Operating Experience Summary

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Lessons Learned from Inadequacies in Management and Oversight at the Integrated Waste Treatment Unit 1

On June 16, 2012, at Idaho National Laboratory, the Integrated Waste Treatment Unit (IWTU) experienced a Rapid Shutdown System (RSS) event during hot startup when two pressure events, one temperature trip event, and a high-efficiency particulate air filtration system failure occurred during a 1.6-hour period. There were no injuries or releases of radioactive material to the environment; however, plant operations were shut down. The IWTU had recently passed Operational Readiness Reviews (ORR) and had been approved for startup. A CWI (Contractor) analysis team was named to investigate the series of events and identify contributing causes. (ORPS Report EM-ID--CWI-IWTU-2012-0008; Final Report issued March 13, 2013)

Background

The IWTU (Figure 1-1) is a first-of-a-kind facility that will treat the remaining 900,000 gallons of liquid radioactive waste generated from the Idaho Site's legacy cleanup mission. Contractor and Department of Energy (DOE) ORRs had been conducted from February 2012 through the first week of April 2012; both ORRs resulted in pre-start findings. Upon closure of the pre-start findings and receipt of approval from the startup authorization authority, the IWTU facility could begin initial startup and operations. That authorization was granted on April 22, 2012.

On June 16, 2012, the IWTU experienced a Rapid Shutdown System (RSS) event while hot functional testing was being performed. The carbon reduction reformer outlet pressure increased to its pressure alarm setpoint and the RSS trip (automatic disconnect as a safety measure) occurred.

The IWTU was in the process of hot (thermal) startup on nonradioactive materials, in accordance with integrated test procedure IWTU-TI-102, *IWTU Integrated System Test: Hot Start-up*. Following the RSS trip, the pressure in the process began to increase again, and resulted in the opening of a rupture disk and the potential opening of its corresponding relief valve in the off-gas line between the off-gas cooler (OGC) and off-gas filter. Then, a safety instrumented function trip occurred when the OGC outlet temperature reached 205°C. All operations at the plant were systematically stopped and the plant was shut down.

It is noteworthy that following the CWI and DOE ORRs, but before the June 16, 2012, event, there was a precursor event at the facility on June 9, 2012. CWI's initial analysis included only the June 16, 2012, event. On August 9, 2012, DOE directed CWI to thoroughly analyze the management and oversight inadequacies related to the precursor event on June 9, 2012, that, left uncorrected, ultimately resulted in the June 16, 2012, IWTU over-pressurization event. The review of both June 9 and June 16 events was performed, and the assessment report was released in September 2012. Its findings are discussed later in this article.

Figure 1-1. The Integrated Waste Treatment Unit

Operational Readiness Reviews

According to DOE-STD-3006-2010, *Planning and Conducting Readiness Reviews*, the Readiness Review process was developed to provide a high degree of confidence that new and restarting DOE nuclear facility operations would be conducted as intended by the design and safety basis. Reviews are based on records review, observation of equipment and operations, and interviews of relevant personnel. The fundamental assumption is that if the programs, operations, equipment, and facilities within the physical or geographic scope of the Readiness Review meet all of the Core Requirements (CR), readiness to start nuclear operations has been achieved.

DOE Order (O) 425.1D, *Verification of Readiness to Start-up or Restart Nuclear Facilities*, identifies 17 CRs that must be evaluated—all or in part—depending on the scope of the Readiness Review. CR 5, for example, evaluates the level of knowledge of managers and operations support personnel based on reviews of examinations and examination results, selected interviews of managers and operations support personnel, and observations of operational demonstrations. CR 11 evaluates the adequacy of startup or restart programs to simultaneously confirm operability of equipment, the viability of procedures, and the operators' performance and knowledge.

Both the CWI Contractor and DOE ORR teams observed performance (evidence) demonstrating completion of CR 5, including the following IWTU-specific items.

- Emergency Response to a breach in a 350-gallon tote of Nitric Acid during a delivery to the IWTU process building
- Radiological Spill/CAM/RAM alarm
- Switching of process exhaust blowers
- Transport of solids from the Denitration and Mineralization Reformer to the Product Receiver Cooler

With regard to CR 11, both ORRs noted that the CWI startup plan did not sufficiently identify a cautious approach to the introduction of radioactive material after initial testing was completed. According to DOE, the startup plan also did not address senior management oversight and control of resumption of testing in the event of test interruptions. These weaknesses in the startup plan were documented as pre-start findings, and satisfactory closure of the associated corrective actions was required to be verified before DOE's April 2012 approval to start.

