Inspection Program." A Special Inspection was established in accordance with NRC Management Directive 8.3, "NRC Incident Investigation Program." The Special Inspection Team charter did not require the team to address compliance or assess significance of findings and observations. Another inspection will be scheduled to address the follow-up items identified by the team.

NRC-Identified and Self-Revealing Findings

Using a procedure approved by the Reactor Safeguards Committee, Kansas State University Nuclear Reactor Facility personnel routinely irradiate samples of known and unknown material. Samples to be irradiated are sealed inside a container (typically a vial), placed in the reactor tank, and moved to the Rotating Sample Ring (RSR) area or to the Central Thimble (CT) for irradiation. After being irradiated for a specified time at a given power level, the samples are usually left in the reactor pool for a period of time to decay and then removed from the pool and subsequently analyzed to determine their isotopic composition. On September 9, 2009, an oil sample (Sample A) was irradiated In the RSR for six hours at 400 kilowatts (kW) and left in the pool for twenty days before being removed. On April 6, 2010, a different oil sample (Sample B) was irradiated in the RSR for two hours at 400 kW and left in the pool for two days prior to removal.

On Wednesday, September 22, 2010, at 7:44 a.m., a Senior Reactor Operator (SRO) pulled oil samples contained in an aluminum rack from the RSR area near the top of the reactor. This occurred following an exposure period of 8 hours and a decay period of 12 hours. When the samples and rack were removed from the reactor pool, a survey meter used to monitor the radiation levels in the area pegged high off-scale at 50 rem per hour. At the same time, three radiation monitoring system (RMS) instruments alarmed. The alarms for the two RMS monitors near/by the pool had been anticipated while the third monitor in the Control Room was not expected to alarm. Receipt of the Control Room alarm alerted the SRO that conditions were not as had been expected. Within approximately 15 seconds of the alarms sounding, the SRO picked up the sample holder with his hands, removed the samples from the rack and placed the samples behind beta shielding, and then positioned the sample holder behind lead shielding located on top of the reactor. Radiation levels in the area subsequently returned to normal and the alarms were reset.

Later that afternoon, the SRO then filled out a report documenting the exposure event and sent it by electronic mail (E-mail) to the campus Radiation Safety Officer. The Reactor Manager, who was out of town on a business trip, was not notified at that time. On Friday, September 24, the Radiation Safety Officer forwarded the exposure report to the State of Kansas for information. On that same day the State of Kansas notified the NRC Headquarters Operations

Office (HOO) of the event. Later that day the SRO contacted the HOO to obtain the telephone number of the NRC Project Manager for Kansas State University. A conference call was held that afternoon between the NRC and the SRO and the Radiation Safety Officer. Another conference call between Kansas State University and the NRC was held on Monday, September 27, and subsequently the NRC was officially notified of the event by the Reactor Manager calling the HOO to report the event.

On September 27, 2010, due to the activities at Kansas State University that led to unplanned changes in restricted area dose rates in excess of 20 rem per hour in an area where personnel were present or which was accessible to personnel, a Special Inspection Team was dispatched to review the event. The Special Inspection Team began their review on September 27, 2010.

The initial review by the Special Inspection Team consisted of in-office document and data review. On September 28, 2010, the team arrived on site to continue gathering information concerning this event. The team found that the licensee had initiated a review of the event. The investigative efforts were divided into three categories including: 1) personnel actions, 2) dose reconstruction, and 3) procedure review. The team reviewed the licensee's immediate corrective actions and found their actions to be acceptable.

Nevertheless, based on the results of this inspection, the team found that the licensee failed to implement a radiation protection program commensurate with the scope and extent of licensed activities and sufficient to ensure compliance with the provisions of the regulations in Part 20. Other issue included the failure to notify the NRC of the event within 24 hours of the event as required.

REPORT DETAILS

1. Introduction

a. Background

The Kansas State University (KSU) Nuclear Reactor Facility is operated under the authority and administration of the President of KSU. Line management functions are through the Provost Chief Academic Officer. Daily operations activities are conducted under the supervision of the Nuclear Reactor Facility Manager who reports to the Head of the Department of Mechanical and Nuclear Engineering. Radiation protection activities and radiological support are overseen by the University Radiation Safety Officer (RSO).

Experiment Procedure 1, "Isotope Production," is the procedure used at the KSU Nuclear Reactor Facility to conduct irradiations of small samples of material. Experiment Procedure 1 addresses both intentional and unintentional production of radioisotopes. The procedure also notes that target holders for irradiations will become radioactive. The procedure stipulates that the Radiation Safety Committee and the RSO bear the responsibility for determining that isotope production procedures are safe in regards to radiation hazards to personnel.

During the past twelve months, three different oil samples from three separate sources were irradiated at the facility. On September 9, 2009, an oil sample (Sample A) was irradiated In the Rotating Sample Ring (RSR) area of the reactor for six hours with the reactor operating at 400 kilowatts (kW). The sample was then left in the pool for twenty days before being removed. At that point the sample produced a radiation reading of 53 millirem per hour (mr/hr) at one meter. On April 6, 2010, a different oil sample (Sample B) was irradiated in the RSR for two hours at 400 kW and left in the pool for two days prior to removal. The radiation level of this sample was 80 mr/hr at one meter. On September 21, 2010, an oil sample (Sample C) was irradiated in the RSR for eight hours at 500 kW and left in the pool for only 12 hours prior to removal.

