



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
WASHINGTON, D.C. 20555-0001

May 20, 2015

MEMORANDUM TO: Anthony Hsia, Deputy Director  
Division of Spent Fuel Management  
Office of Nuclear Material Safety  
and Safeguards

FROM: John P. Wise, Materials Engineer */RA/*  
Renewal and Materials Branch  
Division of Spent Fuel Management  
Office of Nuclear Material Safety  
and Safeguards

SUBJECT: SUMMARY OF APRIL 21, 2015, PUBLIC MEETING WITH THE  
NUCLEAR ENERGY INSTITUTE ON THE CHLORIDE INDUCED  
STRESS CORROSION CRACKING REGULATORY ISSUE  
RESOLUTION PROTOCOL

Background

The U.S. Nuclear Regulatory Commission (NRC) staff held a Category 2 public meeting with the Nuclear Energy Institute (NEI), their members, and consultants on April 21, 2015, to discuss the Chloride Induced Stress Corrosion Cracking Regulatory Issue Resolution Protocol (RIRP). The primary focus of the meeting was to discuss the progress of an Electric Power Research Institute (EPRI) report, "Susceptibility Assessment Criteria for Chloride-Induced Stress Corrosion Cracking (CISCC) of Welded Stainless Steel Canisters for Dry Cask Storage Systems."

The meeting was noticed on April 7, 2015 (ML15097A309). The meeting attendance list is provided in Enclosure 1.

Discussion

The meeting discussion generally followed the meeting agenda, which is included in Enclosure 2. Enclosure 3 contains the presentations given by the NRC and NEI.

NEI provided an update of the schedule and remaining tasks of the RIRP plan, as reflected in their February 7, 2014, letter (ML14052A015). NEI stated that the EPRI report discussed at this meeting is the last major deliverable in the RIRP action plan – specifically, action item No. 17, "Finalize, and send to NRC, Industry Susceptibility Assessment Criteria."

An EPRI contractor from Dominion Engineering gave a presentation on the upcoming EPRI report that will give industry susceptibility assessment criteria for CISCC of stainless steel dry storage systems. As seen in Enclosure 3, the ranking methodology for system susceptibility will be based on two factors (1) ISFSI susceptibility, which is environment-based and considers

factors such as humidity and proximity to chloride sources, and (2) canister-specific susceptibility, which considers factors such as cask geometry, material, storage duration, and fuel load power. EPRI anticipates that the report will be available for NRC review in September 2015. The presentation also briefly outlined the next steps after the RIRP resolution. These include the completion of an EPRI report on the assessment of canister confinement integrity, creation of aging management guidelines, and continuing work on CISCC testing, modeling, and inspection.

The Dominion Engineering presenter provided further detail on the CISCC susceptibility assessment criteria in response to several questions from the NRC staff and staff from the U.S. Nuclear Waste Technical Review Board (NWTRB). The presenter clarified that the susceptibility ranking methodology considers the use of biocides in cooling towers as a chloride source, and that the effects of breaking waves are not considered a necessary condition for elevated chlorides near marine shores (i.e., all marine shores are conservatively considered elevated chloride sources). Duplex stainless steels will not be among the canister materials considered. The presenter also stated that the results of the susceptibility assessment criteria were not checked against specific power reactor components that have experienced cracking; however, the results were compared against *locations* with relevant reactor operating experience to ensure that the environments at those locations were predicted to have high susceptibility. The NWTRB staff member asked about the level of sensitivity of the susceptibility model – specifically, whether it will show sufficient variability between ISFSIs to be useful in prioritizing inspections. The presenter stated that the susceptibility calculations show a significant degree of variability for different ISFSIs and other parameters, and the report will include plots of these variations.

The NRC staff asked NEI how it anticipates the NRC will use the reports created under the RIRP and if there will be an effort to pull all the information together under a comprehensive aging management guidance document. NEI responded that they would take an action to request a public meeting to discuss this. The NRC staff also invited the industry to use the lessons learned from the development of the CISCC susceptibility report to inform comments on NUREG-1927, Revision 1, “Standard Review Plan for Renewal of Specific Licenses and Certificates of Compliance for Dry Storage of Spent Nuclear Fuel.”

The NRC followed with a presentation on an example aging management program (AMP) for localized corrosion and stress corrosion cracking of stainless steel storage canisters. The presentation included a discussion of chloride salt transport to canister surfaces, salt deliquescence as a function of temperature and humidity, and estimated crack growth rates. The NRC staff noted that the calculations of crack growth are likely overestimates, as the calculations assume that (1) sufficient residual tensile stresses and salt concentrations are present to cause cracking initiation and growth, (2) cracks grow whenever the environmental conditions are conducive to salt deliquescence, and (3) salts will not react to form other compounds that are less likely to deliquesce.

In response to questions from industry representatives, the NRC staff clarified that calculations of crack growth are continuing for sites other than those discussed in the presentation. The NRC staff chose Witham Field, Florida and Vandenberg Air Force Base for the initial calculations because of their potentially heightened susceptibility to CISCC and availability of environmental data. However, these sites are not necessarily the worst case regarding cracking susceptibility. Also, these sites are not intended to be representative of any other particular location. An industry representative also asked about insights the NRC has on the influence of chloride concentrations on crack growth rates. The NRC responded that more data is needed

to determine chloride concentration effects, and this is an area that may be explored in the future.

Next, the NRC presentation reviewed the elements of the dry storage canister AMP, which includes periodic visual inspections of canister external surfaces to identify precursors to stress corrosion cracking. When the inspections identify suspected areas of localized corrosion or cracking, additional evaluation of those areas are required. The AMP references the use of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code Section XI for inservice inspections. The NRC recognized that this ASME Code section for power reactors was not a clean fit for storage canisters. As a result, the NRC has requested that ASME develop rules for the inspection of dry storage systems.