Causal Analysis Discussion

A Precursor Event

After the ORRs and after startup authorization, IWTU prepared for actual startup. However, an anomalous event occurred in the facility on June 9; for purposes of clarity, it is called simply the "precursor event." That event presented factors such as the following.

- Unexpected equipment conditions were not evaluated for fundamental causes and impact on subsequent operations.
- A high workload was placed on the shift supervisor and operations personnel who were multitasking because of system anomalies.
- Unclear goals, roles, and responsibilities existed in that operations personnel were not provided instruction/requirements for expected plant parameters such as coal feed rate.
- Simultaneous multiple tasks in progress distracted operations personnel from recognizing abnormal plant conditions, including a multitude of alarms received in the Control Room.

These factors should not have existed, since supposedly they had been satisfactorily addressed for the April Authorization for Startup to be issued. However, the June 9 event did occur.

It presented a missed opportunity to effectively address remaining problems in a timely manner, to either prevent or mitigate future events such as the one that eventually occurred on June 16. As discussed below in the Root and Contributing Causes section, corrective actions resulting from the two ORRs and the precursor event were not sufficiently rigorous and, as a result, were not effective in changing the underlying causes: lack of a questioning attitude; lack of formality and rigor in the review of design changes, test instructions and plans, procedures, and parameters; and insufficient awareness of how actions would impact safety and reliability.

Root and Contributing Causes

The formal cause analysis that followed the June 16 event determined that the *root cause* of the event was the lack of a questioning attitude by IWTU's senior management team. There was a lack of formality and rigor in the review of design changes, test instructions and plans, procedures, and parameters. The management team had a strong desire to move forward to get the facility up and running, and their direction created insufficient awareness of how actions would impact safety and reliability.

There were five *contributing causes*, which are summarized below.

1. The IWTU facility design did not consider all possible scenarios and operating conditions—normal and emergency—so adequate controls were not included in the design and process operating strategies.
2. IWTU management did not establish clear roles and responsibilities for the joint test group (JTG) and senior supervisory watch (SSW) oversight of the startup process. The JTG was made up of members of the management team, so it did not function as an independent oversight body. Originally the SSW had a mentoring role, but when the SSW and JTG roles changed during startup, management expectations for the roles of JTG and SSW were not adequately defined.
3. Because of a lack of operations process data, expert knowledge and performance assumptions were used during startup, and adequate controls were not established.
4. The IWTU management team demonstrated a non-conservative approach to problem solving, and did not take appropriate action after a June 9 precursor event that could have prevented the more serious June 16 event.
5. Written test instructions, operating procedures, and emergency actions did not address situations likely to occur during startup.

Fortunately, the IWTU was in the startup phase and radioactive waste had not been introduced into the process. As a result, no hazardous constituents were released and no personnel were harmed during the event.

Lessons Learned

Startup of first-of-a-kind nuclear facilities, as opposed to restart/resumption of existing processes, where facility knowledge and/or experience with abnormal conditions is well established, requires rigorous assurance that equipment and personnel will function as credited in the approved safety basis documentation. IWTU operators and their management did not have an adequate technical understanding of their facility prior to starting testing. Operators did not fully understand the interactions of the various technical processes being started and were, therefore, unable to recognize valid warning signs and take appropriate actions. The net result was the actuation of a safety system (rupture disk) and loss of containment (high-efficiency particulate air, or HEPA).

Despite the DOE and Contractor ORRs meeting the requirements of DOE O 425.1D and both entities recommending startup upon resolution of pre-start findings, the ORR process was not sufficiently robust for commissioning this first-of-a-kind facility based on experience obtained from smaller-scale demonstrations. The IWTU facility differed not only in scale from the demonstration facilities upon which the IWTU design was based but in specific process features (e.g., IWTU used coal versus natural gas as the heat source for bringing equipment up to temperature). With an assumed, but unproven, confidence in the facility design such that the equipment response to abnormal conditions would be recognizable, IWTU operations personnel were not prepared for startup.

Startup of first-of-a-kind facilities such as IWTU requires a phased approach to ensure that personnel adequately understand the attributes of each component singly and within an integrated system. The selected demonstrations for the ORRs did not provide a representative spectrum of the activities necessary to safely startup the facility as described in the Startup Plan.

KEYWORDS: Startup, Operational Readiness Review, ORR, Rapid Shutdown System, RSS, DOE O 425.1D, Integrated Waste Treatment Unit, IWTU, Core Requirements

ISM CORE FUNCTIONS: Analyze the Hazards, Develop and Implement Hazard Controls, Perform Work within Controls, Provide Feedback and Improvement

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