b. Event Description

On Wednesday, September 22, 2010, a Senior Reactor Operator (SRO) pulled oil samples, which were sealed inside plastic bags, contained in plastic vials, and enclosed inside an aluminum rack, out of the well groove around the reflector near the top of the reactor. The samples and rack had been placed in the well groove (an area known as the Rotating Sample Ring (RSR) area) to be exposed to radiation. Following an irradiation period of 8 hours and a decay period of 12 hours, the samples and rack were removed from the reactor pool. At that point a survey meter used to monitor the radiation levels in the area pegged high off-scale at 50 rem per hour. At the same time, three radiation monitoring system (RMS) instruments alarmed. Two of the RMS detectors were located in the Reactor Bay, one over the pool and one positioned at waist level on the work platform on top of the reactor pool. The third RMS detector was located about forty feet away in the Control Room. The alarms for the two monitors near/by the pool had been anticipated while the third monitor in the Control Room was not

expected to alarm. Receipt of the Control Room alarm, which was an evacuation alarm, alerted the SRO that conditions were not as had been expected. Within approximately 15 seconds of the alarms sounding, the SRO picked up the sample holder with his hands, removed the samples from the rack and placed them behind beta shielding and then positioned the sample holder behind lead shielding located on top of the reactor. Radiation levels in the area subsequently returned to normal and the alarms were reset.

2. Event Follow-up - Sequence of Events

a. Inspection Scope

The inspectors interviewed licensee personnel, observed tests and demonstrations conducted by the licensee to develop the sequence of events leading up to and following the removal of the oil samples from the reactor pool, and reviewed various procedures and documents listed in Attachments A and B.

b. Observations and Findings

(1) Work Activities Performed by the Individual

The individual who conducted the irradiation of the oil samples and who removed the samples from the reactor pool started working at the facility in December 2008 as an operator trainee. In April 2009 he took the NRC exam and became qualified as a Reactor Operator (RO). In November 2009 he took a different NRC exam and became qualified as a Senior Reactor Operator (SRO). He is the most senior operator on staff at the Nuclear Reactor Facility and typically completes all types of routine work at the facility and participates in all aspects of the operation. He was the SRO in charge of the facility during the week of September 19, 2010, when the Reactor Manager was out of town on a business trip.

(2) Chronology or Sequence of Events

The chronology or sequence of events below is based on interviews with licensee staff and all the data accumulated by the licensee and NRC.

Date	Time	Event Description
(All times below are Central Daylight Time)		
September 19, 2010	1700	Oil samples, contained in an aluminum sample holder, were placed in reactor tank (RSR)
September 21, 2010	1153 to 1944	Samples irradiated at 500 KW in the RSR (8 hours total irradiation time)

September 22, 2010	0744	SRO removes sample holder containing the oil samples from reactor tank. Pool Surface, Reactor Top (22 foot level) and Control Room radiation area monitors in alarm. SRO takes the sample holder in his hands to dump out the samples.
September 22, 2010	0745	Samples and sample holder placed in separate shielded facilities.
September 22, 2010	0746	All alarms cleared by SRO.
September 22, 2010	0750	RSO notified.
September 22, 2010	1657	SRO provides RSO exposure summary via E-mail
September 24, 2010	0852	RSO sends exposure summary to State of Kansas
September 24, 2010	1211	State of Kansas notifies NRC Headquarters Operations Office (HOO) of event

(All times below are Eastern Daylight Time.)

September 24, 2010	1311	HOO attempts to reach the NRC Project Manager (PM) for KSU who was in a meeting with the Branch Chief (BC)
September 24, 2010	1330	HOO reaches BC who has PM contact licensee
September 24, 2010	1345	SRO contacts HOO to obtain PM's phone number
September 24, 2010	1430	BC contacts RSO and SRO and sets up conference call between licensee and NRC
September 24, 2010	1500	Conference call between licensee and NRC (Doyle, Adams, Montgomery, Quichocho)
September 25, 2010	1600	Reactor Manager returns from TRTR Conference, determines that

		the event is Reportable and is under the impression that the SRO already contacted NRC HOO
September 27, 2010	0800	PM arranges conference call with SRO, RSO, Reactor Manager for 1250
September 27, 2010	1100	NRC dispatches Special Inspection Team (SIT)
September 27, 2010	1250	Conference call between the licensee and NRC. Reactor Manager informed of SIT. Reactor Manager understands he needs to notify HOO of the reportable event
September 27, 2010	1345	Reactor Manager contacts HOO to report event
September 28, 2010	1300	SIT arrives to begin on site inspection of the event

c. Conclusion

Based on interviews and the records reviewed, the SRO caused the high dose rates in the Reactor Bay by removing a sample holder containing four samples from the reactor pool thereby receiving a significant dose to the hands.

3. Licensee Investigation of the High Dose Rate Incident

a. Inspection Scope (IP 98312)

The inspectors reviewed the licensee's investigation of the event with respect to Technical Specifications (TS) Sections 3.6, 4.6, 6.4, 6.9, and 6.11; 10 CFR 20.1201(a)(1) and (2); and 20.1502(a)(1). In addition, the inspectors reviewed the procedures and documents listed in Attachments A and B.

b. Observations and Findings

(1) Licensee Investigative Efforts

In reviewing the event, the licensee evaluated their notification of the NRC with respect to the TS, and then focused on the actions taken by the individual during the sample removal, on procedural compliance, and on the adequacy of the procedure used. The results of the review by the licensee yielded several causes for the incident which are outlined in Paragraph 4 below.

(2) NRC Review of the High Dose Rate Incident

The inspectors reviewed the licensee's notification procedures and process, the procedures used for conducting sample irradiations, procedural compliance, and the ALARA implications of the incident.

It was noted that there was initial misunderstanding on the part of the licensee about whether or not the NRC had been notified about the incident. During the week of the incident the Reactor Manager was out of town on a business trip. When he returned, after reading electronic mail (E-mail) messages and talking with staff and the RSO, he thought that the NRC had been notified of the incident. On September 27, 2010, while discussing the incident with the NRC, he realized that no formal notification had been made (i.e., calling the NRC Headquarters Operations Office and reporting the incident.) That notification was subsequently completed as stipulated by TS Section 6.11, although not within 24 hours as required. It was noted that the requirements for notifying the NRC following an incident were adequately outlined in the TS.