An industry representative asked the NRC about the acceptance criteria for the AMP when an indication of localized corrosion is identified away from a canister residual stress field (e.g., away from welds). The NRC staff responded that localized corrosion in the absence of a stress field would not, in itself, be expected to challenge the confinement function of the canister. However, if inspections identify localized corrosion away from the welds, that would indicate that the potential for stress corrosion cracking is elevated.

The industry representative also expressed concern that the inspection methodology that will be cited by the new ASME code on inservice inspection will not have the ability to discern acceptable flaws. The industry representative stressed that the acceptance criteria for flaws identified during inservice inspections cannot be more stringent than those for canister fabrication. The NRC staff noted that ASME committee will have to consider the ability to inspect when establishing acceptance criteria. The NRC staff also encouraged the industry to get involved in the new ASME committee to ensure their concerns are addressed.

Another industry representative asked whether there would be a mechanism to reduce the frequency of inspections if supported by new data. The NRC responded that, as new data comes in, the NRC would consider reduced inspection frequencies if the data warrants it.

To close the discussion between the NRC and industry, NEI asked the NRC to consider how the NRC will provide formal feedback on the upcoming EPRI susceptibility report such that the RIRP can move to closure on schedule. The NRC staff responded that it will discuss the mechanism for feedback once the report is made public. NEI suggested holding another meeting after the report comes out, perhaps in the October/November 2015 timeframe. NEI also suggested to follow recent history on the closure of other RIRPs as a template to close out the current work. NEI took an action to send a letter updating the RIRP plan.

Following the discussions between the NRC and industry representatives, members of the public provided comments and asked questions.

One member of the public noted that fog rolls in daily on the California coast and asked whether the presence of this fog is sufficient to cause salts to deliquesce. The NRC staff responded that fog would reflect 100 percent relative humidity and the use of site-specific environmental data would be important to estimate crack growth in such a case. The public member also expressed concern about the ability to perform visual inspections of the canisters, which are difficult to access. The NRC staff responded that the technology currently exists to perform remote inspections of difficult-to-access areas, and other industries regularly use these technologies. The commenter expressed no confidence in such technologies until they can be demonstrated to work on dry storage canisters. Finally, the public member asked what would

happen if an inspection identifies a crack in a canister. The NRC cited experience at the Koeberg nuclear power station where a stress corrosion crack in an outdoor stainless steel tank was repaired with laser welding. In an earlier discussion during the meeting, NEI stated that it is working on a white paper on crack mitigation strategies that it will be sharing that with the NRC.

Another member of the public asked whether the EPRI CISCC susceptibility report would include a map that shows the regions of the United States that have environmental conditions that encourage stress corrosion cracking. The commenter also asked whether the report would provide CISCC-susceptibility "grades" for each dry storage system design. NEI and a representative from EPRI clarified that the report will provide the tools to perform such evaluations, and that the variability in designs and storage conditions is such that completing the requested evaluations is not intended to be a part of the report. The public member stated that it would be helpful for someone to perform such analyses and make them widely available as opposed to have each storage site or interested stakeholder perform them individually. Finally, the public member asked whether the susceptibility report considered cast iron canister materials. Industry representatives clarified that the CISCC RIRP was only considering stainless steel materials.

Another member of the public expressed a concern that it is not always about "can" one identify a crack in a canister, but rather "will" a crack be identified. The public member cited the Davis-Besse reactor head corrosion incident as an example of a case where effective inspection could have been done, but was not. The public member also asked the NRC whether, once chlorides are in a crack, they will always be present and available to cause cracking. The NRC staff clarified that, if chlorides are present in a crack, they must still be in solution in order for stress corrosion cracking to progress.

Another member of the public stated that offshore winds play a very significant role in CISCC susceptibility and asked that these effects be included in the susceptibility models (rather than just considering proximity to the coast). The commenter noted that, having lived near the coast for most of his life, he has experienced the salt air surge that large waves bring to the coastline. The NRC stated that it is very aware of the commenter's concern and noted that wave action is thought to have had a role in the stress corrosion cracking experienced at the Koeberg nuclear power station. The public member also was concerned about the selection of the sites for the crack growth calculations in the NRC presentation. For example, the commenter did not feel that the selection of the Vandenberg Air Force Base site provides much insight to CISCC susceptibility of canisters that are stored right on the marine coast.

Finally, in response to questions from another member of the public, the NRC clarified that the potential for aircraft impacts have been evaluated during the initial licensing of storage systems. Also, although the NRC is recommending that initial inspections for stress corrosion cracking be performed on one storage system per site, inspection findings may prompt an expansion of that sample to multiple systems.

TAC No.: LA0233

Enclosures:

1. Meeting Attendees
2. Agenda
3. Presentation Handouts

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MEETING ATTENDEES

## Agenda

### Public Meeting with Nuclear Energy Institute on Chloride Induced Stress Corrosion Cracking (CISCC) Regulatory Issue Resolution Protocol (RIRP)

April 21, 2015  
1:00 P.M. – 4:30 P.M.

One White Flint North, Commissioner's Hearing Room

1:00 – 1:10 PM	Welcome, Introductions, and Meeting Objectives (All)
1:10 – 1:25 PM	Update of RIRP Schedule/Tasks (NEI)
1:25 – 2:55 PM	CISCC Susceptibility Criteria (Electric Power Research Institute, Dominion Engineering, Inc.)
2:55 – 3:10 PM	<b>Break</b>
3:10 – 3:40 PM	Aging Management Approach for Stress Corrosion Cracking (NRC)
3:40 – 4:05 PM	Open Discussion (All)
4:05 – 4:30 PM	Public Comments and Wrap Up



PRESENTATION HANDOUTS