Jeffrey Geuther
Reactor Manager, Kansas State University
112 Ward Hall
Manhattan, KS 66506

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 Nuclear Regulatory Commission
ATTN: Document Control Desk
11555 Rockville Pike
Rockville, MD 20852

1 October 2010

LICENSE R-88 (KANSAS STATE UNIVERSITY) - PERSONNEL EXPOSURE INCIDENT

Event Description

At 0746 on 22 September 2010, a Senior Reactor Operator (SRO) was removing an oil sample in an aluminum sample rack, which had been irradiated at full power (~500 kW) for 8 hours. The irradiation had been completed 12 hours before removal. The SRO was following facility Experimental Procedure 1: Isotope Production.

Response on the survey meter used to monitor sample withdrawal did not show high exposure rates when the sample was one meter below the surface, and previous experience with the samples led the operator to not expect a high radiation field when the sample was withdrawn. The SRO rapidly removed the samples and sample holder from the pool from the depth of one meter, causing the survey meter and two nearby radiation monitoring system (RMS) instruments to alarm. The alarm levels on the RMS units are set below required action thresholds, and the operator does not know how high the readings actually got. He saw that the portable survey meter was at 50 R / h, full scale on the highest range.

The SRO rapidly ejected the oil samples behind a beta shield, and put the aluminum sample rack behind a 4" lead gamma shield. The high dose rate was caused primarily by the aluminum sample rack. Later analysis showed that the sample rack had large amounts of zinc as an impurity, and the radiation field at the time of the incident was likely caused almost entirely by $^{69}$Zn (E = 436 keV, $T_{1/2}$= 13.76 h). While the exposure rate was high, the SRO's optically stimulated luminescence (OSL) dosimeter indicated 147 mrem of deep dose equivalent, and 148 mrem of shallow dose equivalent, from the incident. Dose rates at the facility boundary stayed well below 2 mrem / hour (the 10CFR-20 limit for dose rate to members of the general public), and no other personnel were present inside the facility at the time. The SRO's extremity dose is estimated to be approximately 12.5 rems (preliminary estimate). He was not wearing ring dosimeters, as these were not required per the procedure.

The Reactor Manager was out of town at the time, and was not directly contacted about the incident. The SRO contacted the University Radiation Safety Officer (RSO) and informed him of the incident. The RSO contacted the Kansas Department of Health and the Environment (KDHE) as a courtesy. The KDHE contacted the NRC Headquarters Operations Office. The SRO, in conference with the NRC, concluded that the event was not reportable (based on dose thresholds).

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The Reactor Manager noticed a report about the event in email on Saturday, 25 September 2010, and determined that the event was reportable per the Facility Technical Specifications (TS) 6.9.6, "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." However, due to misinterpretation of email traffic following the incident on 22 September, the Manager thought that the event had already been reported, and the official report was not made until Monday, 27 September. The NRC determined that, because the instantaneous exposure rate reached in excess of 20 R / hour, a special inspection was required. The inspection was conducted from 28 – 30 September.

Timeline of Events (Central Daylight Time)

Tuesday, 21 September

1944 Sample irradiation (8 hours at 500 kW) ends.

Wednesday, 22 September

0746 The SRO removes samples from reactor reflector region.
Radiation monitoring system alarms.
The SRO shields samples and sample holder.

~0800 The SRO verbally informs the RSO of the event.

1657 The SRO provides the RSO with a written event report.

Thursday, 23 September

Friday, 24 September

0851 The RSO informs the KDHE of the event. The KDHE informs the NRC Headquarters Operations Office (HOO).

~1430 The SRO and RSO, in conference with the NRC, determine that a reportable occurrence has not occurred per 10CFR.

Saturday, 25 September

~1530 The Reactor Manager learns of the event, and recognizes that a reportable occurrence has taken place per TS 6.9.6. The Manager believes that the initial (24 hr) reporting requirement has already been satisfied in the communication between the SRO and the NRC.

1643 The Reactor Manager emails the reactor staff and Reactor Safeguards Committee (RSC) informing them that a reportable occurrence has occurred, and that the reactor is administratively shut down pending RSC approval to restart.

Sunday, 26 September

1441 The RSO informs the Reactor Manager that the whole-body dosimeter evaluation is complete and the individual received 147 mrem of deep-dose equivalent.

Monday, 27 September

1150 The RSO, SRO, and Reactor Manager confer with the NRC. The fact that the event has not been adequately reported as a reportable occurrence per the facility TS is clarified. The NRC informs the Reactor Manager that a special inspection will be conducted.

1247 The Reactor Manager reports the event to the HOO as a reportable occurrence.

1630 Members of the RSC and reactor staff hold an informal event critique to identify contributing causes and potential areas of improvement.

Tuesday, 28 September

~1300 NRC special inspection begins.

Wednesday, 29 September

Thursday, 30 September

0850 The Reactor Manager estimates that the SRO received 12.5 rem of dose equivalent to his hands.

0900 NRC special inspection debrief meeting

Immediate Actions Taken

The following remedial actions were taken immediately following the incident:

1. The reactor was administratively shut down by the Reactor Manager pending approval for restart by the Reactor Safeguards Committee (action required by the Technical Specifications).
2. Four members of the Reactor Safeguards Committee and four members of the Reactor 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 email.
3. The SRO estimated his dose and prepared an incident report.
4. The SRO's dosimeter was sent by overnight mail for analysis.
5. The SRO is restricted from sample handling duty and other duties involving exposure to extremities.

Causes for the Incident

The following causes contributed to the incident:

1. 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 byproduct log entries.
2. The aluminum sample holders contained a high concentration of Zn, which was not included in the byproduct log entry for aluminum.
3. 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 holders into shielding instead of dropping them back into the reactor pool.
4. The SRO was alone during the procedure, which is comparatively complex.
5. 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 this omission did not directly contribute to the occurrence of the event.

It is the judgment of the Reactor Manager that item 5 was the primary cause for the incident.

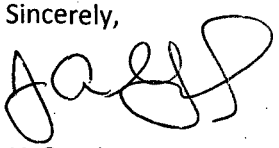
Follow-Up Actions to be Taken Prior to Restart

The following actions are planned prior to reactor restart:

1. The reactor staff will be trained on the incident.
2. The reactor staff will be required to read a memorandum from the Reactor Manager about safety culture.
3. Each procedure will be reviewed for radiological safety risks and will be revised, if necessary, prior to use. (This will not necessary preclude reactor operation. The Reactor Manager plans to request start up prior to the completion of this task, with the restriction that only reviewed / revised procedures can be used during operation). The experimental procedure being used during the incident will be re-written with:
    a. Requirements for ring dosimetry;
    b. A two-person rule (i.e., one person to monitor the survey meter while the other withdraws the samples);
    c. Maximum sample withdrawal rates;
    d. Requirements for sample holder irradiation testing;
    e. Threshold exposure / dose rates for ceasing sample withdrawal and for preparing shielding on the reactor deck.

    The Reactor Safeguards Committee will need to approve any procedures which are revised during this process.
4. The Reactor Safeguards Committee will meet and determine whether other actions are necessary.

Sincerely,



JA Geuther, Reactor Manager

cc: NRC Region IV Office, Arlington, TX