The procedure used for conducting sample irradiations, Experiment Procedure 1, was reviewed, as was the entire irradiation process. From this review it was noted that the procedure was inadequate in that it did not require extremity dosimetry – finger rings – for those handling samples, it did not have a maximum sample withdrawal rate, and it did not specify threshold exposure/dose rates (hold points) to clearly indicate at what dose rate a sample should not be withdrawn from the pool.

The requirements for proposing and planning experiments were reviewed. These requirements were contained in TS Section 6.4 and the Kansas State University TRIGA Mark II Reactor Facility Operations Manual. While the requirements outlined in the Operations Manual were brief, those stated in the TS were specific and contained sufficient guidance to the person proposing an experiment. The TS indicates that the Reactor Supervisor is the person who determines whether or not the proposed experiment is one that can be conducted under a previously approved experiment or procedure. If the Reactor Supervisor determines that the proposed operation has not been approved by the Reactor Safeguards Committee, then the experimenter is required to describe the proposed experiment in sufficient detail for consideration of all safety aspects. If potentially hazardous operations are involved, proposed procedures and safety measures, including protective and monitoring equipment, are required to be described.

c. Conclusion

Based on interviews and the records reviewed, the licensee did not formally report the event within 24 hours as required by the Technical Specifications. The procedure used to conduct the oil sample irradiation was inadequate.

4. Licensee Response to the Event Including Corrective Actions

a. Inspection Scope (IP 98312)

The inspectors reviewed the licensee's response to the event with respect to Technical Specifications (TS) Sections 6.4 and 6.9, 10 CFR 20.1201(a)(1), and (2) and 20.1502(a)(1). In addition, the inspectors reviewed the procedures and documents listed in Attachments A and B.

b. Observations and Findings

(1) Licensee Response to the Incident

On Wednesday, September 22, 2010, once the SRO had completed the task of removing the samples from the pool and storing the samples and sample holder, he documented his initial reaction to the event in an exposure summary and sent it by electronic mail (E-mail) to the University RSO and the Reactor Manager. On Friday, September 24, the RSO contacted the Kansas Department of Health and the Environment (KDHE) and sent them a copy of the SRO's exposure summary as a courtesy. The KDHE then contacted the NRC Headquarters Operations Office. (It should be remembered that the Reactor Manager was out of town during this week on a business trip.) On Saturday, September 25, the Reactor Manager read his E-mail and noticed a report about the event that had occurred. He determined that the event was reportable to the NRC within 24 hours of the event as required by the facility TS Section 6.9 (a) 6. However, due to a misinterpretation of the E-mail traffic following the event, he thought that the event had already been reported to the NRC as required. During a conference call the following Monday, September 27, the licensee was notified that a Special Inspection Team was to be dispatched to the KSU Nuclear Reactor Facility and that the 24-hour report required by the facility TS had apparently not been made. Following the conference call with the NRC, the Reactor Manager contacted the HOO to notify the NRC of the high dose rate event.

As a follow-up action to the event, the licensee submitted a 10-day report to the NRC dated October 1, 2010, which described actions that had been taken or actions which were planned prior to restarting the reactor. The licensee supplemented this report with another letter dated October 7, 2010, which outlined in further detail what actions had been completed and the corrective actions that were still planned.

During the inspection on September 28-30, the inspectors reviewed and verified many of the actions taken by the licensee. On October 12, 2010 a follow-up visit was conducted to verify the licensee's corrective actions documented in the supplement to the 10 Day Report.

(2) Corrective Actions Taken

The licensee has taken or plans to take the following actions as a result of the exposure event:

(a) *Immediate Corrective Actions*

- The SRO estimated his dose and prepared an incident report.
- The SRO's dosimeter was sent by overnight mail for analysis.
- The SRO was restricted from sample handling duty and other duties involving exposure to the extremities.
- The reactor was administratively shut down by the Reactor Manager pending approval for restart by the Reactor Safeguards Committee, a required by the TS.
- Four members of the Reactor Safeguards Committee and four members of the Nuclear Reactor Facility staff, including the Reactor Manager, held a meeting to discuss causes for the incident and ways in which the situation could be averted in the future. Comments from other Reactor Safeguards Committee members were provided verbally or via E-mail.

(b) *Corrective Actions Completed Prior to Restart:*

- On October 1, 2010, the reactor staff was required to read a memorandum from the Reactor Manager about safety culture. The memorandum reinforced safety and the following issues:
  - The importance of attentiveness while operating
  - The need to follow procedures step by step
  - The importance of working in a conservative manner when no procedural requirement exists
  - The need for personal protective equipment
  - The importance of maintaining a questioning attitude
  - The importance of professionalism
- On October 4, 2010, the Nuclear Reactor Facility staff was trained on the incident. Training included the following topics:
  - Details of the incident including actions of the operator
  - Opportunities for improvement to include prompt notification of the Reactor Manager following an incident
  - The requirements of the revised Experiment 1 procedure

- º The importance of ALARA practices and safety culture
- º The importance of checking the TS for reporting requirements following an unusual event

- On October 4, 2010, the Reactor Safeguards Committee met to determine whether other actions were necessary.
- The experimental procedure used during the incident was re-written to include the following:
  - º Requirements for extremity dosimetry – finger rings
  - º A two-person rule (i.e., one person to monitor the survey meter while the other person withdraws the samples)
  - º Maximum sample withdrawal rates for removing samples after they have been irradiated
  - º Requirements for sample holder irradiation testing at low fluence
  - º Threshold exposure/dose rates for ceasing sample withdrawal and for preparing shielding on the reactor deck

(3) Supplemental Corrective Actions

The licensee plans to take the following supplemental actions as a result of the exposure event:

(a) *Corrective Actions Planned:*

- Each procedure will be reviewed for radiological safety risks and will be revised, if necessary, prior to use.
- Each procedure will be reviewed with respect to 10 CFR 50.59.
- The Reactor Safeguards Committee will need to approve any procedures which were revised following the procedure review and revision process.
- The Byproduct Log will be revised for clarification and to provide additional/needed content and information
- The staff member who was exposed will be prohibited from receiving significant extremity dose or handling samples until January 1, 2011.

