

**Radiation Protection Section - Duke Incident Report**

March 3, 2017

**Friday 2/10/2017**

U-235 Source was removed by RES D from storage located at Triangle Universities Nuclear Laboratory (TUNL) and taken to the Upstream Target Room (UTR) at the High Intensity Gamma-ray Source (HIGS) facility.

**Saturday 2/11/2017**

RES A utilizing the U-235 sealed source for research compromised the integrity of the source by bending the corners of the source to fit in a target holder resulting in the contamination of a researcher's hand (RES A) and work surface. The sealed source of a water insoluble form of U-235 with an activity of 3 micro curies containing a total of 1.5 grams of powdered U-235 with the majority still inside. This took place in the UTR located in HIGS and at no time was the source exposed to the accelerator beam. RES A informed RES D of the compromised source where it was confiscated by RES D. Both the RES A & RES D decontaminated their hands and work surfaces suspected to be contaminated.

RES A expressed their concern over the leaking source to RES D, this concern was dismissed by RES D who did not report the status of the source or the possibility of contamination as dictated in Duke University established procedures.

No contamination surveys were reported as performed for the compromised source or work surface areas at the location of UTR in HIGS. The compromised source was contained (bagged), sealed and moved back to storage located at TUNL by RES D following transport to Physics where an attempt was made to repair the source also by RES D. Surveys at Physics on the contained source indicated no contamination by RES D after resealing the source.

At no time were gloves or any Personal Protective Equipment (PPE) reported to be utilized by either RES A or RES D before and after the source was compromised.

Researchers and Duke personnel failed to follow established procedures which dictate that any damage to a radioactive source or suspected contamination be immediately reported to Duke Radiation Safety, RSO or RSM 1 or RSM 2.

**Monday 2/13/2017**

RES D notified RSM 1 of the possibility of leaking compromised source and requested the source be detected for possible leakage. Again, the possible incident was not immediately reported.

Tuesday 2/14/2017

RSO was notified by RSM 2 (who overheard the discussion between RES D & RSM 1 on 2/13/2017) about the possible incident that occurred on Saturday 2/11/2017. This notification should have come from any of the researchers involved (RES A, B, C & D or RSM 1).

Wednesday 2/15/2017

Radiation Protection Section (RPS) was called by RSO Wednesday morning and informed of a possible incident at Duke University. SC and HP 1 were dispatched to conduct a reactive inspection. RPS led a fact finding discussion with Duke personnel (Res D, RSO, RSM 1, RSM 2, LW 2 & LW 3) and international researchers (RES A, RES B & RES C) to establish the chain of events from 2/10/2017 to present.

Following these discussions, RPS determined:

1. The investigation will remain open pending a follow up report from Duke University regarding the compromised source and;
2. That any contamination had been contained at UTR in HIGS by Duke personnel the verification of which; to be included in the follow up report.

Duke Environmental Safety Office then began surveys of the affected areas of UTR at HIGS due to the compromised source and also to verify no further contamination. RES A, RES D & RSM1 were identified as being in contact with the source and were evaluated for contamination exposures by lung scans at TE 1. Results indicated no inhalation occurred. Because of the insoluble nature of the isotope, it was advised by TE 1 that no further bioassays (urine or fecal) were necessary.

SC notified the Division of Public Health (DPH) of the Duke University incident. Roles and collaboration efforts were discussed during this time. The incident was also discussed with Division of Emergency Management (DEM).

Thursday 2/16/2017

RPS was notified at Thursday morning that Duke personnel were discovering contamination found outside of UTR at HIGS. RPS (SC, HP1, HP 2, HP 3 & HP 4) was dispatched again to Duke.

Additional areas at Duke were found to be contaminated at Free-Electron Laser Laboratory (FELL). RPS requested that Duke personnel immediately expand surveys for possible contamination well beyond original surveyed areas to include: bathrooms, stairwells, hallways and other high traffic areas at FELL. This was necessary to establish a high confidence that contamination was contained to Duke property/facilities. HP 1, HP 2, HP 3 & HP 4 observed all surveys conducted by Duke for his incident investigation.

