From: Hardies, Robert
To: van Walle Eric
Cc: Rudland, David; Hiser, Matthew
Subject: RE: RE: program on materials of decommissioned pressure vessels
Date: Thursday, August 11, 2016 6:34:26 AM
Attachments: NRC staff from the Office of Nuclear Reactor Regulation.docx

Note to requester: Attachment is immediately following.

Hi Eric, Our plans are rudimentary at this time. We have ideas but the current state of our program is somewhere between conceptual and exploratory. I've copied Matt Hiser on this email and he is involved in a current project to identify what types of materials would be of interest when harvesting from retired plants. He is planning a workshop in late fall/early winter and I am sure he would like you to attend or participate in some way.
Dave and I met with Jan Bens in March and after that put together a conceptual scoping proposal and I have attached that.
The NRC is cutting back on staff and budget, but harvesting materials from decommissioned plants has always enjoyed great interest and priority from senor level management, so it should not really be very difficult to secure funding, but there is no current funding.
We met with NRA (Japan) this week and they are very interested in our nebulous plans too. I am retiring soon, so Dave Rudland or Matt Hiser is likely to be the long term point of contact on this project.

Robert Hardies
Senior Level Advisor for Materials Engineering
Division of Engineering
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Office Phone 301 415-5802
(b)(6) Cell [redacted]

From: van Walle Eric [mailto:eric.van.walle@sckcen.be]
Sent: Wednesday, August 10, 2016 3:17 AM
To: Hardies, Robert <Robert.Hardies@nrc.gov>
Cc: Rudland, David <David.Rudland@nrc.gov>
Subject: [External_Sender] RE: program on materials of decommissioned pressure vessels

Dear Bob, dear Dave,
Unfortunately I missed Dave at the PVP meeting.
My mail discussion with Tom Rosseel indicated that there is a US program on the Zion material, but I reckon this is under ORNL leadership, and that this is the only material that is under future investigation. Does this mean that USNRC is not involved?
Does USNRC have a description of the conceptual program you mention Bob? I was asked to have a meeting with our Regulatory Body next week, but I am still a bit puzzled on how things might be organized/looked at from US-side. It would be good to understand your approach.
Kindly,
Eric.

From: Hardies, Robert [mailto:Robert.Hardies@nrc.gov]
Sent: dinsdag 12 juli 2016 16:46
To: van Walle Eric
Cc: Rudland, David
Subject: RE: program on materials of decommissioned pressure vessels

Dear Eric,

Of course I remember you. Mark has kept me posted on your rapid career arc. It is great to hear from you again.
The NRC does not have an active program. Instead I would call it a conceptual program. We would like to recover some materials from retired plants. Jan Bens met with us last April and indicated there was interest in Belgium to do the same. We have also met with the Swiss, who indicate they have similar goals.
Dave Rudland is currently the Branch Chief in our Office of Research who is most likely to be heading up this activity. He will be at the PVP meeting. Perhaps you two could arrange to meet there.
Best Regards,

Robert Hardies
Senior Level Advisor for Materials Engineering
Division of Engineering
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Office Phone 301 415-5802
(b)(6) Cell [redacted]

From: van Walle Eric [mailto:eric.van.walle@sckcen.be]
Sent: Tuesday, July 12, 2016 6:30 AM
To: Hardies, Robert <Robert.Hardies@nrc.gov>
Subject: [External_Sender] program on materials of decommissioned pressure vessels
Importance: High

Dear Bob,
I wonder whether you still know me after so many years of silence… I was quite active in ASTM on RPV-issues and still today the subject is very close to my heart.
Since more than ten years now I became the Director-General of the Belgian Nuclear Research Centre, SCK.CEN in Mol, Belgium. As this Centre is the only one in Belgium and covers most nuclear subjects from A to Z, I still spend a little bit of my time to RPV's. Most work is done by Rachid Chaouadi whom you have met before also. I also know you are well aware of the Doel3/Tihange2 Belgian NPP-situation and of course USNRC has followed it closely. I still have a lot of contacts with Mark Kirk, I guess working in your team.
The reason of this email is that I am looking for information on how to participate in the work that the US is planning/executing today on decommissioned RPV's . Our regulatory body and TSO would support this kind of activity and of course also from the viewpoint of our NPP's and the Centre, we have an interest. Moreover, we still have the BR2 reactor fully operational and our state-of-the-art labs. These are interesting tools to use besides the elaborate experience our teams have on RPVs.
So, my question is simple: can we, and if yes how, participate in the ongoing US decommissioned RPV program. Whom do I need to get in touch with, what are the conditions, are there any meetings where we could participate?
I leave on Saturday for the PVP meeting in Vancouver. Rachid comes later also to the meeting in Chicago.
Hope to hear from you soon,
Kindly,
Eric.

NRC staff from the Nuclear Regulatory Commission (NRC) Office of Nuclear Reactor Regulation (R. Hardies, G. Carpenter) and the Office of Nuclear Regulatory Research (D. Rudland) met with Jan Bens, Director General of the Federal Agency for Nuclear Control (FANC), the Belgian nuclear regulatory authority, during the Regulatory Information Conference, Wednesday, March 9, 2016. The purpose of the meeting was to explore the potential for collaborating on performing research on reactor pressure vessel steel from retired nuclear power plants. In principal, both FANC and NRC agree that research on salvaged actual plant materials would prove to be valuable. Both parties plan to continue informal discussion.

The NRC is currently participating in collaborative programs to retrieve and test reactor vessel internals materials from the retired Cabrera plant in Spain. The NRC is interested in testing reactor pressure vessel materials, but has no current programs to retrieve or test material. There is no current funding and no current user need request to address planning, retrieval or testing. FANC is considering programs to retrieve and test materials.

Any program to retrieve and test reactor pressure vessel materials would address several general topics, including planning, acquisition and testing, as follows:

1) Planning

   During the past three years five plants in the U.S. have shut down permanently, and another three have announced their intent to shut down prior to 2020. Other countries also have plants that have or plan to shut down permanently. Each retired plant provides an opportunity to harvest materials that have accumulated extensive service exposure. Testing such materials can provide information on the progression of materials damage mechanisms. The resulting information can be used to inform inspection programs or provide information useful for evaluating suitability for continued operations.

   An initial task prior to testing reactor pressure vessel materials from retired plants is identifying available plant materials and comparing those materials to existing research needs. Different sponsoring organizations or participating countries may have different research priorities. For example, some countries may be most interested in testing forged reactor pressure vessel material. Other countries may be most interested in the most highly irradiated, most radiation sensitive materials available. Finding materials in a plant that satisfy the needs of multiple sponsoring organizations represents the most economical use of sponsorship funding. .

   Typical activities included in this phase include identifying a point of contact at the plant, retrieving materials information about the plants from the point of contact, then determining if the plant has material worth salvaging for research purposes. For those plants that have materials of interest, determine the decommissioning plans to identify the timeframe when the materials could be retrieved. Since many plants enter periods of safe storage that may last decades, the planning must provide for future notification to

both the decommissioning and the acquiring organizations in order to ensure the salvage operation is added to the decommissioning plan and the acquiring organizations are able to plan sufficiently far in advance to secure funding for the acquisition.

2) Acquisition

   The timing for the acquisition phase depends on the outcomes from the planning phase. A few years before the acquisition, the point of contact at the acquiring organization needs to communicate to participating organizations. All participating organizations need to identify sources of funding and secure the funding. Some participating organizations may have budgetary cycles that may take several years of advance planning. Once all participating organizations are identified and funding is secured a single organization needs to centralize funding and begin a single point acquisition activity. Inter-organizational contracting agreements need to be established and executed. The contracting organization needs to begin negotiations with the supplying organization far enough in advance so that the supplying organization can identify accurate availabilities and can provide estimates that permit budgetary planning. It may be advantageous to have the acquiring organization be located in the same country as the supplying organization.

   Arrangements for transportation of harvested radioactive materials needs to be planned, contracted, and executed.

3) Testing

   The type of testing that is required will depend on the material and degradation mechanism that is to be investigated. The type of test facility will depend on the level of radioactivity in the harvested material. All sponsoring organizations will need to agree on the test program scope. The lead organization will need to contract with a test facility and arrange to have a test report prepared.

The NRC expects to continue discussions to work out details of a program to acquire and perform research on reactor pressure vessel materials from decommissioned plants.

From: Frankl, Istvan
Sent: Fri, 16 Dec 2016 18:25:55 +0000
To: Brady, Bennett
Cc: Iyengar, Raj;Hull, Amy
Subject: RE: Revised User Need Request for SLR
Attachments: 2016 NRR UNR - SLR Memo (IF).docx

Note to requester: Attachment is immediately following.

Bennett,

I am fine with overall scope of the draft UNR and have attached my minor editorial revisions of the memo.

Thanks,

Steve F.

From: Iyengar, Raj
Sent: Thursday, December 15, 2016 4:27 PM
To: Brady, Bennett <Bennett.Brady@nrc.gov>; Bloom, Steven <Steven.Bloom@nrc.gov>; Hiser, Allen <Allen.Hiser@nrc.gov>; Hull, Amy <Amy.Hull@nrc.gov>
Cc: Frankl, Istvan <Istvan.Frankl@nrc.gov>
Subject: RE: Revised User Need Request for SLR

Bennett,

I am OK with the write-up. It captures the recent discussions on documentation quite well.

I have forwarded the attachments to Steve Frankl, just in case he has any comments.

My recommendation is for NRR to go ahead with the internal concurrence on this UNR and if RES staff has any insights, we could share those during the development of the UNR response from RES.

We would like to receive this UNR from NRR during Jan of 2017 (after we brief Bill Dean – currently scheduled for Jan. 12).

Amy,

Feel free to provide any comments, if you have not already provided.

Raj

From: Brady, Bennett
Sent: Monday, December 12, 2016 2:58 PM
To: Bloom, Steven <Steven.Bloom@nrc.gov>; Iyengar, Raj <Raj.Iyengar@nrc.gov>; Hiser, Allen

<Allen.Hiser@nrc.gov>; Hull, Amy <Amy.Hull@nrc.gov>
Subject: Revised User Need Request for SLR

All,

I have revised the user need request and transmittal memo. I added a forth task for documentation that I hope will meet the request Mike Weber had.

Please provide me your comments and changes.

Bennett

Bennett M. Brady
Senior Project Manager
Division of License Renewal
Office of Nuclear Reactor Regulation
O 11 – D8
301-415-2981

~~Official Use Only - Sensitive Internal Information~~

December

MEMORANDUM TO: Michael Weber, Director
Office of Nuclear Regulatory Research

FROM: William Dean, Director
Office of Nuclear Reactor Regulation

SUBJECT: **RESEARCH ASSISTANCE ON POTENTIAL SIGNIFICANT TECHNICAL ISSUES DURING THE SUBSEQUENT PERIOD OF EXTENDED OPERATION**

The purpose of this memorandum is to request specific research products to facilitate the evaluation of future applications for a license to operate during the subsequent license renewal (SLR) period (i.e., 60 to 80 years). These products should build upon analysis methods, tools, and expertise developed as part of ongoing and new research activities, focused specifically on aging effects during the SLR period.

This request is a continuation of tasks performed in response to UNR-NRR-2010-006, "Request for Office of Nuclear Regulatory Research Support in Developing Technical Information to Support Evaluating the Feasibility of License Renewal Beyond 60 Years" (ADAMS Accession No. ML092470525). The new support should focus on research activities addressing the most significant technical issues as discussed in the SRM

Commented [IF1]: Please identify.

CONTACT: Bennett M. Brady, NRR/DLR

Commented [IF2]: You may want to add phone number.

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Specifically, NRR is requesting RES support to:

- Hold NRC/industry workshop(s) on the status of domestic and international research activities and operating experience to address issues discussed in the subsequent license renewal guidance documents,
- Develop and implement a long-term strategy and database for obtaining information on materials degradation from harvesting ex-plant components from decommissioning as well as from operating plants,
- Continue to develop domestic and international partnerships to share expertise, capabilities, and resources related to aging management research for SLR, and
- Use the products from the above three tasks to develop documentation of the status of research for the significant technical issues for subsequent license renewal.

Additional details are provided in the Enclosure "Research Assistance on Potential Significant Technical Issues during the Subsequent Period of Extended Operation."

Resources

NRR requests RES to provide the specific resources (contract dollars and FTE) needed to complete the various tasks during the period of activity.

Intended Use of RES Products

The requested RES products will provide confirmatory research on the technical bases for industry research products related to aging degradation and identified in the staff's review of SLR applications.

Coordination and Schedules

This request has been coordinated with RES staff in the Division of Engineering. Based on this, we expect that the requested work could be completed within the requested timeframe. We are prepared to work with your staff to further develop a mutually acceptable technical approach and schedule for this activity, and to engage industry on this important matter. In addition, the Directors of the lead Divisions in each of our Offices, Jane Marshall (Acting) (NRR/DLR) and Brian Thomas, (RES/DE), have discussed and agreed with the scope and schedules of the tasks in this request.

CONTACT: Bennett M.Brady, NRR/DLR

Commented [IF3]: Can this be deleted?

Priority

This request is rated as high priority based on NRR office priority ranking for reactor activities.

Points of Contact

For NRR, the contact is Bennett Brady the Subsequent License Renewal and Operations Branch/Division of License Renewal.

For RES, the contact is Amy Hull, Corrosion and Metallurgy Branch, Division of Engineering.

Additional Information

None.

Enclosure:

Research Assistance on Potential Significant Technical Issues during the Subsequent Period of Extended Operation

CONTACT: Bennett Brady NRR/DLR

Commented [IF4]: Can this be deleted?

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Priority

This request is rated as high priority based on NRR office priority ranking for reactor activities.

Points of Contact

For NRR, the contact is Bennett Brady, ……, Division of License Renewal.

For RES, the contact is Amy Hull, Corrosion and Metallurgy Branch, Division of Engineering.

Additional Information

None.

Enclosure:

User Need: Evaluate the Aging Management of Systems, Structures, and Components for Subsequent License Renewal Period

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OFFICE	NRR/DLR	NRR/DLR: BC	NRR/DLR: SL	NRR/DLR: D	NRR: OD
NAME	BBrady	SBloom	AHiser	JMarshall	WDean
DATE					

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Note to requester: Attachments are immediately following.

From: Moyer, Carol
Sent: Thu, 19 Jan 2017 22:55:59 +0000
To: Hull, Amy;Brady, Bennett
Cc: Iyengar, Raj;Tregoning, Robert
Subject: RE: only received cover memo: Current User Need Request
Attachments: UNR Memo Draft 20161223.docx, UNR Enclosure Draft 20161223.docx

The ADAMS package ML16358A427 contains the two attached files – the memo, dated 12/22/16, and the enclosure, dated 12/23/16.

Carol

From: Hull, Amy
Sent: Thursday, January 19, 2017 4:30 PM
To: Brady, Bennett <Bennett.Brady@nrc.gov>
Cc: Moyer, Carol <Carol.Moyer@nrc.gov>; Iyengar, Raj <Raj.Iyengar@nrc.gov>; Tregoning, Robert <Robert.Tregoning@nrc.gov>
Subject: only received cover memo: Current User Need Request

Thanks Bennett for the cover letter (the actual UNR did not come through). I tried to get into ADAMS via Citrix and get out the current UNR that is referenced in the memo but it is not working. Please can somebody send me the most recent UNR ? – the last version I have is from 12/12/2016 (see attached).

From: Moyer, Carol
Sent: Thursday, January 19, 2017 3:14 PM
To: Brady, Bennett <Bennett.Brady@nrc.gov>; Hull, Amy <Amy.Hull@nrc.gov>
Cc: Iyengar, Raj <Raj.Iyengar@nrc.gov>; Tregoning, Robert <Robert.Tregoning@nrc.gov>
Subject: RE: Current User Need Request

Thanks for the update.

Carol

From: Brady, Bennett
Sent: Thursday, January 19, 2017 3:12 PM
To: Hull, Amy <Amy.Hull@nrc.gov>; Moyer, Carol <Carol.Moyer@nrc.gov>
Subject: Current User Need Request

It is currently with Allen and Allen is busy with requests from everyone, including me, (b)(6) (b)(6) Don't look for it anytime soon.

Bennett

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

MEMORANDUM TO: Michael F. Weber, Director
Office of Nuclear Regulatory Research

FROM: William M. Dean, Director
Office of Nuclear Reactor Regulation

SUBJECT: RESEARCH ASSISTANCE ON POTENTIAL SIGNIFICANT TECHNICAL ISSUES DURING THE SUBSEQUENT PERIOD OF EXTENDED OPERATION

The purpose of this memorandum is to request specific research products to facilitate the evaluation of future applications for a license to operate during the subsequent license renewal (SLR) period (i.e., 60 to 80 years). These products should build upon analysis methods, tools, and expertise developed as part of ongoing and new research activities, focused specifically on aging effects during the SLR period.

In a previous user need request, UNR-NRR-2010-006, "Request for Office of Nuclear Regulatory Research Support in Developing Technical Information to Support Evaluating the Feasibility of License Renewal Beyond 60 Years," (ADAMS Accession No. ML092470525), the Office of Nuclear Regulatory Research (RES) assisted the Office of Nuclear Reactor Regulation (NNR) in developing information for consideration in the SLR guidance documents.

This new user need request focuses on research activities on the technical issues discussed in the SLR guidance documents and in the staff requirements memorandum (SRM) to SECY 14-0016 (ADAMS Accession No. ML14241A578).

Specifically, NRR is requesting RES support to:

- Hold NRC/industry workshop(s) on the status of domestic and international research activities and operating experience to address issues discussed in the SLR guidance documents,
- Develop and implement a long-term strategy and database for obtaining information on materials degradation from harvesting ex-plant components from decommissioning as well as from operating plants,

CONTACT: Bennett Brady, NRR/DLR
(301) 415-2981

- Continue to develop domestic and international partnerships to share expertise, capabilities, and resources related to aging management research for SLR, and
- Use the products from the above three tasks to develop documentation of the status of research for the significant technical issues for SLR.

Additional details are provided in the Enclosure "Research Assistance on Potential Significant Technical Issues during the Subsequent Period of Extended Operation."

Resources

NRR requests RES to provide the specific resources (contract dollars and full-time equivalent staff) needed to complete the various tasks during the period of activity.

Intended Use of RES Products

The requested RES products will provide confirmatory research on the technical bases for industry research products related to aging degradation and identified in the staff's review of SLR applications.

Coordination and Schedules

This request has been coordinated with RES staff in the Division of Engineering (DE). Based on this, we expect that the requested work could be completed within the requested timeframe. We are prepared to work with your staff to further develop a mutually acceptable technical approach and schedule for this activity, and to engage industry on this important matter. In addition, the Directors of the lead Divisions in each of our Offices, George Wilson NRR/Division of License Renewal (DLR) and Brian Thomas (RES/DE), have discussed and agreed with the scope and schedules of the tasks in this request.

Priority

This request is rated as high priority based on NRR office priority ranking for reactor activities.

Points of Contact

For NRR, the contact is Bennett Brady, Subsequent Renewal, Guidance, and Operations Branch, DLR.

For RES, the contacts are Amy Hull and Carol Moyer, Corrosion and Metallurgy Branch, DE.

Additional Information

None.

Enclosure:

Research Assistance on Potential Significant Technical Issues during the Subsequent Period of Extended Operation

RESEARCH ASSISTANCE ON POTENTIAL SIGNIFICANT TECHNICAL ISSUES DURING THE SUBSEQUENT PERIOD OF EXTENDED OPERATION DATED

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ADAMS ACCESSION Nos.:
ML16357A689 (memo), ML16358A414 (enclosure), ML16358A427 (package) *concurred via email

OFFICE	LA:RPB1:DLR*	SPM: NRR:DLR	BC:NRR:DLR	SL:NRR:DLR	D:NRR:DLR	D:NRR
NAME	IBetts	BBrady	SBloom	AHiser	GWilson	WDean
DATE	12/27/2016	1/4/2017	1/ /2017	1/ /2017	1/ /2017	1/ /2017

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User Need

RESEARCH ASSISTANCE ON POTENTIAL SIGNIFICANT TECHNICAL ISSUES DURING THE SUBSEQUENT PERIOD OF EXTENDED OPERATION

Background:

The U.S. Nuclear Regulatory Commission staff (NRC or staff) has recently completed the draft guidance documents for subsequent license renewal (SLR). The draft guidance documents (draft NUREG-2191, Volumes 1 and 2, [ADAMS Accession No., ML16274A389 and ML16274A399, respectively], "Generic Aging Lessons Learned for Subsequent License Renewal (GALL-SLR) Report" and the draft NUREG-2192, [ADAMS Accession No. ML16274A402] "Standard Review Plan for Review of Subsequent License Renewal Applications for Nuclear Power Plants" were issued for public comment in December 2015.

As preparation for drafting these guidance documents, the Office of Nuclear Reactor Regulation (NRR) and the Office of Nuclear Regulatory Research (RES) conducted three audits to investigate the effectiveness of aging management programs (AMPs) used in the plant operating period from 40 to 60 years. The findings from the first two audits are documented in the report titled, "Summary of Aging Management Program Effectiveness Audits to Inform Subsequent License Renewal: R.E. Ginna Nuclear Power Plant and Nine Mile Point Nuclear Station, Unit 1" (ML13122A007). The summary of the third audit can be found in the August 5, 2014, report, "H.B. Robinson Steam Electric Plant, Unit 2, Aging Management Program Effectiveness Audit" (ADAMS Accession No. ML14017A289). RES also published on June 15, 2016, the "Review of Aging Management Programs: Compendium of Insights from License Renewal Applications and from AMP Effectiveness Audits Conducted to Inform Subsequent License Renewal Guidance Documents" (ADAMS Accession No. ML16167A076), which provides the staff's observations from reviewing license renewal applications and from the AMP audits.

RES also completed the Expanded Materials Degradation Assessment (EMDA) in cooperation with the Department of Energy (DOE) Light Water Reactor Sustainability (LWRS) Program. The resultant reports, NUREG/CR-7153, EMDA, Vol. 1-5" (ADAMS Accession Nos. ML14279A321, ML14279A331, ML14279A349, ML14279A430, and ML14279A461), describe the conclusions from an expert elicitation process to identify the most significant aging degradation technical issues for nuclear power reactor operation beyond 60 years.

These four most significant technical issues were also outlined in the staff requirements memorandum (SRM) on SECY 14-0016, "Ongoing Staff Activities to Assess Regulatory Considerations for Power Reactor Subsequent License Renewal" (ADAMS Accession No. ML14241A578).

- Reactor pressure vessel neutron embrittlement at high fluence
- Irradiation-assisted stress corrosion cracking of reactor internals and primary system components
- Concrete and containment degradation
- Electrical cable qualification and condition assessment

The audits and EMDA volumes provided NRC with over 800 suggestions for changes to the license renewal guidance and aging management program activities found acceptable for operation from 60 to 80 years.

Staff in several NRR divisions and RES' Division of Engineering (DE) participated in over ninety

expert panels to review these suggestions along with the staff's own suggestions for changes to license renewal guidance documents for the first license renewal. The expert panels dispositioned the recommendations for the guidance for SLR and drafted the NUREG-2191 and NUREG-2192.

After the draft guidance documents were issued for public comment, the staff held many public meetings with stakeholders and the public to discuss the proposed revisions and the bases for the revisions. In these meetings the staff provided information and clarifications on the proposed changes to the guidance documents, and solicited feedback on the documents.

The NRC staff has responded to the public comments and will publish the documents in final form in mid-2017.

To support their SLR applications, applicants need to demonstrate that the effects of aging will be adequately managed for an operating period from 60 to 80 years and to address the significant technical issues listed above.

The NRR would like RES' assistance in holding meetings on these issues, participating and interacting with the DOE and other industry organizations, cataloguing the materials needed for research, and documenting the status and products of research for SLR.

Description of Scope and Tasks

1. **Hold NRC/industry workshop(s) on the status of domestic and international research activities to address and evaluate the status of aging degradation issues identified in in the SRM on SECY 14-0016 and in the GALL-SLR Report**

   Need: In February 2008, the NRC and the Department of Energy (DOE) first co-sponsored a "Workshop on U.S. Nuclear Power Plant Life Extension Research and Development" (ADAMS Accession No. ML080570419), which requested stakeholder input into aging management research areas for "Life Beyond 60." Since then, there have been multiple domestic and international workshops/meetings on the research activities and operating experience that may impact aging management of systems, structures, and components (SSCs) for an SLR period. The International Atomic Energy Agency (IAEA) will sponsor a meeting in France in October 2017.

   These meetings have been helpful in facilitating technical discussions, disseminating knowledge and information, enabling the understanding of technical challenges, and paving the path forward for resolution of the challenges and issues related to materials degradation during the SLR period. As the NRC staff prepares for the review of SLR applications, there is a need for continued engagement with the domestic industry, DOE, and other federal organizations, academia, international partners, and interested public stakeholders through workshops focused on the status and resolution of the most significant technical issues outlined in the GALL-SLR and the SRM.

   Request: RES is requested to facilitate a minimum of two international activities (either a workshop, conference, symposium, or meeting), one in the early fall 2018 on the mechanical issues and one in late spring 2020 on the concrete and cables issues. These meetings should address:

   - the state of knowledge on the technical issues requested in the SRM on SECY 14-0016,

- on-going research on materials degradation issues and aging management of these issues, as discussed in the GALL-SLR, and
- new operating experience from the initial license renewal period (or the long term operation period for international plants).

These activities should be specifically targeted toward the resolution of technical issues for effective aging management of SSCs during the SLR period.

Deliverable: The deliverables include the international activities (either a workshop, conference, symposium, or meeting) and summary reports on the research insights and knowledge gained on the four major issues identified in the SRM on SECY 14-0016 for SLR.

Prior to the meetings, RES should provide a draft agenda and proposed presenters. The information from these activities should be documented in a NUREG/CP report, if appropriate, or by other sufficient means, including, at a minimum, a summary of the activity with all relevant contributions (e.g., presentations or papers) and research insights and knowledge, due 6 months after each meeting.

Schedule: The effort should continue until the completion of the deliverables from the second activity, tentatively scheduled for late spring 2020.

2. Develop and implement a long-term strategy for obtaining information on materials degradation from decommissioned nuclear power plants, as well as from ex-plant components from operating plants

Need: The NRC performs confirmatory research to inform and develop the technical bases for regulatory decisions related to AMPs for SLR. Historically, this research has included testing virgin materials under simulated aging conditions, as well as testing and characterization of ex-plant materials harvested from nuclear power plants. Ex-plant materials are valuable because they have been exposed to actual in-service plant operating conditions (temperature, irradiation, coolant, etc.), unlike virgin materials tested under simulated conditions in the lab. Testing ex-plant materials also reduces the uncertainty associated with the applicability of the aging conditions. Therefore, this effort is expected to provide fundamental insights on reactor materials degradation and information addressing potential technical issues or identified gaps to support anticipated future NRC needs. It will also inform the value of existing databases based on simulated aging conditions by assessing their applicability to in-service conditions.

Based on the recent experience of recovering materials from decommissioned plants, such as Zion, Crystal River, and Zorita (Spain), the efforts of planning, coordination, and eventual harvesting of these materials could be resource-intensive and time-challenging. Future efforts to retrieve materials from decommissioned plants should be focused on the highest value SSCs by proactively developing a strategic database for obtaining unique and significant materials aging degradation information from ex-plant components. Such a database will enable the NRC to focus its harvesting efforts and expeditiously obtain materials and components from plants to be decommissioned in the near future and develop information and knowledge to assess the efficacy of the AMPs.

Request: RES is requested to:

A. Develop a database which identifies and prioritizes the materials, components, and operating conditions that are needed to address the four significant issues outlined in the SRM on SECY 14-0016, and that, due to challenges in simulating actual

service conditions, may be best addressed by harvesting either from plants that are entering decommissioning or ex-plant components from operating plants.

B. Develop a process to evaluate the components from plants that are entering decommissioning or ex-plant components from operating plants that would be appropriate candidates for harvesting, and to ensure that timely contact is made with the plant owner to facilitate any harvesting targets that may be identified.

C. Use the process developed in item B to evaluate the suitability of components from plants that are currently either under decommissioning or replacing components that may be of interest.

D. Continue to implement the process developed in item B as components become available from additional plants.

Deliverable: RES should provide the database for NRR review, and summarize the priority listing in a letter report. Likewise, items B and C should be documented in a letter report. Item D is a continuing item that should be summarized in a letter report or e-mail as appropriate.

Schedule: Items A and B should be completed within 18 months of issuance of this user need request. Item C should be completed within 24 months of issuance of this user need request. Item D is an activity that should continue 36 months from the issuance of this user need request.

3. Continue to Develop Domestic and International Partnerships to Share Expertise, Capabilities and Resources Related to Aging Management Research for Long-Term Operations

Need: Various domestic and foreign research organizations, government agencies, utilities and research organizations are presently engaged in aging management research, the results of which may be of value to the NRC regarding plant operations during the SLR period. Additionally, the Electric Power Research Institute is engaged with various international research organizations to develop data on aging mechanisms/effects. As such, it benefits the NRC to be engaged in domestic and international research partnerships in order to evaluate all available operating experience and relevant research, leverage resources, and minimize unnecessary duplication of efforts. It would be advantageous to the NRC to develop partnerships with these entities such that the various research programs could be better coordinated and focused on high-priority needs.

Request: RES is requested to continue to develop agreements with domestic and international partners to collaborate on aging management research that results in information to help inform agency decisions regarding SLR applications. RES should evaluate products and reports from these organizations that may be provided to NRC in support of generic or plant-specific issues.

Deliverable: RES should provide to interested NRR branch chiefs (from the Division of Engineering (DE) and the Division of License Renewal (DLR)) and senior staff relevant products (e.g., trip reports, meeting summaries, papers, presentations, reports and other information) from interactions with domestic and international organizations. In addition, relevant findings from recent interactions, the status, and future plans should be discussed as a standing agenda item during the quarterly interface meetings between RES/DE, NRR/DLR and NRR/DE.

Schedule: These products should be provided to NRR in a timely manner; the effort should continue until the closure of this user need request. A quarterly report (or slides) for

presentation at the Director/Deputy Director Quarterly Interface Meeting should be provided five days before the meeting.

4. Documentation and Compilation of Results from Tasks 1, 2, and 3 on the status of research results in support of the Commission's direction to the staff

Need: In the SRM to SECY 14-0016, the Commission directed the staff to keep the Commission informed on the progress in resolving the four significant technical issues related to SLR. The SRM also directed the staff to keep the Commission informed regarding the staff's readiness for accepting an application and any further need for regulatory process changes, rulemaking, or research.

Request: RES is requested to annually prepare a document summarizing the products from tasks 1, 2, and 3 of this user need request to discuss the accomplishments of RES and national and international partners in addressing the four major technical issues in the SRM and other research activities that may be used in reviewing applications for SLR.

The annual report should be at a sufficiently high level to be used to support briefings for the Commission or Advisory Committee on Reactor Safeguards, Commission Assistants' Notes, reporting to the public and interested stakeholders, or other requests for briefings on SLR.

Schedule: Annual report to be provided in the first quarter of each calendar year beginning in the first quarter of calendar year 2018 discussing the research activities of the previous year supporting SLR.

Note to requester: Attachment is immediately following.

From: Hiser, Allen
Sent: Thu, 16 Nov 2017 13:07:34 -0500
To: Moyer, Carol;Hiser, Matthew
Subject: PliM Paper and Presentation
Attachments: Trip Report - 2017-10-23 to 27 - IAEA PLiM Conference - Wilson & Hiser.doc
Importance: High

Can you send me the ADAMS numbers for your PLiM paper and presentation? Have these been made public? If not, is there a reason that they are not public?

Also, please take a look at the attached draft trip report and provide any feedback (I will get the harvesting contact information to you on 11/27).

Thanks!

NRC INTERNATIONAL TRAVEL TRIP REPORT

Traveler, Office, Division, Phone Number:
George A. Wilson, NRR, Division of Materials and License Renewal, 301-415-1183
Allen L. Hiser, Jr., NRR, Division of Materials and License Renewal, 301-415-5650

Subject:
IAEA 4th International Conference on Nuclear Power Plant Life Management (PLiM)

Dates of Travel and Countries/Organizations Visited:
October 21-28, 2017
International Atomic Energy Agency (IAEA)
Lyon Convention Centre (Centre de Congrès de Lyon)
Lyon, France

Desired Outcome:
Improved international understanding, cooperation and coordination on aging management for long term operation (LTO), and informed international counterparts on NRC's confirmatory research efforts related to LTO and subsequent license renewal (SLR).

Results Achieved:
The NRC participants made five separate presentations during the conference (including a keynote speech and two prepared by the Office of Nuclear Regulatory Research), chaired two technical sessions, moderated a discussion session, and manned a poster. The NRC also prepared five papers for the conference, one for each of the presentations. The NRR presentations emphasized the need to combine the limited scope license renewal review of Part 54 and the on-going regulatory process to ensure plant safety during the period of extended operation. The poster and presentation from RES on harvesting of aged materials received some inquiries, which will be sent to RES.

Summary of Trip:
The IAEA 4th International Conference on Nuclear Power Plant Life Management (PLiM) followed similar conferences held in 2002, 2007 and 2012 (co-hosted by the NRC and DOE). Although this conference has been held on a five year basis, the discussion on the last day was to increase the frequency to every 3 years, due to the high level of activity and interest in this area, with the next conference likely to be held in Japan in 2020.

The NRC participants made five separate presentations during the conference (including a keynote speech and two prepared by the Office of Nuclear Regulatory Research), chaired two technical sessions, moderated a discussion session, and manned a poster. Attachment 1 provides a listing of these items.

The objectives of the conference were to:

- Emphasize the role of PLiM programmes in assuring safety and improving reliable nuclear power plant (NPP) operation;
- Identify the economic impacts of PLiM and LTO programmes, as well as methodologies for their evaluation;
- Provide key elements and good practices related to the safety aspects of ageing, ageing management and LTO;

- Provide a forum for information exchange on national and international policies, as well as on regulatory practices, and for the demonstration of strategies, including their application in ageing management and PLiM programmes for operating and new NPPs; and
- Assist Member States in further developing their PLiM programmes taking consideration of lessons learned and of impacts from the Fukushima Daiichi accident.

The conference included a number of presentations and discussions in six topical areas. These areas were:

- Sessions 1-1 to 1-6: Approaches to Plant Life Management
- Sessions 2-1 and 2-2: Economics of Plant Life Management
- Sessions 3-1 to 3-9: Ageing Management and Preparation for Long Term Operation
- Sessions 4-1 to 4-3: Configuration and Modification Management for Safety Enhancement
- Sessions 5-1: Human Factors and Management Aspects
- Sessions 6-1 to 6-4: Regulatory Approaches to Ageing Management and Long Term Operation

The final program agenda and copies of each of the presentations (including keynote speeches and summaries of each of the sessions) are available on an internal Sharepoint site. Due to the four parallel sessions during each time slot, the NRC participants could not experience each presentation.

The conference featured presentations by utility staff, plant personnel, technical support organizations, researchers and regulatory staff. The presentations described plant status and plans for long term operation, specific activities taken to address certain plant issues, economic aspects of LTO and regulatory approaches for LTO.

The discussion during the conference addressed a couple of common themes:

- There is considerable interest internationally by utilities to extend the operating period of their plants beyond their license or design periods.
- Plant economics and the local political environment are important factors in plant's pursuing LTO.
- Public transparency by the regulator was identified as a possible contributor to increasing public confidence as cited in some cases as inadequate, with the overall U.S. regulatory process and the license renewal process in particular cited as model approaches.
- Many countries use the NRC license renewal approach as their plants exceed their design life, and also use the IAEA periodic safety review (PSR) every 10 years to assess and improve plant safety levels.
- The use of the IAEA International Ageing Lessons Learned (IGALL) report, and IAEA peer reviews (such as Safety Aspects of Long Term Operation or SALTO) and workshops, were cited as providing a substantial benefit for both plants entering LTO and regulators.

The "summary and conclusions" from each session are provided in Attachment 2.

Pending Actions/Planned Next Steps for NRC:

1. NRC will continue to support IAEA activities in the area of LTO and aging management on a case-by-case basis.
2. NRC will continue to support the IAEA IGALL program on a case-by-case basis.

3. NRC will consider performing additional “Workshops on Review of License Renewal Applications,” such as in China in spring 2018.

Points for Commission Consideration/Interest:
No points for Commission consideration/interest.

Attachment 1

NRC Presentations and Papers at the 4th PLiM Conference

1. G. Wilson, “Assuring Safe Subsequent License Renewal for Commercial Nuclear Power Reactors in the USA,” keynote speech (ADAMS Accession No. ML17285A717) and paper (ADAMS Accession No. ML17285A712).

2. A. Hiser, “From 40 to 60 to 80 years – Lessons Learned and Approach to Subsequent License Renewal in the USA,” presentation (ADAMS Accession No. ML17285A660) and paper (ADAMS Accession No. ML17285A499).

3. A. Hiser, “Applying the United States License Renewal Approach to an International Environment,” presentation (ADAMS Accession No. ML17285A678) and paper (ADAMS Accession No. ML17285A687).

4. C. Moyer, et. al (presented by A. Hiser), “Regulatory Research on the Aging Management of Structures, Systems and Components in Nuclear Power Plants Supporting License Renewal,” presentation (ADAMS Accession No. ML) and paper (ADAMS Accession No. ML).

5. M. Hiser, et. al (presented by A. Hiser), “Harvesting of Aged Materials from Operating and Decommissioning Nuclear Power Plants,” presentation (ADAMS Accession No. ML) and paper (ADAMS Accession No. ML).

6. **Attachment 2**

SUMMARY AND RECOMMENDATIONS FROM EACH OF THE SESSIONS

Session 1 – Approaches to Plant Life Management:

- AMP of NPPs are continuously developed & updated to account for latest technical issues new regulatory requirements.
- Above process supported by corresponding research, which includes construction of new test facilities (if needed) and harvesting of aged material from decommissioned plants, and technical means (setup & expansion of databases, e.g. EQ).
- Regulatory requirements are also further developed & updated to account for latest operating experience.

Session 2 – Economics of Plant Life Management:

- Research and participant questions confirm economic conditions impacting energy prices is an immediate and long-term challenge to success of LTO.
- It is important for those countries that identify a pathway to success in improving economic conditions, the information be shared.
- Learn from existing platforms for transparency, trust and improving perception of nuclear.
- Further interaction and discussion is needed to address the imminent challenge of obsolescence of nuclear plant components.

Session 3 – Ageing Management and Preparation for Long Term Operation:

- IGALL is developing into a strong reference base for NPPs AM, TLAA practice and OPEX from some MS still need to be added/completed;
- Japan, US, France, perform a large research programme. These research results would be a good contribution to the improvement of database of IGALL;
- SALTO PR service is a good procedure to help the MS for the preparation of their LTO programme. This programme should be widened among the MS;
- It could be interesting to investigate the influence of vibratory fatigue on small bore piping at a more general level within IAEA (IGALL);
- Perform EAF testing on industrial scale components so as to exhibit the margins incorporated in the codified approach covering environmental fatigue;
- There is a need to continue information exchange on material and structural integrity issues and share it through IGALL and other IAEA MSs;
- There is a need for discussions (WS, Safety Standards) for common understanding of LTO technical detailed tasks (scope setting, AMR of active and passive components, TLAAs) (how to do/implement that);
- Continuous improvement for AMP implementation:
  - Share best practices and lessons learned for AMP implementation. More active participation in IGALL.
  - Share results and lessons learned from SALTO reviews
- Provide training for ‘new’ AMP users to ensure technology transfer and development of human resources for IGALL use and sharing operating experience

- Coordination, collaboration and leveraging of research results to support LTO
- IAEA should consider how to promote modernization and economic efficiencies to support LTO

Session 4 – Configuration and Modification ion Management for Safety Enhancement:

- LTO programs have gained from studies directed at improved understanding of NDT techniques and technologies available, their benefits and shortcomings. From which, further development of promising NDT techniques for specific applications can be improvements and further developed. An important consideration is for researchers to look beyond their research fields or industries for potential solutions.
- International collaborations and shared “lessons learned” have proven invaluable for large project efforts for LTO.
- New condition monitoring technologies as well as repair / mitigation techniques being developed are starting to show the potential for significant economic benefits for plant life extension.
- Managers need to understand that multidisciplinary teams are needed in addressing scientific gaps, or engineering problems. Solutions to problems cannot be compartmentalized into one area of focus.
- Ageing and long-term operation of I&C is a crucial topic for NPP. Modernization through digital systems could be a solution that may improve performance and the obsolescence management.