(b) *Discussions to be Held With the Reactor Safeguards Committee During the Next Meeting:*

- The importance of active and critical oversight of reactor operations
- What additional actions are necessary to identify procedural deficiencies
- A proposal by the Reactor Manager to review select procedures on a rotating basis as part of the annual

Reactor Safeguards Committee audit of operations and records
- A proposal for a minimum of three non-nuclear faculty members to constitute a quorum at future RSC meetings
- Training on commonly used reactor facility procedures and conduct of operations
- Proposal for a specific list of guidelines for reviewing new procedures

(4) Actions Completed/In-Progress as of October 12, 2010

As a result of the follow-up inspection completed on October 12, 2010, the inspector noted the following actions had been taken or were in progress:

(a) *Corrective Actions Completed:*

- Experiment Procedure 1 had been revised and contained detailed instructions on removing samples from the reactor tank.
- The procedure contained stopping points, a 2-person rule, finger dosimetry was required and limits had been established on radiation levels for removal of experiments from the reactor tank.
- The new procedure also directed that entries be made in the Sample Log as well as the Console Reactor Log Book when experiments are placed in the reactor tank, irradiated, and removed from the reactor tank.
- The new Experiment 1 procedure contained detailed instructions on removing samples from the reactor tank.
- All existing Byproduct Material Log sheets had been removed from the log in the Control Room.
- The new Byproduct Material Log sheets now included the date, time and person conducting the irradiation and dose rate measurements.
- Finger ring dosimetry had been ordered for all reactor staff personnel.

(b) *Corrective Actions In Progress:*

- All existing procedures were being reviewed with a detailed emphasis placed on radiological safety risks.
- A set of questions was being used to examine the procedures that will be needed in the near future.
- The operators, as a group, had been conducting the individual reviews.
- To date, deficiencies in the Beam Port and Fuel Handling procedures have been identified and corrected. This

process will continue until all procedures have been reviewed.
- All future experiments will have a new Byproduct Material Log sheet completed prior to conducting the experiment.
- Calculations will also be done to determine the expected dose rate following irradiation.

c. Conclusion

The licensee's completed and in-progress corrective actions appeared to be comprehensive and appropriate.

5. Root Cause Determination and Related Contributing Actions

a. Inspection Scope (IP 93812)

The inspectors reviewed the licensee's actions to determine the root cause of the incident with respect to 10 CFR 20.1101 and TS Section 6.3. In addition, the inspectors reviewed the procedures and documents listed in Attachments A and B.

b. Observations and Findings

(1) Licensee Cause Determination

In reviewing the event, the licensee did not determine a root cause but identified various causes that contributed to the incident. These included the following:

- The Byproduct Log was not being kept or utilized as well as it should have been. In some cases, it was difficult to perform dose estimates from by product log entries.
- The aluminum sample holders contained a high concentration of zinc which was not included in the Byproduct Log entry for aluminum.
- The SRO was not following good "ALARA" practice when he rapidly withdrew the samples from the reactor, or when he spent time putting the samples and sample holder into shielding instead of dropping them back into the reactor pool.
- The SRO was alone during the procedure which is comparatively complex.
- The procedure did not contain specific dose rate thresholds above which the sample was not to be withdrawn from the pool, nor did it contain maximum withdrawal rates. Instead, it relied on the judgment of the person performing the procedure, who was required to be trained to handle radioactive samples. The procedure also should have required ring dosimetry although the omission did not directly contribute to the occurrence of the incident.

(2) NRC Root Cause Investigation

The inspectors reviewed the licensee's actions and associated review following the high dose rate event. Although the licensee did not identify a root cause for the incident, many of causal factors were identified.

The inspectors noted that the procedure, Experiment Procedure 1, "Isotope Production," was very general in nature and contained only one paragraph of instructions concerning the actual conduct of irradiating materials. And, as noted by the licensee, it did not contain specific dose rate thresholds above which the samples and sample holders were not to be withdrawn from the pool nor did it contain hold points. The root cause of the incident was an inadequate procedure.

Contributing factors were considered as well. These included the following:

(a) Failure to Follow Procedure

The most apparent contributing factor was the failure to follow the procedure, even as it was written. The procedure required the licensee to take various actions if they were irradiating a sample of an unknown material (i.e., a sample of oil from a different supplier than previous oil samples). Had the licensee followed the procedure and initially irradiated only a small sample of oil, the high dose rate incident might have been avoided. (See Paragraph 6 below for a detailed review of the procedural requirements and the sample irradiation process used at Kansas State University. The detailed review includes other problems that could be considered as being contributors to the event.)

(3) Infrequent Activity

As noted in Section 1 above, oil samples have been irradiated only three times in the past twelve months. In the past the samples were irradiated for shorter periods of time and also allowed to "cool" down in the reactor pool for days not hours before being removed. The infrequent conduct of this particular type of sample irradiation and not referring to the results of the past experiments contributed to the incident on September 22, 2010.

(4) Failure to Follow and Implement ALARA Principles / Failure to Instill a Safety Culture at the Nuclear Reactor Facility

Two previous samples, one an air filter and the other a chemical compound had been irradiated in the RSR in July and September of this year. Sample log book entries for these samples indicated radiation levels in the R/hr range when they were removed from the reactor pool as though these were normal readings and this was a standard practice.