It was during these observations that many common radiation safety practices were not adhered to including:

- Several chances for cross contamination of the samples could take place due to the technique employed (crossing of one hand for samples taken and the other hand for sample collections), witnessed by HP 1.
- While licensee personnel were taking surveys of personal items and surveys of hands and shoes, it was observed that the detector surface was held at an angle which could allow contaminant particles to contaminate the survey window of the detector, potentially compromising the detector to make accurate survey determinations, witnessed by HP 1 & HP 2.
- Through observations, it was discovered that researchers consumed beverages in a radiation use area which lead RPS to the possibility that ingestion was now a possible exposure pathway, witnessed by HP 2.

An additional 2 researchers (RES B & C) and a laboratory worker (LW 1) were identified as possibly having contact with the source on the 2/11/2017 (total of 6 people). RES B & C were also scheduled for lung scans on Friday 2/17/2017 at TE 1.

All individuals that may have come into contact with the source (RES A, RES B, RES C, RES D, & RSM 1) were interviewed to map their routes from Saturday 2/11/2017 to present, with the exception of LW 1 who was not available for interview due to being unreachable via phone, email or page. LW 1 was finally contacted on Friday 2/17/2017.

Based on those interviews, high risk areas were surveyed utilizing an alpha detector to include: initial laboratory areas, immediately surrounding areas, personal items (cell phones, wallets & shoes of RES A, B, C, D & RSM 1) and the vehicle of 1 RES D were completed and indicated no contamination. Duke personnel performed wipe surveys of these items and at the time indicated no contamination.

RPS requested that Duke extend surveys to include the residences of those identified to have come into contact with the source to include: hotel rooms of 3 researchers (RES A, B, & C) who are visiting international researchers, and the residences of RES D & RSM 1 (LW 1 still unavailable at this time). All surveys indicated no contamination with the exception of the residence of RES D. That contamination was found on a toilet seat of the residence, remediated by Duke personnel and resurveyed and indicated no contamination. All other areas of RES D residence surveyed indicated no further contamination.

Public Health Preparedness and Response (PHP&R) supported RPS on site for the investigation. Occupational and Environmental Epidemiology Branch (OEEB) was consulted for additional recommendations for bioassays and Duke personnel was made aware. Durham County Health Director and DPH leadership were informed and through conference call, determined a plan of action for public health. Conference call with Duke VP of Communications, Department of

Health and Human Services (DHHS) Communications Office, RPS and PHP&R was held to draft public and employee messaging. United States Nuclear Regulatory Commission (USNRC) was consulted by RPS on the details of this incident to this point.

Friday 2/17/2017

RPS continued its investigation with Duke Friday morning.

Lung scans for RES B & C were conducted at the location of TE 1 and indicated negative results. LW 1 was interviewed and was eliminated from the list of possible contaminated personnel, as they did not have any contact with the source from when the incident took place (final total of 5 potentially exposed people).

Surveys were expanded to areas known to be frequented by the researcher (RES D) whose residence was found to be contaminated on Thursday 2/16/2017. A keyboard in the researcher's office was found to be contaminated, contained by Duke personnel and removed for isolation. All other areas frequented by this researcher were surveyed and indicated no further contamination.

An additional 10 personnel (ancillary, housekeeping, students, faculty, engineers) were identified as having frequented the affected areas involved with this incident. These individuals were interviewed and were found to not have had contact with any of the contaminated areas or any involvement with the compromised source.

At this time, RPS generated a report to the USNRC under the assumption that a 24-hour report was to be required. This was necessary in assuming a reporting requirement for unplanned contamination and assuming a worst case scenario as the investigation was still ongoing. Additional consultation was provided to RPS from TE 3 & TE 4 with regards to the compromised source to add "perspective", that, should one individual were to consume the entire U-235 source, that person would receive 2 years of natural background radiation upon ingestion. Additionally, given that the source contained an activity of 3 micro curies, it would not have exceeded the threshold for Allowable Limits for Intake (ALI).

