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Subject: Contract No. DE-AC07-05ID14517 - FY14 Level 3 Milestone, Report Documenting Activities to Develop Instrumentation R&D Program to Support Spent Fuel Storage Demonstration Programs - M3FT-14IN0802071

Dr. Herczeg:

This letter officially transmits a white paper (Attachment A) and viewgraphs (Attachment B) documenting work completed to support your request that an Instrumentation Team, which included researchers from Argonne National Laboratory (ANL), Idaho National Laboratory (INL), and Los Alamos National Laboratory (LANL), identify appropriate techniques that can be used for *in-situ*, real-time monitoring and inspection of dry cask storage systems (DCSSs) and other proposed fuel storage options. The white paper describes instrumentation options to address a broad range of parameters. However, the viewgraphs, which were developed to support a meeting at DOE-Nevada, focused on parameters that you, Ned Larson, and Bob Einziger, US NRC, identified as more important to the Used Fuel Disposition Program at this time (e.g., temperature, fission gas pressure and composition, and water level). Transmittal of these documents satisfies the FY14 Level 3 milestone, M3FT-14IN0802071, "Report documenting proposed instrumentation R&D program to support spent fuel storage demonstration programs," or the work package, "Instrumentation Support -INL"

The attendees at the DOE-Nevada meeting (Attachment C) included representatives from the Instrumentation Team (e.g., ANL, INL, and LANL) and members of the Used Fuel Disposition (UFD) Team (e.g., from PNNL, INL, SNL, and DOE-Nevada). This meeting was a useful opportunity to obtain updates on the status of the program and focus on what technologies would be of most interest to the program.

Important insights gained and follow-on actions from this program are summarized below:

- UFD Team members indicated that opportunities for instrumentation are limited to the High Burnup Demonstration Cask (HBU Demo) that will be installed at North Anna and possibly canisters being loaded at operating plants to support licensing beyond 40 years. Participants indicated that it was very unlikely that DOE would sponsor a second demonstration, and no instrumentation needs were identified for deep borehole applications.
- UFD Team members indicated that there were now three IRPs (Integrated Research Proposals) funding activities related to instrumentation: a collaboration ending this fiscal year led by Sean McDeavitt, Texas A&M, The Fuel Aging in Storage and Transportation

IRP addresses low- temperature creep, hydrogen behavior and delayed hydride cracking, canister corrosion, and novel (real-time, live) system monitoring and two new IRPs focused on evaluating the effectiveness of cask/canister drying techniques and on sensor placement and data transmission. However, it appeared that none of these IRPs were providing instrumentation for the HBU Demo or canister monitoring.

- UFD Laboratory Team members were very concerned that instrumentation work completed by the Instrumentation Team would adversely impact their budget, either in FY15 or in future years.
- UFD Team members were not interested in any instrumentation requiring new penetrations, neither for the HBU demonstration cask nor for canisters being loaded at the plants in the future. Ned Larson, DOE-Nevada, and Prasad Nair, DOE-Nevada expressed more interest in (and were more optimistic about) monitoring canisters that would be loaded with fuel after it had been stored for longer than 40 years than laboratory representatives. This interest stemmed from their recognition that DOE would eventually take ownership of such repackaged fuel.
- UFD Laboratory Team members were not interested in any wireless instrumentation because plant owners/operators indicating wireless technologies would violate existing plant security requirements.
- The HBU Demo cask design currently has seven penetrations for thermocouple lances that accommodate nine thermocouples (for a total of 63 Type K thermocouples) and a central port without any sensor that could accommodate an additional sensor. In addition, Dominion has now agreed that they are willing to take gas samples from the HBU Demo cask. Instrumentation Team members requested engineering drawings (with dimensions) of the thermocouple lances. The UFD Team agreed to ask AREVA for permission to provide these proprietary drawings.
- During the meeting, UFD Laboratory Team members were very reluctant to consider replacement sensors for any thermocouples in the thermocouple lance (even if the replacement sensors could fit into the currently planned penetrations and provide higher resolution data or data for multiple parameters). DOE-Nevada UFD Team members were more positive during the meeting about such options being useful to the demonstration or future canisters in the speed of sound gas composition and pressure monitor, which could be externally mounted.
- After the meeting, Brady Hanson, a UFD Team member from PNNL, indicated to Joy Rempe and Joshua Daw, Instrumentation Team members from INL, that he didn't see a reason to not allow an additional sensor, such as the ultrasonic thermometer, in the central port if our Instrumentation Team could demonstrate that it could provide suitable reliability and accuracy, if proposed materials did not adversely impact other materials that would be used in the cask, and if our ultrasonic thermometer could be used in the planned penetration. He indicated that he would request permission from DOE-Nevada to contact AREVA (the manufacturer of the thermocouple lances) and Transnuclear (the cask manufacturer), about the potential to include an additional sensor (as an option for providing redundant data using a diverse method).