Removing items from the pool that have high radiation readings is not a good ALARA practice. Another example of failure to follow ALARA principles was the failure to use engineering controls for handling highly radioactive samples. Engineering controls could include some type of mechanism for remotely handling the samples if needed (i.e., using a hook or tongs or some other device.)

The entire sample irradiation process should be reviewed by management and management attention and support should be directed at correcting these contributing factors in addition to correcting the root cause.

c. Conclusion

The licensee determined that there were a multitude of causes for this event. The NRC concluded that an inadequate procedure was the root cause. This allowed the SRO to proceed with removing the samples and holder from the reactor pool and not stop as he should have when radiation levels were much higher than expected. Failure to follow procedure, not reviewing an activity that is done only infrequently, and failure to follow ALARA principles also contributed to the high dose rate incident.

6. Procedures

a. Inspection Scope (IP 93812)

The inspectors reviewed the licensee's procedures related to the incident with respect to 10 CFR Part 20 and TS Section 6.3. In addition, the inspectors reviewed the procedures and documents listed in Attachments A and B.

b. Observations and Findings

The inspectors noted that the procedure, Experiment Procedure 1, "Isotope Production," addresses both intentional and unintentional production of radioisotopes. The procedure also notes that target holders for irradiations will become radioactive. The Radiation Safety Committee and the Radiation Safety Officer bear the responsibility for determining that isotope production procedures are safe in regards to radiation hazards to personnel. The actual procedure section of Experiment Procedure 1 is only one paragraph in length and general in nature. It stipulates that the Reactor Supervisor must approve the individual to supervise the removal of radioactive materials from the reactor tank. The individual identified must wear a whole body film badge as a minimum. (The SRO removing the samples on September 22 had both a film badge and self reading pocket dosimeter.)

Experiment Procedure 1 is used to cover the irradiation of all materials placed in the RSR or the CT. The procedure directs that a Byproduct Material Log sheet be completed for target materials to be placed in a neutron flux region. A

Byproduct Material Log is used to document irradiation results of known and unknown materials. The inspectors noted that most of the data sheets for past irradiations did not indicate the date of irradiation or time after irradiation when exposure levels were measured. The sheets tend to be a minimum requirement and tend not to be referred to by operating staff after initial entry.

Material amounts of less than 0.1 grams are used for short irradiations to determine source strength of the target for the Byproduct Material Log sheets. The procedure addresses unknown target materials such as the proprietary oil samples provided to the facility for analysis. Additionally, oil samples were provided from different suppliers. Only one Byproduct log sheet existed for an oil irradiation which was conducted in the CT for 1 minute and 100 watts, date unknown. The measured exposure from the oil was 60 mrem/hr, no time after irradiation was given.

Samples to be irradiated are placed in the reactor tank and moved to the RSR or CT for irradiation. Separate Sample Logs are maintained at the upper level of the reactor tank (22 foot level) for each irradiation fixture. When the sample is placed in the reactor tank, a log entry is made and, when removed from the reactor tank, a separate log entry is made. There is no way to tell from the sample log when the irradiation of the sample is actually conducted or completed. Sample irradiations, placement in the reactor, and sample removal from the reactor are supposed to be documented in the reactor console log book however, this was not always done and entries were missing. Two previous irradiations of oil samples prior to the September 21, 2010 irradiation were conducted. The first on September 9, 2009, for 6 hours at 400 kW and the second on April 6, 2010, for 2 hours at 400 kW. These samples remained in the reactor tank for 20 and 2 days respectively, prior to removal. Radiation levels for these samples were 53 and 80 mrem/hr at 1 meter.

The oil sample irradiated on September 21, 2010, was from a different company and a Byproduct Material Log sheet was not completed for the “new” type of oil. The new oil sample and 3 other oil samples were placed in an aluminum holder, irradiated for 8 hours at 500 kW, and removed from the RSR and reactor tank 12 hours later. The new oil sample had an on-contact reading of 40 R/hr when removed from the reactor tank on September 22, 2010. The single oil sample (1 of 4) had an on-contact reading of 4 R/hr on September 29, 2010, one week after removal from the reactor tank.

In the case of aluminum, an irradiation of 0.04 grams in the RSR at 100 kilowatts for 2 minutes yielded a dose rate of 3 R /hr on contact. The oil sample holder assemblies weigh 2.5 pounds each and are machined from solid aluminum billets. The sample holder used on September 21, 2010, was placed in a gamma spectrometer on September 28, 2010, and found to contain radioisotopes of Zinc. Following the September 21, 2010 irradiation, the radiation level measured on September 29, 2010, was 177 mrem/hr at 1 foot.

c. Conclusion

The entire sample irradiation process is not being conducted as described by procedure. It should be reviewed by management and management attention and support should be directed at correcting these deficiencies.

7. Dose Assessment

a. Inspection Scope (IP 93812)

(1) Licensee Dose Calculations

In calculating the dose to the hands of the individual, the licensee first calculated the source strength. The result of that calculation was 4.678 E9 photons per second. Next the licensee calculated the energy deposited to the hands. This was done by assuming that 30 percent (%) of the photons passed through the hands. Then the attenuation of the photons in the hands was calculated based on the assumption that the hands are one centimeter of bone followed by one centimeter of water. The dose to the extremities was calculated to be approximately 12.5 rads.

(2) NRC Dose Calculations

The NRC calculated the dose to the hands of the individual using a different method than the one used by the licensee. The calculations are outlined below.