Session 5 – Human Factors and Management Aspects:

- As an area with increasing importance for LTO,
  - Well-organized HRD,
  - Obsolescence with particular attention to analogue technologies,
  - Configuration management and knowledge management for knowledge transfer from generation to generation,
  - New technologies to support knowledge management.
  - To collect and organize knowledge based on experience of wider range, global cooperative work is essential

Session 6 – Regulatory Approaches to Ageing Management and Long Term Operation:

- A variety of approaches are used for regulation of LTO; many of these approaches either reference or are based on IAEA standards and guides (SSR-2/2, draft SSG-48, SRS-82, SVS-26).
- Openness between the regulator and the utility is important to gain a common understanding of the LTO preparation by the plant and to the regulator’s needs to ensure a successful LTO review process.
- Public transparency by the regulator was identified as a possible contributor to increased public confidence.
- The IGALL report is used in some cases by the regulator as a tool for LTO evaluations.
- A proposal for IGALL phase 4 was suggested: Organize an IGALL Working Group on regulatory aspects of safe LTO (Guideline for self-assessment against IAEA Safety Standards, and How to perform assessment of a plant specific Ageing Management Review…)
- Use of IGALL, and SALTO peer reviews and workshops, were cited as providing a substantial benefit for plants entering LTO and for regulators as well.

From: International Travel
Sent: Sun, 19 Nov 2017 06:54:05 -0500
To: NRRInternationalTravel Resource;RES International Travel Dist;Rodriguez, Veronica;Quinones-Navarro, Lauren
Cc: Hiser, Allen;Wilson, George
Subject: NRR - Trip Report Notification - IAEA 4th International Conference on NPP Life Management

Greetings,

The Trip Report for the trip, IAEA 4th International Conference on NPP Life Management has been submitted by Hiser, Allen.

Regards,
iTravel Administration Team

Trip Name	IAEA 4th International Conference on NPP Life Management
Trip ID:	3799
Travelers:	Hiser, Allen;Wilson, George
Travel Dates:	10/21/2017 - 10/29/2017
Destination:	Lyon, France
Trip Report	ML17317A529
Results Achieved:	The NRC participants made five separate presentations during the conference (including a keynote speech and two prepared by the Office of Nuclear Regulatory Research), chaired two technical sessions, moderated a discussion session, and manned a poster. The NRC also prepared five papers for the conference, one for each of the presentations. The NRR presentations emphasized the need to combine the limited scope license renewal review of Part 54 and the NRC's on-going regulatory process to ensure plant safety during the period of extended operation. The poster and presentation from RES on harvesting of aged materials received some inquiries, which will be sent to RES.

** This is an auto distribution sent from the combined International Travel SharePoint System.*
For questions, please communicate with your Office point(s) of contact.

~~****SENSITIVE INFORMATION - OFFICIAL USE ONLY****~~

Note to requester: Attachments are immediately following.

From: Frankl, Istvan
Sent: Tue, 31 May 2016 12:54:40 +0000
To: Bloom, Steven
Cc: Hiser, Allen;Morey, Dennis;Burton, William;Brady, Bennett;Wittick, Brian;Iyengar, Raj;Hull, Amy;Purtscher, Patrick;Hiser, Matthew
Subject: New UNR for SLR
Attachments: 2016 NRR UNR - SLR-Draft Memo.docx, 2016 NRR UNR - SLR Draft Enclosure.docx

Steve,

Finally we have completed the draft of the new UNR for SLR. I have also attached the draft memo for your use.

Please send us your comments and revision before initiating concurrence review with NRR management. Once I get your final draft we will brief RES/DE management.

Thanks,

Steve F.

June xx, 2016

MEMORANDUM TO: Michael Weber, Director
Office of Nuclear Regulatory Research

FROM: Bill Dean, Director
Office of Nuclear Reactor Regulation

SUBJECT: REQUEST FOR RESEARCH ASSISTANCE TO EVALUATE THE AGING MANAGEMENT OF SYSTEMS, STRUCTURES, AND COMPONENTS FOR SUBSEQUENT LICENSE RENEWAL

The purpose of this memorandum is to request specific research products to facilitate the evaluation of the feasibility of future applications for a subsequent license renewal (SLR) period (i.e., 60 to 80 years). These products should build upon analysis methods, tools, and expertise developed as part of ongoing and new research activities, focused specifically on aging effects during the SLR period.

This request will continue some research currently being performed in response to UNR-NRR-2010-006, "Request For Office Of Nuclear Regulatory Research Support In Developing Technical Information On Materials Degradation and Aging Management To Support Evaluating The Feasibility Of License Renewal Beyond 60 Years And Long-Term Operations (LTO)," (ADAMS Accession No.: ML092470525).

CONTACT: , NRR/DLR

Specifically, NRR is requesting RES support to:

- Hold NRC/industry workshop(s) on status of domestic and international research activities and operating experience to address and evaluate the status of materials degradation issues, identified in NUREG/CR-7153, "Expanded Materials Degradation Assessment (EMDA), Vol. 1-5" reports (ADAMS Accession Nos. ML14279A321, ML14279A331, ML14279A349, ML14279A430, ML14279A461), for SLR,
- Provide RES staff assessments of the current knowledge and disposition of materials degradation issues identified in the EMDA reports,
- Develop and implement a long-term strategy for obtaining information on materials degradation from harvesting ex-plant components from decommissioning as well as from operating plants,
- Continue to develop domestic and international partnerships to share expertise, capabilities and resources related to aging management research for LTO, and
- Provide technical assistance, on emergent issues, for preparation of review of anticipated SLR applications.

Additional details are provided in the Enclosure "User Need: Evaluate the Aging Management of Systems, Structures, and Components for Subsequent License Renewal."

Resources

NRR requests RES to provide the specific resources (contract dollars and FTE) needed to complete the various tasks during the period of activity.

Intended Use of RES Products

The requested RES products will provide the technical basis for disposition of the technical issues related to materials degradation raised in the EMDA reports and further enable the staff to better prepare for the review of the early SLR applications.

Coordination and Schedules

This request has been coordinated with RES staff in the Division of Engineering. Based on this, we expect that the requested work could be completed within the requested timeframe. We are prepared to work with your staff to further develop a mutually acceptable technical approach and schedule for this activity, and to engage industry on this important matter. In addition, the Directors of the lead Divisions in each of our Offices, Jane Marshall (Acting) (NRR/DLR) and Brian Thomas, (RES/DE) have discussed and agreed with the scope and schedules of the tasks in this request.

CONTACT: , NRR/DLR

Priority

This request is rated as high priority based on NRR office priority ranking for reactor activities.

Points of Contact

For NRR, the contact is ……, Division of License Renewal.

For RES, the contact is Raj Iyengar, Corrosion and Metallurgy Branch, Division of Engineering.

Additional Information

None.

Enclosure:

User Need: Evaluate the Aging Management of Systems, Structures, and Components for Subsequent License Renewal Period

CONTACT: , NRR/DLR

Priority

This request is rated as high priority based on NRR office priority ranking for reactor activities.

Points of Contact

For NRR, the contact is ……, Division of License Renewal.

For RES, the contact is Raj Iyengar, Corrosion and Metallurgy Branch, Division of Engineering.

Additional Information

None.

Enclosure:

User Need: Evaluate the Aging Management of Systems, Structures, and Components for Subsequent License Renewal Period

DISTRIBUTION:

ADAMS ACCESSION NO.: ML

OFFICE	NRR/DLR	NRR/DLR: BC	NRR/DLR: SL	NRR/DLR: D	NRR: OD
NAME	POC				
DATE					

User Need

Evaluate the Aging Management of Systems, Structures, and Components for Subsequent License Renewal

Background:

Although the NRC staff can accept subsequent license renewal (SLR) applications now, the review would be based on guidance provided in NUREG-1800, Revision 2, "Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants" and NUREG-1801, Revision 2, "Generic Aging Lessons Learned (GALL) Report – Final Report." Because this guidance applies to plants operating from 40-60 years, additional review would be needed to ensure that the applicant addressed issues anticipated during 60-80 years of plant operation for SLR. Such reviews would be longer and more resource-intensive. To improve the efficiency of SLR application reviews, the NRC staff has undertaken several activities to revise the guidance documents. These activities include reviews of aging management practices, plant audits, technical information exchanges with industry and Department of Energy (DOE), and confirmatory research.

In cooperation with the DOE Light Water Reactor Sustainability (LWRS) Program, the NRC completed NUREG/CR-7153, "Expanded Materials Degradation Assessment (EMDA), Vol. 1-5" (ADAMS Accession Nos. ML14279A321, ML14279A331, ML14279A349, ML14279A430, ML14279A461) to identify the most significant technical issues for nuclear power reactor operation beyond 60 years. The EMDA ranked the significance, current knowledge, and uncertainty associated with aging-related degradation phenomena that could affect systems, structures, and components (SSCs) over 80 years of operation. As outlined in the staff requirements memorandum (SRM) on SECY 14-0016, the major technical issue areas are:

- Reactor pressure vessel neutron embrittlement at high fluence;
- Irradiation-assisted stress corrosion cracking of reactor internals and primary system components;
- Concrete and containment degradation; and
- Electrical cable qualification and condition assessment.

The NRC staff conducted several audits to investigate the effectiveness of aging management programs (AMPs). The findings are documented in the report titled, "Summary of Aging Management Program Effectiveness Audits to Inform Subsequent License Renewal: R.E. Ginna Nuclear Power Plant and Nine Mile Point Nuclear Station, Unit 1" (ML13122A007). The development of SLR guidance was based on NUREG-1800 and NUREG-1801, the understanding gained from the audits, NUREG/CR-7153 (EMDA), an evaluation of domestic and international operating experience of nuclear plants, lessons learned from staff review of previous license renewal applications, and assessment of recent research findings. Draft SLR guidance documents were issued in December 2015, as draft "Generic Aging Lessons Learned for Subsequent License Renewal (GALL-SLR) Report," (NUREG-2191, Volumes 1 and 2) and draft "Standard Review Plan for Review of Subsequent License Renewal Applications for Nuclear Power Plants" (SRP-SLR) (NUREG-2192).

Since the draft guidance documents were issued, the staff has held several public meetings with stakeholders and the public to discuss the proposed revisions and bases for the revisions. The most recent meetings were held on January 21 and February 19, 2016. Going forward, the NRC staff will continue to lead outreach activities to stakeholders and the public in order to

provide information on the proposed changes to the guidance documents, solicit feedback on the documents, and revise the documents, as appropriate, to reflect stakeholder and public feedback. The final guidance documents are expected to be issued in mid-2017.

To support the review of an SLR application, an applicant will need to demonstrate how the effects of aging will be managed, including those associated with the technical issues listed above. Although the industry is conducting research to address these major technical issues for SLR, not all the research will be completed before the first application is submitted. For those issues that the industry has not yet developed a generic technical basis to support its resolution, the NRC will request applicants to address the technical issues with plant-specific programs in their SLR applications. The staff will review these plant-specific programs that address the SLR technical issues, but anticipates a longer application review process in these cases.

The requested research described below would provide information to support the staff in effectively evaluating AMPs and developing staff positions on the technical issues identified in EMDA reports. This effort will also augment the staff's preparedness for the evaluation of the feasibility of future applications for an SLR period. These requested products should build upon analysis methods, tools, and expertise developed as part of ongoing research activities and new research activities focused specifically on aging effects during an SLR period.

Description of Scope and Tasks

A. Hold NRC/industry workshop(s) on status of domestic and international research activities and operating experience to address and evaluate the status of materials degradation issues identified in the EMDA reports for SLR.

Technical Need: In February 2008, the NRC and DOE first co-sponsored a "Workshop on U.S. Nuclear Power Plant Life Extension Research and Development" (ADAMS Accession Number ML080570419), which requested stakeholder input into aging management research areas for "Life Beyond 60." Since then, there have been multiple workshops/meetings on the research activities and operating experience that may impact aging management of SSCs for an SLR period. These meetings have been helpful in facilitating technical discussions, disseminating knowledge and information, enabling the understanding of technical challenges, and paving the path forward for resolution of the challenges and issues related to materials degradation during the SLR period. As the NRC staff prepares for the review of SLR applications, there is a need for continued engagement with domestic industry, DOE and other federal organizations, academia, international partners, and interested public stakeholders through workshops focused on the status and resolution of major technical issues outlined in the SRM and identified in EMDA.

Deliverable: RES staff should facilitate several workshops/meetings on operating experience from the initial license renewal period, research results on materials degradation issues, and aging management of SSCs during the SLR period.

These meetings should be specifically targeted toward the resolution of technical issues for effective aging management of SSCs during the SLR period. RES staff should provide an annual technical letter report summarizing the understanding gained through the workshops/meetings. The summary should include the status of domestic and international research activities in addressing materials degradation issues and aging management practices during the SLR period. The report should also discuss (1) areas of progress and issues resolution, (2) areas of insufficient progress that may warrant additional NRC-driven

interactions, and (3) any newly identified technical issues that should be considered.

Schedule: The effort should last no more than 36 months from the period of inception of this user need request.

B. Provide RES staff assessments of the current knowledge and disposition of materials degradation issues identified in the EMDA reports

Technical Need: As mentioned earlier, the EMDA reports identified significant technical issues for nuclear power reactor operations beyond 60 years related to materials degradation. These issues fall under the following four topical areas, as outlined in SRM on SECY 14-0016:

- Reactor pressure vessel neutron embrittlement at high fluence;
- Irradiation-assisted stress corrosion cracking of reactor internals and primary system components;
- Concrete and containment degradation; and
- Electrical cable qualification and condition assessment.

The NRC, DOE, and industry are addressing the key technical issues related to materials degradation at NPPs. In order to gain better understanding of the materials aging and degradation mechanisms and their implications of structural and component integrity, DOE and the industry have initiated numerous research activities on the four major technical areas. The NRC staff conducts confirmatory research, through several user need requests on specific technical issues, to independently verify licensee data, determine safety margins, and explore uncertainties. In addition, the NRC research will support and increase the efficiency of staff review of SLR applications. To fully support the staff review of the SLR applications, RES should develop staff assessments of the current knowledge and disposition of materials degradation issues related to the four major technical areas. The assessments should also include recommendations on the need for:

- any interim staff guidance (ISG) to address aging management issues, and
- new regulatory guidance and/or revision of existing regulatory guides (RGs) to address uncertainties in knowledge and/or potential non-conservativism.

Deliverable: Deliver a technical letter report that summarizes the current knowledge and disposition of materials degradation issues identified in EMDA. The report should also include recommendations on the need for any new or revised guidance to address component integrity of aging structures.

Schedule: The effort should last no more than 36 months from the period of inception of this user need request. The initial draft report should be completed by the end of FY 2018.

C. Develop and implement a long-term strategy for obtaining information on materials degradation from decommissioned NPPs, as well as from ex-plant components from operating plants.

Technical Need: The NRC performs confirmatory research to inform and develop the technical basis for regulatory decisions related to aging management programs for

SLR. Historically, this research has included testing virgin materials under simulated aging conditions, as well as testing and characterization of ex-plant materials harvested from nuclear power plants. Ex-plant materials are valuable because they have been exposed to actual in-service plant operating conditions (temperature, irradiation, coolant, etc.), unlike virgin materials tested under simulated conditions in the lab. Testing ex-plant materials also reduces the uncertainty associated with the applicability of the aging conditions. Therefore, this effort is expected to provide fundamental insights on reactor materials degradation and information addressing potential technical issues or identified gaps to support anticipated future NRC needs. It will also inform the value of existing databases based on simulated aging conditions by assessing their applicability to in-service conditions.

Based on the recent experience of recovering materials from decommissioned plants, such as Zion, Crystal River and Zorita (Spain), the efforts of planning, coordination and eventual harvesting of these materials could be resource-intensive and time-challenging. Future efforts to retrieve materials from decommissioned plants should be focused on the highest value SSCs by proactively developing a strategic database for obtaining unique and significant materials aging degradation information from ex-plant components. Such a database will enable the NRC to focus its harvesting efforts and expeditiously obtain materials and components from plants to be decommissioned in the near future and develop information and knowledge to assess the efficacy of the AMPs.

Deliverable: RES should develop a database covering the four topical areas outlined in SRM on SECY 14-0016 and containing information on:

- research gaps for SLR that may be best addressed by harvesting due to challenges in simulating actual service conditions, and
- materials that can be harvested from to-be-decommissioned NPPs and ex-plant components from operating plants to better inform the NRC's AMPs and aging-related regulatory oversight and to better plan research activities.

RES should deliver periodic reports assessing the effectiveness of such programs and recommending any improvements for the SLR period.

Schedule: The effort should last no more than 36 months from the period of inception of this user need request.

D. Continue to Develop Domestic and International Partnerships to Share Expertise, Capabilities and Resources Related to Aging Management Research for Long-Term Operations (LTO)

Technical Need: Various domestic and foreign research organizations, government agencies, utilities and research organizations are presently engaged in aging management research, the results of which may be of value to the NRC regarding plant operations during the SLR period. Additionally, the Electric Power Research Institute (EPRI) is engaged with various international research organizations to develop data on aging mechanisms/effects. As such, it benefits the NRC to be engaged in domestic and international research partnerships in order to evaluate all available operating experience and relevant research, leverage resources and minimize unnecessary duplication of efforts. It would be advantageous to the NRC to develop partnerships

with these entities such that the various research programs could be better coordinated and focused on high-priority needs.

Deliverable: Continue to develop agreements with domestic and international partners to collaborate on aging management research that results in information to help inform agency decisions regarding SLR and long-term operations. Integrate as appropriate the results of these collaborative research and information exchanges from international partnerships into Tasks A and B. Provide an annual summary of international collaborative research results and status of interactions (e.g., references to meeting minutes, presentations, technical reports, etc.), highlighting international activities and results that may affect SLR.

Schedule: The effort should continue until the closure of this user need request.

E. **Provide technical assistance, as needed, for preparation of review of SLR applications.**

Technical Need: As the NRR staff prepares for the anticipated SLR application in FY18, technical assistance from RES staff on emergent issues may be needed. Such issues may include, but not restricted to, providing an assessment of effect of specimen size on the prediction of component performance, technical support for aging management program audits, public meetings related to communication efforts, and confirmatory reviews of licensee submittals.

Schedule: This effort, as needed, should continue until the closure of this user need request.

Note to requester: Attachment is immediately following.

From: Hull, Amy
Sent: Thu, 8 Sep 2016 17:10:47 +0000
To: Frankl, Istvan;Iyengar, Raj
Cc: Tregoning, Robert
Subject: my comments attached....: 2016 NRR UNR - SLR Draft Enclosure-Bennett-CMBdocx - hiser - Bennett 8-22-2016.docx, 2016 NRR UNR - SLR-Draft Memo-Bennett comment.docx
Attachments: 2016 NRR UNR - SLR Draft Enclosure-Bennett-CMBdocx - hiser - Bennett 8-22-2016.abh.docx

... I think the UNR looks good. I made a few minor comments, corrections. See track changes, attached. I am happy to see Task 2. the strategic harvesting such an important part of the UNR. Removing the task on disposition documents seems OK to me. That work can be derived as part of Task 1.

-----Original Message-----
From: Frankl, Istvan
Sent: Wednesday, September 07, 2016 3:03 PM
To: Hull, Amy <Amy.Hull@nrc.gov>; Iyengar, Raj <Raj.Iyengar@nrc.gov>
Subject: RE: Emailing: 2016 NRR UNR - SLR Draft Enclosure-Bennett-CMBdocx - hiser - Bennett 8-22-2016.docx, 2016 NRR UNR - SLR-Draft Memo-Bennett comment.docx

Amy,

Yes. That would be helpful which reminds me to schedule our next meeting.

If you are still interested, please follow up on status of the branch going out for lunch once a month.

Thanks,

Steve

-----Original Message-----
From: Hull, Amy
Sent: Wednesday, September 07, 2016 2:50 PM
To: Iyengar, Raj <Raj.Iyengar@nrc.gov>; Frankl, Istvan <Istvan.Frankl@nrc.gov>
Subject: RE: Emailing: 2016 NRR UNR - SLR Draft Enclosure-Bennett-CMBdocx - hiser - Bennett 8-22-2016.docx, 2016 NRR UNR - SLR-Draft Memo-Bennett comment.docx

I will look at the latest iteration now or tomorrow morning. I just got out of the 3WFN training on the NUREG template roll-out. It should make life much easier. I can distribute copies of the handouts at the next CMB meeting if you want.

-----Original Message-----
From: Iyengar, Raj
Sent: Wednesday, September 07, 2016 1:47 PM
To: Frankl, Istvan <Istvan.Frankl@nrc.gov>
Cc: Hull, Amy <Amy.Hull@nrc.gov>
Subject: Re: Emailing: 2016 NRR UNR - SLR Draft Enclosure-Bennett-CMBdocx - hiser - Bennett 8-22-2016.docx, 2016 NRR UNR - SLR-Draft Memo-Bennett comment.docx

I am waiting to see if Rob or Amy will have any comments.

I will schedule a meeting for next week.

From: Frankl, Istvan
Sent: Wednesday, September 7, 2016 10:56 AM
To: Iyengar, Raj
Cc: Hull, Amy
Subject: RE: Emailing: 2016 NRR UNR - SLR Draft Enclosure-Bennett-CMBdocx - hiser - Bennett 8-22-2016.docx, 2016 NRR UNR - SLR-Draft Memo-Bennett comment.docx

Raj,

What is the latest status with the draft? Did you get any feedback?

(b)(6) [redacted] please schedule alignment meeting ASAP.

Thanks,

Steve.

-----Original Message-----
From: Iyengar, Raj
Sent: Monday, August 29, 2016 12:50 PM
To: Hull, Amy <Amy.Hull@nrc.gov>; Tregoning, Robert <Robert.Tregoning@nrc.gov>; Hiser, Matthew <Matthew.Hiser@nrc.gov>; Purtscher, Patrick <Patrick.Purtscher@nrc.gov>
Cc: Frankl, Istvan <Istvan.Frankl@nrc.gov>
Subject: FW: Emailing: 2016 NRR UNR - SLR Draft Enclosure-Bennett-CMBdocx - hiser - Bennett 8-22-2016.docx, 2016 NRR UNR - SLR-Draft Memo-Bennett comment.docx

Attached is the revised UNR (draft) from DLR. Note that DLR removed the task on disposition documents. Please take a look and let me know if you want to see any changes.

I will try to schedule a meeting for tomorrow.

-----Original Message-----
From: Brady, Bennett
Sent: Monday, August 29, 2016 12:30 PM
To: Iyengar, Raj <Raj.Iyengar@nrc.gov>
Cc: Hiser, Allen <Allen.Hiser@nrc.gov>; Bloom, Steven <Steven.Bloom@nrc.gov>
Subject: Emailing: 2016 NRR UNR - SLR Draft Enclosure-Bennett-CMBdocx - hiser - Bennett 8-22-2016.docx, 2016 NRR UNR - SLR-Draft Memo-Bennett comment.docx

Raj,

Attached are the revised new UNR for SLR and the cover transmittal memo. Allen rewrote the UNR and I made minor changes. I have not given it to Steve Bloom yet. [redacted] I wanted to get it back to you for your edits.

(b)(6)

Give me a call if you would like to discuss.

Bennett

User Need

Evaluate the Aging Management of Systems, Structures, and Components for Subsequent License Renewal

Background:

The NRC staff (staff) has recently completed the draft guidance documents for subsequent license renewal (SLR), the draft SLR guidance documents which were issued for public comment in December 2015. The (draft NUREG-2191, Volumes 1 and 2, "Generic Aging Lessons Learned for Subsequent License Renewal (GALL-SLR) ReportReport;," (NUREG-2191, Volumes 1 and 2) and draft NUREG-2192, "Standard Review Plan for Review of Subsequent License Renewal Applications for Nuclear Power Plants" (SRP-SLR) (NUREG-2192)). These guidance documents were developed in a multi-year and multi-step process, as described below.NRC experts in the aging degradation of various structures, systems and components participated in over ninety expert panels to review over 800 comments that were collected for consideration in developing guidance for operation from 60 to 80 years. Staff from the Office of Nuclear Regulatory Research (RES) were members of most of these expert panels, as well as staff members from other NRR divisions. The expert panels dispositioned these comments and drafted the new guidance for SLR

In one of the key steps, the NRC completed the Expanded Materials Degradation Assessment (EMDA) iSome of the 800 comments came from the RES Expanded Materials Degradation Assessment (EMDA) study and RES' assistance in the Aging Management Program (AMP) Effectiveness Audits at three plants in the period of extended operation.

In cooperation with the Department of Energy (DOE) Light Water Reactor Sustainability (LWRS) Program. The resultant reports, the NRC completed NUREG/CR-7153, "Expanded Materials Degradation Assessment (EMDA), Vol. 1-5" (ADAMS Accession Nos. ML14279A321, ML14279A331, ML14279A349, ML14279A430, ML14279A461), describe the conclusions from an expert elicitation process to to identify the most significant aging degradation technical issues for nuclear power reactor operation beyond 60 years. The EMDA ranked the significance, current knowledge, and uncertainty associated with aging-related degradation phenomena that could affect systems, structures, and components (SSCs) over 80 years of operation. As outlined in the staff requirements memorandum (SRM) on SECY 14-0016, the major technical issue areas are:

- Reactor pressure vessel neutron embrittlement at high fluence;
- Irradiation-assisted stress corrosion cracking of reactor internals and primary system components;
- Concrete and containment degradation; and
- Electrical cable qualification and condition assessment.

In another key step, staff from the Office of Nuclear Reactor Regulation (NRR) and the Office of Nuclear Regulatory Research (RES) also assisted in conducted three audits to investigate the

Commented [HA1]: A collective noun—such as *staff* or *committee*—takes a singular verb when the group acts as a whole but a plural verb when its members or parts act separately (e.g., the RES staff has decided to recom-mend Sandia's findings [the deci-sion is a collective action]; how-ever, the RES staff have returned to their offices [each member must act separately in such a situation]). Be careful to ensure that a verb and pronoun reference to the same collective noun are either both singular or both plural—as with *have* and *their* in the second ex-ample.

effectiveness of aging management programs (AMPs) used in the plant operating period from 40 to 60 years. The findings from the first two audits are documented in the report titled, "Summary of Aging Management Program Effectiveness Audits to Inform Subsequent License Renewal: R.E. Ginna Nuclear Power Plant and Nine Mile Point Nuclear Station, Unit 1" (ML13122A007)). The summary of the third audit can be found in the August 5, 2014, report, "H.B. Robinson Steam Electric Plant, Unit 2, Aging Management Program Effectiveness Audit" (ADAMS Accession No. ML14017A289). In addition on June 15, 2016, the staff issued the 1400-pg, publicly-available Technical Letter Report, "Review of Aging Management Programs: Compendium of Insights from License Renewal Applications and from AMP EfffectivensessEffectiveness Audits Conducted to Inform Subsequent License Renewal Guidance Documents," (ADAMS Accession No. ML16167A076), which provides the staff's observations from reviewing LRAs license renewal applications and the AMP audits.

As part of the expert panels, RES evaluatedIn addition, an assessment of domestic and international operating experience of nuclear plants, lessons learned from staff review of previous LRAs,license renewal applications, and an assessment of recent research findings, were considered in the development of the SLR guidance documents.

The draft SLR guidance documents were developed by NRCthe staff with experience in addressing SSC aging degradation of systems, structuresstructures, systems and components. The staff who participated in over ninety "expert panels." . These panelswhich included staff members from the NRR Division of License Renewal (DLR) and other NRR divisions, as well as staff from the Office of Nuclear Regulatory Research (RES). The expert panels dispositioned more than 800 inputs, which Some of the 800 comments came from the RES Expanded Materials Degradation Assessment (EMDA) study, and RES' assistance in the Aging Management Program (AMP) eEffectiveness aAudits at three plants in the period of extended operation, and from the review of operating experience and other sourcesinformation.

Since After the draft SLR guidance documents were issued for public comment, the staff has held several public meetings with stakeholders and the public to discuss the proposed revisions and bases for the revisions. In tThe most recent meetings were held on January 21 and February 19, 2016. Tthe purposes of these meetings the staff were outreach activities to stakeholders and the public to provided information and clarifications on the proposed changes to the guidance documents, and to solicitsolicited feedback on the documents, and revise the documents, as appropriate, to reflect stakeholder and public feedback. The final guidance documents are expected to be issued in mid-2017.

The NRC staff is currently evaluating the public comments and developing final versions of the SLR guidance documents. These documents will be issued in final form in mid-2017.

To support their support the review of an SLR application, an applicants will need to

demonstrate that ~~how~~ the effects of aging will be adequately managed for an operating period from 60 to 80 years, including aging effects ~~those~~ associated with the technical issues listed above. Although the industry is conducting research to address these major technical issues for SLR, not all of the research will be completed before the first application is submitted. For those issues that the industry has not yet developed a generic technical basis to support its resolution and the staff has not provided generic guidance for aging management, ~~the NRC will request~~ applicants will need to address the technical issues with plant-specific programs in their SLR applications. The staff will review these plant-specific programs ~~that address the SLR technical issues~~, but anticipates a longer application review process in these cases.

Commented [HA2]: Not true in all cases, since GALL-SLR has identified generiuc approaches to address some of the issues.

The requested research ~~described below would~~ provides information to support the staff in effectively evaluating AMPs and developing staff positions on the technical issues identified in EMDA reports and in the subsequent license renewal guidance. This effort will also augment the staff's preparedness for the evaluation of future applications for an SLR period. These requested products should build upon analysis methods, tools, and expertise developed as part of ongoing research activities and new research activities focused specifically on aging effects during an SLR period.

Description of Scope and Tasks

1A. Hold NRC/industry workshop(s) on the status of domestic and international research activities and operating experience ~~to~~ to address and evaluate ~~the status of~~ materials degradation issues identified in the EMDA reports and elsewhere, with particular focus on the issues also identified in the GALL-SLR and in the SRM on SECY 14-0016 for SLR.

Commented [BB3]: To be of use to NRR, the workshops should focus on the issues identified in the GALL-SLR and in SRM on SECY 14-0016

The EMDA would have been more useful for subsequent license renewal had it been more in line with GALL components and issues.

CMB: Revised. Please change as you see fit.

~~Technical~~ Need: In February 2008, the NRC and DOE first co-sponsored a "Workshop on U.S. Nuclear Power Plant Life Extension Research and Development" (ADAMS Accession Number ML080570419), which requested stakeholder input into aging management research areas for "Life Beyond 60." Since then, there have been multiple domestic and international workshops/meetings on the research activities and operating experience that may impact aging management of SSCs for an SLR period, with the next such meeting to be sponsored by the International Atomic Energy Agency (IAEA) in France in the October 2017.

Commented [BB4]: I thought RES was a sponsor for three large international meetings. I attended the third one that was held by IAEA in Salt Lake City. But I thought RES was a sponsor.

CMB: I do not have the details. Hence not captured. We can add this information, if needed.

These meetings have been helpful in facilitating technical discussions, disseminating knowledge and information, enabling the understanding of technical challenges, and paving the way ~~path forward~~ for resolution of the challenges and issues related to materials degradation during the SLR period. As the NRC staff prepares for the review of subsequent license renewal applications (SLRAs), there is a need for continued engagement with the domestic industry, DOE, and other federal organizations, academia, international partners, and interested public stakeholders through workshops focused on the status and resolution of major technical issues outlined in the GALL-SLR, the SRM, and in EMDA.

Request: RES is requested to facilitate a minimum of two international activities (either a workshop, conference, symposium, or meeting) in the early fall 2018 and in late spring 2020 to address:

- operating experience from the initial license renewal period (or the long term operation period for international plants)
- the state of knowledge on the relevant technical issues
- on-going research on materials degradation issues and aging management of these issues, in particular as related to the SLR period

These ~~activities should~~activities should be specifically targeted toward the resolution of technical issues for effective aging management of SSCs during the SLR period.

Deliverable: ~~RES staff should facilitate several workshops/meetings on operating experience from the initial license renewal period, research results on materials degradation issues, and aging management of SSCs during the SLR period.~~

~~These meetings should be specifically targeted toward the resolution of technical issues for effective aging management of SSCs during the SLR period.~~ The deliverables include the international activities (either a workshop, conference, symposium, or meeting).

Prior to the meetings, RES should provide a draft agenda and proposed presenters. The information from these activities should be documented in a NUREG/CP report, if appropriate, or by other sufficient means, including, at a minimum, a summary of the activity with all relevant contributions (e.g., presentations or papers) available for subsequent use.~~RES staff should provide an annual technical letter report summarizing the understanding gained through the workshops/meetings. The summary should include the status of domestic and international research activities in addressing materials degradation issues and aging management practices during the SLR period. The report should also discuss (1) areas of progress and issues resolution, (2) areas of insufficient progress that may warrant additional NRC-driven interactions, and (3) any newly identified technical issues that should be considered.~~

Schedule: The effort should continue until the completion of the deliverables from the second activity, tentatively scheduled for late spring 2020.~~last no more than 36 months from the period of inception of this user need request.~~

2B. ~~Provide RES staff assessments of the current knowledge and disposition of materials degradation issues identified in the EMDA reports, with particular focus on the issues identified in the GALL-SLR and in SRM on SECY 14-0016 for SLR.~~

~~Technical Need: As mentioned earlier, the EMDA reports identified significant technical issues for nuclear power reactor operations beyond 60 years related to materials degradation. These issues fall under the following four topical areas, as outlined in the SRM on SECY 14-0016:~~

- ~~Reactor pressure vessel neutron embrittlement at high fluence;~~
- ~~Irradiation-assisted stress corrosion cracking of reactor internals and primary system components;~~

Commented [HA5]: I am skeptical of this task. We need to identify more specific deliverables

Commented [BB6]: I think this is an activity we should support but I am not sure how this would be received in the current NRC climate of frugality.

CMB: This was specifically requested by Allen Hiser and agreed upon (in a broad sense) in our meetings with DLR during the course of development of this UNR.

Commented [HA7]: I am skeptical of this task. We need to identify more specific deliverables

Commented [BB8]: I think this is an activity we should support but I am not sure how this would be received in the current NRC climate of frugality.

CMB: This was specifically requested by Allen Hiser and agreed upon (in a broad sense) in our meetings with DLR during the course of development of this UNR.

Commented [BB9]: We need very explicit deliverables such as an agenda coordinated with NRR, proposed speakers, presentation slides, and a report that addresses aging management programs that may lead to revision of our guidance documents

CMB: Totally agree. During the process of developing the workshops, we will work closely with DLR to ensure agenda, schedule, speakers are agreed upon by all of us. We will mention the close collaboration and alignment with DLR in our response to the UNR. The draft internal report will be sent to NRR for review and comment. If NRR wants to make the final report public, that will be fine. As mentioned before, all milestones will be tracked.

Commented [BB10]: The previous UNR for SLR also had a task to hold public workshops on aging management research with a deliverable after each meeting to provide a technical letter report after each meeting. To my knowledge, all we got was a two-page memo from Gene Carpenter.

CMB: We will make sure these deliverables, with due dates, are specifically stated in our response. As soon as the UNR (and the RES response) is put in place, CMB will add milestones in our Op Plan to tract the deliverables. DLR will have access and can view the updates on the RES OpPlan.

Commented [HA11]: I suggest deleting this.

Commented [BB12]: Again, it would be more useful to NRR if the assessment of issues focused on the issues in the GALL-SLR and in the SRM to SECY 14-0016

CMB: Added the emphasis on SRM.

- Concrete and containment degradation; and
- Electrical cable qualification and condition assessment.

The NRC, DOE, and industry are addressing the key technical issues related to materials degradation at nuclear power plants (NPPs). In order to gain better understanding of the materials aging and degradation mechanisms and their implications of structural and component integrity, DOE and the industry have initiated numerous research activities on the four major technical areas. The NRC staff conducts confirmatory research, through several user need requests on specific technical issues, to independently verify licensee data, determine safety margins, and explore uncertainties. In addition, the NRC research will support and increase the efficiency of staff review of SLR applications. To fully support the staff's review of the SLR applications, RES should develop staff assessments of the current knowledge and disposition of materials degradation issues related to the four major technical areas. The assessments should also include recommendations on the need for:

- new regulatory guidance and/or revision of existing regulatory guides (RGs) to address uncertainties in knowledge and/or potential non-conservativism.

Deliverable: Deliver a technical letter report that summarizes the current knowledge and disposition of materials degradation issues identified in EMDA, with particular focus on the issues identified in the GALL-SLR and in SRM on SECY 14-0016 for SLR. The report should also include recommendations on the need for any new or revised guidance to address component integrity of aging structures.

Schedule: The effort should last no more than 36 months from the period of inception of this user need request. The initial draft report should be completed by the end of FY 2018.

C. Develop and implement a long-term strategy for obtaining information on materials degradation from decommissioned NPPs, as well as from ex-plant components from operating plants.

Technical Need: The NRC performs confirmatory research to inform and develop the technical basis for regulatory decisions related to aging management programs for SLR. Historically, this research has included testing virgin materials under simulated aging conditions, as well as testing and characterizingation of ex-plant materials hharvested from nuclear power plants. Ex-plant materials are valuable because they have been exposed to actual in-service plant operating conditions (temperature, irradiation, coolant, etc.), in contrast to laboratory simulationsunlike virgin materials tested under simulated conditions in the lab. Testing ex-plant materials also reduces the uncertainty associated with the applicability of the aging conditions. Therefore, this effort is expected to provide fundamental insights on reactor materials degradation and information addressing potential technical issues or identified gaps to support anticipated future NRC needs. It will also inform the value of existing databases based on simulated aging conditions by assessing their applicability to in-service conditions.

Commented [BB13]: the assessment of issues focused on the issues in the GALL-SLR and in the SRM to SECY 14-0016

CMB: Added the emphasis on SRM.
I think DLR is very good at identifying ISGs and revisions to our regulatory guidance. Furthermore, ISGs may discontinued.

CMB: Reference to ISG deleted.

Commented [BB14]: Need more specifics on what NRR is getting. Is this an annual report?

CMB: This will be a final report (after incorporating NRR comments on the draft report). During the process of developing the report, RES will work with NRR closely, with frequent updates and meetings.

Commented [BB15]: Or in the GALL-SLR and SRM?

CMB: See change.

Commented [BB16]: Why so long?

CMB: The final report will capture the insights and information gathered from the current research activities (conducted by DOE, EPRI, industry, and NRC) on the SRM technical issues. Many of the activities (cables, internals, selected concrete activities, RPV) are expected to produce results over the course of the next two years. We understand that some of the activities may not be completed (some concrete activities, high-fluence testing of vessel internals etc.) in two years. For these, we will provide a status update and recommendations, if necessary, for any additional research that industry or DOE (or NRC) may want to consider.

Based on the recent experience of recovering materials from decommissioned plants, such as Zion, Crystal River, and Zorita (Spain), the efforts of planning, coordination, and eventual harvesting of these materials could be resource-intensive and time-challenging. Future efforts to retrieve materials from decommissioned plants should be focused on the highest value SSCs by proactively developing a strategic database for obtaining unique and significant materials aging/ degradation information from ex-plant components. Such a database will enable the NRC to focus its harvesting efforts and expeditiously obtain materials and components from plants to be decommissioned in the near future and develop information and knowledge to assess the efficacy of the AMPs.

Request: RES is requested to:

A. Develop a database which identifies and prioritizes the materials, components, and operating conditions that are needed to address the four topical areas outlined in the SRM on SECY 14-0016, and that, due to challenges in simulating actual service conditions, may be best addressed by harvesting either from plants that are entering decommissioning or ex-plant components from operating plants.

B. Develop a process to evaluate the components from plants that are entering decommissioning or ex-plant components from operating plants that would be appropriate candidates for harvesting, and to ensure that timely contact is made with the plant owner to facilitate any harvesting targets that may be identified.

C. Use the process developed in item B to evaluate the suitability of components from plants that are currently either under decommissioning or replacing components that may be of interest.

D. Continue to implement the process developed in item B as components become available from additional plants.

Deliverable: RES should provide the database for NRR review, and summarize the priority listing in a letter report. Likewise, Items B and C should be documented in a technical letter report (TLR). Item D is a continuing item that should be summarized in a TLR letter report or e-mail as appropriate. ~~develop a database covering the four topical areas outlined in the SRM on SECY 14-0016 and containing information on:~~

~~• research gaps for SLR that may be best addressed by harvesting due to challenges in simulating actual service conditions, and~~

~~• materials that can be harvested from to-be-decommissioned NPPs and ex-plant components from operating plants to better inform the NRC's aging management programs (AMPs) and aging-related regulatory oversight and to better plan research activities.~~

Schedule: Item A and B should be completed within 18 months of issuance of this user need request. Item C should be completed within 24 months of issuance of this user need

Commented [BB17]: I think this would be a useful product and might reduce research costs by focusing only on the material for which research is needed. Also, as we learned from the concrete samples from Zorita there is a timing issue in that you have to be ready to be specific what is needed and in a relatively specified by the provider.

CMB: This is our position, as well.

Commented [HA18]: Suggest that we add confirming current approaches

request. Item D is an activity that should continue ~~The effort should last no more than~~ 36 months from the ~~period of inception~~issuance of this user need request.

~~D~~3. ~~Continue to Develop Domestic and International Partnerships to Share Expertise, Capabilities and Resources Related to Aging Management Research for Long-Term Operations (LTO)~~

~~Technical~~ Need: Various domestic and foreign research organizations, government agencies, utilities and research organizations are presently engaged in aging management research, the results of which may be of value to the NRC regarding plant operations during the SLR period. Additionally, the Electric Power Research Institute (EPRI) is engaged with various international research organizations to develop data on aging mechanisms/effects. As such, it benefits the NRC to be engaged in domestic and international research partnerships in order to evaluate all available operating experience and relevant research, leverage resources, and minimize unnecessary duplication of efforts. It would be advantageous to the NRC to develop partnerships with these entities such that the various research programs could be better coordinated and focused on high-priority needs.

