Trip Report
JOWOG 30 "Nuclear Criticality Safety Summit"
AWE September 25-29, 2017

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Summary

The meeting was hosted by Richard Jones, Nuclear Criticality Safety (NCS) Section Leader at AWE. The agenda, prepared prior to the meeting, is attached and the meeting covered all the topics in the agenda, though some scheduling changes were made to accommodate personnel and facility availability. The focus of the meeting was to compare and contrast how the different NCS organizations implement various NCS programmatic elements and to look specifically at the details of NCS evaluations pertaining to specific fissionable material operations.

Observations

Facility Design and Operation Scope

The Pu processing facilities A90 and PF-4 at AWE and LANL respectively are very similar in design and functionality. In fact, A90 was built after PF-4 and used the same overall facility design to limit risk and cost. The flow of material and parts is generally linear and follows the steps in the process to produce and inspect product. As such, both AWE and LANL share similar NCS challenges. The B332 Pu facility at LLNL was designed for a much smaller mission scope but also had the same recovery, machining, and assembly processes. With de-inventory of LLNL, most of these activities are dormant or performed under low fissile mass limits.

Facility Tours

AWE provided tours of A90 and A1. As discussed above, A90 is the primary production facility. Pyrochemistry operations for Pu recovery and component casting were toured. The A1 facility is in D&D and faces significant criticality safety challenges due to the lack of detail surrounding many of the processes and items that remaining in the facility. LANL is in the process of working on the D&D of the Chemistry and Metallurgical Research (CMR) Facility and thus faces a similar challenge. The Logica computer system for control of material movement (discussed later) was also demonstrated in the Logica test laboratory. This is an identical station by station and central mainframe setup of the system in a clean environment for testing system modifications and fault recovery. Simulation of material movement from one station to another, including use of weight scales and container bar-code scanning, as well as an example of an alert initiation for an improper move were demonstrated.

Fissile Material Movement

A principal element of NCS common to all programs is fissile material control and movement. Here, AWE uses a much more restrictive system employing a computer software system named Logica which controls physical gates between gloveboxes. Bulk weights of individual containers are weighed prior to and at the glovebox of receipt and must match. Warnings are displayed on terminals if there are any discrepancies. Further, each movement of fissile material must be approved by two independent checkers who reside at a location off the operating floor. This check not only involves fissile mass but also form, reflectors, etc. and any caveats applicable from NCS limits and controls. Once approval is given, then the control gates can be opened to allow material movement. The drawback of such a system is that operators may have to wait a significant period to get approval for a move. Also, the system is nearing the end of its operational life, optimistically to 2026. Replacement of the system will be a considerable challenge to AWE.

LLNL uses an MC&A system which used to be overlaid by a second software system that checked proposed fissile masses and net weights against criticality limits. The overlay is no longer in use. Both LANL and LLNL require administrative checks by two operators who rely on a database (LANMAS) that stores information about material location physical characteristics (mass, form, isotopics, containerization, etc.).

LANL has some interest in employing a more robust AWE-like system to assist for issues with operator effectiveness and conduct of operations.

Movement of fissile material outside the glovebox lines is accomplished at all three facilities using carts with built in spacing design. The AWE “ever safe” trolley goes a step further by being required to connect to the Logica system when it is parked for temporary storage. The trolley is actually a complete movable workstation, including a computer which communicates with the material control system.

NCS and Facility Interface

AWE had a facility position termed FCR whose role has changed over time. The position was Initially used as an interface between operations and the NCS staff to obtain data, drawings, etc. Over time, the authority to provide NCS advice and guidance was given and finally, at this time, several of the FCRs have become fully qualified NCS assessors, now termed FCSRs and are appointed by the NCS. The FCSRs are similar to the LLNL NCS Team Leads and LANL Point of Contacts. The FCSRs meet weekly to ensure consistent guidance is being given within each facility. This is an admirable program aspect of AWE NCS.

Work Initiation and Prioritization

AWE requires that an "application form" be prepared and accepted by the NCS before any NCS analysis is performed. LANL is similar, although it uses an integrated work management database that covers the entire process from work request to storage of final products as records. LLNL NCS priorities are established by a weekly facility meeting where various program stakeholders negotiate and establish NCS priorities. LLNL NCS personnel attend the meeting and provide work status and estimates of resources needed for any new work.

Fire Scenarios

LANL appears to be taking the most detailed and rigorous approach. Each glovebox is assessed for water flooding based on the specific locations of sprinkler heads and the glovebox ports, as well as ignition sources and combustibles. A 2 hours water flow limit has been determined by engineering analysis and fire department response. They have found that significant flooding is generally not credible and limited water ingress can be mitigated by container geometries and volumes. LANL has many gloveboxes with air environments and is also studying effects of interior fires on containers and gloves. LLNL similarly considers only small quantities of water ingress to be credible based on glovebox window impact tests consistent with a design basis earthquake. External fires, based on the DSA, will be small and will not impact glovebox integrity (gloveboxes use inert atmospheres to preclude interior fires). Container volumes and equipment geometry are used to mitigate small quantities of water ingress or allowed liquids in gloveboxes. AWE takes a very conservative approach and considers full water flooding. This is seemingly contradictory to the fact that A90 has no water fire suppression system. Safety Basis analysis, however, has determined that there are pathways of water ingress through the ventilation system.