(a) Given

Exposure duration = 15 seconds (based on reenactments)
OSL reading = 147 mrem (assumed to be due entirely to this incident)
Activation products in the assembly:
P-32 in the oil contained in the plastic vials
Zn-65 and Zn-69 in the aluminum vial holder

Activity of P-32 was estimated at 30 µCi/vial (method of determination unknown)

(b) Radionuclide Characteristics

Radionuclide	Photon Emissions		Beta Emissions		Half Life
	Energy, MeV	Abundance, %	Mean/max Energy, MeV	Abundance, %	
P-32	-	-	0.695/1.710	100	14.3 d
Zn-65	0.511	2.92	0.143/0.330	1.46	244 d
	1.12	50.80			
Zn-69	-	-	0.321/0.905	100	57 m

(c) Calculations

1. The sample holder and the four vial assembly were modeled on the Monte Carlo code MCNP based on dimensions and material specifications provided by the licensee.

2. The OSL result of 147 mrem was used as a basis to calculate the activity of Zn-65, which is the only significant photon emitter. It was assumed that the entire OSL dose was received in 15 seconds, and the source was at a distance of 1.5 ft. The result of this calculation, using MCNP, was:

   Estimated Zn-65 activity = 25 Ci

3. The activity of the Zn-69 was estimated based on the activity of the Zn-65 as follows. The (n,γ) cross sections for Zn-64 and Zn-68 are both about 1 barn. Therefore the activation rate is about the same. However, the half lives are very different, and therefore Zn-69 will reach saturation much faster than Zn-65. Its activity, which is proportional to the decay constant, will also increase much faster initially than that of the Zn-65. The relative abundances of the two isotopes in natural Zn is Zn-64/Zn-68 = 48.63/18.75, or a ratio of about 2.6. Using the above information, the neutron activation equations, and a reactor irradiation time of 8 hours, the ratio of the relative activities of Zn-69/Zn-65 at the end of irradiation is estimated to be 405. The cool down period was 12 hours, and therefore this ratio after the cooling period will be about 0.07.

4. The shallow dose equivalent to the hands from holding the irradiation fixture with the vials was calculated using MCNP for each of the three radionuclides separately, and the results, per unit activity, were as follows:

P-32 (β)	2.84×10^{-5} rem/sec per mCi
Zn-69(β)	1.84×10^{-5} rem/sec per mCi
Zn-65(γ)	3.36×10^{-5} rem/sec per mCi

Based on the calculations above, the activities of the three radionuclides at the time of handling the irradiated assembly were as follows:

P-32	0.12 mCi
Zn-65	25,000 mCi
Zn-69	1,600 mCi

(d) Results

The extremity dose resulting from handling the activated vials and holder was estimated to be:

D (P-32) = 2.84×10^{-5} (rem/sec per mCi) x 0.12 (mCi) x 15 (sec) = 0.00005 rem

D (Zn-69) = 1.84×10^{-5} (rem/sec per mCi) x 1600 (mCi) x 15 (sec) = 0.442 rem

D (Zn-65) = 3.36×10^{-5} (rem/sec per mCi) x 25000 (mCi) x 15 (sec) = 12.6 rem

Extremity dose = 0.0005 + 0.442 + 12.6 = 13.04 rem

~ 13 rem

The best available data for whole body exposure is the OSL reading, and this should be used as the estimated effective dose for this exposure.

These results are very close to the licensee's assessments, and although the dose to the extremity is high, it is still about one quarter of the annual regulatory limit. This suggests that the level of uncertainty involved in the above assessments is acceptable and further refinements are not warranted.

8. Regulatory, Technical Specification, and Generic Issues

a. Inspection Scope (IP 93812)

The inspectors reviewed the licensee’s program for radiation protection with respect to 10 CFR 20.1101(a), 10 CFR 20.1201(a)(1) and (2), 10 CFR 20.1502(a)(1), and Technical Specifications (TS) Section 6.3 concerning facility procedures. In addition, the inspectors reviewed the procedures and documents listed in Attachments A and B.

b. Observations and Findings

(1) Radiation Protection Program

10 CFR 20.1101(a) requires that each licensee shall develop, document, and implement a radiation protection program commensurate with the scope and extent of licensed activities and sufficient to ensure compliance with the provisions of the regulations in Part 20. In addition, the licensee's Technical Specifications (TS) include Sections for implementing the radiation protection program consistent with the requirements of 10 CFR 20.1101(a).

Contrary to the above, prior to September 22, 2010, the licensee did not implement a radiation protection program commensurate with the scope and extent of licensed activities and sufficient to ensure compliance with the provisions of the regulations in Part 20. The following are specific provisions of part 20 and the TS that the licensee failed to implement:

10 CFR 20.1501 requires that each licensee shall make or cause to be made, surveys that may be necessary for the licensee to comply with the regulations in part 20; and that are reasonable under the circumstances to evaluate the extent of radiation levels; concentrations or quantities of radioactive materials; and the potential radiological hazards that could be present.

On September 21, 2010, the licensee irradiated oil samples contained in an aluminum sample holder in the Rotating Sample Ring area of the reactor for 8 hours at 500 kilowatts without first irradiating a small sample of the oil to determine the radiation levels that would be produced as required by the licensee's Experiment Procedure 1. Before removing the samples, the licensee did not make adequate surveys to assure compliance with 10 CFR 20.1003, which limits radiation levels. *Survey* means an evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal, or presence of radioactive material or other sources of radiation. When appropriate, such an evaluation includes a physical survey of the location of radioactive material and measurements or calculations of levels of radiation, or concentrations or quantities of radioactive material present. The licensee failed to determine the magnitude and extent of radiation levels that would be caused by irradiating an experiment containing oil samples. Subsequently, on September 22, 2010, the licensee removed the experiment containing the highly radioactive oil samples and the sample holder from the reactor pool resulting in an unexpected high shallow-dose equivalent of 12.5 rem to the skin of the extremities (hands) of the operator handling the experiment. This also resulted in an unexpected change in the restricted area dose rates that exceeded 50 rem per hour in an area where personnel were present.