Request: RES is requested to continue to develop agreements with domestic and international partners to collaborate on aging management research that results in information to help inform agency decisions regarding SLR operating periods.

Deliverable: ~~Continue to develop agreements with domestic and international partners to collaborate on aging management research that results in information to help inform agency decisions regarding SLR and long-term operations. Integrate as appropriate the results of these collaborative research and information exchanges from international partnerships into Tasks A and B.~~ RES should p~~P~~rovide to interested NRR branch chiefs (from DE and DLR) and senior staff relevant products (e.g., trip reports, meeting summaries, papers, presentations, reports and other information) from interactions with domestic and international organizations. In addition, relevant findings from recent interactions and future plans should be discussed as a standing agenda item during quarterly meetings between RES/DE, NRR/DLR and NRR/DE. ~~an annual summary of international collaborative research results and status of interactions (e.g., references to meeting minutes, presentations, technical reports, etc.), highlighting international activities and results that may affect SLR.~~

Schedule: These products should be provided to NRR in a timely manner. Effort should continue until the closure of this user need request.

Commented [BB19]: We had a similar task in the previous UNR and a deliverable of an annual summary of international collaborative research but I don't recall getting any reports.

CMB: Again, we will make sure all the deliverables and schedules are specified in our response to the UNR. And we will track the milestones.

Commented [HA20]: We need to be more specific on task and deliverables

~~E.~~

From: RES_International_Mailbox
Sent: Tue, 19 Dec 2017 21:00:00 +0000
To: Hiser, Matthew
Cc: RES_International_Mailbox
Subject: FW: NRR - Trip Report Notification - Nuclear Tech Symposium and Bilateral Meeting with SSM

Hi Matt,

Just touching base that you were contacted by Dave and got all that you need based on his trip report. NRR contacted us to make sure IPT knew Dave was going to coordinate with you.

Lisa-Anne

From: RES_International_Mailbox
Sent: Tuesday, December 19, 2017 1:16 PM
To: Rudland, David <David.Rudland@nrc.gov>
Cc: Culp, Lisa <Lisa.Culp@nrc.gov>; RES_International_Mailbox <RES_International_Mailbox.Resource@nrc.gov>
Subject: FW: NRR - Trip Report Notification - Nuclear Tech Symposium and Bilateral Meeting with SSM

"On the Margins"

David Rudland discussed with Daniel Kjellin of SSM details of his weld residual stress analyses of strip clad plate. Mr. Kjellin had problems with the material properties used for elastic modulus as a function of temperature. Dr. Rudland agreed to send him the publically available material property sets from the NRC international weld residual stress round robin effort.

David Rudland discussed with Peter Ekstrom of SSM details of the SSM harvesting program for the recent and upcoming decommissioning of the Swedish plants. Dr. Rudland agreed to get Dr. Ekstrom in contact with Matthew Hiser from NRC RES to investigate the possibility of collaboration on harvesting materials.

From: Quinones-Navarro, Lauren
Sent: Monday, December 18, 2017 5:01 PM
To: Emche, Danielle <Danielle.Emche@nrc.gov>; RES_International_Mailbox <RES_International_Mailbox.Resource@nrc.gov>
Cc: Rodriguez, Veronica <Veronica.Rodriguez@nrc.gov>
Subject: FW: NRR - Trip Report Notification - Nuclear Tech Symposium and Bilateral Meeting with SSM

Good afternoon,

I would like to highlight this trip report from NRR since it contains some follow-up items that involve RES (see "On the Margins" section) and OIP may receive follow-up request on the meeting topic.

Thanks,
Lauren

From: International Travel [mailto:SVCportaladmin@nrc.gov]
Sent: Monday, November 27, 2017 1:12 PM
To: NRRInternationalTravel Resource <NRRInternationalTravel.Resource@nrc.gov>; RES International Travel Dist <RESInternationalTr@nrc.gov>; Rodriguez, Veronica <Veronica.Rodriguez@nrc.gov>; Quinones-Navarro, Lauren <Lauren.Quinones-Navarro@nrc.gov>
Cc: Rudland, David <David.Rudland@nrc.gov>
Subject: NRR - Trip Report Notification - Nuclear Tech Symposium and Bilateral Meeting with SSM

Greetings,

The Trip Report for the trip, Nuclear Tech Symposium and Bilateral Meeting with SSM has been submitted by Rudland, David.

Regards,
iTravel Administration Team

Trip Name	Nuclear Tech Symposium and Bilateral Meeting with SSM
Trip ID:	4429
Travelers:	Rudland, David
Travel Dates:	11/12/2017 - 11/18/2017
Destination:	Stockholm, Sweden
Trip Report	ML17326A508
Results Achieved:	The NRC participant made one plenary presentation during the symposium, and two formal presentations to the Swedish Radiation Safety Authority (SSM) on probabilistic fracture mechanics in risk-informed decision making and license renewal activities. In addition, the participant had several discussions with Finnish and Swedish regulators on ongoing technical issues, and had informal technical discussions on topics such as: • LBB, analysis and acceptance criteria • Macro carbon segregations in reactor components • Vessel internal integrity issues, including IASCC and baffle bolt cracking

- SCC crack growth rates in un-irradiated piping made of stainless steel and Ni-based alloys
- SCC initiation.

The results from these discussions allow the NRC to verify that its technical and regulatroy processes are inline with the international regulatory community. For the topics discussed, the NRC and SSM are aligned in the technical areas, but continued discussions are needed to gain full alignment on risk-informed thinking activities.

** This is an auto distribution sent from the combined International Travel SharePoint System.*
For questions, please communicate with your Office point(s) of contact.

~~*****SENSITIVE INFORMATION - OFFICIAL USE ONLY*****~~

Note to requester: Attachment immediately following.

From: Frankl, Istvan
Sent: Wed, 25 Apr 2018 15:27:38 +0000
To: RES_DE_CMB
Subject: ACTION: Topics for Materials Exchange Meeting May 22-26
Attachments: 2018-05-22 agenda draft.docx
Importance: High

All,

The attachment is the latest NRR draft agenda. We will need to provide input for AM methods and have responsibility for the 30 minute time slot on 5/23 for "Status of Related Research" in CMB. If you have comments on the draft agenda, please send them to me by COB Friday.

For AM I want to make sure that we are aligned with our counterparts in NRR/NRO on the proposed presentation(s) and presenter(s). (Amy, please get back to me on this.)

For our 30 minute time slot we can cover summaries of some or all topics proposed earlier. Here is the list:

1. Harvesting – Current plans and activities
2. IAD – confirmatory testing plans
3. PWSCC Crack Growth – Current research plans and results
4. Status Update on the PWSCC Initiation Program
5. Status of Confirmatory Research for SLR/LTO

At this stage, I will ask the respective leads to draft about 3 summary slides for each of the above topics.

.
Thanks,

Steve

From: Rudland, David
Sent: Wednesday, April 25, 2018 6:22 AM
To: Alley, David <David.Alley@nrc.gov>; Ruffin, Steve <Steve.Ruffin@nrc.gov>; Collins, Jay <Jay.Collins@nrc.gov>; Cumblidge, Stephen <Stephen.Cumblidge@nrc.gov>; Davis, Robert <Robert.Davis@nrc.gov>; Tsao, John <John.Tsao@nrc.gov>; Poehler, Jeffrey <Jeffrey.Poehler@nrc.gov>; Fairbanks, Carolyn <Carolyn.Fairbanks@nrc.gov>; Hovanec, Christopher <Christopher.Hovanec@nrc.gov>; Yee, On <On.Yee@nrc.gov>; Cheruvenki, Ganesh <Ganesh.Cheruvenki@nrc.gov>; Hoffman, Keith <Keith.Hoffman@nrc.gov>; Medoff, James <James.Medoff@nrc.gov>; Iyengar, Raj <Raj.Iyengar@nrc.gov>; Frankl, Istvan <Istvan.Frankl@nrc.gov>; Mitchell, Matthew <Matthew.Mitchell@nrc.gov>; Rezai, Ali <Ali.Rezai@nrc.gov>
Subject: FW: 2018-05-22 agenda draft

Everyone

Please take a look at the draft agenda for the materials meeting and let me know if you have any comments. We are still determining who will be making what presentation. Can I please get your comments by April 30?

Ali, did Allen talk with you about getting the meeting set up?

Thanks
Dave

David L. Rudland, Ph.D.
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From: Dyle, Robin [mailto:rdyle@epri.com]
Sent: Tuesday, April 24, 2018 9:00 PM
To: Hiser, Allen <Allen.Hiser@nrc.gov>; Rudland, David <David.Rudland@nrc.gov>
Subject: [External_Sender] 2018-05-22 agenda draft

Gents – here is a first cut at the agenda. I'll let the 2 of you coordinate with your peers. I sent a copy to the industry leads for their review and comment. We can adjust as needed.

I'm not sure this bunch will interested in the advanced non-LWRs. If we need more time for other items we could reduce the time for that topic. Also we are very light on Thursday morning so we can stretch out some items or finish Wednesday afternoon.

Thoughts?

Robin Dyle
Office: 205-426-5371
(b)(6) Cell: [redacted]

Tuesday, May 23, 2018		
Time	**Presentation Topic**	**Presenter Organization**
0830	**Introduction and Welcome**	NRC – Wilson
0845	BWRVIP update	Odell - BWRVIP
0915	Mitigation, BWRVIP-62 update	Odell - BWRVIP
0945	NRC OLNC review status	Poehler - NRC
1000	**Break**	
1015	BWRVIP SLR update	Lunceford - EPRI
1040	BWRVIP OE (may be in overview)	
1100	Primary Systems Corrosion Research update	Demma - EPRI
1200	**Lunch**	
1300	PWROG MSC update	Wax - PWROG
1330	MRP Update	Hoehn - MRP
1415	Thermal Fatigue update	Crooker - MRP
1445	**Break**	
1500	Peening confirmatory research status	Alley – NRC
1515	RES status on Weld Residual Stress NUREG	Benson - NRC
1540	xLPR status and NRR plans	Hovanec/Kalikian/Homiak - NRC
1600	NRR independent flaw evaluations	Collins - NRC
1620	Use of xFEM to simulate 3-D PWSCC flaw growth	Collins/Facco - NRC
1640	VHP nozzle integrity – beyond NDE aspects	Collins - NRC
1700	**Public comment**	
1715	**Adjourn**	

Wednesday, May 23, 2018		
Time	**Presentation Topic**	**Presenter Organization**
0830	PWR vessel internals (MRP-227, R1 update and RAI responses, NRC status on MRP-227, R1 review and action item status, status of SLR work)	NRC and Industry
0915	Guide cards – OE and guidance changes	Wax - PWROG
0945	Baffle Former Bolt issues (OE update, testing update, guidance changes, NRC assessment of guidance changes)	NRC and Industry
1030	**Break**	
1045	Upper shelf J-R testing	Hardin - EPRI
1105	BWRVIP ISP	Palm - EPRI
1130	NRC RPV topics (Appendix H status, Appendix G work on small flaws, CMAC disposition, FAVOR long-term maintenance status, etc.)	NRC
1215	**Lunch**	
1315	Welding Program update and Code applications	McCracken - WRTC
1415	Excavate and Weld repair issues	
1440	Additive Manufacturing	Gandy – EPRI and NRC
1530	**Break**	
1545	Status of Related Research	RES-Corrosion and Metallurgy
1615	Status of Related Research	RES-Component Integrity
1645	Materials/Component Integrity issues for Advanced non-LWRs	NRC
1715	Public comment	
1730	Adjourn	

Thursday, May 24, 2018		
Time	**Presentation Topic**	**Presenter Organization**
0830	Codes and standards update	NRC
0900	GALL-SLR status	Hiser - NRC
0930	Discussion, Capture Action Items	NRC and Industry
0945	Public Comment	
1000	**Adjourn**	

Note to requester: Attachment is immediately following.

From: Frankl, Istvan
Sent: Thu, 20 Sep 2018 16:23:04 +0000
To: Hiser, Matthew
Subject: FW: Monthly report for NRC-HQ-60-17-T-0002
Attachments: Ex-plant_MLSR_(08-2018).pdf

FYI

From: Chen, Yiren [mailto:yiren_chen@anl.gov]
Sent: Thursday, September 20, 2018 10:21 AM
To: Rao, Appajosula <Appajosula.Rao@nrc.gov>; Frankl, Istvan <Istvan.Frankl@nrc.gov>
Cc: Biwer, Bruce M. <bmbiwer@anl.gov>; Dority, Dayna <Dayna.Dority@nrc.gov>; ContractsPOT Resource <ContractsPOT.Resource@nrc.gov>; Natesan, Krishnamurti <natesan@anl.gov>; Alexandreanu, Bogdan <abogdan@anl.gov>; Farmer, Mitchell T. <farmer@anl.gov>; Grandy, Christopher <cgrandy@anl.gov>; Roglans-Ribas, Jordi <roglans@anl.gov>; Prokop, Karen Christine <kprokop@anl.gov>; Mendoza, Rosa <rmendoza@anl.gov>; NRC Fiscal Treasury <NRC@fiscal.treasury.gov>
Subject: [External_Sender] Monthly report for NRC-HQ-60-17-T-0002

Sri,
Please find the attached monthly report on ex-plant material testing for August 2018.
Yiren

MONTHLY LETTER STATUS REPORT

Reporting Period Start Date 07/21/2018	**Reporting Period End Date** 08/20/2018	
NRC Agreement Number NRC-HQ-25-14-D-0003	**Task Order Number (if applicable)** NRC-HQ-60-17-T-0002	**Common Cost Center Code**
Project Title Testing of Irradiated Ex-Plant Materials in Environment		
Period of Performance Start Date 1/11/2017	**Period of Performance End Date** 12/31/2019	
COR Appajosula S. Rao	**Telephone** 301-415-2381	**E-mail** Appajosula.Rao@nrc.gov
DOE Laboratory UChicago Argonne, LLC Argonne National Laboratory		
DOE Site Address 9700 Cass Avenue, Lemont, IL 60439		
Principal Investigator Yiren Chen	**Telephone** 630-252-6670	**E-mail** Yiren_chen@anl.gov

Financial Status Section

A. Overall Funding

Current Month Cost: $ 45,844
Total Ceiling Amount: $ 1,189,000
Total Amount of Funds Obligated to Date: $ 1,188,646
Total Amount of Funds Expended to Date: $ 426,409
Percentage of Funds Expended to Date: 35.9%
Balance of Obligated Funds Remaining: $ 762,237
Total Estimated Encumbered Costs: ($ 6,030)
Balance Available Less Estimated Encumbered Costs: $ 768,267

B. DOE Laboratory Acquired Property

N/A

C. NRC-Funded Software Developed

N/A

Argonne spending plan update

	NRC Agreement Number	NRC Agreement Modification Number	NRC Task Order Number	NRC Task Order Modification Number
	NRC-HQ-25-14-D-0003	**1**	**NRC-HQ-60-17-T-0002**	

Project Title: **Testing of Irradiated Ex-Plant Materials in Environment**

FY __2018__

	October	**November**	**December**	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**
Estimated Cost	-	$20,000	$20,000	$51,000	$51,000	$51,000	$51,000	$51,000	$51,000	$51,000	$51,000	$51,000
Revised	-	-	-	-	-	-	-	-	-	-	-	
Actual	-	$17,864	$8,651	$25,491	$22,392	$38,074	$70,388	$65,145	$60,095	$72,465	$45,844	
Variance (%)	-	-10.7	-56.7	-50	-56	-25	38	28	18	42	-10	
Total FY Cost												**$ 499,000**

FY __2019__

	October	**November**	**December**	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**
Estimated Cost	$60,000	$61,000	$60,000									
Revised												
Actual												
Variance (%)												
Total FY Cost												**$ 241,000**

Technical Status Section

A. Deliverables/Milestones Schedule

Task	Description	Planned Completion Date	Revised Completion Date (if applicable)	Actual Completion Date
1	CGR, J-R curve tests	Dec 2018		
2	Technical letter report	Dec 2018		

B. Progress During Reporting Period

- Removed the specimen B1CT10 (~ 40 dpa) and install the specimen A3CT04 (< 1dpa) in cell 1.
- Continued the test on Specimen ACT03 (~15-20 dpa) in cell 2.

C. Travel

None

D. Description of Estimated Encumbered Costs

N/A

E. Anticipated and Encountered Problem Areas

We removed the sample B1CT10 and try to re-tap the threads. The effort was unsuccessful, and the DCPD reading remained unstable. We have removed the sample and initiated a new test on Specimen A3CT03 in cell 1. The removed specimen B1CT10 will be tested in the cell 2 system after the current test in cell 2 is complete.

F. Plans for the Next Reporting Period

- Continue the test on Specimen ACT03 (~15-20 dpa) in cell 2.
- Start the cyclic test on Specimen A3CT04 in cell 1.

Testing of Irradiated Ex-Plant Materials in Environment

Technical Status

1. Background and objective

The performance of structural materials subjected to reactor core environments is critical for the safe and economic operation of commercial light water reactors (LWRs). Exposed to both energetic neutron bombardment and corrosion of high-temperature coolant, the reactor core internal materials undergo significant microstructural changes during power operations. Various irradiation effects, such as irradiation-assisted stress corrosion cracking, irradiation embrittlement, radiation-induced segregations, void swelling, etc. can occur at LWR temperatures and irradiation doses, leading to deteriorated mechanical properties, elevated cracking susceptibility, and even geometrical instability of reactor core internals. Due to the potentially serious impact on the safety and operation of LWRs, material degradations are of great interest to reactor aging management and regulation.

To develop guidelines for subsequent license renewal, the mechanisms of irradiation-induced degradations must be identified and technique data must be obtained. It has been recognized that knowledge and data gaps are present in the existing information and technical bases. In particular, fracture toughness (FT) and crack growth rate (CGR) data are critically needed for evaluating the extent of irradiation embrittlement and developing disposition curves of cyclic and IASCC growth rates. To fill the data gaps in irradiation-induced degradations, ex-plant materials harvested from decommissioned nuclear power reactors are of great importance. The Zorita Power Plant was a pressurized water reactor (PWR) decommissioned after approximately 38 years of operation. The maximum neutron fluence received by the reactor vessel internals was estimated to be over ~50 dpa. Materials obtained from this decommissioned reactor offer an excellent opportunity to examine core internal materials exposed to a real PWR irradiation and coolant environment, and thus are invaluable for the subsequent license renewal beyond 60 years.

The objective of this work is to conduct the CGR and J-R curve tests on irradiated ex-plant materials in simulated LWR environments, and obtain the CGR and FT data that can be used directly in supporting the technical evaluation of the subsequent license renewal. The microstructure of the ex-plant materials will also be examined to characterize their irradiated microstructure and to determine the damage mechanism for the loss of FT after prolonged operation.

2. Status of sample shipment

The specimens to be tested in this program have been machined by Studsvik from ex-plant materials harvested from the Zorita power plant. A total of 14 miniature compact-tension (CT) specimens, 7 flat tensile specimens, and 4 small coupon plates will be transferred from Studsvik to Argonne. Studsvik has applied for an export license from Swedish authority for shipping these samples.

The samples have been packaged in a Type-A cask with added shielding inside the secondary container. The cask has been sealed and tagged as shown in Figure 1. Table 1 shows the activity information provided by Studsvik. The shipment contains a total of 7.3 Ci activity, and

the main contributor to the exposure dose rate is Co-60. The dose rate of the shipping cask is about 16 mR/hr at 1 m, and will be transferred under the Yellow III category.

Figure 1. Shipping cask containing all specimens to be shipped from Studsvik.

Table 1. Major radionuclide and their activity contents in the shipment

Radionuclide	Activity (Bq)
Co-60	9.36E+10
Fe-55	9.27E+10
Ni-63	8.19E+10
Nb-93m	1.59E+10
Mn-54	3.86E+10
Total	**2.70E+11**

After an eight-month delay of the shipment, the certificate of the shipping cask was expired in August. Studsvik had to perform a maintenance service on the shipping cask to re-certify its condition. All samples were unloaded from the shipping cask and moved into a hot cell. The interior of the cask was cleaned and surveyed for loose contamination. After the samples were re-loaded into the cask, a dose rate measurement was performed outside the cask. After reloading, the transportation index (TI) decreased from a previous value of 7.5 to the current value 3 (as shown in Figure 2). Studsvik engineers believed that, in addition to the natural decay of short-life isotopes, this large decline in TI value was mainly due to a rearrangement of

samples inside the cask. The cask has been sealed and ready for the shipment. The shipping document needs be updated and provided to carrier for export controls and cargo reservation.

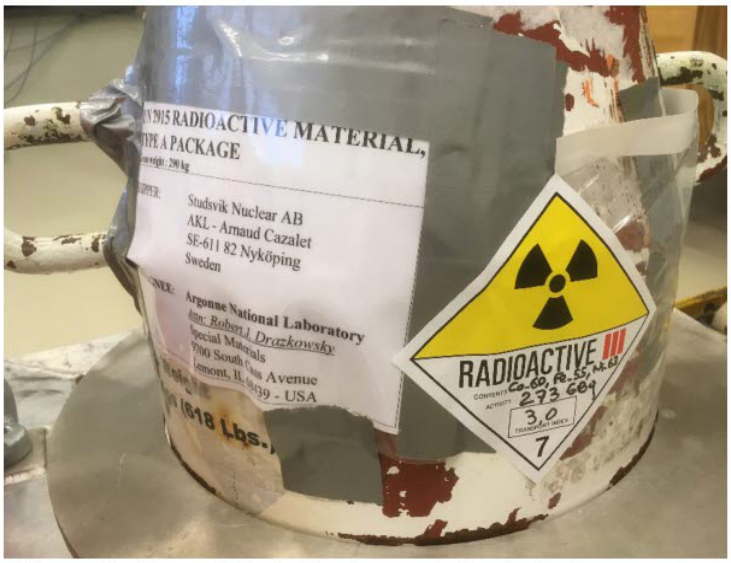


Figure 2. Re-certified shipping cask loaded with samples.

3. Preparation and safety reviews for unloading the Studsvik shipment

Because of its high radioactivity, the shipping cask must be unloaded with special precautions. We have developed an unloading procedure to receive the shipment, conduct a receiving survey of the shipping casks, and retrieve the samples from the shipping cask to the hot cells of the irradiated materials laboratory (IML). Table 2 shows the sample IDs and their estimated activities used for the unloading procedure.

Table 2. Specimen ID and estimated activity to be received

Specimen ID	ANL tracking ID	Specimen type	Estimated Activity (mCi)
ACT03	1106-C-01	1/4T-CT	506.03
ACT04	1106-C-02	1/4T-CT	506.03
A3CT03	1106-C-03	1/4T-CT	506.03
A3CT04	1106-C-04	1/4T-CT	506.03
B1CT10	1106-C-05	1/4T-CT	506.03
B1CT07	1106-C-06	1/4T-CT	506.03
B1CT08	1106-C-07	1/4T-CT	506.03
B1CT09	1106-C-08	1/4T-CT	506.03
B3CT13	1106-C-09	1/4T-CT	506.03
B3CT14	1106-C-10	1/4T-CT	506.03
W1WCT03	1106-C-11	1/4T-CT	506.03
W1WCT04	1106-C-12	1/4T-CT	506.03
W1WCT05	1106-C-13	1/4T-CT	506.03
W1WCT06	1106-C-14	1/4T-CT	506.03
AT01	1106-A-01	tensile	22.66
A3T01	1106-A-02	tensile	22.66

A3T02	1106-A-03	tensile	22.66
B1T05	1106-A-04	tensile	22.66
B1T06	1106-A-05	tensile	22.66
W1WT03	1106-A-06	tensile	22.66
W1WT04	1106-A-07	tensile	22.66
ATEM01	1106-H-01	TEM blank	10.57
A3TEM01	1106-H-02	TEM blank	10.57
B1TEM04	1106-H-03	TEM blank	10.57
W1WTEM01	1106-H-04	TEM blank	10.57

Table 3 shows the radiological survey results provided by Studsvik. It is estimated that all samples (bare samples without shielding) will have a dose rate reading between 14 and 36 R/hr at 30cm. The work area to be used to unload the cask will be categorized as a high-radiation area. Engineering controls such as adequate shielding and extension tools are needed to minimize workers' exposure. Since all samples will be packaged in clean plastic bags inside a secondary container, the removable contamination inside the shipping cask should be relatively low. However, precautions are still needed to prevent cross-contamination since the cask and the secondary inner container may have been handled in highly contaminated hot cells. Based on the radiological profile of the shipping package, we have developed a step-by-step unloading procedure. A total of 25 steps will be carried out by three IML technicians, three HP technicians and one HP supervisor. Based on the unloading procedure, a work-control package was prepared and submitted for review. The work control package has been fully approved by the NE division.

In the approved work procedure, six safety-critical steps involving high risk of exposure and contamination trigger the criteria established at Argonne for an ALARA review. Working with health physicists, we have evaluated the dose rates and removable contamination levels with engineering controls, and estimated the time duration for each step. Table 4 shows the effective doses calculated for the ALARA review. An effective dose of 202 mrem may be taken from the unloading work, and the highest individual dose is 110 mrem. A draft ALARA review document was prepared based on this assessment and submitted to the review committee. A review meeting was held, and we presented our work procedure, engineering controls, and radiological risk assessment to the nine-member ALARA committee. Figure 3 shows a schematic of the configuration to introduce the inner container into the hot cell. During the discussion with the review committee, several key questions were raised about the estimates of contamination level and effective dose. Additional information regarding the contamination level inside the cask was required by the review committee. Also, we were required to re-evaluate the necessity of using respirators since it may affect the time duration for key steps. The comments and suggestions of ALARA committee have been addressed, and the ALARA review has been formally completed.

For the preparation of unloading, we removed the autoclave and load train inside the hot cell 2. The benchtop was cleaned and a temporary lead shielding was built for the unloading work. A "dry-run" of the unloading was conducted, and two workers and two HP technicians participated. We used a mock-up drum to simulate the shipping cask, and practiced the steps specified in the procedure. The time durations of several key steps were also validated. Additional dry-runs are being planned to improve the efficiency in handling tools and the coordination among workers.

Table 3. Dose rate measurements and smear test results provided by Studsvik

Table summarizing the specimens fabricated in 212518 (7th Dec)

No	Specimen ID	Specimen type	Source material	Type	Piece Id	Suggested container	Nominal dose	Sample dose rate, ~2 cm	Sample dose rate, ~30 cm	Sample smear test*	Photo (Y/N)
1	B1CT08	CT	B1	Plate	B1F	32x45-1	50 dpa	1.0 Sv/h	25 mSv/h	107 KBq/m^2	Y
2	B1CT09	CT				32x45-1		1.2 Sv/h	23.5 mS/h	260 KBq/m^2	Y
3	B1T05	tensile				15x27-1		72 mSv/h	1.6 mSv/h	474 KBq/m^2	Y
4	B1T06	tensile				15x27-1		12 mSv/h	0.36 mSv/h	154 KBq/m^2	Y
5	B1TEM04	TEM				15x27-1		51 mSv/h	0.7 mSv/h	127 KBq/m^2	Y
6	B1CT10	CT	B1	Plate	B1E	32x45-1	40 dpa	700 mSv/h	18 mSv/h	142 KBq/ m^2	Y
7	B1CT07	CT				32x45-1		1.4 Sv/h	20 mSV/h	290 KBq/m^2	Y
8	ACT03	CT	A	Plate	A-A	32x45-1	15-20 dpa	555 mSv/h	12mSv/h	186 KBq/m^2	Y
9	ACT04	CT				32x45-1		800 mSv/h	12mSv/h	100 Cps (red) **	Y
10	AT01	tensile				15x27-2		50 mSv/h	0.75 mSv/h	47.2 KBq/m^2	Y
11	ATEM01	TEM				15x27-2		18.5 mSV/h	0.3 mSv/h	273 KBq/m^2	Y
12	B3CT13	CT	B3	Plate	B3	32x45-2	5 dpa	800 mSV/h	11 mSv/h	288 KBq/m^2	Y
13	B3CT14	CT				32x45-2		810 mSV/h	11 mSv/h	131 KBq/m^2	Y
14	A3CT03	CT	A3	Plate	A3A	32x45-2	<1 dpa	13 mSv/h	0.2 mSv/h	3.29KBq/m^2	Y
15	A3CT04	CT				32x45-2		14 mSv/h	0.2 mSv/h	13.9 KBq/m^2	Y
16	A3T01	tensile				15x27-3		1.45 mSv/h	0.2 mSv/h	5.97 KBq/m^2	Y
17	A3T02	tensile				15x27-3		0.8 mSv/h	0.015 mSv/h	39.5 KBq/m^2	Y
18	A3TEM01	TEM				15x27-3		0.45 mSv/h	0.02 mSv/h	21.3 KBq/m^2	Y
19	W1WCT03	CT	W1	Weld	W1A	32x45-2	1 dpa	135 mSv/h	1.3 mSv/h	47.5 KBq/m^2	Y
20	W1WCT04	CT				32x45-2		84 mSv/h	0.95 mSv/h	16.2 KBq/m^2	Y
21	W1WCT05	CT	W1	Weld	W1K	32x45-2	<0.1 dpa	9.5 mSv/h	0.15 mSv/h	10.3 KBq/m^2	Y
22	W1WCT06	CT				32x45-2		6.0 mSv/h	0.1 mSv/h	17.4 KBq/m^2	Y
23	W1WT03	tensile				15x27-4		0.05 mSv/h	0.015 mSv/h	8.8 KBq/m^2	Y
24	W1WT04	tensile				15x27-4		0.85 mSv/h	0.02 mSv/h	8.8 KBq/m^2	Y
25	W1WTEM01	TEM				15x27-4		0.50 mSv/h	0.03 mSv/h	72 KBq/m^2	Y

* Beta Activity, no alpha is detected (detection limit 0.4 kBq/m^2) in any specimens

** Too high activity to measure the contamination level

Table 4. Effective dose assessment for ALARA review

Task in procedure	Source configuration	Distance	Dose rate (mR/hr at 30cm)	Duration (hr)	Number of workers	External exposure (mrem)
Step 1	Shielded by cask	1 m, and 30 cm	88	0.5	3	52
Step 6	Partially Shielded	30 cm	200	0.03	2	12
Step 8	Partially Shielded	30 cm	200	0.02	2	8
Step 9	Unshielded	1.22 m	2721	0.02	2	109
Step 10	Shielded by bricks	1 m	15	0.08	3	3.6
Various steps with HP support	Unshielded and partially shielded	3 m	450	0.04	1	18

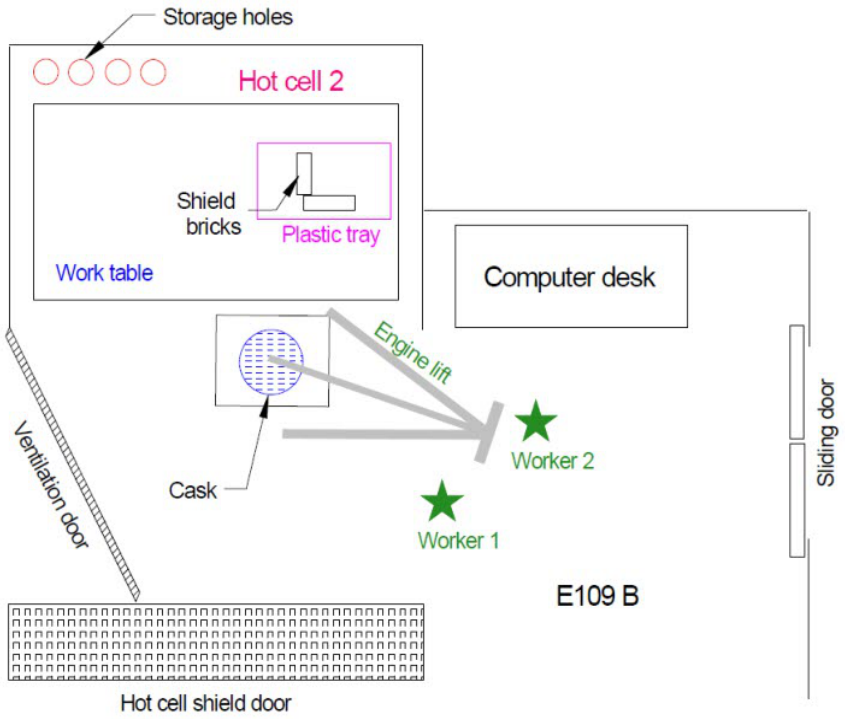


Figure 3. A schematic of an intermedia step to introduce the inner container into hot cell.

4. Preparation of CGR/JR tests and microstructural characterization

A direct current potential drop (DCPD) method will be used to monitor the crack extension of specimens during CGR tests. Depending on the dose rate of the specimen, DCPD leads could be attached to the sample either with threaded pins or with spot welding. The spot welding has a smaller contact resistance and thus shows a better noise to signal ratio during tests. A procedure and a work control document (WCD) was prepared and reviewed by a safety committee. The WCD has been approved.

When spot weld is impossible or the weld fails during sample installation, our backup plan is to use threaded pins to attach the DCPD leads. In this case, two tapped holes are needed on each CT sample. Two blind holes have already been drilled on each sample by Studsvik, but have not been tapped. These two holes were drilled incline to the sample front surface at a ~20 degree angle. This makes the task of hole-tapping more difficult, particularly when it has been performed remotely with manipulators. We are designing and making a fixture that will not only hold the sample in place precisely for tapping, but also maintain a correct angle between the tap drill and the inclined holes. All necessary parts and components have been ordered, and will be assembled and tested in hot cells.

Transmission electron microscope (TEM) examinations will be performed on Zorita materials to characterize their irradiated microstructures. Three-mm TEM disk samples will be prepared from 0.25-mm thick coupon samples. A work procedure has been prepared to cut the TEM disks from the coupons inside hot cells. Two cutting methods that are commonly used for TEM sample

preparation have been included in this procedure. The first method is to cut the TEM disks with a TEM punch, a punch and die set designed for cutting TEM disks. This method is our preferred choice since it is relatively easier and quicker. A potential drawback of this method is that plastic deformation may be introduced during the process. This potential issue does exist for our samples since their thickness is approaching to the upper limit of the TEM punch. If the punch method is unsuccessful, our backup plan is to use a rotary disk cutter. With this method, no deformation will be introduced in the TEM disks, but additional steps for sample installation and removal will be needed. Also, the rotating head and cutting fluid used in this method will generate a condition that radiological contamination is a serious concern. These potential safety hazards are being addressed in our procedure with necessary engineering and administration controls and will be implemented in a work control document.

5. Receiving and unloading of the shipping cask

The shipping cask containing Zorita samples was delivered to Argonne by a local trucking company. Argonne HP technicians performed a receiving survey on the package and no removable contamination was found on the exterior surface of the cask. The dose rate of the cask was about 40 mR/hr on contact, and 7 mR/hr at 30 cm. No dose rate measurement was performed at the bottom of the cask which may be slightly higher according to the configuration of the cask. Based on the receiving survey, we established a temporary radiation area to store the package.

Figure 4. Moving the shipping cask on to the “hot dock” of the IML.

Survey Points			
Survey Point: 1	Dose rate a cask on the steel pallet 5 smears		
Instr. Set #: 3877 EBER: RO-20	Value Type	Value	Distance
	Gross γ	40 mR/h	0 cm
Instr. Set #: 1913 ANL: DABRAS, GATE: GP7-600, BERTH: MZ200	Value Type	Value	Distance
	Gross Removable α	4 cpm/100cm²	N/A
	Gross Removable β (Use Beta High)	243 cpm/100cm²	N/A
	Removable α	7.8 dpm/100cm²	
	Removable β (Use Beta High)	14.9 dpm/100cm²	
Instr. Set #: 3877 EBER: RO-20	Value Type	Value	Distance
	Gross γ	7 mR/h	30 cm
Instr. Set #: 3877 EBER: RO-20	Value Type	Value	Distance
	Gross γ	3 mR/h	1 m

Figure 5. Receiving survey of the shipping cask.

A total of three IML workers, two health physicists, and two HP technicians were involved in the unloading work. The shipping cask was first moved into the IML and position in front of the hot cell door (Figure 6). After the seal of the cask was cut, the lid of the shipping cask was lifted with tools (Figure 7). At this point, HP technicians performed a radiological survey of the cask to determine that the conditions are within the control limits (Figure 8). The survey results showed similar radiological conditions as estimated, validating our methodology used in the work planning. After confirming the dose rate and contamination level inside the cask, the inner container holding all specimens was lifted out of the cask cavity and moved into the hot cell with an extension tool. A brief but high radiation field was present once the secondary container was lifted out the cask cavity. A post-job review of workers' dose meters showed a total dose of 2.45 mrem, significantly lower than what we estimated in the work planning. Figure 9 shows the sample capsules removed from the secondary container.

After the unloading, the empty cask was cleaned and sealed. Working with an outside contractor, Argonne Special Materials has shipped the empty cask back to Studsvik in early December.

Figure 6. Move the shipping cask into the IML.

Figure 7. Pre-job survey and cut the seal of the cask.

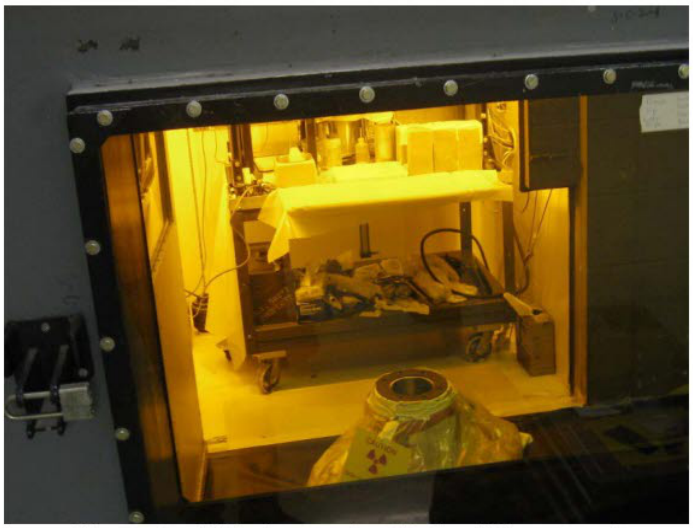
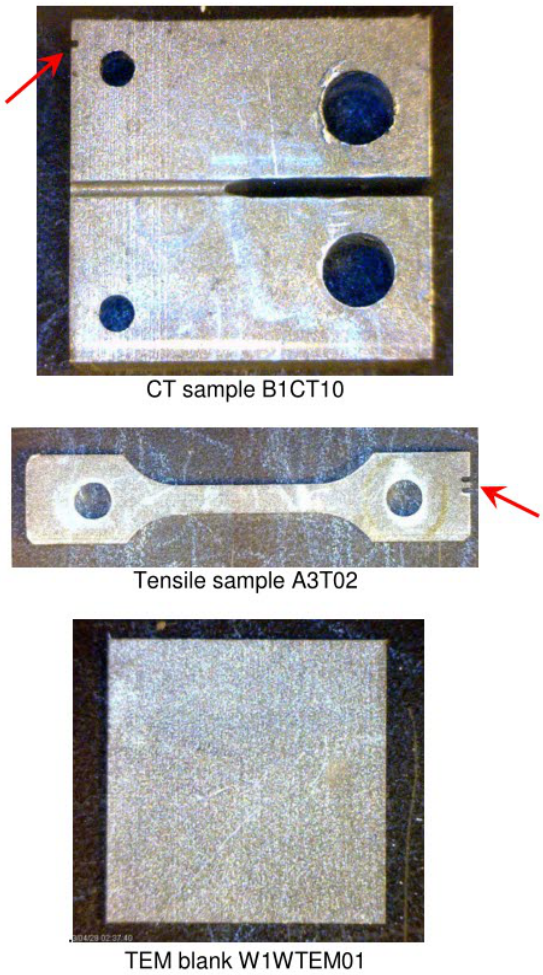


Figure 8. Shipping cask with the lid removed

Figure 9. Removed sample capsules from the cask.

6. Inspection and Inventory

The sample capsules have been opened using manipulators inside the hot cell. To remove gross contamination, the samples were wiped with moist rags, cleaned with an ultrasonic cleaner, and dried on paper towels. Following the decontamination, the samples were visually inspected for manufacturing defects and photographed individually. Figure 10 shows some of the samples inspected. Note that the samples' IDs are marked with shallow EDM cuts on the side surfaces or the ends of the samples. No manufacturing defects were identified for all samples received. One specimen showed different colors on its side surface as shown in Figure 11. The Studsvik staff performing the machining task confirmed that this surface discoloration was resulted from a broken EDM wire during the cutting of this sample. The sample was immersed in an oil bath for several days while the EMD wire being replaced. So, the surface discoloration was not related to any dimensional irregularity, and thus should not have any negative impact on testing.