Casting Operations Analysis

In analysis of very similar Electrorefining operations, AWE and LANL derived 4.2 and 4.5 kg Pu mass limits, respectively. LLNL also allows 4.5 kg Pu but requires ER rings to be broken prior to movement out of the glovebox. Major differences in the analytical approach are: (1) LANL uses input from engineering to declare only a limited amount of water flooding is credible while AWE looks at full flooding and (2) AWE credits the chlorine content of the salt. LANL does not credit chlorine and is not confident there are enough current benchmark experiments involving chlorine at the right neutron energy spectrum. All consider an overbatch to be credible in the glovebox, although AWE overbatches the crucible while LANL and LLNL overbatch the glovebox. At LANL, the use of containers with built in spacing for items greater than 3.0 kg Pu mass greatly limits the impact of overbatching. LLNL limits overbatching based on a facility wide limit on individual Pu items of 2.5 kg unless specially approved.

LANL has adopted a standardized control system similar to that employed at LLNL. Further, LANL performs generic NCS evaluations of each control condition and then individual operations are assessed against the envelope of the generic evaluation. LLNL provides the technical basis of the control condition in each evaluation, though often very similar from one evaluation to the next.

The discussion of chlorine credit prompted further discussion on establishment of subcritical limits. Both LANL and LLNL use evaluations of benchmarks to establish subcritcal limits for general applications. Specific applications may provide alternative analysis when necessary. AWE uses a keff of 0.95 based on historic use of this limit and regulatory comfort. The 0.95 value is then adjusted downward based on fast, thermal, or intermediate neutron energy spectrums with adjustment values provided by the code developers. This is unusual since the developers are not part of AWE or the UK government.

One difference in the structure of NCS evaluations is that AWE generates technical calculation documents which provide results of neutronic code calculations. This is then supplemented by a second evaluation which applies the results in a process evaluation, so there are typically two separate analyses which form an NCS assessment at AWE. The assessment receives two separate independent reviews, a quality review followed by a technical review. Both LANL and LLNL generally include the relevant calculations in the same single evaluation document which then receives one independent review. The AWE evaluation preparation and review process, though comprehensive and rigorous, can take upwards of a year or more to complete. This time frame would not be acceptable by LANL or LLNL management.

Response to Process Deviations

All use similar response protocols. AWE identifies senior staff and provides separate training for response duties. At LANL and LLNL all personnel who are qualified NCS engineers may respond to incidents. LANL response is facility and personnel specific based on assignments and staff familiarity. LLNL, limited in staff and operation scope in LLNL and NNSS are all authorized to respond. LANL and LLNL use automated call-out systems for off hours. AWE has a designated on-call staff member. AWE's unfavorable experience with the call-out system lead them to adopt the on-call approach.

AWE and LANL experience similar frequencies of off-normal events, perhaps a bit more for LANL. LLNL has only 2 or 3 infractions per year and perhaps as many off-normal events which do not result in an infraction.

One very desirable quality of the AWE CAAS system (CIDS) is that it automatically resets in one minute and retains all the data which is accessible in a separate location well away from any potential accident location. Both LANL and LLNL systems do not reset without human intervention, requiring response personnel to have to cross the 20 RAD boundary to reset the CAAS and obtain readings from the individual heads.

NCS Qualification and Staff Retention

Both AWE and LANL have suffered from staff retention issues in the recent past. Both however appear to have improved staff stability. LANL has initiated a retention bonus program which is primarily focused on attracting new engineers to join the staff. Attraction of new staff is also the driver for initiating an "Nuclear Criticality Safety Pipeline" where some of the LANL NCS staff are professors at Universities which are providing credited course work in criticality safety and related areas. The Pipeline is new and it is hoped that graduates of these programs will have been given an introduction to the field, a desire to join LANL, and have a head start on qualification. LLNL staff is aging and attrition through retirement has been addressed by the hire of two new personnel: one early career and one out of college.

All the qualification programs meet regulatory expectations and are rigorous. It is expected that a new engineer will become qualified in about a year at LLNL and about 18 months at LANL. AWE qualification is generally about 2 years. LANL and LLNL allow engineers-in-training to perform NCS work under the guidance of a qualified engineer, thereby resulting in useful work and interest level of the in-training engineer. AWE does not allow any significant NCS work until full qualification is achieved. This appears to be a drawback since engineers-in-training may feel like they are not contributing and the relatively long qualification period could lead to defection.

