PHMC Lessons Learned Fluor Hanford Inc.

Caution Bulletin

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Title: Spill of Highly Enriched Uranium (HEU) Solution at NRC Facility

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Identifier: 2006-RL-HNF-0020

Lessons Learned Summary: A 35 L spill of HEU solution occurred in the U.S. at an NRC-licensed facility on March 6, 2006. The IAEA event rating form for this event indicates there is/was no off-site impact, no worker overexposure, no worker injury, no damage to radiological barriers, no continuing problem, and no press release. However, there was a contamination spread within the facility and a degradation of the facility's defense in-depth measures.

Discussion of Activities: In a facility authorized to process high-enriched uranium (HEU), a glovebox enclosure containing bag filters was connected to a transfer line for HEU solution when a new process system was first constructed. The facility operator decided not to use the filter glovebox enclosure when it began processing HEU solution in the new process system, but left the enclosure connected to the HEU transfer line. Before the event, a system diagram was updated and mistakenly indicated that a sample valve was a ball valve. The sample valve diverted flow to a sample line without stopping flow to the glovebox. Workers mistakenly believed that the valve isolated the glovebox from the HEU transfer line.

On several occasions before the event, workers reported signs of a yellowish liquid in the glovebox. Supervisors failed to fully investigate the reports because they assumed the yellowish liquid was natural uranium solution which had been used to initially test the new process system. Immediately prior to the event, the facility operator decided to move the unused filter glovebox enclosure to another location. Workers opened the filter housings and observed yellowish liquid which they were instructed to drain so that the enclosure could be moved. After the liquid was drained, workers failed to reseal the system tightly. During the next transfer of HEU solution through the transfer line, approximately 35 liters of HEU solution leaked into the glovebox.

The primary controls to prevent accumulation of a critical mass of HEU solution in the enclosure were drains to divert solution to the floor. Management measures to verify that the drains remained open and free of debris were never applied to the enclosure because the enclosure was considered out of service. During the event, there was debris in the enclosure but the drains were not blocked. When the HEU solution reached the floor, it began spreading and ran under a door. Neither the worker posted at the vessel being drained, nor the worker posted at the vessel being filled, were close enough to the glovebox to detect the spill. Another worker in the hall outside the room noticed the solution coming under the door and alerted the other workers of the spill. The transfer was complete and the lines were being drained when operations were secured and actions were taken to address the spill.

The primary control to prevent accumulation of a critical mass of HEU solution on the facility floor was a flat floor with no accumulation points. During the investigation of the event, the operator identified a pit under an unused elevator near the door where the spill was identified.

The pit provided an accumulation point that compromised the control provided by the floor. The total volume of the transfer was more than enough solution to create a critical mass in the glovebox or the elevator pit if the circumstances had been different. If a criticality accident had occurred in the glovebox or the elevator pit, it is likely that at least one worker would have received an exposure high enough to cause acute health effects or death.

The operator stopped all processing of HEU in the affected processing area. Adequate corrective actions must be implemented and approved by regulatory authorities before processing can be restarted.

Analysis: The NRC confirmed that the situation developed over many months if not years. There was time and multiple opportunities to discover the problem and correct it before the transfer that resulted in this spill.

The debris that was in the glovebox was composed of items that were intentionally placed in it. Because it was out-of-service, the glovebox became, at times, a convenient location for workers to place item(s) that were inconvenient to hold or carry. At least some items were things that somebody did not think of as debris.

Recommendations: This event is a reminder that we need to be especially careful when making changes.