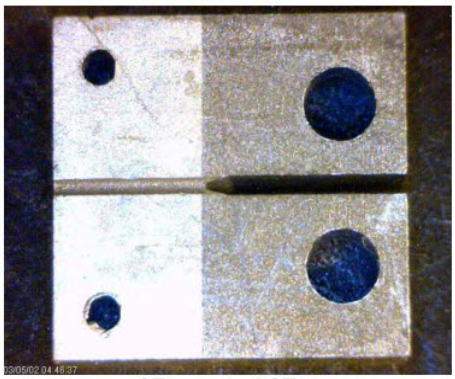


CT sample B1CT10

Tensile sample A3T02

TEM blank W1WTEM01

Figure 10. Zorita samples machined by Studsvik.



CT sample ACT04

Figure 11. Surface discolor observed on Specimen ACT04.

After the visual inspection, each sample was surveyed for its dose rate and weighed with a digital scale. Table 5 shows the results of sample inspection and inventory. Most of the samples were measured at 30 cm for their dose rates. For some high-dose CT samples, the dose rates were measured at 1 m to reduce worker's exposure.

Table 5. Receiving inspection and inventory of Zorita specimens

Source Material	Material Type	Source Piece	Nominal Dose, dpa	Sample ID	Sample Type	CMM ID	CURIE ID	Dose rate, mR/hr	Weight, g	Inspection
B1	Plate	B1F	50	B1CT08	CT	1106-C-01	149824	270 mR @ 1 m	9.45	√
B1	Plate	B1F	50	B1CT09	CT	1106-C-02	149825	340 mR @ 1 m	9.35	√
B1	Plate	B1F	40	B1CT10	CT	1106-C-03	149826	310 mR @ 1 m	9.2	√
B1	Plate	B1F	40	B1CT07	CT	1106-C-04	149827	300 mR @ 1 m	9.35	√
A	Plate	A-A	15-20	ACT03	CT	1106-C-05	149828	160 mR @ 1 m	9.4	√
A	Plate	A-A	15-20	ACT04	CT	1106-C-06	149829	150 mR @ 1 m	9.15	√
B3	Plate	B3	5	B3CT13	CT	1106-C-07	149830	950 mR @ 30 cm	9.35	√
B3	Plate	B3	5	B3CT14	CT	1106-C-08	149831	800 mR @ 30 cm	9.35	√
A3	Plate	A3A	<1	A3CT03	CT	1106-C-09	149832	33 mR @ 30 cm	9.4	√
A3	Plate	A3A	<1	A3CT04	CT	1106-C-10	149833	28 mR @ 30 cm	9.35	√
W1	Weld	W1A	1	W1WCT03	CT	1106-C-11	149834	140 mR @ 30 cm	9.25	√
W1	Weld	W1A	1	W1WCT04	CT	1106-C-12	149835	100 mR @ 30 cm	9.35	√
W1	Weld	W1K	<0.1	W1WCT05	CT	1106-C-13	149836	21 mR @ 30 cm	9.3	√
W1	Weld	W1K	<0.1	W1WCT06	CT	1106-C-14	149837	22 mR @ 30 cm	9.3	√
B1	Plate	B1F	50	B1T05	Tensile	1106-A-01	149750	140 mR @ 30 cm	0.45	√
B1	Plate	B1F	50	B1T07	Tensile	1106-A-02	149751	110 mR @ 30 cm	0.5	√
A	Plate	A-A	15-20	AT01	Tensile	1106-A-03	149752	80 mR @ 30 cm	0.4	√
A3	Plate	A3A	<1	A3T02	Tensile	1106-A-04	149753	28 mR @ 30 cm	0.5	√
A3	Plate	A3A	<1	A3T03	Tensile	1106-A-05	149754	28 mR @ 30 cm	0.45	√
W1	Weld	W1K	<0.1	W1WT03	Tensile	1106-A-06	149755	28 mR @ 30 cm	0.4	√
W1	Weld	W1K	<0.1	W1WT04	Tensile	1106-A-07	149756	30 mR @ 30 cm	0.4	√
B1	Plate	B1F	50	B1TEM04	TEM blank	1106-H-01	149706	50 mR @ 30 cm	0.2	√
A	Plate	A-A	15-20	ATEM01	TEM blank	1106-H-02	149704	16 mR @ 30 cm	0.15	√
A3	Plate	A3A	<1	A3TEM01	TEM blank	1106-H-03	149705	1.8 mR @ 30 cm	0.2	√
W1	Weld	W1K	<0.1	W1WTEM01	TEM blank	1106-H-04	149707	1.7 mR @ 30 cm	0.2	√

During the process of inventory, one of the manipulator was broken, limiting the movement of the manipulator inside the hot cell. The failure was caused by a fractured cable on the slave size of the manipulator. To repair the cable, the manipulator has to be removed from its installation port, and be positioned in front of the hot cell. A work-control document and radiological work permit were prepared and reviewed by a divisional safety committee. After the work control document was approved, the repair work was carried out by two IML workers and one HP technician. Using an overhead hoist, the workers moved the damaged manipulator out of its port and place it on a support rack. The slave side of the manipulator and the section

embedded in the wall were wiped down carefully to eliminate contaminations. After an acceptable radiological condition was achieved, the broken cables were replaced with new ones and adjusted to required tension. The manipulator was then moved back and inserted into its port on the shield wall.

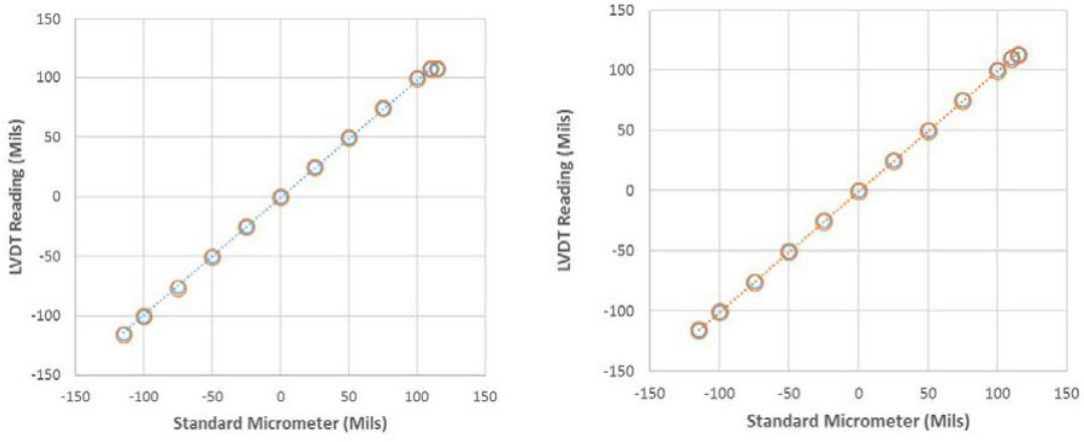
After the repair work, the sample inventory was continued. The dose rates of the remaining samples were surveyed (Table 5), and their weights were measured. Additional pictures were taken on the side surfaces of each specimen to document their identification markings before testing. These records are necessary since a long-term exposure to the test environments may reduce the contrast of the shallow EDM cuts and make them illegible.

7. System Calibration and Preparation

7.1 System Calibration

Two mechanical test systems located in Hot Cells #1 and #2 will be used for testing the Zirota specimens. Each system is equipped with its own servo-hydraulic loading frame, water recirculation loop, and data acquisition system. All electronic equipment of the data acquisition systems has been calibrated. The LVDTs of both systems have been verified with a standard micrometer (Figure 12). Using a rigid tensile specimen, the load train responses of both test frames have also been validated.

All control channels of the Instron systems have been tuned with an unirradiated 1/4T-CT sample. A more realistic load train compliance can be simulated by using a 1/4T-CT sample, and the PID feedback control can be optimized. Figure 13 - Figure 15 show the tuning results of different channels for the cell 2 system. Similar results have been obtained for the cell 1 system as well. Note that both the position and load channels show good responses after the tuning. For the strain channel (to be used for the J-R curve test), the accuracy of the control depends on straining rate. When the straining rate is below 0.02 mil/s, the control is not optimum and a stepwise ramping curve can be seen. Above 0.05 mil/s, a much better strain-control can be achieved. The poor response of the strain channel at low strain rates is perhaps due to a physical limit of actuator. The strain control is even worse in cell 1 system where a larger actuator is used. Since we found previously that the J-R curve result is not very sensitive for a wide range of strain rates, we will use a strain rate of 0.05 mil/s in the future.



(a) (b)

Figure 12. Calibrations of LVDTs for hot cell #1 (a) and #2 (b)

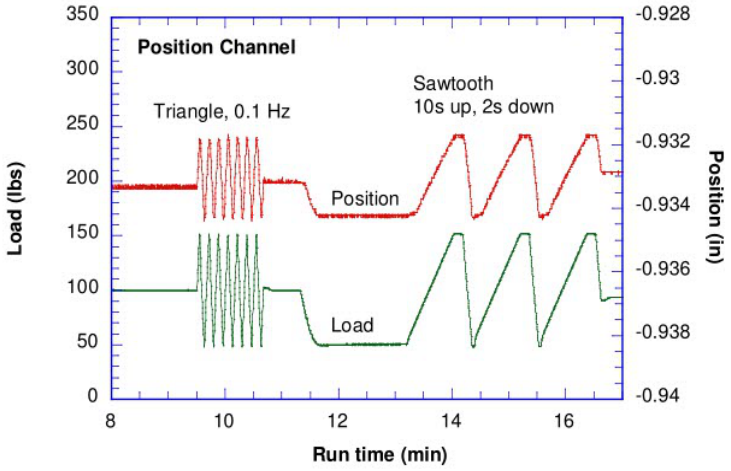


Figure 13. The response of the position channel after tuning with a 1/4T-CT sample.

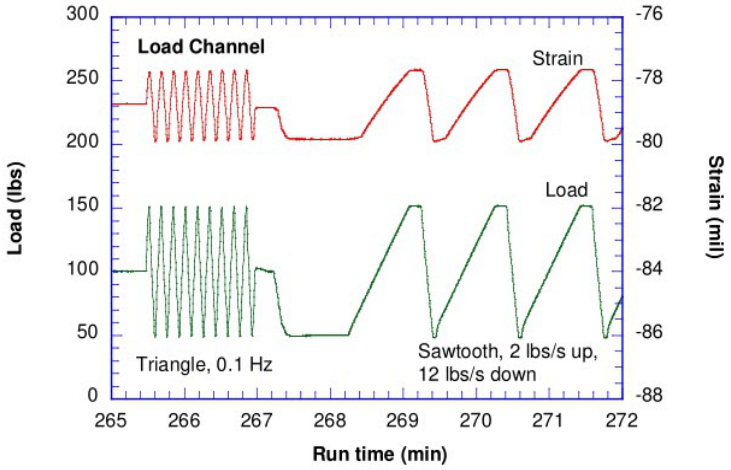


Figure 14. Calibrations of LVDTs for hot cell #1 (a) and #2 (b)

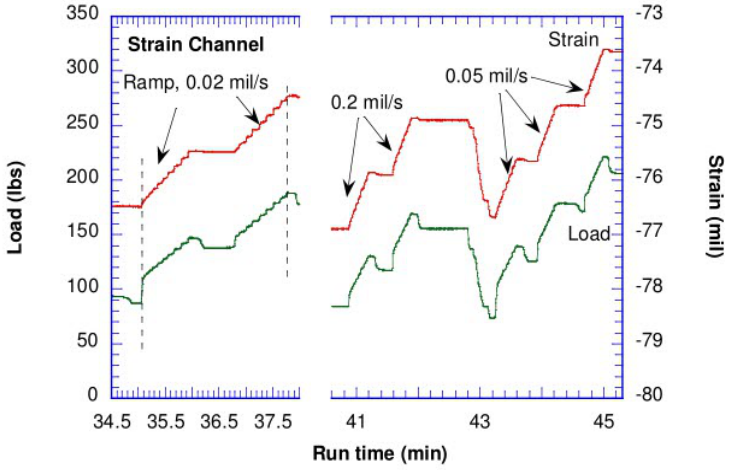


Figure 15. Calibrations of LVDTs for hot cell #1 (a) and #2 (b)

7.2 Tapping threads on high-dose samples

As part of the preparation work, screw threads need to be cut on high-dose samples. Since spot welding cannot be easily performed on the high-dose samples, DCPD leads must be attached with threaded pins. All samples machined by Studsvik contain prefabricated 3/64"-dia holes inclined at ~20° about the sample notch. Since the diameter of the tap is very small, a breakage of drill bits is a real risk during tapping. A special setup (as shown in Figure 16) was assembled inside the hot cell for facilitating the operation with manipulators. The purpose of this setup was (1) to ensure a good alignment between the inclined hole and the tap, and (2) to provide a small but stable pressure over the tap. Two high-dose samples, B1CT09 and B1CT10, were tapped successfully with the setup. Each of the samples read about 3 R/hr at 30 cm. After the tapping, two threaded pins were screwed to the sample as potential leads. Additional high-dose samples will be tapped with the same method in the future.

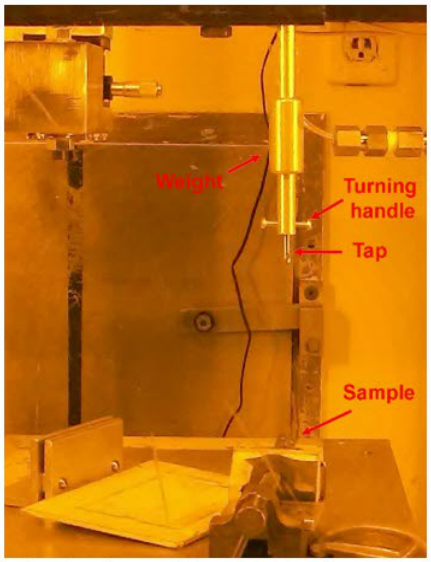


Figure 16. A setup inside the hot cell for tapping threads on high-dose samples

7.3 Preconditioning of the filter for PWR water test

In the water recirculation system, water coming out of the autoclave contains corrosion products that are radiologically contaminated. While the contamination in the water must be removed, boron and lithium ingredients in the PWR water must be retained during the tests. To achieve this goal, we need to pre-condition a filter (ion-exchange bed) by saturating it with boron and lithium. Previously, PWR water had been prepared, and a filter had been preconditioned in an out-of-cell loop. A concentrated B/Li solution was first circulated through the filter. After the filter was fully saturated, the PWR water (containing ~1000 ppm B and ~2 ppm Li) was allowed to flow through the filter to achieve an equilibrium. Figure 17 shows the conductivity measurement in the preconditioning loop. A constant conductivity about 20 μS/cm was obtained with and without the charged filter, indicating an equilibrium state.

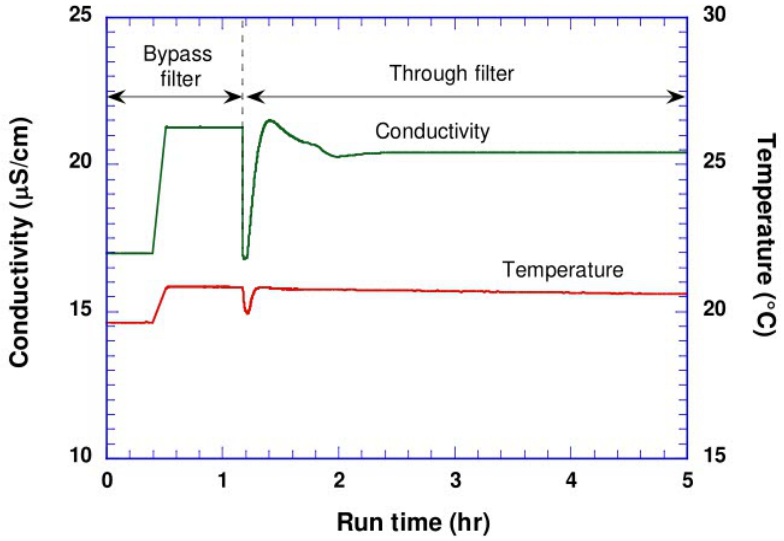


Figure 17. Conductivity measurement in the preconditioning loop

A water sample was collected downstream from the charged filter and sent to an analytical chemistry laboratory for analysis. The result showed a boron content of ~950 PPM and a lithium content of ~2.5 PPM. All other ions were less than 0.1 PPM in the loop. After the high-pressure pump was re-conditioned, the charged filter was re-located in the cell 1 loop. All preparation work for cell 1 has been completed, and the system is ready for starting.

8. Crack growth rate and fracture toughness tests

8.1 CGR/JR test on Specimen B1CT09

The CGR/JR test on Specimen B1CT09 has been completed. The sample is a 1/4T-CT specimen cut from the baffle plate B1F as shown in Table 5. The baffle plate is a Type 304 stainless steel, but its precise chemical composition and heat treatment history are not available at present. The displacement damage accumulated on this sample is about 50 dpa. The identification of the specimen is marked with three grooves (one on the back surface, and two on the top surface) based on the Studsvik's sample fabrication report (Fig. C.2 in the report). These ID markings have been confirmed with the optical images shown in Figure 18.

Table 6 shows the dimensions of the specimen provided by Studsvik. Two dimensions highlighted in yellow, L7 and W2, are out of the tolerances specified in the fabrication report. Both of the out-of-range dimensions are not critical for determining K values. Thus, we determine the sample is adequate for CGR/JR testing. The dimensions of the sample are summarized in Table 7.

The CGR results of this test and corresponding loading conditions are given in Table 8. The fracture surface of the test sample has been examined, and all data reported in Table 8 have been corrected with the SEM measurements. The fracture toughness J-R curve test shows a power-law correlation of $J = 80\Delta a^{0.04}$, and the J value at the 0.2-mm offset line is approximately 75 kJ/m^2. A near-zero power exponent exhibited in this J-R curve test suggests severe irradiation embrittlement at ~50 dpa.

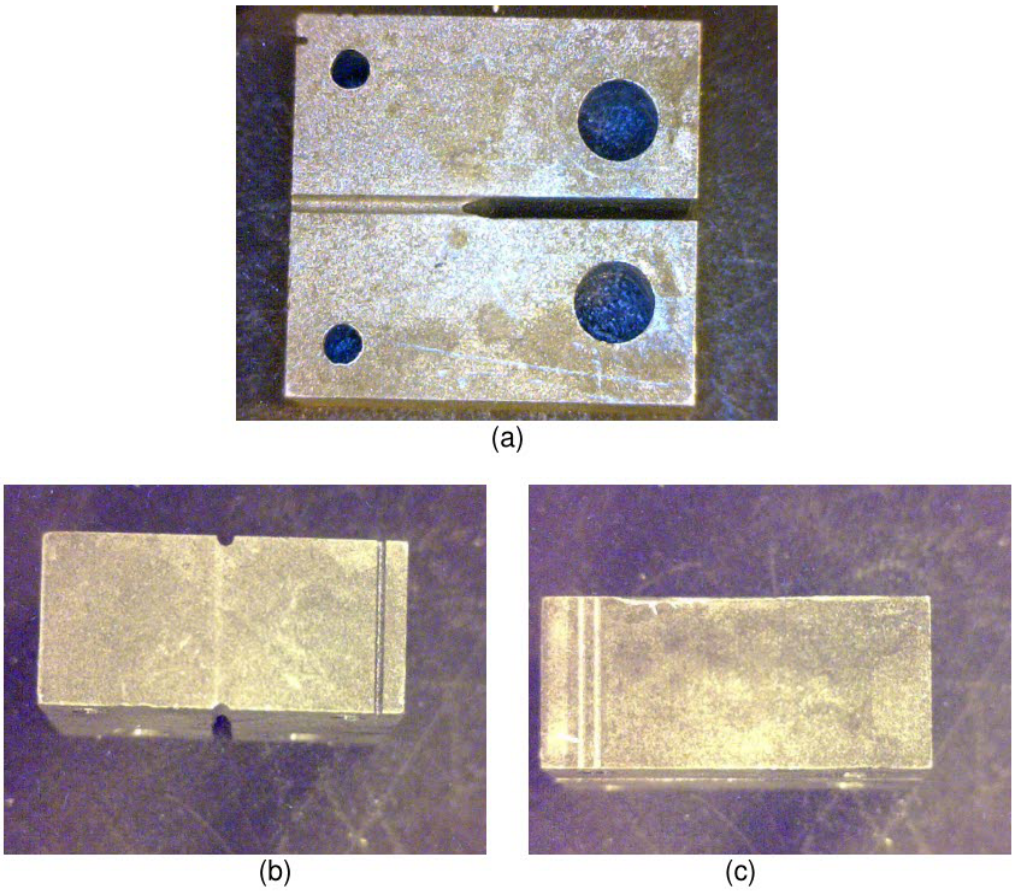


Figure 18. Specimen B1CT09, a 50-dpa CT sample cut from the baffle plate B1F. (a) The front view of the specimen, and (b) and (c) the ID markings on the sample.

Table 6. Sample dimensions provided by Studsvik (in mm)

Sample ID	**B1**	**B2**	**B3**	**B4**	**B5**	**D1**	**D2**	**L1***	**L3***	**L6**	**L7**	**W1**	**W2**	**W3**
Nominal values	**7.00**	**7.00**	**0.79**	**3.3**	**3.3**	**3.00**	**3.00**	**12.00**	**5.75**	**2.00**	**2.00**	**6.50**	**0.33**	**0.33**
Tolerances	**±0.05**	**±0.05**	**±0.05**	**±0.05**	**±0.05**	**0.05**	**0.05**	**±0.1**	**±0.05**	**±0.05**	**±0.05**	**±0.1**	**±0.05**	**±0.05**
B1CT09	6.99	6.98	0.79	3.27	3.32	3.00	3.00	12.01	5.71	2.05	2.07	6.52	0.24	0.38

Table 7. Dimensions for Specimen B1CT09 (in mm)

W	B	B_{net}	a_o
12.01	6.52	5.90	5.71

Table 8. Crack growth rates of Specimen B1CT09 (304 SS, ~50 dpa) in low-DO high-purity water.

Test Period	Test Time, h	Test Temp., °C	DO PPb	Cond. µS/cm	Load Ratio	Rise Time, s	Return Time, s	Hold Time, s	Kmax, MPa $m^{1/2}$	ΔK, MPa $m^{1/2}$	CGR in Env., m/s	CGR in Air, m/s	Crack Length, Mm
Start	0.4												5.710

a	5.3	315	8	0.06	0.34	0.38	0.38	0.12	11.5	7.6	5.12E-10	1.25E-08	5.714
b	24.7	314			0.33	0.39	0.39	0.11	12.5	8.3	negligible	1.64E-08	5.714
c	46.7	315			0.33	0.39	0.39	0.11	13.5	9.0	negligible	2.09E-08	5.713
d	50.9	314			0.33	0.40	0.40	0.10	14.5	9.7	negligible	2.64E-08	5.717
e[1]	80.6	315			0.30	0.41	0.41	0.09	14.9	10.5	2.98E-09	3.22E-08	5.757
f[1]	99.2	314			0.31	0.40	0.40	0.10	15.1	10.5	1.77E-08	3.32E-08	5.934
G	114.0	314			0.40	1.93	1.93	0.57	14.5	8.9	2.49E-10	4.35E-09	5.948
h[1]	137.3	314			0.35	0.79	0.79	0.21	15.1	9.9	4.13E-09	1.43E-08	6.103
i[1]	166.1	314	8	0.06	0.39	1.92	1.92	0.58	15.0	9.1	2.38E-09	4.74E-09	6.204
J	209.9	314			0.45	3.73	3.73	1.27	14.8	8.1	3.20E-10	1.79E-09	6.228
k[1]	234.3	314			0.45	1.49	1.49	0.51	15.2	8.3	2.48E-09	4.78E-09	6.314
L	281.6	314			0.50	3.63	3.63	1.37	15.0	7.5	2.75E-10	1.45E-09	6.333
M	290.4	314			0.50	1.84	1.84	0.66	15.9	7.9	2.11E-09	3.49E-09	6.352
n	307.5	314			0.50	3.68	3.68	1.32	15.9	8.0	7.23E-10	1.77E-09	6.368
o	331.1	314			0.49	7.38	3.69	2.62	16.1	8.1	3.64E-10	9.30E-10	6.387
p	354.5	314			0.49	22.2	3.70	7.82	16.0	8.1	2.11E-10	3.07E-10	6.396
q	378.0	314			0.45	75.8	9.09	24.2	16.3	8.7	2.17E-10	1.14E-10	6.410
r	402.1	314	8	0.06	0.48	186.3	8.94	63.7	16.2	8.5	1.70E-10	4.20E-11	6.417
s	425.9	314			0.47	373.9	8.97	126.1	16.3	8.6	1.09E-10	2.17E-11	6.425
t	449.7	314			0.47	746.1	8.95	253.9	16.2	8.6	6.93E-11	1.08E-11	6.428
1	570.0	314	8	0.06	0.50	12	12	7200	16.4	8.2	1.20E-11	9.97E-13	6.439
2	714.3	314			1	-	-	-	16.6	-	7.98E-12	-	6.448
u	737.7	314	8	0.06	0.48	191.6	9.20	58.4	19.8	10.3	6.39E-10	7.77E-11	6.500
v	762	314			0.53	373.6	8.97	126.4	19.8	9.3	2.17E-10	2.99E-11	6.514
w	786.3	314			0.55	739.1	8.87	260.9	19.9	8.9	1.48E-10	1.35E-11	6.522
3	882.1	314			0.55	12	12	7200	20.1	9.0	1.75E-11	1.43E-12	6.530
4	1050.6	314	8	0.06	1	-	-	-	20.2	-	1.24E-11	-	6.540
x	1073.6	314			0.59	189.6	9.10	60.4	24.9	10.1	8.29E-10	8.22E-11	6.600
y	1105.6	314			0.62	371.7	8.92	128.3	25.0	9.4	2.37E-10	3.37E-11	6.617
z	1145.7	314			0.62	744.4	8.93	255.6	25.1	9.5	1.77E-10	1.74E-11	6.639
5	1241.6	314	8	0.06	0.62	12	12	7200	25.2	9.6	2.46E-11	1.85E-12	6.647
6	1433.9	314			1	-	-	-	25.3	-	1.04E-11	-	6.657
Complete													

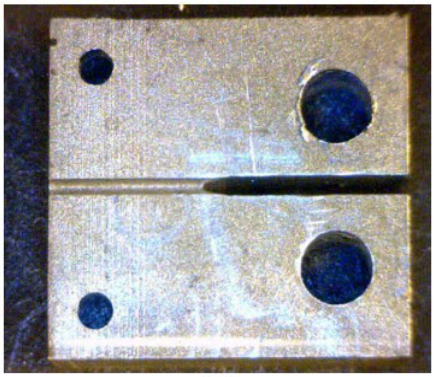
[1] Crack growth rate at the later part of the test period is reported.

8.2 CGR/JR test on Specimen B1CT10

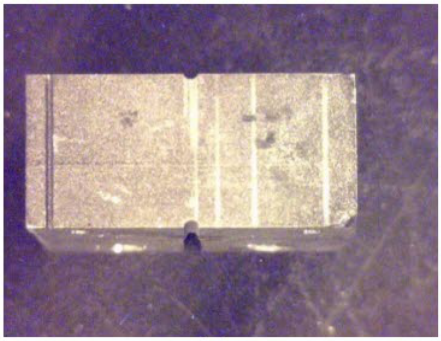
The CGR/JR test on Specimen B1CT10 has been initiated previously. The sample is a 1/4T-CT specimen cut from the baffle plate B1E. The accumulated displacement damage for this sample is about 40 dpa. The specimen ID is marked with four grooves (one deep groove on the back surface, and three shallow grooves on the top surface) based on the Studsvik's sample fabrication report (Fig. C.4 in the report). These ID markings have been verified with the optical images shown in Figure 19.

Table 9 shows the dimensions of the specimen provided by Studsvik. Five dimensions highlighted in yellow are out of the tolerances. Four of the out-of-range dimensions are not critical, but the value of L3 is essentially the crack length. An inaccurate value of crack length may give rise to an inaccurate K. However, since we will be able to correct the crack length using post-test measurements with SEM images, a certain level of uncertainty is acceptable during the test. Thus, the sample is deemed to be adequate for testing, and a larger than usual post-test correction is anticipated for this sample. The dimensions to be used in the test are summarized in Table 10. In addition, one of the angular holes in this sample is too deep and penetrates its neighboring loading pin hole. This may cause an unexpected contact

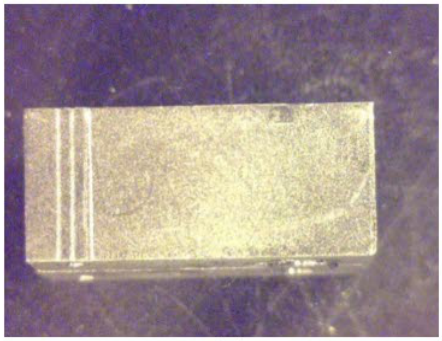
between the loading pin and potential lead, leading to an unstable contact resistance at the potential leads. Special care will be needed during sample installation to avoid such a contact.



(a)



(b)



(c)

Figure 19. Specimen B1CT10, a 40-dpa CT sample cut from the baffle plate B1E. (a) The front view of the specimen, and (b) and (c) the ID markings on the sample.

Table 9. Sample dimensions provided by Studsvik (in mm)

Sample ID	**B1**	**B2**	**B3**	**B4**	**B5**	**D1**	**D2**	**L1***	**L3***	**L6**	**L7**	**W1**	**W2**	**W3**
Nominal values	**7.00**	**7.00**	**0.79**	**3.3**	**3.3**	**3.00**	**3.00**	**12.00**	**5.75**	**2.00**	**2.00**	**6.50**	**0.33**	**0.33**
Tolerances	**±0.05**	**±0.05**	**±0.05**	**±0.05**	**±0.05**	**0.05**	**0.05**	**±0.1**	**±0.05**	**±0.05**	**±0.05**	**±0.1**	**±0.05**	**±0.05**
B1CT10	6.92	6.97	0.80	3.22	3.37	3.02	3.03	11.90	5.52	1.93	1.96	6.47	0.32	0.28

Table 10. Dimensions for Specimen B1CT10 (in mm)

W	B	B_{net}	a_o
11.90	6.47	5.87	5.52

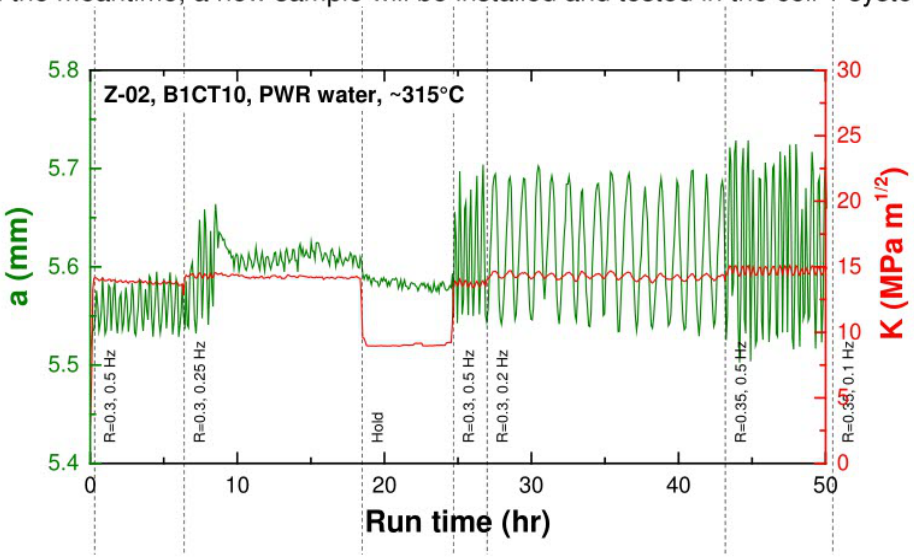
The sample was initially installed four months ago. After the autoclave was sealed, the system was pressurized to ~1800 psig, and heated slowly to ~315°C. A small tensile load about 20 lbs was maintained on the sample during the heating. After the sample was soaked in the PWR water for 8 days, the test was started with cyclic loading. The Instron tower was tripped several times after only several dozen cycles. During the trips, a significant displacement of ~50 mils was registered on the LVDT, leading to a suspicion that the sample had already broken. A

decision was made to cool down and depressurize the system. After the autoclave was open, the sample was found intact and not damaged. It appears that the trips were caused by a signal issue related to the Instron controller. Since both cell 1 and 2 systems share one single hydraulic pump, to avoid any risk affecting the cell 2 test, we decided to wait until the completion of the cell-2 test before troubleshooting the cell-1 Instron system.

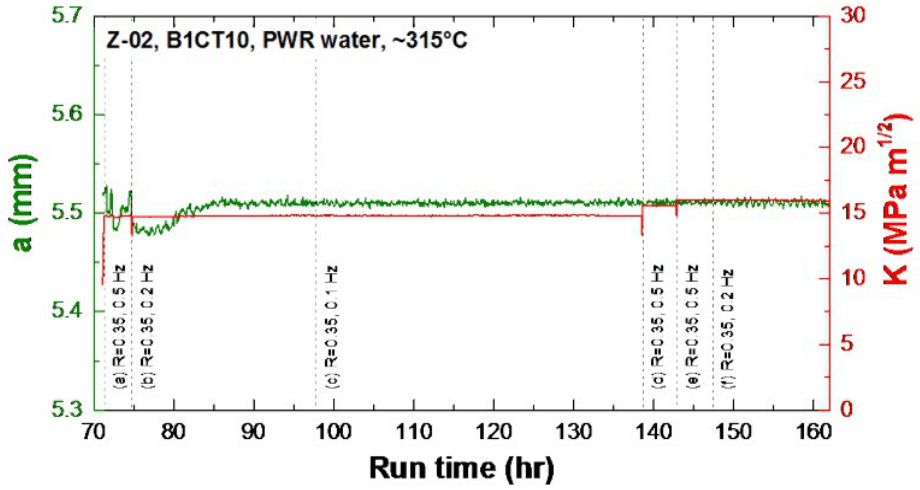
After the completion of the Cell 2 test, the hydraulic pump was shut down, and the hydraulic line connecting the hydraulic pump to the Cell-1 actuator was examined. Two components controlling the oil flow into the cell-1 actuator were replaced to eliminate any potential issue of hydraulic flow. In the meantime, we also modified all the LabView data acquisition codes, changing all GPIB functions to VISA functions. This is recommended by National Instrument for communicating with various instruments because some old GPIB commands may have compatibility issues with newer computer systems.

After the sample was re-installed, the system was pressurized and heated to the test condition. The sample was then soaked in the test environment for 6 days before the cyclic CGR test was started with a triangle waveform at 0.5 Hz. Once the cyclic loading started, the DCPD reading became unstable and oscillated as shown in Figure 20a. Obviously, this wide swing of DCPD reading was not sample's response, but rather an indication of the unstable contact of potential leads. It appears that the loading pin was in contact with the potential lead, giving rise to an oscillating contact resistance. After multiple attempts to correct this problem, a stable DCPD reading was eventually obtained by swapping the potential and current leads (as shown in Figure 20b). Although this wiring pattern is not ideal for DCPD measurement, the potential drop across the crack month should response to the change of crack size. We decided to continue this test and make any necessary correction later with post-test SEM measurements. In the following test periods, quite aggressive loading conditions were applied to the sample to initiate cracking. After repeated attempts over 100 hours, no crack growth was observed even at a K_{max} as high as 18 MPa $m^{1/2}$ (Figure 20c). It appears that the sensitivity of the DCPD measurement was reduced too much with the new wiring pattern and no adequate CGR measurement can be attained. The test had to be stopped and the sample removed. This sample will be moved to cell 2 to enlarge the damaged angular hole, and to re-attach a set of DCPD wires. In the meantime, a new sample will be installed and tested in the cell 1 system.

(a)



(b)



(c)

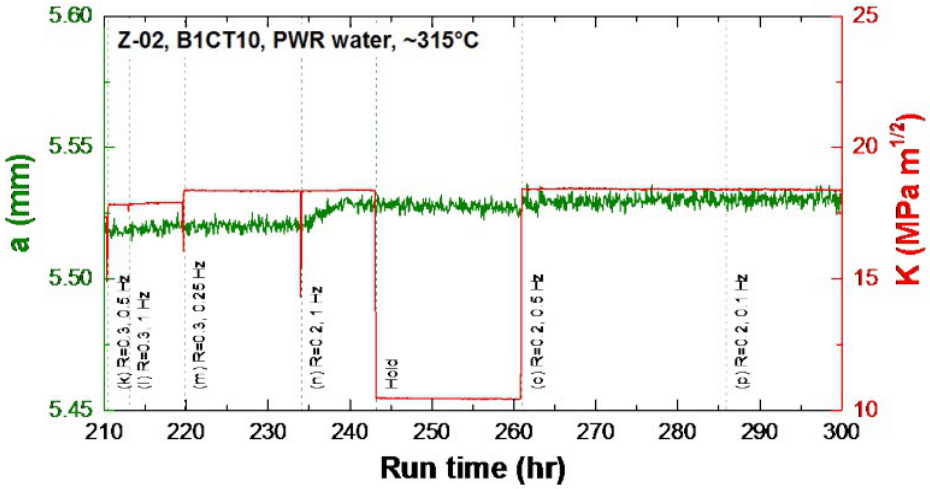


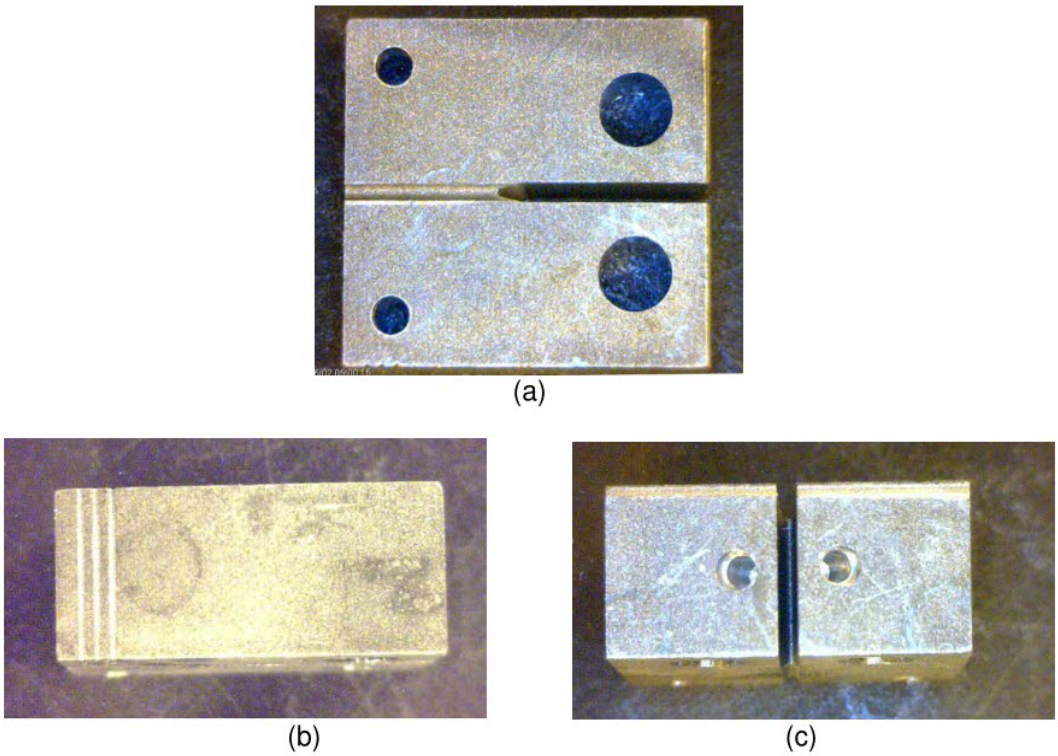
Figure 20. Crack-length-vs.-time plot of Specimen B1CT10 (a baffle plate at 40 dpa) tested in PWR water.

8.3 CGR/JR test on Specimen ACT03

The CGR/JR test on Specimen ACT03 has been initiated previously. The sample is a 1/4T-CT specimen cut from the baffle plate "A". The accumulated displacement damage in this sample is about 15-20 dpa. The specimen ID is marked with three shallow grooves based on the Studsvik's sample fabrication report (Fig. C.5 in the report). These ID markings have been verified with the optical images shown in Figure 21. On one side of the specimen, small imperfection from EDM cutting can be seen (Figure 21c). However, the area of the imperfection will not be stressed and thus will not have any effect on the test.

Table 11 shows the dimensions of the specimen provided by Studsvik. Three dimensions highlighted in yellow are out of the tolerances. None of them is critical for determining the crack

size or stress intensity factor, and thus the sample is deemed adequate for testing. The dimensions to be used in the test are summarized in Table 12.



(a) (b) (c)

Figure 21. Specimen ACT03, a 15-20-dpa CT sample cut from the baffle plate A. (a) The front view of the specimen, and (b) and (c) the ID markings on the sample.