Training for those involved with this incident was also reviewed. During this review, it was confirmed that all individuals involved in this incident received Radiation Safety Training. This training specifically indicates that any damage to radioactive sources, suspected contamination and unexpected radiation exposures be reported immediately. The fact that this was not reported on 2/11/2017 appears to be in violation of Duke University Procedures.

Other Procedures were reviewed with regards to the compromised source. Specifically, Duke's own customized procedures tailored for this source, indicated that the source was to be tested for leakage every six months. Duke could not provide documentation that these leak tests took place and freely admitted that they were not conducting these tests for this source.

As surveys were continued to be expanded it was discovered that equipment used to reseal the compromised source on 2/11/2017 was found to be contaminated at the location in Physics. This equipment was remediated and removed. Additional surveys expanded out of Physics (door leading to Physics & hallways leading to Physics room) were conducted to confirm containment of any contamination and the area cordoned off pending results. Additional surveys and observations made where the source was stored at TUNL and no further contamination was detected at this location.

Through interviews by HP 1 & HP 2 with Duke personnel conducting the wipe surveys for areas suspected to contain contamination, it was discovered that techniques utilized were suspected as inadequate (samples exposed to ESD, improper lighting, temperature control) to provide reliable results and further put into question the capabilities of the detector equipment via Liquid Scintillation Counter (LSC) to provide reliable results. RPS requested that Duke personnel utilize another reliable LSC and re-run all samples up to this point for this incident and any future samples taken in this investigation. The results of which are pending.

Duke personnel decided to conduct Whole Body scans for RES A, B & C to compound the Lung Scans previously performed for these individuals. The results for the WB scans were negative. This was necessary as these individuals were scheduled to depart to their home countries on Saturday 2/17/2017 and this was the most reliable additional testing that could be conducted in the time available. Urine samples were also taken for bioassays from RES A, B & C. RSO has reached out to the Japanese Atomic Energy Agency Radiation Safety Officer to inform him of events and discussed testing and results of the researchers from Japan. Additionally, Duke personnel committed to conducting 24-hour urine bioassays and possible blood analysis for Duke personnel involved in this incident. The results of which are pending. The decisions to conduct further tests were made in consultation with TE 1 & TE 2.

An exit meeting was conducted by Radiation Protection Program with Duke University personnel in which preliminary items of Non-Compliance were discussed. A corrective action plan was presented which was acceptable to Radiation Protection Program as next steps:

1. Shut down the High Intensity Gamma Source (HIGS) operations within the Free Electron Laser Laboratory (FELL) until March 27, 2017. During this time DU will be modifying procedures and working toward needed improvements. On 2-18-17 this commitment had been upgraded by the new Director of FELL and Triangle Universities Nuclear Laboratories (TUNL), to an indefinite suspension of operations in HIGS using radioactive targets. HIGS is where the incident occurred using radioactive targets.
2. The involved Duke University Laboratory Manager has been demoted and temporarily replaced by a Duke Radiation Safety Program (DRSP)Health Physicist until a permanent replacement may be found. DRSP will maintain a larger footprint and role in operations within the facility while improvements are being made.
3. DRSP is considering hiring a consultant to help with procedural improvements and restore safety culture beyond implementing their own resources.
4. Duke University has committed to begin leak testing all sealed sources prioritizing custom

radioactive sources.

5. Duke University leadership has committed to providing DRSP with funding and resources needed to upgrade radiological analysis equipment and facilities.
6. DRSP has suspended online training practices and have committed to face-to-face training with all new researchers emphasizing safety practices and procedures.

NOTE: This report was submitted March 3, 2017. RPS is continuing its investigation until all deficiencies identified in this report have been corrected to the satisfaction of RPS that Duke University is in compliance.