In addition, the licensee failed to properly evaluate the potential radiological hazards that could be present following irradiation of their aluminum sample holders in that, the licensee irradiated 0.4 grams of aluminum in the Rotating Sample Ring of the reactor at 100 kilowatts for 2 minutes and upon removal the aluminum yielded a dose rate of 3 rem per hour. The licensee failed to recognize that irradiating their aluminum sample holders, weighing 2.5 pounds each, would produce very high radiation levels.

The NRC has determined that this event represented a substantial potential for exposure in excess of the applicable limits in 10CFR20.1201. The following factors were used to determine the potential for overexposure. The first factor is the timing. Because of the duration of the exposure (15 seconds), no limits were exceeded; however the individual could reasonably have stayed in proximity to the source long enough to be overexposed. Based on the above factors, this event had a substantial potential for overexposure. The second factor is the source strength. Although the extremity exposure did not exceed the regulatory limit of 50 rem, the same experiment could have easily had a source term with enough radioactivity to exceed the limits. In the report submitted to NRC on October 1, 2010, the licensee determined that the large amount of ^{69}Zn in the sample holder for the experiment was the likely cause of the high radiation field. At the time of the experiment, the amount of impurities in the sample holder was unknown to the licensee. Had the sample holder contained much more impurities, the potential dose would have been much higher. In addition, the sample holder contained four different samples of oil. One oil sample was highly radioactive, but the facility did not know the content of any of the four samples. All four of the samples could have been equally as radioactive, increasing the potential dose by a factor of four.

Under different circumstances, the source strength could have been substantially higher and the handling time could have exceeded 15 seconds. This event, which had a substantial potential for exposure in excess of the applicable limits in 10CFR20.1201, also demonstrated a lack of procedural guidance and engineering controls based upon sound radiation protection principles to achieve occupational doses as low as reasonably achievable contrary to the requirements of 10CFR20.1101(b).

10 CFR 20.1502(a)(1) requires that each licensee shall monitor exposures to radiation and radioactive material at levels sufficient to demonstrate compliance with the occupational dose limits of this part. As a minimum--(a) Each licensee shall monitor occupational exposure to radiation from licensed and unlicensed radiation sources under the control of the licensee and shall supply and require the use of individual monitoring devices by--(1) Adults likely to receive, in 1 year from sources external to the body, a dose in excess of 10 percent of the limits in 20.1201(a).

10 CFR 20.1201(a)(1) requires that the licensee shall control the occupational dose to individual adults, except for planned special exposures under § 20.1206, to the following dose limits: (1) An annual limit, which is the more limiting of--(i) The total effective dose equivalent being equal to 5 rems (0.05 Sv); or (ii) The sum of the deep-dose equivalent and the committed dose equivalent to any individual organ or tissue other than the lens of the eye being equal to 50 rems (0.5 Sv). (2) The annual limits to the lens of the eye, to the skin of the whole body, and to the skin of the extremities, which are: (i) A lens dose equivalent of 15 rems (0.15 Sv), and (ii) A shallow-dose equivalent of 50 rem (0.5 Sv) to the skin of the whole body or to the skin of any extremity.

The inspectors reviewed the procedure for conducting irradiations of samples and interviewed licensee personnel. It was noted that the procedure did not require the use of extremity monitoring/dosimetry (i.e., a finger ring) for sample handling. The SRO involved indicated that he was not wearing a finger ring when removing the samples on September 22, 2010. The RSO indicated that he was not aware that the operators were handling samples and had not assigned extremity dosimetry as a result.

TS Section 6.3 requires that the licensee will have written procedures, reviewed and approved by the Reactor Safeguards Committee that are adequate to assure the safety of the reactor, persons within the Laboratory, and the public.

Contrary to TS Section 6.3, the licensee did not have an adequate written procedure that would assure the safety of personnel within the Laboratory. The procedure used on September 22, 2010 for conducting sample irradiations, Experiment Procedure 1, “Isotope Production,” was very general in nature and contained only one paragraph of instructions concerning the actual conduct of irradiating materials. It was noted that the procedure was inadequate in that it did not require extremity dosimetry – finger rings – for those handling samples, it did not have a maximum sample withdrawal rate, and it did not specify threshold exposure/dose rates (hold points) to clearly indicate at what dose rate a sample should not be withdrawn from the pool.

The licensee was informed that the above failures to make proper survey, to supply and require the use of individual monitoring devices to licensee personnel who were handling samples and likely to exceed in 1 year a dose in excess of 10 percent of the limits in 10 CFR 20.1201(a), to have adequate procedures, were an apparent violation (VIO) of 10 CFR 20.1101(a) (VIO 50-188/2010-202-01).

(2) Reporting Requirements

TS Section 6.11(a) 3 requires that a report be made to the NRC within 24 hours by telephone and fax or electronic mail to the NRC Operations

Center and the USNRC Region IV of any reportable occurrences as defined in Section 6.9 of the specifications.

TS section 6.9(a) 6 defines a reportable occurrence as an observed inadequacy in the implementation of either administrative or procedural controls, such that the inadequacy has caused the existence or development of an unsafe condition in connection with the operation of the reactor.

As noted above, on Wednesday, September 22, 2010, at 7:40 a.m., a Senior Reactor Operator (SRO) pulled oil samples contained in an aluminum rack from the RSR area near the top of the reactor. This occurred following an exposure period of 8 hours and a decay period of 12 hours. When the samples and rack were removed from the reactor pool, a survey meter used to monitor the radiation levels in the area pegged high off-scale at 50 rem per hour. At the same time, three radiation monitoring system (RMS) instruments alarmed. The alarms for two of the monitors near/by the pool had been anticipated while the third monitor in the Control Room was not expected to alarm. Receipt of the Control Room alarm alerted the SRO that conditions were not as had been expected. Within approximately 15 seconds of the alarms sounding, the SRO picked up the sample holder with his hands, removed the samples from the rack and placed the samples behind beta shielding, and then positioned the sample holder behind lead shielding located on top of the reactor.