1. In hindsight, the decision to not use the glovebox did not include an adequate evaluation of the decision's effects and/or adequate actions to reduce or minimize adverse effects. For example:

    a. If equipment is placed out-of-service for a long time because it is not needed, people usually treat it with significantly less concern than most other equipment. People assume actions were taken to ensure safety no matter what might happen to the equipment unless the equipment is subject to periodic surveillance. It is therefore prudent to take such actions to ensure safety.

    b. If one does not want solution to be transferred through a particular abandoned or long-term-out-of-service line, the line should be disconnected. Otherwise, surveillance is needed to ensure inadvertent transfers do not occur because any valve will eventually leak. Further, valve-use is vulnerable to human error because somebody must position a valve correctly, whether or not they manipulate the valve directly. (NOTE: Incidents elsewhere indicate that balancing fluid masses [or volumes] between sending and receiving points might not always be sufficient. In those cases, a small amount of material was 'lost' with each transfer and was unnoticed or written-off as measurement uncertainty. The 'lost' material accumulated over time in an unobserved location, eventually reaching an unsafe mass.)

    c. Documentation changes to equipment that connects with or is part of a fissile, radioactive, and/or hazardous material process should be verified. In this case, a diagram update incorrectly identified the sample valve as a ball valve. Presumably the initial error can be explained simply (for example, perhaps some

sample and ball valves are similar in appearance). However, whatever configuration control and/or quality assurance measures were in place for the diagram update did not catch the error.

2. This event is also a reminder that we should confirm assumptions before deciding that a condition is negligible, especially if there could be unsafe consequences due to an incorrect assumption. Questioning attitudes can be invaluable.

    a. Occasions in which yellowish liquid appeared in the glovebox were missed opportunities to discover that HEU solution was leaking. Supervisors and workers used an assumption to decide these earlier signs were negligible. Sampling would have confirmed if the liquid contained natural uranium, as assumed, or HEU. In hindsight, the first occasion in which yellowish liquid was found probably also should have prompted a more complete cleanout of the relevant sampling lines. Whether or not the first occasion involved natural uranium from the initial testing, the liquid represented a contamination source that somebody would eventually have to clean up. Confidence in a cleanout would also have increased suspicion of a bigger problem when later signs of yellowish liquid occurred.

    b. The discovery of yellowish liquid that had to be drained before moving the glovebox also represented a missed opportunity to discover that HEU solution was leaking. It was missed due to the same assumption and mindset discussed above (2a).

    c. Assumptions that the sample valve (or ball valve as it was later thought to be) isolated the glove box apparently were not questioned. Presumably, the assumption would have been rejected based on a check of the original diagram, original design specifications, and/or initial testing documents. If a more thorough investigation into the appearance of yellowish solution were conducted, testing to discover the solution's source might also have revealed the error.

3. In addition, the event is a reminder of the importance of configuration control and verifying that configurations adequately conform to the descriptions upon which safety analysis, evaluation, and/or decisions rest. Effective methods are needed to identify facility and equipment features and specifications necessary for safety, (ii) ensure conformance before use, (iii) ensure conformance as appropriate during use, and (iv) ensure change proposals are adequately reviewed. In the latter case, the methods should ensure that changes conform to the necessary features and specifications and/or that safety documentation is appropriately revised to accommodate the changes. Further, these methods should be robust enough to ensure that changes to out-of-service equipment does not adversely affect the safety of in-use equipment. Whatever methods were in-use at the event facility were not fully effective in that at least three configuration discrepancies existed at the time of the spill:

    a. As previously mentioned, an erroneously identified valve did not provide the glovebox isolation that workers assumed. Perhaps workers based their

assumption at least in part on the valve's erroneous identification.

b. Failure to seal the system tightly after moving the glovebox compromised the integrity of one or more solution line(s) to, from, and/or through the glovebox.

c. The presence of a pit in the floor invalidated safety arguments based on the lack of accumulation points in the event that solution leaked from the process.

Cost Savings/Avoidance: Not determined

Work Function: Conduct of Operations - General, Criticality

Hazards: Environmental Release, Personal Injury/Exposure - Radiation Contamination

Keywords: Highly Enriched Uranium, contamination, critical mass, glovebox, configuration management

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References: Abstract from IAEA webpage http://www-news.iaea.org/news/default.asp

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