Table 11. Sample dimensions provided by Studsvik (in mm)

Sample ID	B1	B2	B3	B4	B5	D1	D2	L1*	L3*	L6	L7	W1	W2	W3
Nominal values	7.00	7.00	0.79	3.3	3.3	3.00	3.00	12.00	5.75	2.00	2.00	6.50	0.33	0.33
Tolerances	±0.05	±0.05	±0.05	±0.05	±0.05	0.05	0.05	±0.1	±0.05	±0.05	±0.05	±0.1	±0.05	±0.05
	6.98	7.01	0.80	3.21	3.37	3.00	3.01	11.95	5.64	1.97	2.00	6.47	0.30	0.30

Table 12. Dimensions for Specimen ACT03 (in mm)

W	B	B_{net}	a_o
11.91	6.52	5.87	5.63

After the DCPD leads were attached to the sample, the specimen was loaded into the autoclave remotely with manipulators. The autoclave was then sealed, and the system was pressurized to ~1800 psig, and heated slowly to ~315°C. A small tensile load about 25 lbs was maintained on the sample during the heating. The sample was soaked in the low-DO high-purity water for 5 days to stabilize the test condition.

The cyclic CGR test was started with a triangle waveform at 0.5 Hz and a maximum stress intensity factor (K_{max}) of 14.3 MPa $m^{1/2}$. The load ratio (R) was 0.2. It appears this initial K_{max} was too low for pre-cracking, and no crack grow was observed until the K_{max} was increased to 15.5 MPa $m^{1/2}$. The first substantial crack propagation occurred in test period *i* with a R of 0.3 and a frequency of 0.5 Hz. After some 70 μm crack extension, the load ratio and rise time were gradually increased to encourage the development of environmental enhancement. These changes reduced the fatigue driving force of cracking, and the crack was eventually stalled in test period *l*.

After the crack was re-initiated in test period *m* with a R of 0.4 and a frequency of 0.25 Hz, another attempt was made to establish environmentally enhanced cracking. With the decline of cyclic amplitude (i.e., rising R), the measured CGR decreased consistently, but was always lower than the anticipated fatigue growth rate in air (see Figure 24). Only after the K_{max} was increased to about 16 MPa $m^{1/2}$, a CGR slightly below the fatigue growth rate was obtained. In the following test periods, the rise time was increased while the load ratio was held a constant. By the end of the cyclic loading test period, the measured CGR was about a factor of 4.5 higher than that of the expected fatigue growth rate in air. The test was then set to a constant K of ~16 MPa $m^{1/2}$ with a periodical partial unloading (PPU) every 2 hours. A SCC CGR of 7.3E-12 m/s was measured over 5 μm crack extension. After the PPU was removed, the CGR only decreased slightly, to 7.0E-12 m/s.

After about 190 hours, the SCC test was stopped and the sample was again cyclically loaded to increase the applied K to ~20 MPa $m^{1/2}$. A total of four cyclic loading periods were performed with a rise time ranging from 100 to 1000 sec. The environmental effect remained strong in this sample as shown in Figure 24. After a total of 50 μm crack extension, the test was transitioned to a constant K test with PPU every 2 hours. A CGR of 9.9E-12 m/s was recorded over ~100 hours. After the PPU was removed, the CGR was about the same initially but declined considerably after a temperature trip at the autoclave heater controller (Figure 23). The temperature trip did not cause any pressure drop in the system, and the autoclave temperature recovered after about 8 hours. The SCC CGR test continued and an average CGR of 4.5E-12 m/s was recorded over 200 hours. In the next reporting period, the K level will be increased again to about 25 MPa $m^{1/2}$ for another SCC CGR measurement.

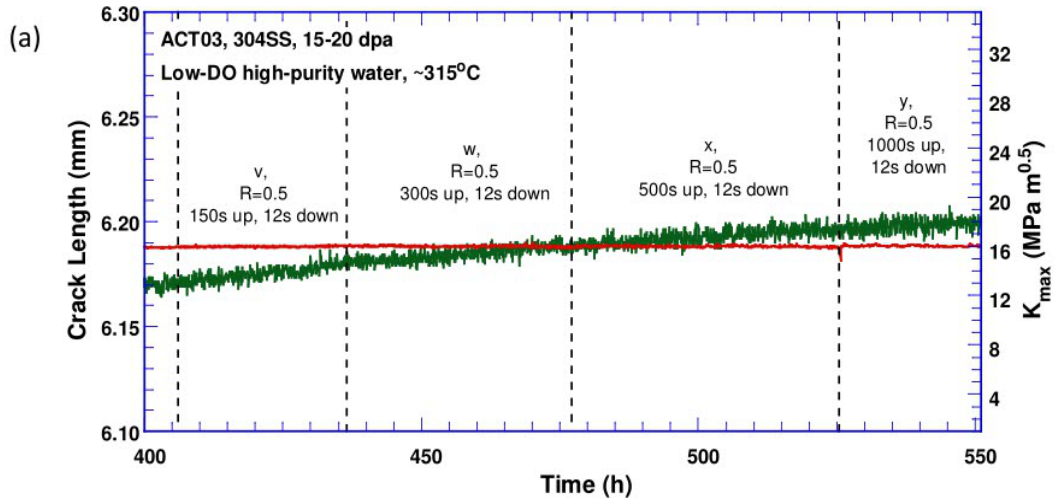
All CGR results obtained to date are summarized in Table 13. Figure 22 shows the time history plots of the test periods performed during this reporting period. The cyclic CGRs in water are also plotted against the anticipated fatigue growth rates in air in Figure 24. The SCC CGRs obtained to date are shown in Figure 25.

Table 13. Crack growth rates of Specimen ACT03 (304 SS, 15-20 dpa) in low-DO high-purity water.

Test Period	Test Time, h	Test Temp., °C	DO PPb	Cond. μS/cm	Load Ratio	Rise Time, s	Return Time, s	Hold Time, s	Kmax, MPa $m^{1/2}$	ΔK, MPa $m^{1/2}$	CGR in Env., m/s	CGR in Air, m/s	Crack Length, Mm
Start	2.0												5.630
a	6.7	314	25	0.06	0.20	0.9	0.9	0.1	14.3	11.5	1.21E-11	1.81E-08	5.633
b	21.8	314			0.20	8.6	8.6	1.4	14.4	11.6	negligible	1.84E-09	5.629
c	29.9	314			0.19	0.9	0.9	0.1	14.7	11.9	1.39E-10	2.00E-08	5.633
d	45.1	314			0.20	8.6	8.6	1.4	14.8	11.9	negligible	2.00E-09	5.631
e	55.3	314			0.30	0.9	0.9	0.1	15.2	10.6	3.20E-10	1.61E-08	5.639
f	68.7	314			0.30	4.3	4.3	0.7	15.1	10.6	negligible	3.20E-09	5.639
g	81.1	314			0.30	0.4	0.4	0.1	15.5	10.8	1.37E-09	3.40E-08	5.663
h	95.4	314			0.30	2.1	2.1	0.4	15.5	10.9	6.76E-10	6.88E-09	5.679
i	105.8	314			0.30	0.9	0.9	0.1	15.6	11.0	1.65E-09	1.76E-08	5.708

j	117.8	314			0.30	1.7	1.7	0.3	15.8	11.1	3.43E-09	9.28E-09	5.771
k[1]	126.2	314			0.30	0.8	0.8	0.2	15.8	11.1	1.45E-08	1.84E-08	5.894
l	141.4	314			0.40	4.1	4.1	0.9	15.2	9.2	3.54E-10	2.29E-09	5.911
m[1]	165.0	314	20	0.06	0.40	1.6	1.6	0.4	15.5	9.4	4.53E-09	6.08E-09	6.028
n	189.3	314			0.45	4.0	4.0	1.0	15.4	8.4	6.61E-10	1.87E-09	6.053
o	197.9	314			0.45	2.0	2.0	0.5	15.4	8.5	1.38E-09	3.76E-09	6.072
p	236.9	314			0.45	4.0	4.0	1.0	15.3	8.4	6.34E-10	1.87E-09	6.109
q	296.9	314			0.48	7.9	3.9	2.1	15.4	8.0	1.28E-10	8.06E-10	6.126
r	314.0	314	20	0.06	0.49	7.9	4.0	2.1	15.6	8.0	1.77E-10	8.28E-10	6.133
s	335.9	314			0.49	4.0	4.0	1.0	15.8	8.1	4.97E-10	1.72E-09	6.149
t	363.8	314			0.48	23.8	4.0	6.2	15.9	8.3	1.20E-10	3.02E-10	6.159
u	406.0	314			0.47	47.8	4.0	12.2	15.9	8.4	1.14E-10	1.58E-10	6.171
v	436.5	314			0.48	119.1	9.5	30.9	16.0	8.3	1.15E-10	6.09E-11	6.181
w	477.2	314			0.47	239.0	9.6	61.0	15.9	8.4	7.92E-11	3.17E-11	6.189
x	525.3	314			0.47	398.3	9.6	101.7	15.8	8.4	6.26E-11	1.91E-11	6.197
y	551.2	314			0.46	800.1	9.6	199.9	16.1	8.6	4.50E-11	1.02E-11	6.199
1	623.7	313			0.50	12	12	7200	16.1	8.1	7.32E-12	9.35E-13	6.204
2	717.0	313			1.0	-	-	-	16.1	-	7.03E-12	-	6.210
z	741.1	314			0.56	79.8	9.6	20.2	19.6	8.6	3.85E-10	1.11E-10	6.237
aa	765.9	313			0.55	200.5	9.6	49.5	19.8	8.9	1.90E-10	4.81E-11	6.251
ab	787.8	314			0.56	399.3	9.6	100.7	19.7	8.7	1.23E-10	2.29E-11	6.257
ac	813.0	314	20	0.06	0.55	802.5	9.6	197.5	19.8	8.9	1.09E-10	1.23E-11	6.266
3	917.4	314			0.58	12	12	7200	20.0	8.4	9.92E-12	1.15E-12	6.269
4	1175.8	314	20	0.06	1.0	-	-	-	20.0	-	4.50E-12	-	6.276
In progress													

[1] Crack growth rate at the later part of the test period is reported.



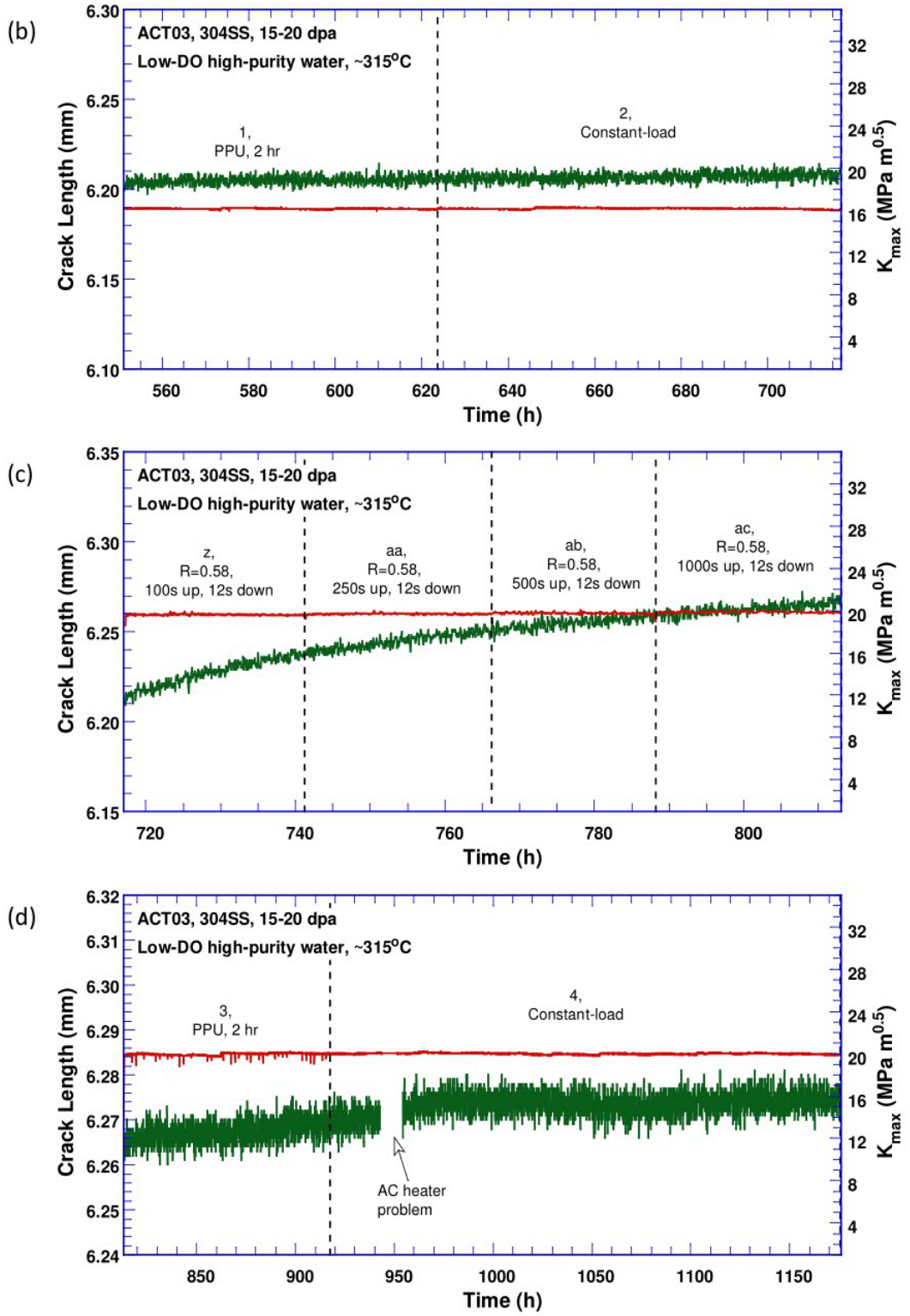


Figure 22. Crack-length-vs.-time plot of Specimen ACT03 (baffle plate A, 304 SS, 15-20 dpa) tested in low-DO high-purity water.

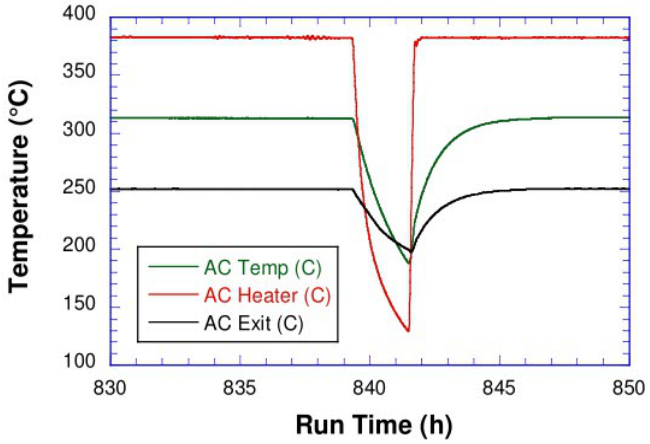


Figure 23. Temperature drops caused by the autoclave heater controller during the test on Specimen ACT03.

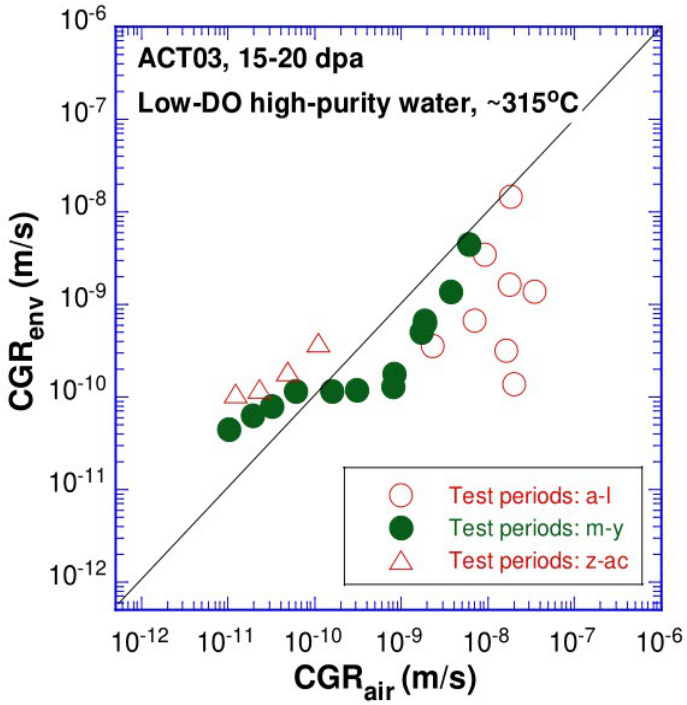


Figure 24. Cyclic CGRs of Specimen ACT03 (baffle plate A, 304 SS, 15-20 dpa) tested in low-DO high-purity water.

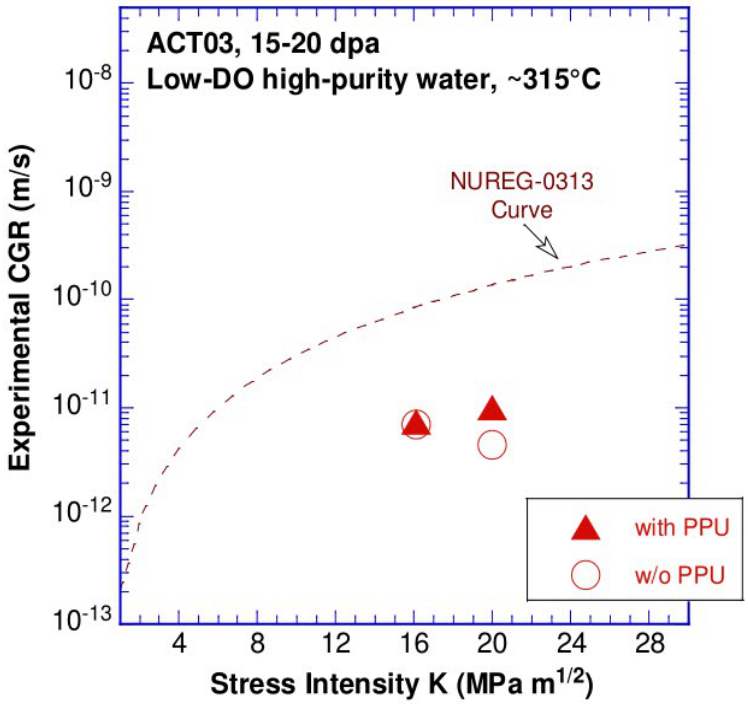


Figure 25. SCC CGRs of Specimen ACT03 (baffle plate A, 304 SS, 15-20 dpa) tested in low-DO high-purity water.

8.4 CGR/JR test on Specimen A3CT04

The CGR/JR test on Specimen A3CT04 has been initiated during this reporting period. The sample is a 1/4T-CT specimen cut from a baffle plate further away from the reactor core, A3. The estimated displacement damage for this sample is less than 1 dpa. The objective of this test is to provide a baseline for other tests conducted on higher dose samples. For this sample, the specimen ID is marked with a single shallow groove based on the Studsvik's sample fabrication report (Fig. C.10 in the report). These ID marking has been verified with optical images as shown in Figure 26.

Table 14 shows the dimensions of the specimen provided by Studsvik. Three dimensions highlighted in yellow are out of the tolerances. Two of the three out-of-range dimensions are not critical for calculating the crack size and stress intensity factor. The other one is the depth of a side groove. It appears that the two side-grooves were uneven on this sample. As a result, the crack propagation direction may be affected slightly. Nonetheless, since this is not a critical issue for testing, the sample is deemed adequate for testing. The dimensions to be used are given in Table 15.

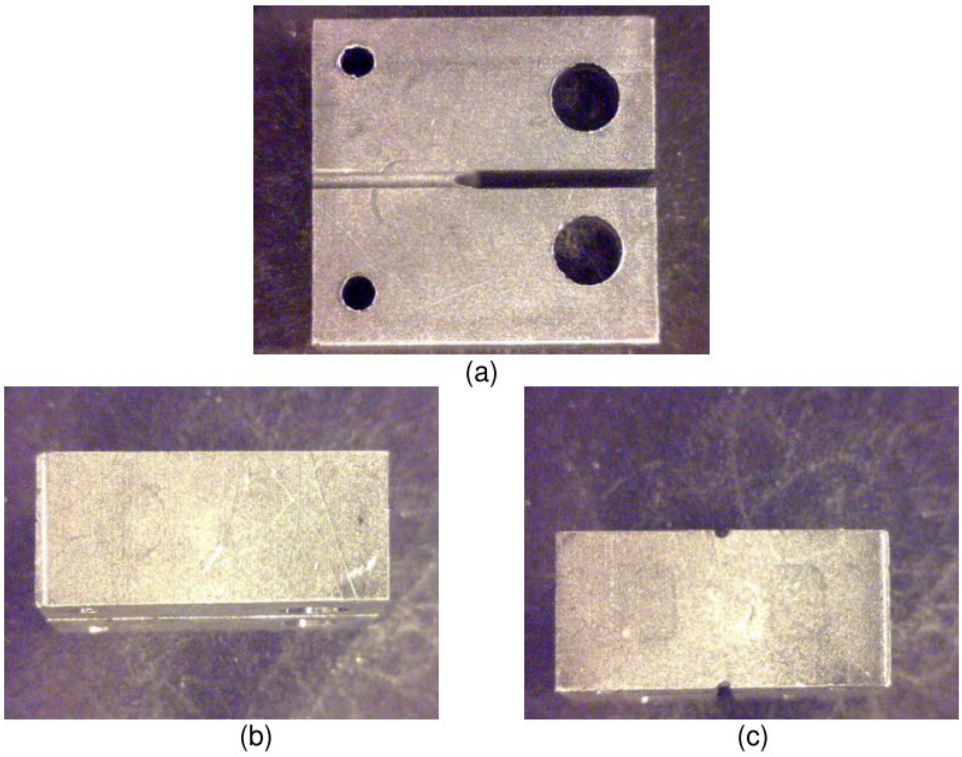


Figure 26. Specimen A3CT04, a CT sample less than 1 dpa cut from the baffle plate A3. (a) The front view of the specimen, and (b) and (c) the ID markings on the sample.

Table 14. Sample dimensions provided by Studsvik (in mm)

Sample ID	**B1**	**B2**	**B3**	**B4**	**B5**	**D1**	**D2**	**L1***	**L3***	**L6**	**L7**	**W1**	**W2**	**W3**
Nominal values	**7.00**	**7.00**	**0.79**	**3.3**	**3.3**	**3.00**	**3.00**	**12.00**	**5.75**	**2.00**	**2.00**	**6.50**	**0.33**	**0.33**
Tolerances	**±0.05**	**±0.05**	**±0.05**	**±0.05**	**±0.05**	**0.05**	**0.05**	**±0.1**	**±0.05**	**±0.05**	**±0.05**	**±0.1**	**±0.05**	**±0.05**
A3CT04	7.00	7.05	0.80	3.26	3.69	3.03	3.03	11.99	5.70	2.08	2.00	6.50	0.36	0.23

Table 15. Dimensions for Specimen A3CT04 (in mm)

W	B	B_{net}	a_o
11.99	6.50	5.91	5.70

The dose rate of the sample is low enough which allow us to attach the DCPD leads with spot weld. After the specimen was installed, the autoclave was sealed, and the system was pressurized to ~1800 psig, and heated slowly to ~315°C. A small tensile load about 25 lbs was maintained on the sample during the heating. The sample was then soaked in the PWR water to stabilize the test condition. During the soaking time, the potential reading of the sample started to drift higher, and eventually caused a huge jump in the crack length estimate. The system had to be shut down for inspection. After the autoclave was open, one of the spot welds on the potential leads was found broken, causing a false reading. After this potential lead was re-attached, the autoclave was closed and pressurized and heated again to the test conditions. Currently, the sample is being soaked it the PWR water to stabilize the test condition. The cyclic CGR test will be started in the next reporting period.

Note to requester: Attachment is immediately following.

From: Hiser, Matthew
Sent: Tue, 21 Nov 2017 15:59:16 +0000
To: Audrain, Margaret;Purtscher, Patrick;Tregoning, Robert
Subject: FW: RE: ANL Harvesting Trip
Attachments: IML materials.xlsx

Sharing this spreadsheet from Yiren at ANL (Rob wasn't on the initial email chain). It's probably a good initial stab at what ANL has available in terms of irradiated materials.

From: Chen, Yiren [mailto:yiren_chen@anl.gov]
Sent: Friday, November 17, 2017 11:12 AM
To: Hiser, Matthew <Matthew.Hiser@nrc.gov>; Audrain, Margaret <Margaret.Audrain@nrc.gov>; Purtscher, Patrick <Patrick.Purtscher@nrc.gov>
Subject: [External_Sender] RE: ANL Harvesting Trip

Meg, and Pat,
I think you can contact Ken for SG materials.
Recently, Ken and I also compiled a list of irradiated materials available at Argonne. Please see the attached excel file. I still need to improve this table to include more details about their heat treatment conditions and actual doses. Most of these samples are small TEM disks and miniature tensile samples (gauge section: 0.3x0.06x0.03"), but we do have a few 1/4T-CT samples left from previous programs. Please let me know what we can help with this effort.
Thanks,
Yiren

Untested irradiated materials at IML

Material Type	Source	Heat IDs	Heat treatment	Sample form	Dose	Number of samples	Comments	Availability of Archive material
304, 316 SSs, and 690	BOR-60	Various	SA, CW, GBE	TEM disks	5 dpa	~20	Various heats, some IDs are illegible.	Some are available
304, 316 SSs, and 690	BOR-60	Various	SA, CW, GBE	TEM disks	10 dpa	~20	Various heats, some IDs are illegible.	Some are available
304, 316 SSs, and 690	BOR-60	Various	SA, CW, GBE	TEM disks	40 dpa	~25	Various heats, some IDs are illegible.	Some are available
347, 304	BOR-60	316642CW, GBE304	SA, GBE	Small tensile	5 dpa	2		no
316Ti, CF-3	BOR-60	625, 52, 59	SA, as-cast	Small tensile	10 dpa	4		no
CF-3, CF-8	BOR-60	68, 69	as-cast	Small tensile	40 dpa	4		yes
304	Halden-I, and II	?	Sensitized at 600C	1/4T	2	1		no
304, 304L, 316 with different S or Ni contents	Halden-I, and II	various lab heat	SA, GBE	Tensile	0.5-2	15	Some tensile samples are bent.	No
CF-3, CF-8	Halden-III	68, 69, 52, 61	As cast, or aged	TEM disks	0.1	25	Exposure rate is high	Yes
CF-3, CF-8	Halden-III	68, 69, 52, 61	As cast, or aged	TEM disks	3	40	Exposure rate is high	Yes
SS weld	Halden-III	?	as weld	TEM disks	0.1	2	Exposure rate is high	Yes
SS weld	Halden-III	?	as weld	TEM disks	3	2	Exposure rate is high	Yes
304, 304L, 316	Halden-III	C10, C19, AS, CR	solution-annealed	TEM disks	0.1	15	Exposure rate is high	No
304, 304L, 316	Halden-III	C10, C19, AS, CR	solution-annealed	TEM disks	3	15	Exposure rate is high	No
CF-3, CF-8	Halden-III	68, 69, 52, 61	As cast, or aged	1/4T	0.1	4	Exposure rate is high	Yes
CF-3, CF-8	Halden-III	68, 69, 52, 61	As cast, or aged	1/4T	3	2	Exposure rate is high	Yes
SS weld	Halden-III	?	as weld	1/4T	3	1	Exposure rate is high	Yes
304, 304L, 316	Halden-III	C10, C19, AS, CR	solution-annealed	1/4T	3	4	Exposure rate is high	No
CF-3, CF-8	Halden-III	68, 69, 52, 61	As cast, or aged	small tensile	3	18	Exposure rate is high	Yes
SS weld	Halden-III	?	as weld	small tensile	3	2	Exposure rate is high	Yes
304, 304L, 316	Halden-III	C10, C19, AS, CR	solution-annealed	small tensile	3	6	Exposure rate is high	No
304, weld	Zorita	?	?	TEM	0.1-50	4		No
304, weld	Zorita	?	?	Small tensile	0.1-50	7		No
304, weld	Zorita	?	?	1/4T	0.1-52	14		No
Alloy 82+Alloy 182	V C Summer	?	?	1/2T-CT	negligible	5		No
Alloy 82+Alloy 182	V C Summer	?	?	tensile	negligible	3		No
Alloy 600+Alloy 182	Davis-Besse	?	?	1/4T, 1/2T	negligible	6		no

Note to requester: Attachment is immediately following.

From: Hiser, Matthew
Sent: Tue, 15 May 2018 13:12:13 +0000
To: Purtscher, Patrick
Cc: Audrain, Margaret
Subject: Harvested Materials Template
Attachments: IML materials_update.xlsx

Hi Pat,

This is the latest version of the harvested materials input from ANL that I have. Do you have a newer version? I'm looking for the best template to feed to Battelle for them to input their materials…

Thanks!
Matt

Untested irradiated materials at IML

Material Type	Source	Heat IDs	Heat treatment	Sample form	Dose, dpa	Number of samples	Comments	Availability of unirradiated Archive material
304, 316LN SSs, and 690	BOR-60	2333, 623, 625, C21, GBE304, GBE316, GBE690	SA, CW, GBE	TEM disks	5	~20	Some IDs are illegible.	GBE304, C21
304, 316 SSs, and 690	BOR-60	2333, 623, 625, C21, GBE304, GBE316, GBE690	SA, CW, GBE	TEM disks	10	~20	Some IDs are illegible.	GBE304, C21
304, 316 SSs, and 690	BOR-60	2333, 623, 625, C21, GBE304, GBE316, GBE690	SA, CW, GBE		20	~15	Some IDs are illegible.	GBE304, C21
304, 316 SSs, and 690	BOR-60	2333, 623, 625, C21, GBE304, GBE316, GBE690	SA, CW, GBE	TEM disks	48	~25	Some IDs are illegible.	GBE304, C21
347, 304	BOR-60	316642CW, GBE304	SA, GBE	Small tensile	5	2	-	no
316Ti, CF-3	BOR-60	625, 52, 59	SA, as-cast	Small tensile	10	4	-	no
CF-3, CF-8	BOR-60	68, 69	as-cast	Small tensile	48	4	-	yes
Sensitized 304	Halden II	10285	Sensitized at 600C	1/4T	0.75	2	-	Yes
Sensitized 304	Halden II	10285	Sensitized at 600C	1/4T	2	1	-	Yes
Lab heats of 304, 304L, 316 with different S or Ni contents	Halden-I, and II	various lab heats	SA, GBE	Tensile	0.5-2	15	Some samples are bent.	No
CF-3, CF-8	Halden-III	68, 69, 52, 61	As cast, or aged	TEM disks	0.1	25	High exposure	Yes
CF-3, CF-8	Halden-III	68, 69, 52, 61	As cast, or aged	TEM disks	3	40	High exposure	Yes
SS weld	Halden-III	Grand Gulf Baffle plate	as weld	TEM disks	0.1	1	High exposure	Yes
SS weld	Halden-III	Grand Gulf Baffle plate	as weld	TEM disks	3	1	High exposure	Yes
304, 304L, 316	Halden-III	C10, C19, AS, CR	solution-annealed	TEM disks	0.1	15	High exposure	No
304, 304L, 316	Halden-III	C10, C19, AS, CR	solution-annealed	TEM disks	3	15	High exposure	No
CF-3, CF-8	Halden-III	68, 69, 52, 61	As cast, or aged	1/4T	0.1	4	High exposure	Yes
CF-3, CF-8	Halden-III	68, 69, 52, 61	As cast, or aged	1/4T	3	2	High exposure	Yes
SS weld	Halden-III	Grand Gulf Baffle plate	as weld	1/4T	3	1	High exposure	Yes
304, 304L, 316	Halden-III	C10, C19, AS, CR	solution-annealed	1/4T	3	4	High exposure	No
CF-3, CF-8	Halden-III	68, 69, 52, 61	As cast, or aged	small tensile	3	18	High exposure	Yes
SS weld	Halden-III	Grand Gulf Baffle plate	as weld	small tensile	3	2	High exposure	Yes
304, 304L, 316	Halden-III	C10, C19, AS, CR	solution-annealed	small tensile	3	6	High exposure	No

304, weld	Zorita	Zorita Baffle plate	?	TEM	0.1-50	4	High exposure	No
304, weld	Zorita	Zorita Baffle plate	?	Small tensile	0.1-50	7	High exposure	No
304, weld	Zorita	Zorita Baffle plate	?	1/4T	0.1-52	14	High exposure	No
Alloy 82+Alloy 182	V C Summer	hotleg nozzle-to-pipe weld	?	1/2T-CT	negligible	5	No dose	No
Alloy 82+Alloy 182	V C Summer	hotleg nozzle-to-pipe weld	?	tensile	negligible	3	No dose	No
Alloy 600+Alloy 182	Davis-Besse	CRDM nozzole #3	?	1/4T, 1/2T	negligible	6	No dose	No

RPV materials acquired from previous NRC programs

Material Type	Source	Heat IDs / location	Heat treatment	Current storage
A533-Gr. B low-alloy steel	Midland	Lower head	?	?
A212 Gr. B steel	Shipping Port	Neutron Shield tank	?	?

CASS and SS weld acquired from NRC programs

Material Type	Source	Heat IDs / location	Heat treatment	Sample form
CF-3	ESCO Foundry	51, 52, 69	As cast, or aged	1T blocks or Charpy samples
CF-8	ESCO Foundry	59, 61, 68	As cast, or aged	1T blocks or Charpy samples
CF-8M	ESCO Foundry	73, 75	As cast, or aged	1T blocks or Charpy samples
CF-8	KRB	Reactor pump cover plate	Aged	?
Stainless Steel weld	Grand Gulf	Baffle plate	?	Plate 1" thick

Note to requester: Attachment is immediately following.

From: Purtscher, Patrick
Sent: Wed, 10 Jan 2018 16:31:49 +0000
To: Tregoning, Robert;Hiser, Matthew;Audrain, Margaret
Subject: FW: Re: follow up on harvesting
Attachments: IML materials_update.xlsx

FYI from December meeting at ANL.

Pat

From: Natesan, Krishnamurti [mailto:natesan@anl.gov]
Sent: Wednesday, January 10, 2018 10:41 AM
To: Purtscher, Patrick <Patrick.Purtscher@nrc.gov>
Subject: [External_Sender] Re: follow up on harvesting

Thanks. I am attaching the spreadsheet on inventory of irradiated materials.

Ken

Untested irradiated materials at IML

Material Type	Source	Heat IDs	Heat treatment	Sample form	Dose, dpa	Number of samples	Comments	Availability of unirradiated Archive material
304, 316LN SSs, and 690	BOR-60	2333, 623, 625, C21, GBE304, GBE316, GBE690	SA, CW, GBE	TEM disks	5	~20	Some IDs are illegible.	GBE304, C21
304, 316 SSs, and 690	BOR-60	2333, 623, 625, C21, GBE304, GBE316, GBE690	SA, CW, GBE	TEM disks	10	~20	Some IDs are illegible.	GBE304, C21
304, 316 SSs, and 690	BOR-60	2333, 623, 625, C21, GBE304, GBE316, GBE690	SA, CW, GBE		20	~15	Some IDs are illegible.	GBE304, C21
304, 316 SSs, and 690	BOR-60	2333, 623, 625, C21, GBE304, GBE316, GBE690	SA, CW, GBE	TEM disks	48	~25	Some IDs are illegible.	GBE304, C21
347, 304	BOR-60	316642CW, GBE304	SA, GBE	Small tensile	5	2	-	no
316Ti, CF-3	BOR-60	625, 52, 59	SA, as-cast	Small tensile	10	4	-	no
CF-3, CF-8	BOR-60	68, 69	as-cast	Small tensile	48	4	-	yes
Sensitized 304	Halden II	10285	Sensitized at 600C	1/4T	0.75	2	-	Yes
Sensitized 304	Halden II	10285	Sensitized at 600C	1/4T	2	1	-	Yes
Lab heats of 304, 304L, 316 with different S or Ni contents	Halden-I, and II	various lab heats	SA, GBE	Tensile	0.5-2	15	Some samples are bent.	No
CF-3, CF-8	Halden-III	68, 69, 52, 61	As cast, or aged	TEM disks	0.1	25	High exposure	Yes
CF-3, CF-8	Halden-III	68, 69, 52, 61	As cast, or aged	TEM disks	3	40	High exposure	Yes
SS weld	Halden-III	Grand Gulf Baffle plate	as weld	TEM disks	0.1	1	High exposure	Yes
SS weld	Halden-III	Grand Gulf Baffle plate	as weld	TEM disks	3	1	High exposure	Yes
304, 304L, 316	Halden-III	C10, C19, AS, CR	solution-annealed	TEM disks	0.1	15	High exposure	No
304, 304L, 316	Halden-III	C10, C19, AS, CR	solution-annealed	TEM disks	3	15	High exposure	No
CF-3, CF-8	Halden-III	68, 69, 52, 61	As cast, or aged	1/4T	0.1	4	High exposure	Yes
CF-3, CF-8	Halden-III	68, 69, 52, 61	As cast, or aged	1/4T	3	2	High exposure	Yes
SS weld	Halden-III	Grand Gulf Baffle plate	as weld	1/4T	3	1	High exposure	Yes
304, 304L, 316	Halden-III	C10, C19, AS, CR	solution-annealed	1/4T	3	4	High exposure	No
CF-3, CF-8	Halden-III	68, 69, 52, 61	As cast, or aged	small tensile	3	18	High exposure	Yes
SS weld	Halden-III	Grand Gulf Baffle plate	as weld	small tensile	3	2	High exposure	Yes
304, 304L, 316	Halden-III	C10, C19, AS, CR	solution-annealed	small tensile	3	6	High exposure	No

304, weld	Zorita	Zorita Baffle plate	?	TEM	0.1-50	4	High exposure	No
304, weld	Zorita	Zorita Baffle plate	?	Small tensile	0.1-50	7	High exposure	No
304, weld	Zorita	Zorita Baffle plate	?	1/4T	0.1-52	14	High exposure	No
Alloy 82+Alloy 182	V C Summer	hotleg nozzle-to-pipe weld	?	1/2T-CT	negligible	5	No dose	No
Alloy 82+Alloy 182	V C Summer	hotleg nozzle-to-pipe weld	?	tensile	negligible	3	No dose	No
Alloy 600+Alloy 182	Davis-Besse	CRDM nozzole #3	?	1/4T, 1/2T	negligible	6	No dose	No

RPV materials acquired from previous NRC programs

Material Type	Source	Heat IDs / location	Heat treatment	Current storage
A533-Gr. B low-alloy steel	Midland	Lower head	?	?
A212 Gr. B steel	Shipping Port	Neutron Shield tank	?	?

CASS and SS weld acquired from NRC programs

Material Type	Source	Heat IDs / location	Heat treatment	Sample form
CF-3	ESCO Foundry	51, 52, 69	As cast, or aged	1T blocks or Charpy samples
CF-8	ESCO Foundry	59, 61, 68	As cast, or aged	1T blocks or Charpy samples
CF-8M	ESCO Foundry	73, 75	As cast, or aged	1T blocks or Charpy samples
CF-8	KRB	Reactor pump cover plate	Aged	?
Stainless Steel weld	Grand Gulf	Baffle plate	?	Plate 1" thick

Note to requester: The box containing the X is the Outlook email attachment, which is immediately following.

From: Hiser, Matthew
Sent: Thu, 12 Jul 2018 19:37:00 +0000
To: Miller, Kenneth A
Subject: FW: Harvesting Prioritization
Attachments: RE: Materials Harvesting

Hi Kenn,

I reached out to Tom Koshy to meet earlier this week regarding harvesting of electrical components following our meeting back in May (summary email attached). Tom indicated he's on rotation, but I should reach out to you (below). Have you guys been able to make any progress on prioritizing harvesting needs for electrical components?

Thanks!
Matt

Matthew Hiser
Materials Engineer
US Nuclear Regulatory Commission | Office of Nuclear Regulatory Research
Division of Engineering | Corrosion and Metallurgy Branch
Phone: 301-415-2454 | Office: TWFN 10D62
Matthew.Hiser@nrc.gov

-----Original Appointment-----
From: Koshy, Thomas
Sent: Monday, July 09, 2018 12:51 PM
To: Hiser, Matthew
Subject: Declined: Harvesting Prioritization
When: Monday, July 09, 2018 3:00 PM-3:30 PM (UTC-05:00) Eastern Time (US & Canada).
Where: HQ-TWFN-10A73-8p

I am on rotation to NRR
Get Kenn Miller to participate

Note to requester: This email is the attachment from the previous page. All the attachments to this email are immediately following.

From: Hiser, Matthew
Sent: Wed, 16 May 2018 14:35:54 +0000
To: Purtscher, Patrick;Tregoning, Robert;Audrain, Margaret;Sircar, Madhumita;Pires, Jose;Koshy, Thomas;Murdock, Darrell;Philip, Jacob
Cc: Miller, Kenneth A;Christensen, Jason
Subject: RE: Materials Harvesting
Attachments: Harvesting Needs Prioritization 5-16-18.xlsx, IML materials_update.xlsx, NRC Technical Data Needs for Harvesting.pptx

Thanks everyone for attending the meeting this morning. I appreciate the update on activities for electrical and concrete and have attached the documents that were printed out this morning.