Contrary to the above requirement of TS Section 6.11(a) 3, the licensee did not make a report within 24 hours. Although the NRC Headquarters Operations Office (HOO) was contacted on September 22, no formal report was made. After the Reactor Manager returned to work on September 25, he recognized that the event was reportable per TS. However, he stated that he believed the NRC event report had been made on September 22 based on his understanding of the conversations held with the NRC on that date. Subsequently during a conference call between the Reactor Manager and NRC personnel, on Monday, September 27, the Reactor Manager recognized that a formal report had not been made to the NRC. Following the conference call on September 27, the Reactor Manager did make the formal report was made to the HOO. This was not within the 24 hour reporting period prescribed by the TS. The licensee was informed that failure to make a report to the NRC of a reportable occurrence within 24 hours was an apparent violation of TS Section 6.11

However, because the violation was identified by the licensee, was not repetitive, was not willful, and because various remedial actions were taken, this will be identified as a Non-Cited Violation (NCV) in accordance with Section VI.A.8 of the NRC Enforcement Policy (NCV 50-188/2010-202-02).

c. Conclusion

The NRC inspection team identified one Apparent Violation and one Non-Cited Violation.

9. Exit Interview

The inspectors presented the inspection results to licensee management at the conclusion of the inspection on October 12, 2010 and during a conference call with the Reactor Manager on November 19, 2010. The inspectors described the areas inspected and discussed in detail the inspection observations. No dissenting comments were received from the licensee. The licensee acknowledged the observations presented and did not identify as proprietary, any of the material provided to or reviewed by the inspectors during the inspection.

PARTIAL LIST OF PERSONS CONTACTED

Licensee Personnel

M. Jones	Reactor Support Staff (SRO)
J. Geuther	Reactor Manager

Other Personnel

R. Bridges	Head of the Radiation Safety Office, Environmental Health and Safety Division and Campus Radiation Safety Officer
D. Fenton	Department Head and Professor, Department of Mechanical and Nuclear Engineering
S. Galixer	Director, Environmental Health and Safety Division

INSPECTION PROCEDURES USED

IP 93812	Special Inspection

ITEMS OPENED, CLOSED, AND DISCUSSED

OPENED

50-188/2010-201-01	VIO	Failure to develop, document, and implement a radiation protection program commensurate with the scope and extent of licensed activities and sufficient to ensure compliance with the provisions of the regulations in Part 20 as required by 10 CFR 20.1101(a).
50-188/2010-202-02	NCV	Failure to make a report to the NRC of a reportable occurrence within 24 hours as required by TS Section 6.11.

CLOSED

50-188/2010-202-02	NCV	Failure to make a report to the NRC of a reportable occurrence within 24 hours as required by TS Section 6.11.

PARTIAL LIST OF ACRONYMS USED

10 CFR	Title 10 of the *Code of Federal Regulations*
ADAMS	Agency-wide Document Access Management System
ALARA	As Low As Reasonably Achievable
IFI	Inspector Follow-up Item
IP	Inspection Procedure
KSU	Kansas State University
LCO	Limiting conditions for operation
NCV	Non-Cited Violation
NRC	U. S. Nuclear Regulatory Commission
Rev.	Revision
RO	Reactor Operator
RSC	Reactor Safety Committee
SRO	Senior Reactor Operator
TS	Technical Specifications
URI	Unresolved Item
VIO	Violation

ATTACHMENT A

Licensee Procedures Reviewed

- Procedure Experiment 1, “Isotope Production,” Revised June 1991 and approved by the Reactor Safety Committee (RSC) March 5, 1992, which outlined the use of the following forms:
  - Form KSUTMII 2: Request for KSU TRIGA Mark II Operation
  - Irradiation Facility Log
  - Form KSUTMII-4: Byproduct Log
  - Form KSUTMII-5: Radioactive Material Transfer Log
- Kansas State University TRIGA Mark II Reactor Facility Operations Manual, latest approval dated June 23, 2010

ATTACHMENT B

Licensee and/or Vendor Documents Reviewed

- Exposure Summary dated September 22, 2010
- Byproduct Log, KSUTMII-4, revised March 1993
- Sample Log for Rotating Sample Ring (RSR) and Central Thimble (CT)
- Reactor Console Log Book from June 12, 2010, to the present
- Reactor Console Log Book from March 3, 2010, to June 11, 2010
- Reactor Console Log Book from October 1, 2009, to March 2, 2010
- Reactor Console Log Book from May 1, 2009, to September 30, 2009
- Monthly Exposure Reports issued by Landauer for January through August 2010
- Preliminary Calculation of Extremity Dose completed by the Reactor Manager, dated September 29, 2010
- Radiation Protection Program, KSU Nuclear Reactor Facility, Mechanical and Nuclear Engineering Department, Kansas State University, approval dated May 7, 2002
- Emergency Plan, Kansas State University, TRIGA Mark II Nuclear Reactor Facility, dated August 2006
- License R-88 (Kansas State University) – Personnel Exposure Incident, 10-Day Report, from the Reactor Manager to the NRC dated October 1, 2010
- License R-88 (Kansas State University) – Personnel Exposure Incident, Supplement to 10-Day Report, from the Reactor Manager to the NRC dated October 7, 2010
- Confirmatory Action Letter, CAL No. NRR-10-001, from the NRC to the Licensee issued October 8, 2010