- UFD Team members were interested in sensors that could be externally mounted on the cask. In particular, they expressed interest in externally mounted speed-of-sound ultrasound sensors for monitoring gas composition and pressure for the high burnup demonstration and for subsequent use (as a miniature device) that could be used for canisters and in the millimeter wave gas analysis option as a method that could be applied to gas sampled from the cask in the high burnup demonstration. UFD Team members cited detection levels for various isotopes with Krypton-85 having a lower limit in the 13 to 107 ppb range.[1] It was agreed that initial research would need to focus on determining lower detection limits for these technologies. In addition, there were questions related to the ability of externally mounted techniques to be used in conditions where temperature was unknown within the cask (due to thermocouple failures) or canisters (where temperature is not measured) and multiple gases could be released and where curved geometries of the cask/canisters and flight paths were small (due to structures within the casks/canisters).
- DOE-Nevada and laboratory program participants indicated that proposed methods for measuring water level would not be suitable for either the high burnup demonstration or subsequent cask demonstrations. Rather, methods were needed that could detect thin films on structures within the cask/canisters or water level within dashpots at the base of PWR assemblies or within water rod locations in BWR fuel assemblies.
- UFD Team members expressed interest in proposed options for monitoring stress corrosion cracking in canisters. However, they noted they are already funding highest priority research in this area. Meeting attendees agreed that it would be best to review reports on existing research and develop a revised proposal that would be better coordinated with currently-funded research. Program participants agreed to send the Instrumentation Team members copies of these reports.
- During the meeting, UFD laboratory program participants mentioned a "Gap Analysis Report" that documented various proposed instrumentation options considered. The Instrumentation Team will also be requesting a copy of this report

[1] It should be noted that Krypton-85 values cited during our meeting differ from values cite in the presentation, "DOE Cask Monitoring Development - Public Meeting at the Nuclear Regulatory Commission," by S. Saltzstein, S. Marschman, and B. Hanson, March 6, 2014. It is assumed that different calculational assumptions led to different results, and our team will investigate further to ensure that we accurately identify the best estimate ranges with appropriate uncertainties.

In summary, there appear to be several opportunities for the Instrumentation Team to pursue: externally mounted speed-of-sound ultrasound sensors or the Millimeter wave gas analysis remote option for gas concentration evaluations; ultrasonic thermometers installed in the extra port within the thermocouple lances, and sensors and in-situ inspection techniques for evaluating stress corrosion cracking that would enhance currently-funded activities. Attendees agreed that after action items identified during and after the meeting are completed, a revised workscope would be developed and submitted to DOE-NE for funding. It is currently anticipated that this follow-on proposal could be completed during October 2014 so that Instrumentation Team members will have sufficient time to review UFD program reports completed in September 2014.

Thank you again for the opportunity to pursue this instrumentation activity. We look forward toward completing the work to address the UFD program needs.

Sincerely,

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JLR: VJP

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