Action Items for Metals, Concrete, and Electrical
1. Use prioritization criteria to prioritize data needs for harvesting in each area.
2. Catalog any previously harvested materials that may be available at labs.
3. Identify relevant information from license renewal documents for decommissioning plants

Thanks!
Matt

-----Original Appointment-----
From: Hiser, Matthew
Sent: Monday, May 07, 2018 3:56 PM
To: Hiser, Matthew; Purtscher, Patrick; Tregoning, Robert; Audrain, Margaret; Sircar, Madhumita; Pires, Jose; Koshy, Thomas; Murdock, Darrell; Philip, Jacob
Cc: Miller, Kenneth A; Christensen, Jason
Subject: Materials Harvesting
When: Wednesday, May 16, 2018 9:00 AM-10:00 AM (UTC-05:00) Eastern Time (US & Canada).
Where: T10D40

Rescheduling for hopefully a better time for everyone.

We'd like to meet with electrical and concrete research staff to discuss the latest status of the materials harvesting activities under Task 2 of UNR NRR-2017-006.

The four topics we'd like to update you on / discuss in this meeting are:

1. CMB staff development of prioritization criteria for harvesting needs and lessons learned from exercising them for metals
2. CMB staff effort to development inventory of previously harvested materials already available at lab facilities
3. Latest status of harvesting plans for electrical and concrete components
4. Pulling relevant information from license renewal documents for decommissioning plants

Criteria Title	Description	Scoring Guidance	
Criticalness of Technical Gap Addressed	Harvesting to address critical gaps should be prioritized over less essential technical gaps	**H = high risk significance / little to no available data** **MH = Medium-high risk significance / limited data available** **M = Moderate risk significance / some data available** **ML = low to moderate risk signficance / sufficient data available for regulatory decisions** **L = Low risk significance / large amount of data available**	**H = High** **MH = Medium-high** **M = Medium** **ML = Medium-low** **L = Low**
Importance of Harvested Materials over Laboratory Aging	Key considerations are the ease of laboratory replication of aging mechanism and unique field aspects of the aging mechanism. Degradation mechanisms that are harder to replicate with simulated aging conditions would be of higher priority for harvesting. For example, simultaneous thermal and irradiation conditions are difficult to replicate outside of the plant environment. Alternatively, accelerated aging may not be feasible for a mechanism sensitive to dose rate. These two degradation mechanisms may be best evaluated using harvested materials. For unique field aspects, legacy materials (e.g., fabrication methods, composition) that are no longer available, but may play an important role in a potential degradation mechanism, would have a higher priority than harvesting materials that can be obtained from other sources with representative properties.	**H = Nearly impossible to replicate service enviroment / critically important to use harvested materials** **MH = Challenging to replicate service enviroment / important to use harvested materials** **M = Possible with some limitations to replicate service enviroment / moderately important to use harvested materials** **ML = Not challenging to replicate service enviroment / less important to use harvested materials** **L = Very easy to replicate service enviroment / not important to use harvested materials**	
Applicability to US Operating Fleet	There is greater value in developing knowledge to address an issue that may be applicable to a larger number of plants compared to one that may only affect a relatively small number of plants.	**H = All plants** **MH = All PWRs** **M = All BWRs or most PWRs** **ML = ~10-15 plants** **L = <5 plants**	
Regulatory Considerations Related to Inspections and AMPs	If mature inspection methods exist and are easy to apply to monitor degradation, harvesting may be less valuable. If inspection methods do not exist, harvesting may be essential to ensure confidence in the assessment of age-related degradation in that particular component.The less confidence that NRC staff has in the effectiveness of the relevant AMP, the higher priority for harvesting.	**H = No or very limited inspection methods available / low confidence in AMPs** **MH = Limited inspection methods available / low-to-moderate confidence in AMPs** **M = Some inspection methods available / moderate confidence in AMPs** **ML = Good inspection methods available / medium-high confidence in AMPs** **L = Effective, well-accepted inspection methods exist / high confidence in AMPs**	
Harvesting cost and complexity	Activities with higher costs and complexity are less attractive than similar activities with lower costs and that are simpler to execute.. For example, harvesting unirradiated concrete or electrical cables is less expensive and less complex than harvesting from the RPV internals or the RPV.	**H = Highly irradiated (>5 dpa)** **MH = Lightly irradiated / contaminated** **M = Minimal contamination or high effort unirradiated** **ML = Unirradiated, moderate effort expected** **L = Unirradiated, low effort expected**	
Timeliness of results	The ability of a potential harvesting program to provide timely results to support either a technical or regulatory need is important. Having high confidence that results will be timely increases the priority.		
Availability of materials for harvesting	The availability of materials to harvest for a particular data need is clearly essential and increases the priority.		

	Basic Info		Technical Criteria										Cost / Complexity		Project Specific	
Need Description	Purpose / Testing Planned	Technical Knowledge Gained	Criticalness of Technical Gap Addressed		Importance of Harvested Materials over Laboratory Aging		Applicability to US Operating Fleet		Regulatory Considerations Related to Inspections and AMPs		Score Average	Basis for Priority			Timeliness of results	Availability of materials for harvesting
METALS			Score	Comment	Score	Comment	Score	Comment	Score	Comment			Score	Comment		
High fluence reactor internals	Void swelling, mechanical properties, IASCC	Likely extent of void swelling in PWRs during extended operation and impact on cracking													TBD	TBD
Thermally aged unirradiated CASS	Fracture toughness and microstructure	Fracture toughness data in real conditions to compare to accelerated aging data														
Moderate fluence (1-2 dpa) CASS	Fracture toughness and microstructure	Fracture toughness data near limit requiring further evaluation														
Metallic components with known flaws	NDE and destructive examination	Determine whether SCC mitigation methods are effective at preventing SCC; effectiveness of NDE at detection and sizing														
Metallic components with limiting fatigue life	NDE and destructive examination	Determine whether fatigue flaws are present in high usage locations														

	Basic Info		Technical Criteria										Cost / Complexity		Project Specific	
Need Description	Purpose / Testing Planned	Technical Knowledge Gained	Criticalness of Technical Gap Addressed		Importance of Harvested Materials over Laboratory Aging		Applicability to US Operating Fleet		Regulatory Considerations Related to Inspections and AMPs		Score Average	Basis for Priority			Timeliness of results	Availability of materials for harvesting
METALS			Score	Comment	Score	Comment	Score	Comment	Score	Comment			Score	Comment		
High fluence reactor internals															TBD	TBD
Thermally aged unirradiated CASS																
Moderate fluence (1-2 dpa) CASS																
Metallic components with known flaws																
Metallic components with limiting fatigue life																

	Basic Info		Technical Criteria										Cost / Complexity		Project Specific	
Need Description	Purpose / Testing Planned	Technical Knowledge Gained	Criticalness of Technical Gap Addressed		Importance of Harvested Materials over Laboratory Aging		Applicability to US Operating Fleet		Regulatory Considerations Related to Inspections and AMPs		Score Average	Basis for Priority			Timeliness of results	Availability of materials for harvesting
METALS			Score	Comment	Score	Comment	Score	Comment	Score	Comment			Score	Comment		
High fluence reactor internals															TBD	TBD
Thermally aged unirradiated CASS																
Moderate fluence (1-2 dpa) CASS																
Metallic components with known flaws																
Metallic components with limiting fatigue life																

Untested irradiated materials at IML

Material Type	Source	Heat IDs	Heat treatment	Sample form	Dose, dpa	Number of samples	Comments	Availability of unirradiated Archive material
304, 316LN SSs, and 690	BOR-60	2333, 623, 625, C21, GBE304, GBE316, GBE690	SA, CW, GBE	TEM disks	5	~20	Some IDs are illegible.	GBE304, C21
304, 316 SSs, and 690	BOR-60	2333, 623, 625, C21, GBE304, GBE316, GBE690	SA, CW, GBE	TEM disks	10	~20	Some IDs are illegible.	GBE304, C21
304, 316 SSs, and 690	BOR-60	2333, 623, 625, C21, GBE304, GBE316, GBE690	SA, CW, GBE		20	~15	Some IDs are illegible.	GBE304, C21
304, 316 SSs, and 690	BOR-60	2333, 623, 625, C21, GBE304, GBE316, GBE690	SA, CW, GBE	TEM disks	48	~25	Some IDs are illegible.	GBE304, C21
347, 304	BOR-60	316642CW, GBE304	SA, GBE	Small tensile	5	2	-	no
316Ti, CF-3	BOR-60	625, 52, 59	SA, as-cast	Small tensile	10	4	-	no
CF-3, CF-8	BOR-60	68, 69	as-cast	Small tensile	48	4	-	yes
Sensitized 304	Halden II	10285	Sensitized at 600C	1/4T	0.75	2	-	Yes
Sensitized 304	Halden II	10285	Sensitized at 600C	1/4T	2	1	-	Yes
Lab heats of 304, 304L, 316 with different S or Ni contents	Halden-I, and II	various lab heats	SA, GBE	Tensile	0.5-2	15	Some samples are bent.	No
CF-3, CF-8	Halden-III	68, 69, 52, 61	As cast, or aged	TEM disks	0.1	25	High exposure	Yes
CF-3, CF-8	Halden-III	68, 69, 52, 61	As cast, or aged	TEM disks	3	40	High exposure	Yes
SS weld	Halden-III	Grand Gulf Baffle plate	as weld	TEM disks	0.1	1	High exposure	Yes
SS weld	Halden-III	Grand Gulf Baffle plate	as weld	TEM disks	3	1	High exposure	Yes
304, 304L, 316	Halden-III	C10, C19, AS, CR	solution-annealed	TEM disks	0.1	15	High exposure	No
304, 304L, 316	Halden-III	C10, C19, AS, CR	solution-annealed	TEM disks	3	15	High exposure	No
CF-3, CF-8	Halden-III	68, 69, 52, 61	As cast, or aged	1/4T	0.1	4	High exposure	Yes
CF-3, CF-8	Halden-III	68, 69, 52, 61	As cast, or aged	1/4T	3	2	High exposure	Yes
SS weld	Halden-III	Grand Gulf Baffle plate	as weld	1/4T	3	1	High exposure	Yes
304, 304L, 316	Halden-III	C10, C19, AS, CR	solution-annealed	1/4T	3	4	High exposure	No
CF-3, CF-8	Halden-III	68, 69, 52, 61	As cast, or aged	small tensile	3	18	High exposure	Yes
SS weld	Halden-III	Grand Gulf Baffle plate	as weld	small tensile	3	2	High exposure	Yes
304, 304L, 316	Halden-III	C10, C19, AS, CR	solution-annealed	small tensile	3	6	High exposure	No

304, weld	Zorita	Zorita Baffle plate	?	TEM	0.1-50	4	High exposure	No
304, weld	Zorita	Zorita Baffle plate	?	Small tensile	0.1-50	7	High exposure	No
304, weld	Zorita	Zorita Baffle plate	?	1/4T	0.1-52	14	High exposure	No
Alloy 82+Alloy 182	V C Summer	hotleg nozzle-to-pipe weld	?	1/2T-CT	negligible	5	No dose	No
Alloy 82+Alloy 182	V C Summer	hotleg nozzle-to-pipe weld	?	tensile	negligible	3	No dose	No
Alloy 600+Alloy 182	Davis-Besse	CRDM nozzole #3	?	1/4T, 1/2T	negligible	6	No dose	No

RPV materials acquired from previous NRC programs

Material Type	Source	Heat IDs / location	Heat treatment	Current storage
A533-Gr. B low-alloy steel	Midland	Lower head	?	?
A212 Gr. B steel	Shipping Port	Neutron Shield tank	?	?

CASS and SS weld acquired from NRC programs

Material Type	Source	Heat IDs / location	Heat treatment	Sample form
CF-3	ESCO Foundry	51, 52, 69	As cast, or aged	1T blocks or Charpy samples
CF-8	ESCO Foundry	59, 61, 68	As cast, or aged	1T blocks or Charpy samples
CF-8M	ESCO Foundry	73, 75	As cast, or aged	1T blocks or Charpy samples
CF-8	KRB	Reactor pump cover plate	Aged	?
Stainless Steel weld	Grand Gulf	Baffle plate	?	Plate 1" thick

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

NRC High-Priority Data Needs for Harvesting

NRC Staff

March 7, 2017

Metals

- RPV
  - High fluence & high shift vessel with well-established unirradiated properties (or a means to estimate them)
    - Through thickness section to validate fluence & attenuation models
    - Measure fluence, toughness, & chemistry as a function of through-thickness position
  - Samples from virtually any vessel
    - Of sufficient size to enable measurement of both the Charpy transition curve and master curve transition temperature T_0
    - This testing
      - Enables demonstration of the conservatism of regulatory approaches for transition temperature prediction
      - Provides data supporting evolution from the use of correlative (Charpy-based) to direct measurement (fracture toughness-based) approaches

Metals

- CASS and Internals
  - High fluence reactor internals
    - >50 dpa 304 SS from high core outlet temp plant
    - Bounding temperature and high fluence for void swelling
  - Thermally aged unirradiated CASS
    - >30 years at ~320°C; Validate accelerated aging data
  - Moderate fluence (1-2 dpa) CASS
    - Bolster technical basis for embrittlement in this fluence range
- Components with known flaws
  - Example: weld overlays over known flaws
    - NDE evaluations or to assess effectiveness of mitigation techniques
- Components with limiting fatigue life
  - Confirm fatigue calculations are accurate by inspecting for flaws

Electrical

- Cables
  - Low and medium voltage cables
  - Cables protected with fire retardant coating
- Electrical components
  - 1E MOVs from harsh and mild environments
  - 1E Air operated valves; 4160 1E breakers
  - 1E Molded case breakers 480V, 250V DC, 125 VDC,
  - 1E Relays from mild environment GE – HFA, Agastat timing relays, any from Westinghouse, Potter Brumfield, Stuthers Dunn etc.,
  - Electrical penetrations; Batteries
- Fire research interest
  - Electrical enclosures
    - Distribution : switchgear, MCCs, LCs | Control : Horseshoe, SSCP, ASP, etc.

Concrete

- Structures exposed to high radiation
- Post-tensioned structures
- Corrosion of reinforcing steel, tendon, liner, embedment
- Spent fuel pool and transfer canal-boric acid attack on concrete in PWRs
- Alkali Aggregate Reaction
- Large structural sections for testing

Note to requester: Attachment is immediately following.

From: Frankl, Istvan
Sent: Thu, 20 Apr 2017 13:26:44 -0400
To: Hiser, Matthew
Cc: Moyer, Carol;Tregoning, Robert
Subject: ACTION: Update - Check and Adjust: EPRI Working Agenda for June 5 and 6 (Comments due April 21)
Attachments: EPRI - NRC June 5 and 6 2017 meeting agenda - R1.docx
Importance: High

Matt,

Brian requested input for the upcoming rescheduled EPRI – NRC management meeting. The attached draft agenda already has harvesting under LTO Beyond 60 Years as one of the topics that Brian will present. Should we have a separate IAD topic on RVIs or should regulatory research on IAD be folded in sub-topic on Research priorities for 2017/2018?

There is also a main topic on Strategic Areas and Areas for Future Collaboration in the agenda. Should we propose sub-topic on collaboration for further irradiation of internals, etc.?

Please reply ASAP. (Our acting TA requested BC input by COB today.)

Carol,

Please coordinate the CMB inputs supporting subject meeting as soon as you are back from official travel.

Thanks,

Steve

From: Martinez Rodriguez, Erick
Sent: Thursday, April 20, 2017 12:26 PM
To: Jung, Ian <Ian.Jung@nrc.gov>; Seber, Dogan <Dogan.Seber@nrc.gov>; Iyengar, Raj <Raj.Iyengar@nrc.gov>; Frankl, Istvan <Istvan.Frankl@nrc.gov>; Boyce, Tom <Tom.Boyce@nrc.gov>
Subject: RE: Update - Check and Adjust: EPRI Working Agenda for June 5 and 6 (Comments due April 21)

BCs,

Just a follow-up for comments on the EPRI agenda. Brian mentioned earlier this week (on Monday) of the action to review and provide comments on the EPRI agenda (attached).

Please let me know if you have comments by COB today. I will put them together and share them with Brian tomorrow (feel free to coordinate with him, that way he is already aware of any changes) before sending them to the FO.

Thanks.

From: Difrancesco, Nicholas
Sent: Tuesday, April 11, 2017 2:42 PM
To: Aird, David <David.Aird@nrc.gov>; Martinez Rodriguez, Erick <Erick.MartinezRodriguez@nrc.gov>; Algama, Don <Don.Algama@nrc.gov>; Bales, Michelle <Michelle.Bales@nrc.gov>; Armstrong, Kenneth <Kenneth.Armstrong@nrc.gov>
Cc: Weber, Michael <Michael.Weber@nrc.gov>; Boland, Anne <Anne.Boland@nrc.gov>; Nakoski, John <John.Nakoski@nrc.gov>; Thomas, Brian <Brian.Thomas@nrc.gov>; Cheok, Michael <Michael.Cheok@nrc.gov>; Case, Michael <Michael.Case@nrc.gov>; Thaggard, Mark <Mark.Thaggard@nrc.gov>; Webber, Kimberly <Kimberly.Webber@nrc.gov>
Subject: Update - Check and Adjust: EPRI Working Agenda for June 5 and 6 (Comments due April 18)

Folks,

Attached are EPRI proposed changes to the agenda for June 5 and 6. Please provide comments against EPRI's Rev 1.

As noted below, EPRI has made changes to support a more strategic discussion on efficiencies.

Appreciate division comments by COB April ~~18~~21.

Many thanks,
Nick

From: Canavan, Ken [mailto:kcanavan@epri.com]
Sent: Tuesday, April 11, 2017 11:27 AM
To: Difrancesco, Nicholas <Nicholas.DiFrancesco@nrc.gov>
Subject: [External_Sender] RE: RE: Checking-in: Updated Agenda and Planning Timeline for June 5 and 6

Nick:

I have solicited input from the EPRI senior leadership team. Attached is a some suggested revisions and thoughts for the agenda. We would like the agenda and meeting to become more strategic and less focus on status of what we are currently doing. Of particular interest from the EPRI side is how do we become more efficient in R&D space. Can we do more than cooperate or collaborate? Perhaps some integration on key research. In some cases are we doing too much or seeking too much precision on an activity that does not require or warrant it. Let me know your thoughts and we can have another iteration. Thanks!

Ken Canavan
Director, Plant Technology

Electric Power Research Institute
1300 West WT Harris Blvd | Charlotte NC 28262-2867
Office No.: 704-595-2731 | Mobile: [redacted] (b)(6)
Assistant: Morgan Saucier, msaucier@epr.com, 704-595-2466

From: Difrancesco, Nicholas
Sent: Wednesday, April 05, 2017 4:32 PM
To: Herrity, Thomas <Thomas.Herrity@nrc.gov>; Berrios, Ilka <Ilka.Berrios@nrc.gov>; Armstrong, Kenneth <Kenneth.Armstrong@nrc.gov>
Cc: Weber, Michael <Michael.Weber@nrc.gov>; Boland, Anne <Anne.Boland@nrc.gov>; Bales, Michelle <Michelle.Bales@nrc.gov>; Martinez Rodriguez, Erick <Erick.MartinezRodriguez@nrc.gov>; Algama, Don <Don.Algama@nrc.gov>; Aird, David <David.Aird@nrc.gov>; Nakoski, John <John.Nakoski@nrc.gov>; Thomas, Brian <Brian.Thomas@nrc.gov>; Cheok, Michael <Michael.Cheok@nrc.gov>; Case, Michael <Michael.Case@nrc.gov>; Thaggard, Mark <Mark.Thaggard@nrc.gov>; Webber, Kimberly <Kimberly.Webber@nrc.gov>
Subject: Check and Adjust: EPRI Working Agenda for June 5 and 6

Folks,

Please take a look at the draft EPRI / NRC agenda for June 5 and 6 and let me know if you would like to make any adjustments. EPRI is performing a similar review of the agenda in parallel.

Appreciate comments by COB April 18. After alignment with EPRI on the agenda, please plan for development of talking bullets by May 5.

Thanks,

Nick

Technical Assistant
Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission
301-415-1115

Agenda

NRC/EPRI Annual Meeting

June 5 - 6, 2017 – Charlotte, NC

NRC Travel Morning of June 5

EPRI Tours Wednesday June 5

~~?~~2:00~~?~~ p.m.	**Laboratory Tour** - I&C and Cyber Laboratory - Concrete degradation Laboratory - Welding Laboratory - NDE Laboratory - Performance Demonstration Initiative	All
5:00 p.m.	Adjourn	

EPRI / NRC Discussions Tuesday June 6

8:00 a.m.	**Welcome and Introduction** • Partnership Progress over the last year • EPRI Strategic Research Priorities • NRC Research Priorities	Neil Wilmshurst Mike Weber
THEME: A Strategic View of Nuclear R&D with a Focus on Efficiency The desire for increased efficiency of nuclear R&D stakeholders results in the need to be both strategic as well as investigate opportunities for simplification and elimination of overlap. Are there research areas that could be simplified or eliminate to improve overall efficiency? Areas could include computer codes with similar missions, confirmatory R&D, and others. Are there an opportunities to perform more integrated R&D in a few key areas where resources the result could be increased efficiency?		
~~9~~8:~~0~~30 a.m.	**Enhanced Advanced Technology Fuel** • Status of Industry and NRC Activities • Research priorities for 2017/2018	EPRI: ~~[Randy Stark]~~Al Cantos NRC: Michael Case
9:~~3~~00 a.m.	**Long Term Operation (LTO) Beyond 60 Years** • Progress and Readiness – what remains before submittal of lead SLR application • Co-sponsorship of public workshop on SLR technical topics and publicly-available documentation on research progress • Technical reports on Continued Adequacy of RG 1.99 • Highlights of harvesting workshop • Research priorities for 2017/2018	EPRI: ~~[~~Kurt Edsinger~~]~~ NRC: Brian Thomas

10:00 a.m.	**Break**	
10:15 a.m.	**Fire Analysis** • Future focus of fire PRA activities • Future focus of fire testing	EPRI: [Ken Canavan] NRC: Mike Cheok
10:45 a.m.	**Advanced Reactor Safety Research** • IAP[1] Status • Codes for non-LWRs	EPRI: [Kurt Edsinger] NRC: Michael Case
11:15 a.m.	**xLPR and leak-before break (LBB) analyses**	EPRI: [Kurt Edsinger] NRC: Brian Thomas
11:45 a.m.	**Lunch**	
1:00 p.m.	**Risk-Informed Tools and Models** • Level 3 PRA Progress and Completion • Probabilistic Approach to Flooding • External Hazards (i.e. non-seismic or flood) • Future focus of Seismic PRA Modeling • Human Reliability Analysis • Common-Cause Failure • Uncertainty in risk informed decision making • Aggregation of PRA results • Advanced PRA methods, models, and tools	EPRI: [Ken Canavan] NRC: Mike Cheok
2:00 p.m.	Digital Instrumentation & Control Collaboration • Progress during previous year • Priorities for 2017/2018	EPRI: ~~tbd~~Ken Canavan / Rob Austin NRC: Brian Thomas
2:45 p.m.	**Break**	
3:00 p.m.	**Strategic Areas and ~~Areas for~~ Future Collaboration** • Radiation protection ~~Research needs~~ • Ground Water Remediation • • Sensor and Robotics Technologies • EPRI O&M Reduction / DNP Activities	EPRI: NRC: Michael Case, Mike Cheok

Commented [CK1]: Perhaps we could focus on how we plan to work together or the top 3 items (besides fire) that we should engage together.

[1] Implementation Action Plans

	• Emerging Technologies ○ Advanced Manufacturing ○ Gen IV Materials ○ Modeling and simulation •○ SMR R&D	
4:00 p.m.	**Review of Action Items and Wrap-Up**	Neil Wilmshurst Mike Weber
5:00 p.m.	Adjourn	

Commented [CK2]: Since we are being strategic and aligning (hopefully) on an "efficiency improvement" theme – can we summarize the strategic areas where we integrate efforts to improve overall efficiency?

Subject: Harvested Materials at Battelle
Location: Telecon: to be added

Start: Mon 5/14/2018 10:00 AM
End: Mon 5/14/2018 11:00 AM
Show Time As: Tentative

Note to requester: The Outlook email attached to this page is immediately following.

Recurrence: (none)

Meeting Status: Not yet responded

Organizer: Hiser, Matthew
Required Attendees (b)(6); Tregoning, Robert; (b)(6)

FW: RE: RE: Couple of things

Dear (b)(6)

Following up from Rob's initial contact with (b)(6) we'd like to set up a brief telecom sometime in the next few weeks to discuss what harvested materials may be available at Battelle. Please let me know if another time would be better for this call.

I will be attending a training course at Edison Welding Institute in Columbus in early June, which would provide a good opportunity to potentially visit and see what materials are available if there is enough to be worthwhile.

Thanks!
Matt

Matthew Hiser
Materials Engineer
Transformation Team member
US Nuclear Regulatory Commission
Phone: 301-415-2454
Matthew.Hiser@nrc.gov

From: Tregoning, Robert
Sent: Mon, 7 May 2018 14:53:38 +0000
To: Hiser, Matthew
Cc: Audrain, Margaret;Purtscher, Patrick
Subject: FW: RE: RE: Couple of things
Importance: High

Matt:

This email has the entire thread of our discussion.

Rob

Robert Tregoning
Technical Advisor for Materials
US Nuclear Regulatory Commission
Two White Flint North, M/S T-10 A36
11545 Rockville Pike
Rockville, MD 20852-2738
ph: 301-415-2324
fax: 301-415-6671

(b)(6) **From:** [redacted]
Sent: Wednesday, March 28, 2018 9:28 AM
To: Tregoning, Robert <Robert.Tregoning@nrc.gov>
Subject: [External_Sender] RE: RE: Couple of things
Importance: High

Rob,

I have pictures from our WJ pipe facility.
It is mainly cold-leg pipe with one section of a nozzle branch.

I will try to get you the pictures today.

We could support a call next week.

Regards,

(b)(6)

Connect with me on (b)(6)

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From: Tregoning, Robert <Robert.Tregoning@nrc.gov>
Sent: Wednesday, March 28, 2018 9:26 AM
(b)(6) **To:** [redacted]
Subject: FW: RE: Couple of things

(b)(6) [redacted]

I just wanted to follow-up on our activity to develop an inventory of ex-plant materials that may still exist at Battelle. We would ultimately like to possibly travel up for a day to see what's left but it might be good to have a call initially with you, [redacted] to see if a trip is worthwhile. (b)(6)
Is this something that you could support?

Thanks,

Rob

Robert Tregoning
Technical Advisor for Materials
US Nuclear Regulatory Commission
Two White Flint North, M/S T-10 A36
11545 Rockville Pike
Rockville, MD 20852-2738
ph: 301-415-2324
fax: 301-415-6671

From: Tregoning, Robert
Sent: Wednesday, February 07, 2018 1:46 PM
(b)(6) **To:** [redacted]
Cc: Wallace, Jay <Jay.Wallace@nrc.gov>
Subject: RE: RE: Couple of things

(b)(6) [redacted]

Thanks for getting back to me so quickly. I appreciate your comments and welcome further discussion. See my responses to your initial questions/comments below, in red.

Cheers,

Rob

Robert Tregoning
Technical Advisor for Materials
US Nuclear Regulatory Commission
Two White Flint North, M/S T-10 A36
11545 Rockville Pike
Rockville, MD 20852-2738
ph: 301-415-2324
fax: 301-415-6671

(b)(6) **From:** [redacted]
Sent: Wednesday, February 07, 2018 1:01 PM
To: Tregoning, Robert <Robert.Tregoning@nrc.gov>
(b)(6) **Cc:** [redacted]
Subject: [External_Sender] RE: Couple of things
Importance: High

Rob,

Great to hear from you!! Things are well here at Battelle and also personally; I hope the same for you.

I have a couple of comments about the questions on the Round Robins and Components.

1) It is difficult for us these days to do anything without a contract. I would love to see the results of the round robins, but I am not sure we can participate (Trying to convince management that it is the right thing without even a hint of billable hours from the NRC in the future is a tough sell.)

Believe me, I understand the climate but I just thought you would be interested. The final report for both projects will be made public and I can share them with you when they are complete.

2) As for the LBB Analysis Round robin, I definitely have some opinions on Cases 3 and 4 that I would like to share (hoping you can provide some insight):
   a. These are SCC cracks with a morphology parameter which make take care of "twists and turns" but the COD will still be calculated for a planar crack, not a porous media (which I am not sure what COD even means for porous media).

Agreed that this is a gross simplification of the actual geometry of a complex crack. I think we're still a little ways away from effectively modeling the effects of such a crack on COD (or leak rate for that matter) but could use sensitivity analyses to study. This is well outside the scope of the current benchmark

   b. The morphology knock-down factors only effect the leak rate, not the driving force, so what is the driving force for a SCC crack which has connected ligaments?

Agreed that the knock-down factors only affect leak rate; those knock-down factors also don't consider the effect of connected ligaments. As above, this is another simplification. This one, at least, is a conservative assumption.

c. Real plants have high restraint on the pipes (pumps, pressure vessels…etc.) which restrain the crack opening (and reduce the driving force) – do any of the codes have a Restraint of Pressure Induced Bending module?

Some codes do consider the effect of end restraints on the stress state. The benchmark problem assumes freely rotated ends, again, as a simplification.

d. To my knowledge in xLPR and Pro-LOCA, WRS's only effect the K-solutions up until a TWC occurs. WRS are not accounted for in either COD or K-solutions for TWC.

You are correct; for this exercise, we plan on calculating the effect of WRS on COD outside of xLPR and then using the CODs as input to the LEAPOR (or other) leak rate code.

e. *My major concern is "How can we determine the effects of Leak Rate on LBB if we are not modeling the behavior correctly or even using the correct models?" (not saying conservative / non-conservative, just not correctly). It is kind of like inferring how fast you are going by counting the number of dead bugs on your car window.*

Philosophically I agree with your concern that we need to understand model uncertainty in order to properly evaluate the results of any calculation. This is been a principle concern for the xLPR program which has the objective of developing a "best estimate model". In reality, such a model is not achievable because a whole host of simplifying assumptions are required along the way (you've indicated as few of them). The best we're able to do at this point is to qualitatively assess each aspect of model uncertainly in an attempt to understand what the true biases are. LBB analyses, however, have never pretended to be best estimate analyses and they have always intended to be conservative simplifications of reality. The factors of 10 on leak rate and 1.4 on loading and 2 on crack size are intended to conservatively account for such uncertainties. This round robin obviously will not address such complexities and it is only intended to take a small step by considering the effects that different models and modeling assumptions have on an LBB problem. I recognize that such sensitivity studies are not new and that Battelle and EMCC (among others) have performed such studies around 20 years ago. However, the hope here is that we'll be able to look at these effects in other leak rate codes (e.g., PICEP) to better understand sensitive parameters.

By the way, if you know the density of live bugs that you're traveling through, counting the number of dead bug is actually an effective strategy of measuring speed ☺

(b)(6)

3) I have copied [redacted] on this message because they will have more knowledge on anything "left" here. To my knowledge it was all "abandoned in place", I have nothing I am keeping track of on government tags…etc. As for pipe and or components, it may have been scrapped.

(b)(6)

I appreciate you copying [redacted] on the message. Please let me know if they are able to definitively address what materials/components may or may not be left at Battelle.

(b)(6)

(b)(6)

(b)(6) Connect with me on

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From: Tregoning, Robert [mailto:Robert.Tregoning@nrc.gov]
Sent: Wednesday, February 07, 2018 8:24 AM
(b)(6) **To:**
Cc: Wallace, Jay <Jay.Wallace@nrc.gov>; Audrain, Margaret <Margaret.Audrain@nrc.gov>; Purtscher, Patrick <Patrick.Purtscher@nrc.gov>
Subject: Couple of things

(b)(6)

How are things going? It's been awhile since I've seen or talked to you and I hope you and your family are well. I wanted to send you this email to cover a couple of topics. The first is that we (NRC) are involved in a couple of international computational round robins that are being conducted under the auspices of NEA\CSNI. The first attachment describes the xFEM round robin which was recently approved but has yet to formally begin. I've provided the proposal description. This round robin is being coordinated by France (IRSN) and Belgium (BelV). The second attachment is an LBB round robin which was approved a year or so ago, but we're really just getting rolling on this effort as well. The US (me) and Sweden (SSM) are the leads on this round robin. Let me know if you guys have any interest in possibly participating in either activity. I can also answer any questions that you many have on both of these projects.

On another note, we have recently started to compile a database of ex-plant materials/components that we have accumulated through the years at various laboratories. We're trying to get a good accounting of what materials we have left for possible future research projects. Of course, we've sponsored quite a bit of work at Battelle over the years and while I'm generally aware of the projects, I'm not sure how much, if any, excess materials, components, or specimens still remain at Battelle.

Do you have a good handle on what ex-plant materials/components still exist at Battelle?
(b)(6) Would it be worth contacting [redacted] or other past-Battelle workers to help out? We've developed a spreadsheet for the database to capture the information but I think we'd ultimately like to visit so that we can actually view any remains.

Thanks so much for your help with this.

Warm regards,

Rob

Robert Tregoning
Technical Advisor for Materials
US Nuclear Regulatory Commission
Two White Flint North, M/S T-10 A36
11545 Rockville Pike
Rockville, MD 20852-2738
ph: 301-415-2324
fax: 301-415-6671

From: Hiser, Matthew
Sent: Fri, 22 Jun 2018 13:00:53 +0000
To: Audrain, Margaret;Purtscher, Patrick
Cc: Tregoning, Robert
Subject: RE: RE: Pictures, PARTRIDGE-III, and Experimental Leak-Rate

Yeah, it might be good on Monday to reset where we are in general on harvesting:

- Metals prioritization
- Electrical/concrete prioritization
- PNNL report
- Previously harvested materials (ANL, PNNL, Battelle, ???)
- Supply database

From: Audrain, Margaret
Sent: Friday, June 22, 2018 8:46 AM
To: Hiser, Matthew <Matthew.Hiser@nrc.gov>; Purtscher, Patrick <Patrick.Purtscher@nrc.gov>
Cc: Tregoning, Robert <Robert.Tregoning@nrc.gov>
Subject: RE: RE: Pictures, PARTRIDGE-III, and Experimental Leak-Rate

Matt,

Unfortunately I didn't write our discussion down and it was too long ago for me to remember. We can discuss on Monday if we want to run the exercise again?

Meg

-------- Original Message --------
From: "Hiser, Matthew" <Matthew.Hiser@nrc.gov>
Date: Fri, June 22, 2018 8:41 AM -0400
To: "Audrain, Margaret" <Margaret.Audrain@nrc.gov>, "Purtscher, Patrick" <Patrick.Purtscher@nrc.gov>
CC: "Tregoning, Robert" <Robert.Tregoning@nrc.gov>
Subject: RE: RE: Pictures, PARTRIDGE-III, and Experimental Leak-Rate

Hey Meg,

Sorry I am just getting around to looking at this now. It looks like you filled in the scores for each category, which is good.

However, as you said the discussion of each topic was most valuable. Do your notes capture that discussion at all to reflect the rationale behind each need's prioritization (ie, the "basis for priority" column)?

Thanks!

Matt

From: Audrain, Margaret
Sent: Wednesday, June 06, 2018 12:26 PM
To: Purtscher, Patrick <Patrick.Purtscher@nrc.gov>; Hiser, Matthew <Matthew.Hiser@nrc.gov>
Cc: Tregoning, Robert <Robert.Tregoning@nrc.gov>
Subject: RE: RE: Pictures, PARTRIDGE-III, and Experimental Leak-Rate

I realize now that I owed the group the scored prioritization sheet. After adding the numbers, I think the conversation was more valuable than the actual results!

From: Purtscher, Patrick
Sent: Wednesday, June 06, 2018 9:40 AM
To: Hiser, Matthew <Matthew.Hiser@nrc.gov>; Audrain, Margaret <Margaret.Audrain@nrc.gov>
Cc: Tregoning, Robert <Robert.Tregoning@nrc.gov>
Subject: RE: RE: Pictures, PARTRIDGE-III, and Experimental Leak-Rate

I don't see any CASS materials. Some of the stainless steel pipes with welds could be of interest? That is the only material I see that is potentially of interest.

What is a "Robert Cloud pipe"?

Pat

RC-8AW1	8	0.56	Stainless Steel	48	Inside Cold Leg A at North End	Robert Cloud pipe with circ weld at mid length
H	8	1	Stainless Steel	61	See figure to right	Robert Cloud pipe with stainless steel weld at mid length

---

From: Hiser, Matthew
Sent: Wednesday, June 06, 2018 8:57 AM
To: Audrain, Margaret <Margaret.Audrain@nrc.gov>; Purtscher, Patrick <Patrick.Purtscher@nrc.gov>
Cc: Tregoning, Robert <Robert.Tregoning@nrc.gov>

Subject: Fw: RE: Pictures, PARTRIDGE-III, and Experimental Leak-Rate
Importance: High

Hi Meg and Pat,

Here's what we received back from Battelle. Any thoughts on additional information we might like?

Thanks!
Matt

From: (b)(6)
Sent: Friday, June 1, 2018 11:07:32 AM
To: Tregoning, Robert; Hiser, Matthew
Cc: Raynaud, Patrick
Subject: [External_Sender] RE: Pictures, PARTRIDGE-III, and Experimental Leak-Rate

Rob / Matthew,

Please see the attached inventory excel file.

(b)(6) We (mainly [redacted]) added a worksheet to the file entitled "Battelle Pipe Samples" with the information.

Please let us know if there is anything else you need.

Rod – any comments on the SCC Experimental Prospectus or the PARTRIDGE-III work scope?

Regards,

(b)(6)

Connect with me on (b)(6)

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(b)(6) **From:** [redacted]
Sent: Tuesday, May 22, 2018 2:16 PM
To: Tregoning, Robert <Robert.Tregoning@nrc.gov>
Cc: 'Patrick.Raynaud@nrc.gov' <Patrick.Raynaud@nrc.gov>; 'Hiser, Matthew'
(b)(6) <Matthew.Hiser@nrc.gov>; [redacted]
Subject: Pictures, PARTRIDGE-III, and Experimental Leak-Rate
Importance: High

Rob,

I place a directory called “Pictures” on the PARTRIDGE-II BOX site. Patrick should be able to get them.

I have enclosed the PARTRIDGE-III Draft work scope. This may be shared as you see fit.

(b)(6) [redacted] and I are working on getting you the Leak Rate Testing Concept Paper, you should have it later this week.

(b)(6) Over the next several days, [redacted] and I will go to our “bone yard” and document in information in the spreadsheet Matthew sent.

Best Regards,

(b)(6)

Connect with me on (b)(6)

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CONFIDENTIALITY NOTICE

From: Tregoning, Robert
Sent: Tue, 20 Feb 2018 15:10:05 +0000
To: 'Smith, Jean'
Cc: Moyer, Carol
Subject: FW: Possible supply of high (> 15 dpa) materials for new PWR CGR test

Jean:

I'm very interested in your thoughts on this. Would it be possible to get material from any of the BFBs that have been recently harvested? If not, is there agreement in providing some additional Zorita material, if it can be done in such a way as to not dilute the value of the ZIRP project? We can have a call to discuss if you'd like.

Warm regards,

Rob

Robert Tregoning
Technical Advisor for Materials
US Nuclear Regulatory Commission
Two White Flint North, M/S T-10 A36
11545 Rockville Pike
Rockville, MD 20852-2738
ph: 301-415-2324
fax: 301-415-6671

From: Torill Marie Karlsen [mailto:Torill.Karlsen@ife.no]
Sent: Tuesday, February 20, 2018 8:25 AM
To: 'Ekström, Peter' (Peter.Ekstrom@ssm.se) <Peter.Ekstrom@ssm.se>; Smith, Jean <jmsmith@epri.com>; Tregoning, Robert <Robert.Tregoning@nrc.gov>; Moyer, Carol <Carol.Moyer@nrc.gov>
Subject: [External_Sender] Possible supply of high (> 15 dpa) materials for new PWR CGR test

Dear all

At the IASCC review meeting that was held in Oslo in November 2017, we discussed the materials matrix for the new PWR crack growth rate test that we will begin in the first half of 2019.

It was recommended that the materials matrix for the test comprise 3 low dose materials and 3 high (> 15 dpa) dose materials.

The low dose CTs will be:

i) a 5.2 dpa 321 SS specimen
ii) the 1 and 2 dpa Zorita weld and HAZ CTs that will be transferred from the BWR CGR test, IFA-791, which ends this week. Due to moisture ingress in the dcpd cables during irradiation

in IFA-791, no CGR data could be obtained for these two specimens and they remained in an unloaded condition throughout the test in IFA-791.

For the high dose materials we wonder if it would be possible to obtain some additional high dose (e.g. 40 dpa 304 SS) Zorita CTs for inclusion in the matrix. High dose 347 SS from Zorita was also mentioned as a possibility. If these materials are a possibility we believe that costs for machining the specimens could be covered by the SSM in-kind contribution to the Joint Programme, which in past programme periods has also covered machining of CT specimens for the CGR tests.

Other high dose materials that were mentioned were baffle bolts. Are there any high dose baffle former bolts that have been removed from the Ringhals NPPs that could be made available ?

Looking forward to hearing from you regarding possible sources of high dose material.

Best regards Torill

Note to requester: Attachment is immediately following.