LANL requires that the NCSD Leader re-qualify each engineer every 2 years based on performance and areas of work experience. LLNL does not require re-qualification unless the individual did not perform NCS work for a period of 2 years. Work performance is evaluated through the annual performance appraisal.

NCS Program Enhancements

LANL is leading the way in enhancing its NCS program using experimental tests and modern technology. LANL has initiated tests of glovebox flooding and integrity under fire scenarios, in collaboration with Universities. The initial thought was that gloves would rupture long before the glovebox flooded appreciably. The result was, in fact, that the gloves expand like a spherical balloon and can withstand essentially full glovebox flooding. Plans are under way to initiate test fires in the gloveboxes to test integrity as well as effects on various containers which might be stored in the glovebox. This kind of practical data is lacking and will be of benefit to all NCS practitioners. LANL is also planning on enhancing the training in response to process deviations by 3-D printing of inert materials in various historical process upset configurations and then requiring real time response under exercise conditions.

JOWOG 30 Future Work

AWE expressed interest in visiting LANL for further discussions on NCS assessments of specific operations and further discussions on potential installation of a Logica type system at LANL. It was agreed that an updated NCS JOWOG 30 Quad Chart and tasking status will be prepared over the next few weeks to support the JOWOG 30 meeting scheduled for Washington D.C. in late October 2017. LLNL will take the lead in preparing a joint LANL-LLNL trip report as required by each laboratory and for submission to Angela Chambers NNSA NCSP Manager.

Meeting Agenda

1958 U.S./UK MUTUAL DEFENSE AGREEMENT

JOWOG 30 Nuclear Criticality Safety Summit

Dates: Monday, September 25 - Friday, September 29

Technical Host:
AWE: Richard Jones, Criticality Safety Group Leader

Technical Leads:
AWE: Richard Jones, Criticality Safety Group Leader
LANL: Andrew Wysong, Nuclear Criticality Safety Division Leader
LLNL: Dave Heinrichs, Nuclear Criticality Safety Division Leader

Monday, September 25th

Time	Location	Activity	Session Lead
08:00-09:00	AWE Badge Office	Access/Badging	N/A
09:00-10:00	TBD	Introductions	Jones/Wysong
10:00-11:30	TBD	A90 Introduction	TBD
11:30-13:00	AWE Canteen	Lunch	N/A
13:00-16:00	A90	Facility Tour	TBD
16:00-17:00	TBD	Daily Wrap Up	Jones/Wysong

Tuesday, September 26th

Time	Location	Activity	Session Lead
08:00-09:30	TBD	AWE Material Transfer System Demo/Discussion	TBD
09:30-10:00	TBD	Break	N/A
10:00-11:30	TBD	Electrorefining Evaluation Discussion	TBD/Zhang
11:30-13:00	AWE Canteen	Lunch	N/A
13:00-14:30	TBD	LANL Glovebox Fire/Flooding Experiments	Wysong/Gordon
14:30-15:00	TBD	Break	N/A
15:00-17:00	TBD	Open Discussion & Daily Wrap Up	Jones/Wysong

Wednesday, September 27th

Time	Location	Activity	Session Lead
08:00-09:30	TBD	Emergency Response Practices	Jones/Wysong
09:30-10:00	TBD	Break	N/A

10:00-11:30	TBD	LANL Studies on Mobility of Oxide/Compounds	TBD/Wysong
11:30-13:00	AWE Canteen	Lunch	N/A
13:00-16:00	TBD	Facility Tour (A45? – Something Else)	TBD
16:00-17:00	TBD	Daily Wrap Up	Jones/Wysong

Thursday, September 28th

Time	Location	Activity	Session Lead
08:00-09:30	TBD	Training & Qualification Best Practices	Jones/Wysong
09:30-10:00	TBD	Break	N/A
10:00-11:30	TBD	LANL NCS Pipeline Discussion	Salazar-Crockett
11:30-13:00	AWE Canteen	Lunch	N/A
13:00-14:30	TBD	Staff Retention Best Practices	Jones/Wysong
14:30-15:00	TBD	Break	N/A
15:00-17:00	TBD	Open Discussion & Daily Wrap Up	Jones/Wysong

Friday, September 29th

Time	Location	Activity	Session Lead
08:00-09:30	TBD	Discussion on Future Collaborative Efforts	Jones/Wysong
09:30-10:00	TBD	Break	N/A
10:00-11:30	TBD	Future JOWOG 30 VTC/Meeting Schedule Planning	Jones/Wysong
11:30-13:00	AWE Canteen	Lunch	N/A
13:00-14:30	TBD	Open Discussion	Jones/Wysong
14:30-15:00	TBD	Break	N/A
15:00-17:00	TBD	Open Discussion & Daily Wrap Up	Jones/Wysong

JOWOG 30 Nuclear Criticality Safety Summit Participants

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