From: Ahluwalia, Kawaljit
To: Hiser, Matthew
Subject: [External_Sender] RE: RE: [External] RE: Ex-plant Materials Harvesting Workshop Presentations
Date: Monday, March 6, 2017 8:14:23 AM
Attachments: NRC Meeting Vattenfall Harvesting 170303.pptx

Matt,
Just got them a few minutes ago. They are attached.
See you tomorrow.
Al

From: Hiser, Matthew [mailto:Matthew.Hiser@nrc.gov]
Sent: Monday, March 06, 2017 7:17 AM
To: Ahluwalia, Kawaljit <kahluwal@epri.com>
Subject: RE: RE: [External] RE: Ex-plant Materials Harvesting Workshop Presentations
Hi Al,
Just wanted to check if you have slides for Ringhals yet. Whenever you get them, just shoot an email or upload to Google Drive.
Thanks!
Matt

Matthew Hiser
Materials Engineer
US Nuclear Regulatory Commission | Office of Nuclear Regulatory Research
Division of Engineering | Corrosion and Metallurgy Branch
Phone: 301-415-2454 | *Office: TWFN 10D62*
Matthew.Hiser@nrc.gov

From: Ahluwalia, Kawaljit [mailto:kahluwal@epri.com]
Sent: Thursday, March 02, 2017 9:51 AM
To: Hiser, Matthew <Matthew.Hiser@nrc.gov>
Subject: [External_Sender] RE: [External] RE: Ex-plant Materials Harvesting Workshop Presentations
Matt,
Here are my slides for the 2:10 PM Tuesday KHNP (Korea) presentation. I am awaiting slides from Ringhals and will send to you once I get them. See you on Tuesday.
Al

From: Hiser, Matthew [mailto:Matthew.Hiser@nrc.gov]
Sent: Wednesday, March 01, 2017 9:45 AM
To: Bernhoft, Sherry <sbernhoft@epri.com>; Dyle, Robin <rdyle@epri.com>; Smith, Jean <jmsmith@epri.com>; Ahluwalia, Kawaljit <kahluwal@epri.com>; 'Richard Reister (Richard.Reister@nuclear.energy.gov)' <Richard.Reister@nuclear.energy.gov>; 'leonardk@ornl.gov' <leonardk@ornl.gov>; 'Rosseel, Thomas M.' <rosseeltm@ornl.gov>; 'William F Zipp (Generation - 4)' <william.f.zipp@dom.com>; 'Gerard P. Van Noordennen' <gpvannoordennen@energysolutions.com>; 'Ramuhalli, Pradeep (Pradeep.Ramuhalli@pnnl.gov)' <Pradeep.Ramuhalli@pnnl.gov>; 'daniel.tello@canada.ca' <daniel.tello@canada.ca>; 'Uwe.Jendrich@grs.de' <Uwe.Jendrich@grs.de>; 'rachid.chaouadi@sckcen.be' <rachid.chaouadi@sckcen.be>; 'arait@criepi.denken.or.jp' <arait@criepi.denken.or.jp>; 'alpanfa@westinghouse.com' <alpanfa@westinghouse.com>; Jackson, John Howard <john.jackson@inl.gov>

Cc: Tregoning, Robert <Robert.Tregoning@nrc.gov>; Purtscher, Patrick <Patrick.Purtscher@nrc.gov>
Subject: [External] RE: Ex-plant Materials Harvesting Workshop Presentations

Dear Presenters:

Thank you for sending presentation titles. I have all but a couple at this point and have attached the updated agenda.

I know many of you are working on finalizing your slides for the workshop (I already have 2 submitted as of today!). Please provide slides by Friday if at all possible. It will be very challenging to load presentations onto the computer via thumb drive the day of the workshop due to NRC computer security restrictions, so sending them in advance is greatly preferred. Again, best options for sending are either email or upload to Google Drive: https://drive.google.com/drive/folders/0B5DWMLch5YSXcnpZZ0JOS055QUU?usp=sharing.

I am looking forward to a productive workshop next week and appreciate your participation. Please let me know if you have any questions or suggestions for the workshop.

Thanks!

Matt

From: Hiser, Matthew
Sent: Thursday, February 23, 2017 9:07 AM
To: Bernhoft, Sherry (sbernhoft@epri.com) <sbernhoft@epri.com>; Dyle, Robin <rdyle@epri.com>; Jean Smith (jmsmith@epri.com) <jmsmith@epri.com>; Ahluwalia, Kawaljit <kahluwal@epri.com>; Richard Reister (Richard.Reister@nuclear.energy.gov) <Richard.Reister@nuclear.energy.gov>; 'leonardk@ornl.gov' <leonardk@ornl.gov>; 'Rosseel, Thomas M.' <rosseeltm@ornl.gov>; 'William F Zipp (Generation - 4)' <william.f.zipp@dom.com>; 'Gerard P. Van Noordennen' <gpvannoordennen@energysolutions.com>; Ramuhalli, Pradeep (Pradeep.Ramuhalli@pnnl.gov) <Pradeep.Ramuhalli@pnnl.gov>; 'daniel.tello@canada.ca' <daniel.tello@canada.ca>; 'Uwe.Jendrich@grs.de' <Uwe.Jendrich@grs.de>; 'rachid.chaouadi@sckcen.be' <rachid.chaouadi@sckcen.be>; 'arait@criepi.denken.or.jp' <arait@criepi.denken.or.jp>; 'alpanfa@westinghouse.com' <alpanfa@westinghouse.com>; Jackson, John Howard <john.jackson@inl.gov>; desire.ndomba@canada.ca
Cc: Tregoning, Robert <Robert.Tregoning@nrc.gov>; Purtscher, Patrick <Patrick.Purtscher@nrc.gov>
Subject: RE: Ex-plant Materials Harvesting Workshop Presentations

Dear Presenters:

Friendly reminders:

- Please provide presentation title by February 28.
- Please send me your slides (either via email or upload to Google Drive: https://drive.google.com/drive/folders/0B5DWMLch5YSXcnpZZ0JOS055QUU?usp=sharing) by March 3.

I have attached the workshop agenda to this email. Please let me know if you have any questions or corrections.

Thanks!

Matt

From: Hiser, Matthew
Sent: Wednesday, February 15, 2017 10:47 AM
To: Bernhoft, Sherry (sbernhoft@epri.com) <sbernhoft@epri.com>; Dyle, Robin <rdyle@epri.com>; Jean Smith (jmsmith@epri.com) <jmsmith@epri.com>; Ahluwalia, Kawaljit <kahluwal@epri.com>; Richard Reister (Richard.Reister@nuclear.energy.gov) <Richard.Reister@nuclear.energy.gov>;

'leonardk@ornl.gov' <leonardk@ornl.gov>; 'Rosseel, Thomas M.' <rosseeltm@ornl.gov>; 'William F Zipp (Generation - 4)' <william.f.zipp@dom.com>; 'Gerard P. Van Noordennen' <gpvannoordennen@energysolutions.com>; Ramuhalli, Pradeep (Pradeep.Ramuhalli@pnnl.gov) <Pradeep.Ramuhalli@pnnl.gov>; 'daniel.tello@canada.ca' <daniel.tello@canada.ca>; 'Uwe.Jendrich@grs.de' <Uwe.Jendrich@grs.de>; 'rachid.chaouadi@sckcen.be' <rachid.chaouadi@sckcen.be>; 'arait@criepi.denken.or.jp' <arait@criepi.denken.or.jp>; 'alpanfa@westinghouse.com' <alpanfa@westinghouse.com>
Cc: Tregoning, Robert <Robert.Tregoning@nrc.gov>; Purtscher, Patrick <Patrick.Purtscher@nrc.gov>
Subject: Ex-plant Materials Harvesting Workshop Presentations

Dear Harvesting Workshop Presenters:

If you are receiving this email, then I have you down on the agenda to present at the upcoming Ex-plant Materials Harvesting Workshop on March 7-8. I have attached the workshop introduction slides that have been shared with most, if not all, of you. These slides cover meeting logistics, motivation, approach, expected outcome, and session expectations. We are hoping these slides provide a common vision for the workshop that will allow for a focused, productive discussion. Please take a look at these slides and try to tailor your presentation to the focus and length of the respective session.

There are two actions I request from presenters:

1. I have attached the confirmed list of speakers in an Excel document. Please take a look at this list to confirm you are presenting in the session you expected and if I have made any mistakes in the list of speakers. If you have not already done so, please provide me with a presentation title.
2. Please send me your slides (either via email or upload to Google Drive: https://drive.google.com/drive/folders/0B5DWMLch5YSXcnpZZ0JOS055QUU?usp=sharing) by the end of February if possible.

Thank you for your participation in the workshop. We are looking forward to the discussion and engagement and appreciate your contribution to a productive and interesting meeting!

Thanks!

Matt

Matthew Hiser
Materials Engineer
US Nuclear Regulatory Commission | Office of Nuclear Regulatory Research
Division of Engineering | Corrosion and Metallurgy Branch
Phone: 301-415-2454 | *Office: TWFN 10D62*
Matthew.Hiser@nrc.gov

administrator and/or provider. ***

MATERIALS HARVESTING AT RINGHALS

Materials for presentation at NRC Harvesting meeting March, 2017

Henric Lidberg & Pål Efsing Ringhals AB

ON-GOING PROJECT:

- BREDA-project (Barsebäck as R&D platform)IRRADIAT EMBRITTLEMENTStudy of Authentic Irradiated BWR F MaterialsSurveillance data vs. actual RPV properties THERMAL AGING EMBRITTLEMENTStudy of Thermally RPV MaterialsQUALIFICATION OF SAMPLING METHODOLOGY

BREDA STEP BY STEP

- **STEP 1 - MATERIAL SAMPLING BARSEBÄCK 22017 Q1 – 2018 Q2Sampling 2018 Q1Transport of samples to laboratory 2018 Q2STEP 2 - MATERIAL TESTING2018 Q3 – 2019 Q2STEP 3 - EVALUATION2019 Q3 – 2019 Q4**

RINGHALS 1 & 2

- The two oldest plants at the Ringhals site will be shut-down permanently in 2020 and 2019, respectivelyPartially caused by post-Fukushima activities and partially due to plant economics (which indeed are coupled to each other)Ringhals 1 – BWR ASEA type, 6 external Main Circ loopsRinghals 2 – Westinghouse 900 MWe 3-loop plantSG replaced with A690 1989RPVH replaced with A690 1994

RINGHALS OVER-ALL INTEREST

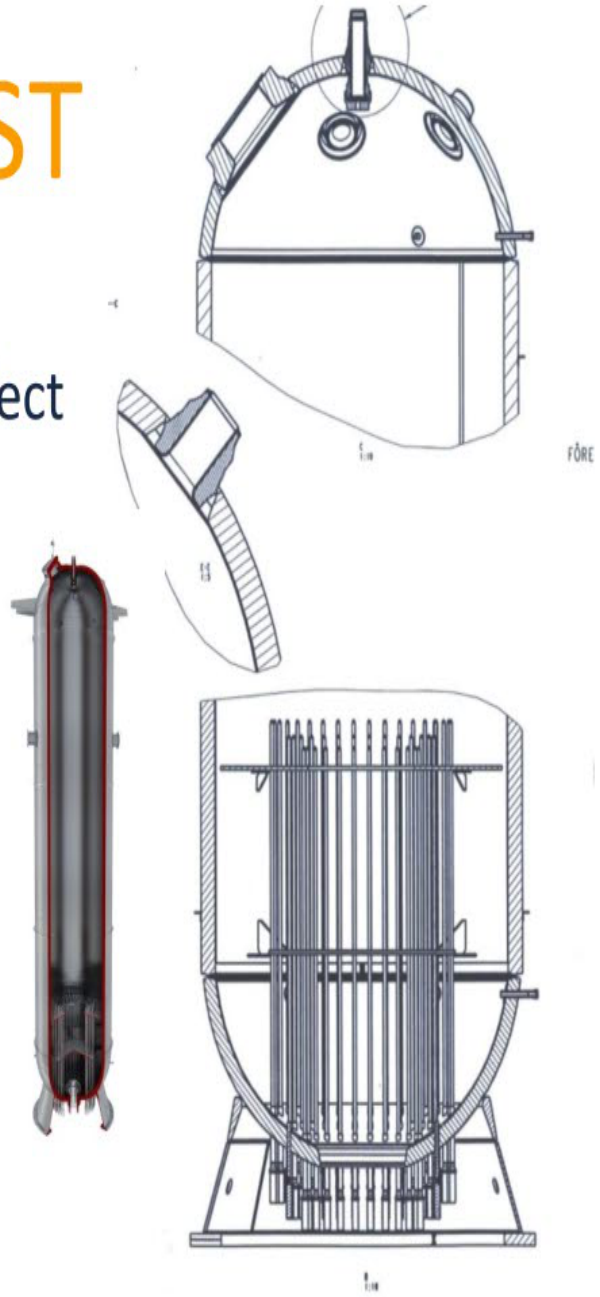
- RPV + RPVHSecond oldest A690-tubed replacement RPVHStandard type RPV incl. welds – significant surveillance programBottom Mounted NozzlesReactor Vessel InternalsComparison between inspection results and actual outcome

RINGHALS OVER-ALL INTEREST

- R2 Steam GeneratorsSampling can be made reasonably quickly after shut-down!Second oldest A690-tubed replacement SGExcellent operating historyInterest to verify superior resistance to EAC Long range vs short range ordering of Ni-base alloysI.e. Long term susceptibility build upStructural components i.e. divider plate and stub, DMW weldments, instrumentation nozzles etc.

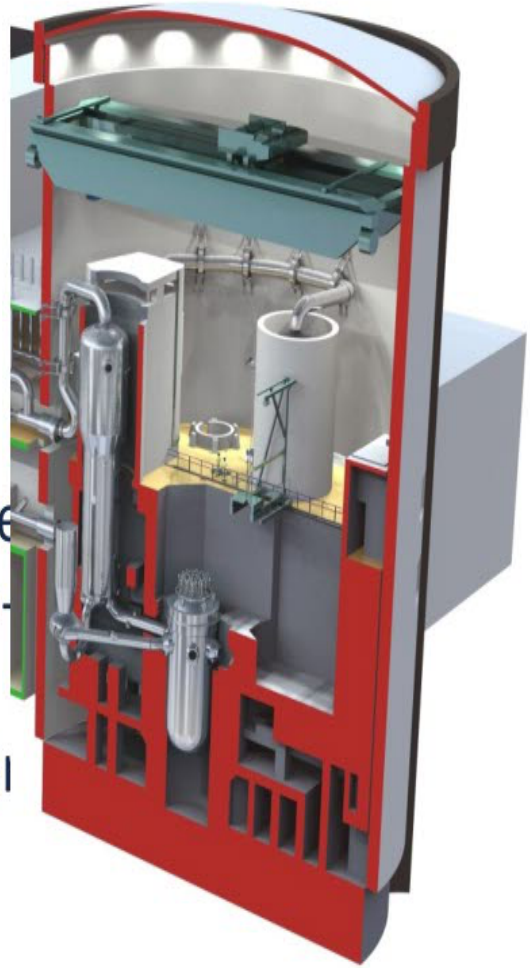
RINGHALS OVER-ALL INTEREST

- Thermal ageing effects of LAS and high-Ni/Mn weld material available in PRZPrevious studies indicate an effect that is larger than expectedTesting on-going currentlySampling from the “to-be decommissioned” pressure vessel will provide us with one more firm data point



CIVIL STRUCTURES

- Steel lined concrete containmentIrradiation effectsThermal effectsPossibility to make sampling at multiple locationsOthe structures such as water inlets and buildings etc. Scoping on- make a proposal to decommissioning team regarding both primary/secondary systems and civil structures as well as coı ageing



From: Hiser, Matthew
Sent: Wed, 10 Aug 2016 17:11:45 +0000
To: Tregoning, Robert
Subject: NRC-NRAJ Bilateral Meeting Summary.docx
Attachments: NRC-NRAJ Bilateral Meeting Summary.docx

Note to requester: Attachment is immediately following.

Hi Rob,

Just a couple edits of typos on the harvesting writeup (see tracked changes).

Thanks!
Matt

Summary of NRC/NRAJ Bilateral Meeting on Materials Issues

NRC Headquarters, Rockville, MD, USA
August 8 - 9, 2016

Representatives from the United States Nuclear Regulatory Commission (NRC) and the Japanese Nuclear Regulatory Authority (NRAJ) met on August 8 – 9, 2016 at NRC headquarters in Rockville, MD, USA. The principal purpose of the meeting was to share information on research and operating experience related to the age-related degradation of metal, concrete, and electrical cables in commercial nuclear reactors. Additionally, the possibility of future collaboration on these topics was discussed.

The agenda for the main meeting is attached (Enclosure 1). The meeting was structured so that all participants were initially together to provide introductions. Next, the NRC welcomed our Japanese colleagues to the U.S. and NRC, and both the NRC and NRCJ provided opening remarks about the meeting purpose and expected outcome. The meeting agenda was also reviewed to ensure that the final agenda was mutually acceptable. After this discussion, the meeting split into parallel sessions. One session discussed metals and cable aging issues as outlined in the main meeting agenda. The other session discussed aging of structural concrete. The agenda for the concrete portion of the meeting is attached (Enclosure 1). The list of participants in all the meetings is also attached (Enclosure 2).

All presentations provided during the meeting were provided electronically. The NRC presentations were collected by R. Tregoning while the NRAJ presentation were collected by K. Sakamoto. Dr. Tregoning will distribute all the presentations to the NRC participants and other interested NRC staff while Dr. Sakamoto will distribute all presentations to the NRAJ participants and other interested NRAJ staff.

Summary of Discussion on Cable Aging

NRC (Murdock) and NRAJ (Minakawa) each provided presentations that discussed research activities related to cable aging. Operating experience and the existing regulatory framework associated with aging management programs (AMPs) and environmental qualification (EQ) of cables was also discussed. As part of this discussion, both sides identified technical issues and concerns that are currently being addressed or considered. The following next steps, or action items, were identified during the discussion on this topic.

Next Steps/Action Items

Operating Experience:

- NRAJ will provide details on the three cable failures that were input to the SCAP database
- NRAJ will identify how cable failures are reported to their agency if they occur before the 30-year periodic safety review (PSR)
- NRAJ will identify the four approaches that are used by the Japanese industry to detect cable failures other than the tan-δ approach. Partial discharge and resistance measurement were identified as two of these approaches.

Research:

- NRC will send the test plan (including test matrix) on the condition monitoring research to NRAJ once it is available. It is expected to be available in fall of 2016.
- NRAJ will send the test plans for the severe accident and flammability research activities
- Both sides agreed to share results and reports associated with these research programs when they are completed.
- Both sides also agreed to solicit and provide advice and guidance on the research activities being conducted at both NRAJ and NRC.
- Both the NRC and NRAJ will consider exchanging samples of cables that have been aged and tested under ongoing and planned research activities. Discussion on this topic will be held between NRC (Murdock) and NRAJ (Minakawa) to determine feasibility and next steps.
- NRAJ will provide the report that relates the quantified level of degradation (QLD) to both elongation at break and indenter measurement techniques.

Regulatory Framework:

- NRC will provide RG 1.97, "Criteria for Accident Monitoring Instrumentation for Nuclear Power Plants."
- NRC will provide the latest publicly-available presentation on the public comments – and staff thoughts on addressing these comments - related to cable aging AMPs that are contained in the draft GALL guidance for subsequent license renewal (SLR).
- NRC will provide an EQ inspection report(s). St. Lucie and Watts Bar were identified as possible candidates.
- NRC will provide the inspection plan related to **EQ or Cables**. (Darrell, which is correct?)

Summary of Discussion on Metals Aging

Two topics were discussed related to metals aging: reactor pressure vessel (RPV) embrittlement and irradiated assisted degradation (IAD). As part of this discussion, both sides identified technical issues and concerns that are currently being addressed or considered for each of these topics.

1. RPV Embrittlement

NRC (Gordon) provided a summary of research activities, development of regulatory guidance, and codes and standards activities related to RPV integrity. Similarly, NRAJ (Sakamoto) summarized research activities in Japan. The following next steps, or action items, were identified during the discussion of this topic.

Next Steps/Action Items

- NRC and NRAJ will continue to discuss the plans, status, and results of their research programs related to RPV integrity.
- NRC (Kirk) and NRAJ (Arai) will discuss the feasibility of benchmarking the Japanese (PASCAL) and U.S. (FAVOR) computer codes using common problems. Next steps will be identified if mutual interest in conducting such exercises exists.
- NRAJ will provide a schedule and timeline for their RPV research.

- NRAJ indicated that it is possible to provide the yearly research summary reports to the NRC. If interested, the NRC (Kirk) will request that NRAJ (Sakamoto) provide these reports.
- NRAJ will provide the Japanese surveillance program requirements to the NRC.

2. IAD

NRC (Rao) provided a summary of recently completed, current, and planned research activities related to IAD. NRAJ (Sakamoto) provided a presentation of both operating experience related to IASCC and associated research activities. The following next steps, or action items, were identified during the discussion of this topic.

Next Steps/Action Items

- NRC and NRAJ will continue to discuss the plans, status, and results of their research programs related to IAD.
- NRC will provide information on the test plans for the ANL program when it is completed.
- NRC (Rao/Hiser) will determine if information and results pertaining to the programs that are being conducted jointly (e.g., ZIRP, Zorita Weld Testing) can be provided to NRAJ once these programs are completed.
- NRC will provide answers to questions related to IASCC posed by NRAJ in email sent in mid-July.
- NRAJ provided references related to IASCC operating experiences that are in Japanese. NRC will determine if there is interest in obtaining any of these references for translation into English. NRAJ (Sakamoto) agreed to help the NRC determine interest by summarizing the content of these references if requested by the NRC.

Summary of Discussion on Possible Future Collaboration Areas

The following four topics were discussed to determine if there is mutual interest in pursuing future collaboration: peening, aging of cast austenitic stainless steel (CASS), environmentally assisted fatigue, and ex-plant material harvesting. For each topic, NRAJ and NRC provided a brief, high-level summary of related activities and identified ideas for future collaboration. These ideas were then discussed to determine if mutual interest exists and, if so, identify the next steps for pursuing collaboration.

1. Peening

NRC and NRAJ each provided presentations on the use of peening in their respective countries. The NRC presentation focused on the regulatory reviews currently ongoing to determine if inspection relief will be granted. NRAJ discussed possible research to evaluate the long-term effectiveness of peening. There was also discussion of the NRC's research to evaluate the effects of peening on crack initiation and growth. The following next steps, or action items, were identified during the discussion of this topic.

Next Steps/Action Items

- NRC will provide details of the test plan for their peening research.
- NRAJ will provide information on the method that the Japanese industry uses to measure residual stress.

- NRAJ will provide operating experience for peened components. Specifically, NRAJ will identify any instances where crack formed after peening or cracks that existed before peening grew after peening.
- NRAJ (Sakamoto) and NRC (Alley) will each develop a list of questions related to peening for the other side to answer.

2. Aging of CASS

NRC and NRAJ each provided presentations on CASS. The NRC presentation discussed recently completed and ongoing research related to thermal embrittlement and thermal embrittlement combined with irradiation embrittlement. The current regulatory position and ASME code activities were also summarized. The NRAJ presentation focused on past research that was used to verify the Japanese embrittlement prediction model. The NRC presentation also identified several ideas for collaboration that were discussed. The following next steps, or action items, were identified during the discussion of this topic.

Next Steps/Action Items

- NRC will verify that it has received all the JNES CASS. If not, NRAJ will provide any missing data
- NRC will provide information related to ASME Code Case 838. The Code Case and technical basis will be provided along with a list of questions for NRAJ to consider. NRC is interested in obtaining any feedback that NRAJ can provide on this Code Case.
- NRC will develop a list of questions related to CASS testing, operating experience, or regulatory treatment for NRAJ to answer

3. Environmentally Assisted Fatigue

NRC provided a presentation on environmentally assisted fatigue (EAF). The presentation addressed the regulatory requirements and regulatory treatment of this issue for nuclear power plants (NPPs) operating with their initial license, NPPs in license renewal, and new NPPs. Further, planned treatment for NPPs during the SLR period was also discussed. ASME code activities and recent research in this area were summarized and the significant Japanese contribution to this research was acknowledged. Discussion of future collaboration focused on sharing fatigue test data internationally. The following next steps, or action items, were identified during the discussion of this topic.

Next Steps/Action Items

- NRC will propose a CSNI-sponsored activity to develop an international fatigue database. This is the route that NRAJ prefers for sharing data
- NRC will summarize the method that was used to exchange data from EdF through an existing MOU with the French Regulator, ASN. NRAJ will consider using a similar approach to share fatigue data with EdF.

4. Material Harvesting

NRC provided a presentation that summarizes a current project to develop a proactive plan for identifying opportunities to harvest ex-plant materials and components from decommissioned plants. There was also discussion about Japanese participation in an NRC-sponsored workshop on material harvesting that will be planned for 2017. NRAJ also developed a presentation on

material harvesting, but it was not presented due to time constraints. However, the presentation will be provided electronically to the NRC along with the other NRAJ presentations. ~~on environmentally assisted fatigue (EAF). The presentation addressed the regulatory requirements and regulatory treatment of this issue for nuclear power plants (NPPs) operating with their initial license,~~ The following next steps, or action items, were identified during the discussion of this topic.

Next Steps/Action Items

- NRC will provide the contractor report on the first phase of the material harvesting project to NRAJ when it is completed
- NRC (Hiser) will work with NRAJ (Sakamoto) to determine a mutually acceptable date and location for the material harvesting workshop
- NRAJ will attempt to get participation from Japanese utilities and other government organizations in the material harvesting workshop.

Summary of Discussion on Structural Concrete Issues

NRC and NRAJ presented research activities on four topics. These topics were discussed in detail during the parallel meeting of concrete issues. A summary of this meeting was also provided as part of the main meeting on the second day. The summary of the discussion and next steps, or action items, related to each topic follows.

1. Research on Radiation Effects on Concrete Structures

NRC presented the overall research activities on radiation effects on concrete. NRAJ presented test programs on radiation research. NRC and NRAJ mutually understand research activities on radiation effects on concrete structures. NRC and NRAJ also mutually agreed on the importance of modeling using the test results. Such results can be used to validate the model to predict material degradation and the FEM model for the assessment of structural safety significance for structures exposed to long term radiation. The following next steps, or action items, were identified during the discussion of this topic.

Next Steps/Action Items

- NRC & NRAJ will continue to share the information about research activities
- NRAJ research reports will be shared with the NRC (planned 2017).
- NRC and NRAJ mutually agreed to share intermediate and final research results and reports.

2. Overview of Aging Management and Life Extension of NPPs: NRC Activities and NRAJ Activities

Both NRC and NRAJ provided presentations to summarize the approach that each country follows. NRAJ was very familiar with the NRC's approach. NRAJ requires special safety checks before 40-60 life extension. In Japan, the licensees harvest several concrete cores from various locations for condition assessment before entering 40-60 years. Types of tests are determined by the industry and reviewed by NRAJ. Another feature of Japanese Plant Life Management (30-10-10), which is of interest to the NRC, is drilling holes and collecting dust from concrete structures for chemical evaluations (pH, carbonation, chloride etc.). The following next steps, or action items, were identified during the discussion of this topic.

Next Steps/Action Items

- NRC and NRAJ mutually agreed to continue discussion on future activities related to this topic

3. Monitoring and Aging Management of ASR Affected Concrete Structures

Both NRC and NRAJ provided presentations to summarize activities in this area. The NRAJ research program includes two activities. The first program is evaluating the susceptibility of aggregate for new constructions by both the JIS and RILEM methods. The second program is assessing the progress of ASR degradation in existing structures. The research is planned to be completed next year. NRC provided one presentation on operating experience related to ASR and another presentation on the research activities being conducted at NIST. This research focuses on existing structures affected by ASR. The NRC research will continue for next few years. The following next steps, or action items, were identified during the discussion of this topic.

Next Steps/Action Items

- NRAJ will share the results of their research in this area after the results have been published.
- NRC and NRAJ mutually agreed to exchange the research results and continue discussion on future activities

4. Research on Non-destructive Evaluations, Instrument/Sensor and Its Applicability for Thick Heavily Reinforced Concrete Structures

Both NRC and NRAJ provided presentations to summarize activities in this area. NRC does not have any current research related to NDE of concrete structures. NRC reviews NDE methods developed by the industry. As per the current practice, in US concrete is inspected visually. Based on the findings of visual inspections, NDE methods are applied as appropriate. Industry and DOE are developing methods and testing advanced techniques. NRC plans to conduct confirmatory review of these methods. Two NDE methods from NRAJ presentation are of special interest to the NRC. The first method is the estimation of the steel-plate-sandwich-section strength. The second method is the strength evaluation of high strength concrete ($>50N/mm^2$) in the prestressed concrete containment vessel. The following next steps, or action items, were identified during the discussion of this topic.

Next Steps/Action Items

- NRC and NRAJ mutually agreed to exchange information and continue discussion on future activities related to this topic

After discussion of the technical topics was completed, the next agenda item was to plan the next meeting to discuss materials aging issues. The next meeting will be held in Tokyo, Japan. Both sides agreed to search for a mutually acceptable date between November 2017 and February 2018. NRAJ is open to any date within this window. Therefore, NRC will propose the date. If possible, the date will be selected to allow participation in any other materials meetings being held in Asia during this timeframe. NRAJ also indicated that meeting after April 2018 could be advantageous because all the end-of-fiscal-year technical reports are submitted in March. A meeting after April 2018 will be pursued only if it is not possible to schedule a meeting during

the November 2017 – February 2018 window. Both NRAJ and NRC will continue to meet on specific topics before this next bilateral meeting as opportunities arise.

The meeting closed with both sides confirming the significant value of discussion and collaboration on materials degradation issues. It is desirable to strengthen this partnership even further in the future.

AGENDA

NRC/NRAJ Bilateral Meeting on Materials Issues

NRC Headquarters, Rockville, MD, USA
August 8 - 9, 2016

Monday, August 8th, 2016
Location: Room O7-B4

Time	Topic	Speaker
8:00 am	Introductions	All
8:05 am	Welcome	B. Thomas, NRC
8:15 am	Opening Remarks	R. Tregoning, NRC K. Sakamoto, NRAJ
	Cable Aging	
8:30 am	NRC Research Activities	D. Murdock, NRC
9:30 am	NRAJ Research Activities	T. Minakawa, NRAJ
10:30 am	Break	
10:45 am	Technical and Regulatory Concerns	All
12:00 pm	Lunch	
	Metals Aging	
1:30 pm	RPV embrittlement studies	M. Gordon, NRC K. Sakamoto, NRAJ
2:45 pm	Break	
3:15 pm	Irradiated Assisted Degradation	A. Rao, NRC K. Sakamoto, NRAJ
4:15 pm	Technical and Regulatory Concerns	All
5:00 am	Adjourn	

AGENDA

NRC/NRAJ Bilateral Meeting on Materials Issues

NRC Headquarters, Rockville, MD, USA
August 8 - 9, 2016

Tuesday, August 9th, 2016
Location: Room O7-B4

Time	Topic	Speaker
	Possible Future Collaboration Areas	
8:00 am	Peening	R. Tregoning, NRC K. Sakamoto, NRAJ
8:30 am	Aging of CASS	P. Purtscher, NRC K. Sakamoto, NRAJ
9:00 am	Environmentally Assisted Fatigue	R. Tregoning, NRC
9:30 am	Material Harvesting	M. Hiser, NRC K. Sakamoto, NRAJ
10:00 am	Break	
10:15 am	Summary of Concrete Discussions	M. Sircar, NRC M. Nakano, NRAJ
11:15 am	Actions and Next Meeting	All
11:45 am	Closing Remarks	B. Thomas, NRC K. Sakamoto, NRAJ
12:00 pm	Adjourn	

AGENDA

NRC/NRAJ Bilateral Meeting on Concrete Issues

NRC Headquarters, Rockville, MD, USA
August 8 - 9, 2016

Monday, August 8th, 2016
Location: Room O7-B2

Time	Topic	Speaker
8:00 - 8:30 am	Participate in the Main Meeting	All
8:30 - 8:45 am	Move to Room O7- B2	
8:45 - 10:30 am	Research on Radiation Effects on Concrete Structures	M. Sircar, NRC M. Nakano, NRAJ
10:30 - 10:45 am	Break	
10:45 - 12:00 pm	Continue Radiation Effects on Concrete Structures and Possible Collaboration	M. Sircar, NRC M. Nakano, NRAJ
12:00-1:30 pm	Lunch	
1:30 - 3:00 pm	Overview of Aging Management and Life Extension of NPPs: NRC Activities and NRA Activities	M. Sircar, A. Prinaris NRC M. Nakano, NRAJ
3:00 - 3:30 pm	Break	
3:30 - 5:00 pm	Monitoring and Aging Management of ASR Affected Concrete Structures	J. Phillip, A. Buford NRC M. Nakano, NRAJ

Tuesday, August 9th, 2016
Location: Room O7-B2

Time	Topic	Speaker
8:00 - 9:00 am	Research on NDE, Instrument/Sensor and Its Applicability for Thick Heavily Reinforced Concrete Structures	M. Sircar, NRC M. Nakano, NRAJ
9:00 -10:00 am	Recap and Review Summary	All
10:00 - 10:15 am	Break	
10:15 - 11:15 am	Summary of Concrete Discussion in the Main Meeting	M. Sircar, NRC M. Nakano, NRAJ

ATTENDANCE LIST

NRC/NRAJ Bilateral Meeting on Materials Issues
NRC Headquarters, Rockville, MD, USA
August 8 - 9, 2016

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Note to requester:
Attachments are
immediately following.

From: Prokofiev, Iouri
Sent: Tue, 7 Feb 2017 09:29:45 -0500
To: Hiser, Matthew;Tregoning, Robert
Cc: Iyengar, Raj
Subject: FW: Query Meeting with NRA in Aug
Attachments: NRC-NRAJ Bilateral Meeting Summary rev.docx, [External_Sender] FW: more thoughts: Reflections on PARENT 13 Meeting

Good Morning,

I am sorry bother you. I am working with PARENT Follow on project proposal and I sent the attached email "*more thoughts: Reflections on PARENT 13 Meeting*" to Dr. Ichiro Komura, Steering Committee member from JAPEIC komura-ichirou@japeic.or.jp. with the harvesting workshop info.
It was surprised me, he asked question related to Harvesting; "Can I distribute the attached document you sent me to the people of NRA, MHI, other electric power company in Japan, and University?"
Can you please update the attached below information from Meeting Summary rev.docx

4. Material Harvesting

NRC provided a presentation that summarizes a current project to develop a proactive plan for identifying opportunities to harvest ex-plant materials and components from decommissioned plants. There was also discussion about Japanese participation in an NRC-sponsored workshop on material harvesting that will be planned for 2017. NRAJ also developed a presentation on material harvesting, but it was not presented due to time constraints. However, the presentation will be provided electronically to the NRC along with the other NRAJ presentations. The following next steps, or action items, were identified during the discussion of this topic.

Next Steps/Action Items

- NRC will provide the contractor report on the first phase of the material harvesting project to NRAJ when it is completed
- NRC (Hiser) will work with NRAJ (Sakamoto) to determine a mutually acceptable date and location for the material harvesting workshop
- NRAJ will attempt to get participation from Japanese utilities and other government organizations in the material harvesting workshop.

Thanks,
Iouri

From: Tregoning, Robert
Sent: Monday, November 28, 2016 2:52 PMeve

To: Wong, Albert <Albert.Wong@nrc.gov>
Cc: Sadollah, Mohammad <Mohammad.Sadollah@nrc.gov>; Prokofiev, Iouri <Iouri.Prokofiev@nrc.gov>
Subject: RE: Query_Meeting with NRA in Aug

All:

Attached is the meeting summary for the materials meeting with NRAJ held last August. The presentation files from the meeting are too large to send so I'm going to either put them on a shared drive or the sharepoint site. I'll send the link when it's up. Let me know if you have any questions in the interim.

Cheers,

Rob

Robert Tregoning
Technical Advisor for Materials
US Nuclear Regulatory Commission
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11545 Rockville Pike
Rockville, MD 20852-2738
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From: Wong, Albert
Sent: Wednesday, November 23, 2016 11:43 AM
To: Tregoning, Robert <Robert.Tregoning@nrc.gov>
Cc: Sadollah, Mohammad <Mohammad.Sadollah@nrc.gov>
Subject: Query_Meeting with NRA in Aug

Hello Rob,

Greetings! I was told you're the POC for a material aging meeting with the Japanese regulatory agency NRA back in August. Mo was at the meeting, but he only attended the electrical portion of the discussion. If you have the entire meeting presentation materials, could you send him a copy, please? Thanks you very much and Happy Thanksgiving.

aw

Summary of NRC/NRAJ Bilateral Meeting on Materials Issues

NRC Headquarters, Rockville, MD, USA
August 8 - 9, 2016

Representatives from the United States Nuclear Regulatory Commission (NRC) and the Japanese Nuclear Regulatory Authority (NRAJ) met on August 8 – 9, 2016 at NRC headquarters in Rockville, MD, USA. The principal purpose of the meeting was to share information on research and operating experience related to the age-related degradation of metal, concrete, and electrical cables in commercial nuclear reactors. Additionally, the possibility of future collaboration on these topics was discussed.

The agenda for the main meeting is attached (Enclosure 1). The meeting was structured so that all participants were initially together to provide introductions. Next, the NRC welcomed our Japanese colleagues to the U.S. and NRC, and both the NRC and NRCJ provided opening remarks about the meeting purpose and expected outcome. The meeting agenda was also reviewed to ensure that the final agenda was mutually acceptable. After this discussion, the meeting split into parallel sessions. One session discussed metals and cable aging issues as outlined in the main meeting agenda. The other session discussed aging of structural concrete. The agenda for the concrete portion of the meeting is attached (Enclosure 1). The list of participants in all the meetings is also attached (Enclosure 2).

All presentations provided during the meeting were provided electronically. The NRC presentations were collected by R. Tregoning while the NRAJ presentation were collected by K. Sakamoto. Dr. Tregoning will distribute all the presentations to the NRC participants and other interested NRC staff while Dr. Sakamoto will distribute all presentations to the NRAJ participants and other interested NRAJ staff.

Summary of Discussion on Cable Aging

NRC (Murdock) and NRAJ (Minakawa) each provided presentations that discussed research activities related to cable aging. Operating experience and the existing regulatory framework associated with aging management programs (AMPs) and environmental qualification (EQ) of cables was also discussed. As part of this discussion, both sides identified technical issues and concerns that are currently being addressed or considered. The following next steps, or action items, were identified during the discussion on this topic.

Next Steps/Action Items

Operating Experience:

- NRAJ will provide details on the three cable failures that were input to the SCAP database
- NRAJ will identify how cable failures are reported to their agency if they occur before the 30-year periodic safety review (PSR)
- NRAJ will identify the four approaches that are used by the Japanese industry to detect cable failures other than the tan-δ approach. Partial discharge and resistance measurement were identified as two of these approaches.

Research:

- NRC will send the test plan (including test matrix) on the condition monitoring research to NRAJ once it is available. It is expected to be available in fall of 2016.
- NRAJ will send the test plans for the severe accident and flammability research activities
- Both sides agreed to share results and reports associated with these research programs when they are completed.
- Both sides also agreed to solicit and provide advice and guidance on the research activities being conducted at both NRAJ and NRC.
- Both the NRC and NRAJ will consider exchanging samples of cables that have been aged and tested under ongoing and planned research activities. Discussion on this topic will be held between NRC (Murdock) and NRAJ (Minakawa) to determine feasibility and next steps.
- NRAJ will provide the report that relates the quantified level of degradation (QLD) to both elongation at break and indenter measurement techniques.

Regulatory Framework:

- NRC will provide RG 1.97, "Criteria for Accident Monitoring Instrumentation for Nuclear Power Plants."
- NRC will provide the latest publicly-available presentation on the public comments – and staff thoughts on addressing these comments - related to cable aging AMPs that are contained in the draft GALL guidance for subsequent license renewal (SLR).
- NRC will provide an EQ inspection report(s). St. Lucie and Watts Bar were identified as possible candidates.
- NRC will provide the inspection plan related to the environmental qualification of safety related cables

Summary of Discussion on Metals Aging

Two topics were discussed related to metals aging: reactor pressure vessel (RPV) embrittlement and irradiated assisted degradation (IAD). As part of this discussion, both sides identified technical issues and concerns that are currently being addressed or considered for each of these topics.

1. RPV Embrittlement

NRC (Gordon) provided a summary of research activities, development of regulatory guidance, and codes and standards activities related to RPV integrity. Similarly, NRAJ (Sakamoto) summarized research activities in Japan. The following next steps, or action items, were identified during the discussion of this topic.

Next Steps/Action Items

- NRC and NRAJ will continue to discuss the plans, status, and results of their research programs related to RPV integrity.
- NRC (Kirk) and NRAJ (Arai) will discuss the feasibility of benchmarking the Japanese (PASCAL) and U.S. (FAVOR) computer codes using common problems. Next steps will be identified if mutual interest in conducting such exercises exists.
- NRAJ will provide a schedule and timeline for their RPV research.

- NRAJ indicated that it is possible to provide the yearly research summary reports to the NRC. If interested, the NRC (Kirk) will request that NRAJ (Sakamoto) provide these reports.
- NRAJ will provide the Japanese surveillance program requirements to the NRC.

2. IAD

NRC (Rao) provided a summary of recently completed, current, and planned research activities related to IAD. NRAJ (Sakamoto) provided a presentation of both operating experience related to IASCC and associated research activities. The following next steps, or action items, were identified during the discussion of this topic.

Next Steps/Action Items

- NRC and NRAJ will continue to discuss the plans, status, and results of their research programs related to IAD.
- NRC will provide information on the test plans for the ANL program when it is completed.
- NRC (Rao/Hiser) will determine if information and results pertaining to the programs that are being conducted jointly (e.g., ZIRP, Zorita Weld Testing) can be provided to NRAJ once these programs are completed.
- NRC will provide answers to questions related to IASCC posed by NRAJ in email sent in mid-July.
- NRAJ provided references related to IASCC operating experiences that are in Japanese. NRC will determine if there is interest in obtaining any of these references for translation into English. NRAJ (Sakamoto) agreed to help the NRC determine interest by summarizing the content of these references if requested by the NRC.

Summary of Discussion on Possible Future Collaboration Areas

The following four topics were discussed to determine if there is mutual interest in pursuing future collaboration: peening, aging of cast austenitic stainless steel (CASS), environmentally assisted fatigue, and ex-plant material harvesting. For each topic, NRAJ and NRC provided a brief, high-level summary of related activities and identified ideas for future collaboration. These ideas were then discussed to determine if mutual interest exists and, if so, identify the next steps for pursuing collaboration.

1. Peening

NRC and NRAJ each provided presentations on the use of peening in their respective countries. The NRC presentation focused on the regulatory reviews currently ongoing to determine if inspection relief will be granted. NRAJ discussed possible research to evaluate the long-term effectiveness of peening. There was also discussion of the NRC's research to evaluate the effects of peening on crack initiation and growth. The following next steps, or action items, were identified during the discussion of this topic.

Next Steps/Action Items

- NRC will provide details of the test plan for their peening research.
- NRAJ will provide information on the method that the Japanese industry uses to measure residual stress.

- NRAJ will provide operating experience for peened components. Specifically, NRAJ will identify any instances where crack formed after peening or cracks that existed before peening grew after peening.
- NRAJ (Sakamoto) and NRC (Alley) will each develop a list of questions related to peening for the other side to answer.

2. Aging of CASS

NRC and NRAJ each provided presentations on CASS. The NRC presentation discussed recently completed and ongoing research related to thermal embrittlement and thermal embrittlement combined with irradiation embrittlement. The current regulatory position and ASME code activities were also summarized. The NRAJ presentation focused on past research that was used to verify the Japanese embrittlement prediction model. The NRC presentation also identified several ideas for collaboration that were discussed. The following next steps, or action items, were identified during the discussion of this topic.

Next Steps/Action Items

- NRC will verify that it has received all the JNES CASS. If not, NRAJ will provide any missing data
- NRC will provide information related to ASME Code Case 838. The Code Case and technical basis will be provided along with a list of questions for NRAJ to consider. NRC is interested in obtaining any feedback that NRAJ can provide on this Code Case.
- NRC will develop a list of questions related to CASS testing, operating experience, or regulatory treatment for NRAJ to answer

3. Environmentally Assisted Fatigue

NRC provided a presentation on environmentally assisted fatigue (EAF). The presentation addressed the regulatory requirements and regulatory treatment of this issue for nuclear power plants (NPPs) operating with their initial license, NPPs in license renewal, and new NPPs. Further, planned treatment for NPPs during the SLR period was also discussed. ASME code activities and recent research in this area were summarized and the significant Japanese contribution to this research was acknowledged. Discussion of future collaboration focused on sharing fatigue test data internationally. The following next steps, or action items, were identified during the discussion of this topic.

Next Steps/Action Items

- NRC will propose a CSNI-sponsored activity to develop an international fatigue database. This is the route that NRAJ prefers for sharing data
- NRC will summarize the method that was used to exchange data from EdF through an existing MOU with the French Regulator, ASN. NRAJ will consider using a similar approach to share fatigue data with EdF.

4. . Material Harvesting

NRC provided a presentation that summarizes a current project to develop a proactive plan for identifying opportunities to harvest ex-plant materials and components from decommissioned plants. There was also discussion about Japanese participation in an NRC-sponsored workshop on material harvesting that will be planned for 2017. NRAJ also developed a presentation on

material harvesting, but it was not presented due to time constraints. However, the presentation will be provided electronically to the NRC along with the other NRAJ presentations. The following next steps, or action items, were identified during the discussion of this topic.

Next Steps/Action Items

- NRC will provide the contractor report on the first phase of the material harvesting project to NRAJ when it is completed
- NRC (Hiser) will work with NRAJ (Sakamoto) to determine a mutually acceptable date and location for the material harvesting workshop
- NRAJ will attempt to get participation from Japanese utilities and other government organizations in the material harvesting workshop.

Summary of Discussion on Structural Concrete Issues

NRC and NRAJ presented research activities on four topics. These topics were discussed in detail during the parallel meeting of concrete issues. A summary of this meeting was also provided as part of the main meeting on the second day. The summary of the discussion and next steps, or action items, related to each topic follows.

1. Research on Radiation Effects on Concrete Structures

NRC presented the overall research activities on radiation effects on concrete. NRAJ presented test programs on radiation research. NRC and NRAJ mutually understand research activities on radiation effects on concrete structures. NRC and NRAJ also mutually agreed on the importance of modeling using the test results. Such results can be used to validate the model to predict material degradation and the FEM model for the assessment of structural safety significance for structures exposed to long term radiation. The following next steps, or action items, were identified during the discussion of this topic.

Next Steps/Action Items

- NRC & NRAJ will continue to share the information about research activities
- NRAJ research reports will be shared with the NRC (planned 2017).
- NRC and NRAJ mutually agreed to share intermediate and final research results and reports.

2. Overview of Aging Management and Life Extension of NPPs: NRC Activities and NRAJ Activities

Both NRC and NRAJ provided presentations to summarize the approach that each country follows. NRAJ was very familiar with the NRC's approach. NRAJ requires special safety checks before 40-60 life extension. In Japan, the licensees harvest several concrete cores from various locations for condition assessment before entering 40-60 years. Types of tests are determined by the industry and reviewed by NRAJ. Another feature of Japanese Plant Life Management (30-10-10), which is of interest to the NRC, is drilling holes and collecting dust from concrete structures for chemical evaluations (pH, carbonation, chloride etc.). The following next steps, or action items, were identified during the discussion of this topic.

Next Steps/Action Items

- NRC and NRAJ mutually agreed to continue discussion on future activities related to this topic

3. Monitoring and Aging Management of ASR Affected Concrete Structures

Both NRC and NRAJ provided presentations to summarize activities in this area. The NRAJ research program includes two activities. The first program is evaluating the susceptibility of aggregate for new constructions by both the JIS and RILEM methods. The second program is assessing the progress of ASR degradation in existing structures. The research is planned to be completed next year. NRC provided one presentation on operating experience related to ASR and another presentation on the research activities being conducted at NIST. This research focuses on existing structures affected by ASR. The NRC research will continue for next few years. The following next steps, or action items, were identified during the discussion of this topic.

Next Steps/Action Items

- NRAJ will share the results of their research in this area after the results have been published.
- NRC and NRAJ mutually agreed to exchange the research results and continue discussion on future activities

4. Research on Non-destructive Evaluations, Instrument/Sensor and Its Applicability for Thick Heavily Reinforced Concrete Structures

Both NRC and NRAJ provided presentations to summarize activities in this area. NRC does not have any current research related to NDE of concrete structures. NRC reviews NDE methods developed by the industry. As per the current practice, in US concrete is inspected visually. Based on the findings of visual inspections, NDE methods are applied as appropriate. Industry and DOE are developing methods and testing advanced techniques. NRC plans to conduct confirmatory review of these methods. Two NDE methods from NRAJ presentation are of special interest to the NRC. The first method is the estimation of the steel-plate-sandwich-section strength. The second method is the strength evaluation of high strength concrete ($>50N/mm^2$) in the prestressed concrete containment vessel. The following next steps, or action items, were identified during the discussion of this topic.

Next Steps/Action Items

- NRC and NRAJ mutually agreed to exchange information and continue discussion on future activities related to this topic

After discussion of the technical topics was completed, the next agenda item was to plan the next meeting to discuss materials aging issues. The next meeting will be held in Tokyo, Japan. Both sides agreed to search for a mutually acceptable date between November 2017 and February 2018. NRAJ is open to any date within this window. Therefore, NRC will propose the date. If possible, the date will be selected to allow participation in any other materials meetings being held in Asia during this timeframe. NRAJ also indicated that meeting after April 2018 could be advantageous because all the end-of-fiscal-year technical reports are submitted in March. A meeting after April 2018 will be pursued only if it is not possible to schedule a meeting during the November 2017 – February 2018 window. Both NRAJ and NRC will continue to meet on specific topics before this next bilateral meeting as opportunities arise.

The meeting closed with both sides confirming the significant value of discussion and collaboration on materials degradation issues. It is desirable to strengthen this partnership even further in the future.

AGENDA

NRC/NRAJ Bilateral Meeting on Materials Issues

NRC Headquarters, Rockville, MD, USA
August 8 - 9, 2016

Monday, August 8th, 2016
Location: Room O7-B4

Time	Topic	Speaker
8:00 am	Introductions	All
8:05 am	Welcome	B. Thomas, NRC
8:15 am	Opening Remarks	R. Tregoning, NRC K. Sakamoto, NRAJ
	Cable Aging	
8:30 am	NRC Research Activities	D. Murdock, NRC
9:30 am	NRAJ Research Activities	T. Minakawa, NRAJ
10:30 am	Break	
10:45 am	Technical and Regulatory Concerns	All
12:00 pm	Lunch	
	Metals Aging	
1:30 pm	RPV embrittlement studies	M. Gordon, NRC K. Sakamoto, NRAJ
2:45 pm	Break	
3:15 pm	Irradiated Assisted Degradation	A. Rao, NRC K. Sakamoto, NRAJ
4:15 pm	Technical and Regulatory Concerns	All
5:00 am	Adjourn	

AGENDA

NRC/NRAJ Bilateral Meeting on Materials Issues

NRC Headquarters, Rockville, MD, USA
August 8 - 9, 2016

Tuesday, August 9th, 2016
Location: Room O7-B4

Time	Topic	Speaker
	Possible Future Collaboration Areas	
8:00 am	Peening	R. Tregoning, NRC K. Sakamoto, NRAJ
8:30 am	Aging of CASS	P. Purtscher, NRC K. Sakamoto, NRAJ
9:00 am	Environmentally Assisted Fatigue	R. Tregoning, NRC
9:30 am	Material Harvesting	M. Hiser, NRC K. Sakamoto, NRAJ
10:00 am	Break	
10:15 am	Summary of Concrete Discussions	M. Sircar, NRC M. Nakano, NRAJ
11:15 am	Actions and Next Meeting	All
11:45 am	Closing Remarks	B. Thomas, NRC K. Sakamoto, NRAJ
12:00 pm	Adjourn	

AGENDA

NRC/NRAJ Bilateral Meeting on Concrete Issues

NRC Headquarters, Rockville, MD, USA
August 8 - 9, 2016

Monday, August 8th, 2016
Location: Room O7-B2

Time	Topic	Speaker
8:00 - 8:30 am	Participate in the Main Meeting	All
8:30 - 8:45 am	Move to Room O7- B2	
8:45 - 10:30 am	Research on Radiation Effects on Concrete Structures	M. Sircar, NRC M. Nakano, NRAJ
10:30 - 10:45 am	Break	
10:45 - 12:00 pm	Continue Radiation Effects on Concrete Structures and Possible Collaboration	M. Sircar, NRC M. Nakano, NRAJ
12:00-1:30 pm	Lunch	
1:30 - 3:00 pm	Overview of Aging Management and Life Extension of NPPs: NRC Activities and NRA Activities	M. Sircar, A. Prinaris NRC M. Nakano, NRAJ
3:00 - 3:30 pm	Break	
3:30 - 5:00 pm	Monitoring and Aging Management of ASR Affected Concrete Structures	J. Phillip, A. Buford NRC M. Nakano, NRAJ

Tuesday, August 9th, 2016
Location: Room O7-B2

Time	Topic	Speaker
8:00 - 9:00 am	Research on NDE, Instrument/Sensor and Its Applicability for Thick Heavily Reinforced Concrete Structures	M. Sircar, NRC M. Nakano, NRAJ
9:00 -10:00 am	Recap and Review Summary	All
10:00 - 10:15 am	Break	
10:15 - 11:15 am	Summary of Concrete Discussion in the Main Meeting	M. Sircar, NRC M. Nakano, NRAJ

ATTENDANCE LIST

NRC/NRAJ Bilateral Meeting on Materials Issues
NRC Headquarters, Rockville, MD, USA
August 8 - 9, 2016

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Note to requester: This email is the attachment to the previous email record. (KD)

From: IchiroKOMURA
Sent: Tue, 7 Feb 2017 09:26:02 +0900
To: Prokofiev, Iouri
Subject: [External_Sender] FW: more thoughts: Reflections on PARENT 13 Meeting
Attachments: ATT00001.txt

Dear Iouri,

Can I distribute the attached document you sent me to the people of NRA, MHI, other electric power company in Japan, and University ?

Ichiro

From: Prokofiev, Iouri [mailto:Iouri.Prokofiev@nrc.gov]
Sent: Thursday, February 2, 2017 9:47 AM
To: IchiroKOMURA
Cc: Lin, Bruce; Iyengar, Raj
Subject: more thoughts: Reflections on PARENT 13 Meeting

Good Morning Dear Ichiro,

Thank you very much for taking the initiative and accelerating the process with the Scope of Work preparation. I am working with topics related to 3) and 2).

I have two personal questions:

1. What do you think about this - will it be interesting for JAPEIC/NRA activity with Harvesting (please see the Attachments)?
2. I read *The Mainichi, 2016-12-20; Japan: Gap emerges between gov't, private sector over Monju reactor* and my question is -- did you or our NDE MHI colleagues have experience with components of Fast Reactors examination?

I have really enjoyed knowing and working with you during these past years. It has been a privilege for
(b)(6) me. [redacted]
(b)(6) [redacted]

Always my Best regards,
Iouri

From: Lin, Bruce
Sent: Wednesday, February 01, 2017 1:39 PM
To: IchiroKOMURA <komura-ichirou@japeic.or.jp>; Prokofiev, Iouri <Iouri.Prokofiev@nrc.gov>
Subject: RE: RE: Reflections on PARENT 13 Meeting

Dear Ichiro,

Ryan and I are working on the draft work scope for the follow on project. We are hoping to get that out to PARENT members for review soon. Based on PARENT 13 meeting, the three potential topic areas are: 1) NDE Modeling and Simulation, 2) Flaw Relevance Evaluation, and 3) Material Degradation Monitoring.

From NRC perspective, there is strong support for tasks 1 and 2. However, at this point, there is no decision on the follow on project yet. We need to finalize the work scope and then present to the management for approval. It is likely there will be a gap between the end of PARENT extension and the start of the follow-on project. If we don't have an agreement in place prior to the end of PARENT extension, we can continue to work on putting the agreement in place.

Regards,
Bruce

From: IchiroKOMURA [mailto:komura-ichirou@japeic.or.jp]
Sent: Tuesday, January 31, 2017 3:01 AM
To: Prokofiev, Iouri <Iouri.Prokofiev@nrc.gov>; Lin, Bruce <Bruce.Lin@nrc.gov>
Subject: [External_Sender] RE: Reflections on PARENT 13 Meeting

Dear Iouri and Bruce,

Today, I am sending this e-mail to you for requesting to hear your supposition about the schedule for starting the Follow-on Project.

PARENT Extension is scheduled to finish at the end of July in this year. I think that the Follow-on Pj would not be fixed at that time.
In the PARENT-13 meeting, Iouri said that all the organization would work for discussion and planning about Follow-on Pj under the umbrella agreement with NRC. How do you think/schedule the period between the end of PARENT Extension and the decision or the starting of Follow-on Pj ?

(b)(6)

I would like to hear your opinion, if it would be temporary plan.

Best regards,
Ichiro

Note to requester: Attachment is immediately following.

From: Tregoning, Robert
To: Purtscher, Patrick; Hiser, Matthew
Subject: FW: RE: Harvesting workshop
Date: Friday, January 13, 2017 7:42:08 AM
Attachments: Material Harvesting_Sakamoto_2016.08.08.pdf

Pat/Matt:
See below for the JNRA response. I've also attached the short presentation that they gave in August. This short talk appears more consistent with a session 1 type talk, but it sounds like from their email that they do not want to be a panelist. Therefore, maybe their brief presentation should be put in Session 2. Thoughts?
RT

Robert Tregoning
Technical Advisor for Materials
US Nuclear Regulatory Commission
Two White Flint North, M/S T-10 A36
11545 Rockville Pike
Rockville, MD 20852-2738
ph: 301-415-2324
fax: 301-415-6671

From: 坂本 一信 [mailto:kazunobu_sakamoto@nsr.go.jp]
Sent: Thursday, January 12, 2017 7:12 PM
To: Tregoning, Robert <Robert.Tregoning@nrc.gov>
Cc: 田口 清貴 <kiyotaka_taguchi@nsr.go.jp>; 小山 正邦 <masakuni_koyama01@nsr.go.jp>; 小澤 正義 <masayoshi_ozawa@nsr.go.jp>
Subject: [External_Sender] RE: Harvesting workshop

Rob,
I hope you and your family members had a restful and wonderful holidays.
As for the workshop, the discussion between regulatory side and industries/METI(having similar function with DOE in the U.S.) has not started in Japan. So, our motivation may be different from the one of the industry side.
Under such circumstance, I will be able to touch on our interest/motivation for the harvesting as a really short presentation. However, our organization has not established concrete plans at all. So my presentation may be almost identical (within 10 minutes) to the one I did at bilateral meeting with you in last August.
Anyway, please understand that the objective of NRA's participation this time is not take initiative of the discussion as a panelist but correct international members' perspective on this matter.
Best,
Kazu

From: Tregoning, Robert [mailto:Robert.Tregoning@nrc.gov]
Sent: Friday, January 13, 2017 6:17 AM
To: 坂本 一信 <kazunobu_sakamoto@nsr.go.jp>
Subject: Harvesting workshop

Kazu:
I hope that the New Year is treating you and your family well. I just want to reach out to you again about the our harvesting workshop in early March. I know that you are working on CRIEPI and other organizations in Japan to discuss your participation in the workshop. I would be particularly interested if the Japanese perspective can be provided with a presentation in one or more of the following five workshop sessions: Session 1, 2, and/or 5. As mentioned in an earlier email, here's a summary of the approach and format for these

sessions:

- Session 1 will consist of short presentations and a panel discussion on the motivation for harvesting.
- Session 2 will discuss data needs best met through harvesting.
- Session 5 will consist of short presentations that will attempt to summarize the workshop and planning a harvesting program, as well as discuss actions and next steps

We plan on working closely with all presenters so that we all have similar ideas about the objectives of the workshop as a whole and then the objectives of each session. I'm hopeful that there will be Japanese representation within one or more of these sessions.

Please let me know if you have any questions about the workshop or the sessions that you would like more information on to help with your discussions among the various Japanese organizations.

Thank you for your help, and I wish you all the best,

Rob

Robert Tregoning
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fax: 301-415-6671

Material Harvesting

U.S.NRC-S/NRA/R Bilateral Meeting on Materials Issues
NRC Headquarters, Rockville, MD,
August 8 - 9, 2016

Kazunobu SAKAMOTO

**Division of Research for Reactor System Safety,
Secretariat of Nuclear Regulation Authority
(S/NRA/R)**

Background

- A variety of studies regarding material aging such as prediction of degradation and evaluation method for aged SSCs were carried out so far, and those results were reflected to regulatory activities.
- Past studies mainly relied on accelerated aging test. Hence, the possibility of deviation from degradation of actual plant cannot be denied.
- The number of retiring unit is increasing.

Objective

To confirm the adequacy (conservatism) of past results of safety research programs applied in the PLM review and the license renewal review using materials from decommissioned plants.

- RPV steel
- CASS (PWR: MCP, RCP casing　BWR：PLR pump casing)
- Electrical and I&C equipment (Cable, polymer material)
- Anchor bolt
- Concrete, etc.

Candidate and its current status

Irradiation embrittlement of RPV

- Evaluate the material toughness at the EOL using prediction equation of RPV embrittlement. And confirm the toughness by surveillance test.
- Prediction equation for the decrease in upper shelf energy of irradiated RPV steel was developed through regulatory research.

Thermal aging of CASS

The concept of prediction method for the decrease in material toughness developed in the regulatory research is utilized in the structural integrity assessment of the piping system with a postulated crack at the EOL.

Electrical and I&C equipment (Cable, polymer material)

Result of regulatory research obtained from specimens treated simultaneous thermal & radiation aging is utilized in the utility's assessment of cable integrity.

Anchor bolt (Degradation of polymer and others)

Characteristics of degradation beyond 30 years operation are not clear.

Deterioration of concrete strength

Regulatory research program is ongoing focusing on composite degradation (neutralization, salt damage and temperature), irradiation and alkali aggregate reaction.

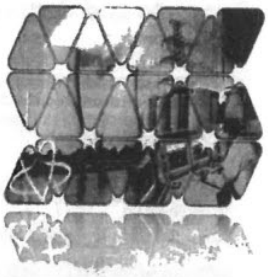
Thank you!

Note to requester: This presentation, and the next 2 presentations, were provided to the FOIA team in paper. These are the best quality scans available.

LWRS U.S. DEPARTMENT OF ENERGY Nuclear Energy

EPRI ELECTRIC POWER RESEARCH INSTITUTE

Electrical Cables – Aging Management Research Joint EPRI-LTO DOE-LWRS Presentation to ACRS November 17, 2015



Keith Leonard
LWRS Program Materials Aging and Degradation Pathway Lead

Sherry Bernhoft
EPRI LTO Program Manager

EPRI Research in Electrical Cables

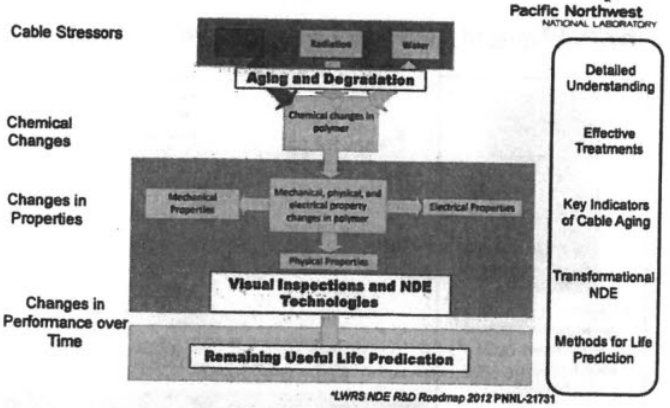
- Aging of cable insulation materials due to radiation, temperature and submergence
- EPRI Technical Reports:
  - ✓License Renewal Electrical Handbook
  - ✓Cable Aging Reports
    - ✓Low voltage thermal/radiation
    - ✓Low and Medium voltage wet/submerged failure mechanisms
  - ✓Medium and Low Voltage Aging Management Implementation Guidelines
  - ✓Cable Testing Guidelines
  - ✓In-containment Radiation and Temperature Measurements

Electrical cable systems are performing well and tools exists for aging management.

EPRI

Cable Program Summary

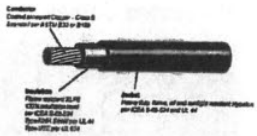
Pacific Northwest NATIONAL LABORATORY



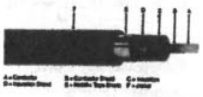
*LWRS NDE R&D Roadmap 2012 PNNL-21731

OAK RIDGE EPRI USNRC

Cables Types

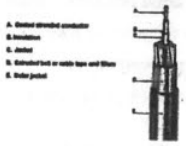


Low-voltage cable <2 kV



Medium-voltage cable 5-46 kV

Instrument Cable



Control Cable

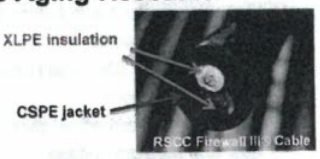
EPRI

Materials Focus on Cable Aging Research

Applications
- Instrument and Control (81%)
- Power Cables (15%)
- Communication (5%)

Insulation
- XLPE - cross-linked polyethylene
- EPR - ethylene-propylene rubber
- Silicone Rubber (SiR)

Jacketing
- Hypalon® - Chlorosulfonated polyethylene (CSPE)
- Neoprene - Polychloroprene
- CPE - Chlorinated polyethylene elastomer
- PVC - Poly(vinyl chloride)



Cables in US Plants
36% of cables are XLPE
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5% of cables are SiR

Cables in Containment
90% of units have XLPE
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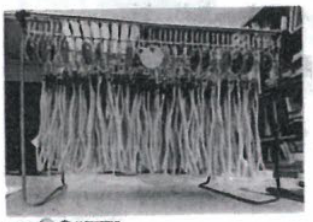
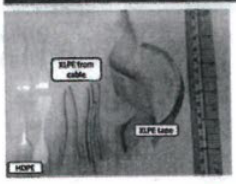
Separate and Synergistic Thermal / Irrad. Aging

Method /Approach
- Coordinated, accelerated aging of harvested cable insulation/jacket materials that are representative of current NPP systems
- Electrical and mechanical characterization to determine key factors in cable aging
- XLPE and EPR materials tested





Synergistic Testing Conducted on Harvested Cables

- Insulation and jacket samples produced from harvested cables from decommissioned NPP's
- Remaining useful life determination
- *Callaway control rod cable*
  - Hypalon jacket with EPR insulated wires
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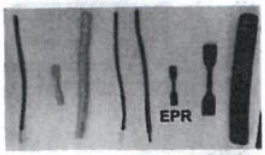
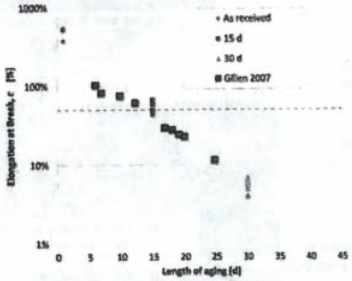


Callaway

Thermal Aging of Callaway Control Rod Cable Jacket

Elongation at break (EAB) measured with Instron 4465 Tensile Tester according to IEC/IEEE 62582-2



EAB with respect to length of aging in air at 125°C

Good agreement possibly indicates little evidence of aging since 1984 installation: Additional condition verification of Gillen 2007 and Callaway under way

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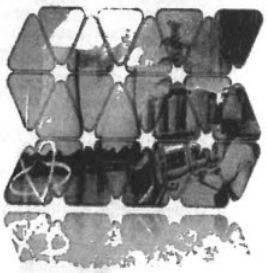

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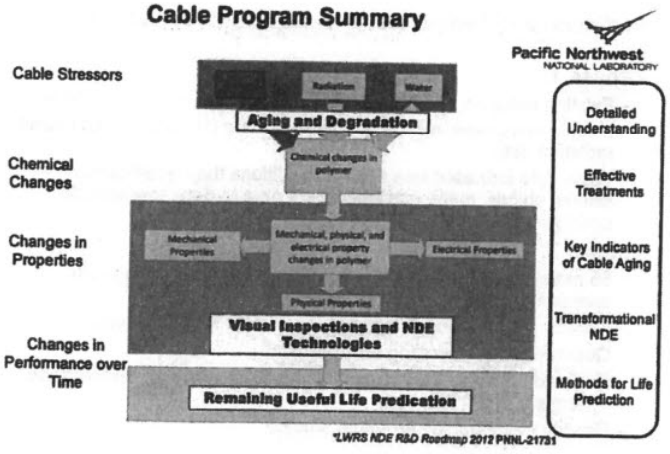
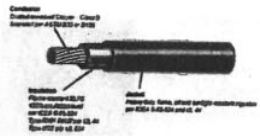
Cable Program Summary



*LWRS NDE R&D Roadmap 2012 PNNL-21731

Cables Types



Low-voltage cable <2 kV

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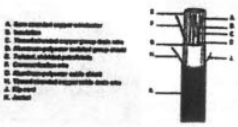
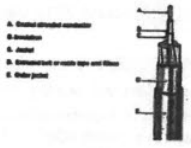


Instrument Cable



Control Cable

Primary Aging Stressors for Cable Type

Low Voltage (LV) Cables (<2kV)	Medium Voltage (MV) Cables (< 46 kV)
Major aging concerns ▪ Thermal >50° C ▪ Radiation >200 kGy (20 Mrad)	**Major aging concerns** ▪ Electrical stress induced degradation : water treeing, partial discharge in splices or terminators
Lesser Aging Concerns ▪ Chemical ▪ Polymer stability in water	**Lesser Aging Concerns** ▪ Thermal ▪ Radiation ▪ Ohmic heating ▪ Chemical
Low voltage cables age more thermally due to thinner insulation layer	

Nuclear Power Plant Cable Aging Management Strategy

- **Evaluate for susceptibility** – focus on rooms/areas with highest temp and highest radiation. Also give special attention to most safety critical components. Select samples for test if signs of aging are seen
- **Visual walk-down** looking for visible indications on jackets.
- **Tan-Delta and Withstand Testing for MV and Insulation Resistance for LV (and unshielded MV)** looking for worst case areas of degradation on sample of cables.
- **Local specific NDE** (indenter, capacitance, UT, ...) at local area identified with bulk tests.
- **Repair/replace** where indicated. Extend evaluation to other similar areas and the next most severe locations. Take additional actions based on visual/specific evaluations

Condition Monitoring: Tan δ Testing Shielded Medium Voltage Cable

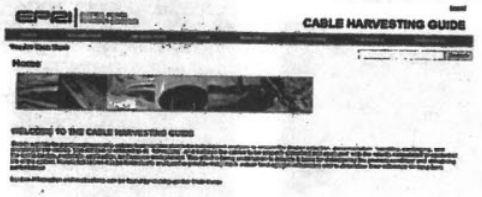
- Tan δ testing is used to evaluate shielded medium voltage cable
- Applying EPRI Tan δ acceptance criteria will identify degraded cable insulation due to water treeing or thermal damage in MV cables, cable terminations and splices
- EPRI collects member test data since 2009 to evaluate effectiveness
- Report 1025262-June 2012 validated assessment criteria
- Report 3002005321-September 2015
  - Degraded cables, wet and dry, identified by tan δ
  - Failure mechanism confirmation of tan δ results of cables that tested in severely degraded criteria
  - No failures of cables with good or slightly degraded tan δ

Radiation and Temperature Assessment for Cables

- Phase 1:
  - Existing radiation and temperature data collected from US NPPs
  - Limited responses, mostly temperature data (14 plants) with limited radiation data
  - While data indicated less severe conditions then qualification lifetime values, there was insufficient data to draw any specific conclusions
- Phase 2:
  - 55 radiation and temperature monitors have been installed in containment and other high thermal/radiation areas
  - Collect data radiation and temperature data for a fuel cycle
  - Quantify cable "operating environment"
  - Evaluate collected data to see if it can inform inverse temperature, synergistic effect research
  - Provide methodology for future studies

Harvesting of Cables

- Harvesting of aged cables provides valuable research data:
  - Crystal River 3
  - Zion
  - International (Krsko and Ringhals) may have cables available from cables replacement work
  - Evaluating other harvesting opportunities
- Cable Harvesting guide issued (3002002994)



DOE / LWRS Research in Electrical Cables

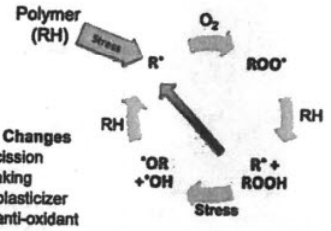
- Synergistic and inverse temperature effects due to thermal and radiation degradation
- Diffusion limited oxidation in LOCA tests
- Dose rate effects
- Limitations of activation energy values
- NDE (key indicators, methods)

Addressing Gaps in the Expanded Materials Degradation Assessment

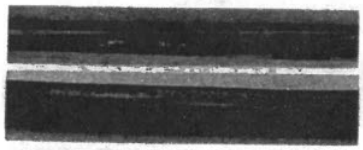
Research and experimental test develops data on key factors and synergies contributing to cable degradation from which predictive models can be developed to evaluate actual cable lifetimes.

Multi-variable Environmental Effects on Cable Insulation

Environmental Stressors
- Radiation (UV, gamma)
- Thermal
- Mechanical (tensile, vibration)
- Moisture

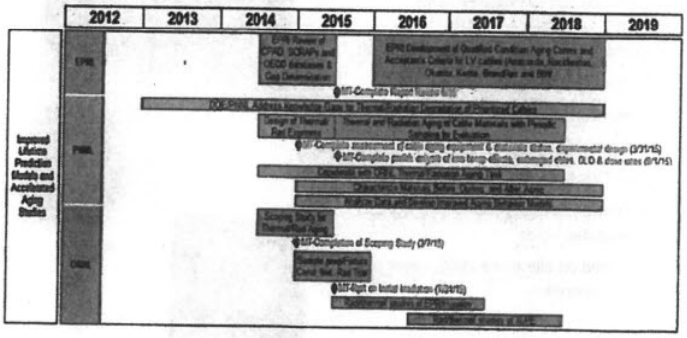


Chemical Changes
- Chain scission
- Cross-linking
- Loss of plasticizer
- Loss of anti-oxidant



Property Changes
- Mechanical
- Electrical
- Physical

Improved Lifetime Prediction Models and Accelerated Aging Studies



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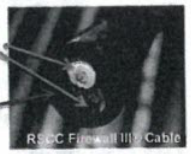

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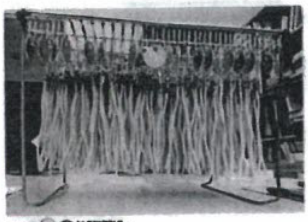

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Callaway

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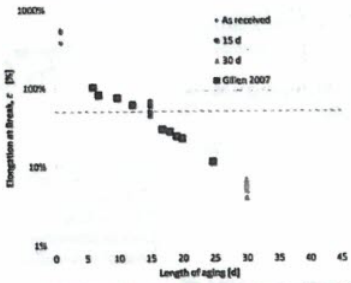


EAB with respect to length of aging in air at 125°C

Good agreement possibly indicates little evidence of aging since 1984 installation: Additional condition verification of Gillen 2007 and Callaway under way

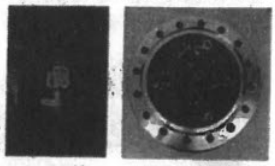
Combined Exposure Experiments at PNNL

PE Samples inside source cone—highest dose (>1kGy/h)

Each row achieves a distinct dose rate at constant temperature

Cable Irradiation Aging at ORNL (Dose Rate and Effects of Oxygen)

- Co-60 irradiator
  - 60 day irradiation
  - Dose rate 140 Gy/hr
  - Accumulated doses of 50, 100, 150 and 200 kGy.



Sample canister and sample arrangement for insertion into Co-60 irradiation

- HFIR - Gamma Irrad. Facility
  - 10 day irradiation cycle
  - Dose rate 410 Gy/hr
  - Accumulated doses of 20, 50, 80 and 100 kGy

Sample holder for high dose GIF exposures

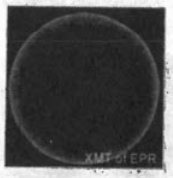
Data at multiple dose rates and accumulated doses provide fundamental information for model development

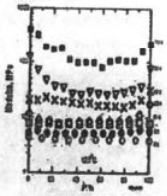
Inhomogeneous Aging Study
Understanding of Mechanisms

- Diffusion Limited Oxidation
- Nucleation of Degradation
- Effect of Sample Geometry

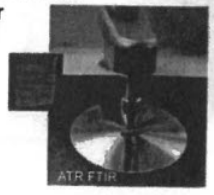
Microstructure Analysis
Imaging and Quantifying Degradation

- Defect mapping
  - X-ray microtomography
- Chemical mapping
  - TOF-SIMS/XPS
  - X-ray diffraction
  - FTIR/Raman
- Mechanical mapping
  - Nanoindenter





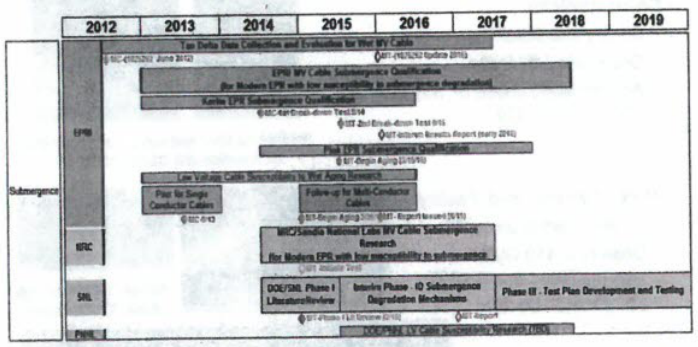
*NUREG/CR-7153, Vol. 6



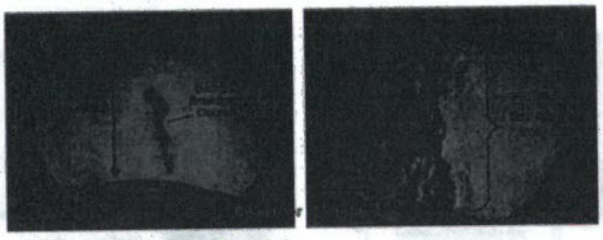
ATR FTIR

Nanoindenter

EPRI and NRC Coordinated Research Effort on Submergence Research



Water Treeing: Cable Degradation in Wet Environments



- Water Treeing, conditions needed:
  - Voltage stress > 0.8 kV/mm
  - Water or high humidity
  - Polymer
- Medium voltage typically operates > 1 kV/mm
- Low voltage typically operates < 0.2 kV/mm

Only Medium Voltage Cables Water Tree

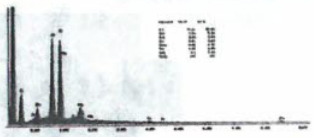
Understanding Water Treeing

- Failure Mechanism Research Report 3002005323, Update 7 (August 2015)
- Completes wet failure mechanism research
- Confirmation that defects in EPR are identified by tan δ testing

- Pink EPR, 8 kV, manufactured 1979-80
- Water tree root contains metallic elements
- Metallic elements act as catalyst for water tree growth

Optical photomicrograph of CTL-G bow-tie tree

FE-SEM image of CTL-G wafer water tree

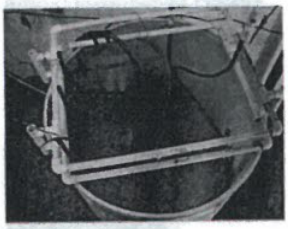


EDX spectrum of the area in question

Qualifying MV Cables For Submergence

- **MV Cable Submergence Qualification-Supplemental Project**
  - –Attempting to accelerate aging via high frequency and high voltage to obtain "accelerated aging factor" for submergence
  - –Brown ethylene propylene rubber cable is 2+ years aging, complete in 2016 or 2017
  - –Pink ethylene propylene rubber cable complete in 2018
  - –Power law used to determine aging factor

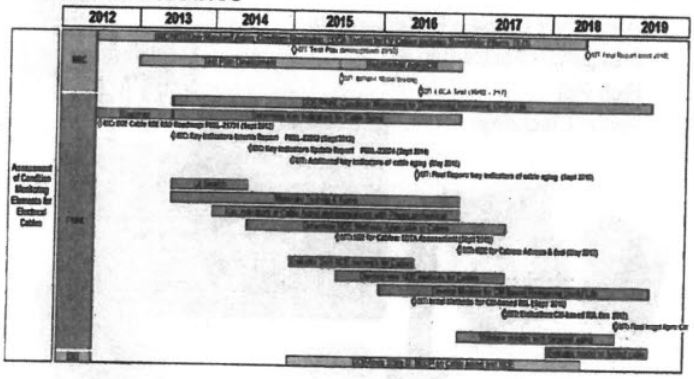
Qualified Life= (Operating Time) + (Accelerated Aging Time X Aging Factor)



Researching Low Voltage Cable Wet Aging

- Low voltage wet susceptibility study: Do LV cables wet age?
  - Pilot study: No issue with Cross-linked polyethylene
  - Possible issue with ethylene propylene rubber insulations, however
  - Follow-up study will look at jacketed, multi-conductor cables with no thermal or insulation physical damage
  - 1 year aging at 90°C water temp, AC and DC voltages
  - Results of Pilot and follow-up published in late 2016

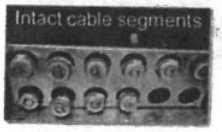
Assessment of Condition Monitoring Elements for Electrical Cables



Non-Destructive Evaluation (NDE) of Cable Remaining Useful Life

Pacific Northwest NATIONAL LABORATORY

- Coordination of Aging and NDE
- Sensitivity analysis of key indicators
- Correlation of destructive and non-destructive data
- Assessment of NDE methods



Condition-Monitoring Techniques for Electric Cables Used in NPPs

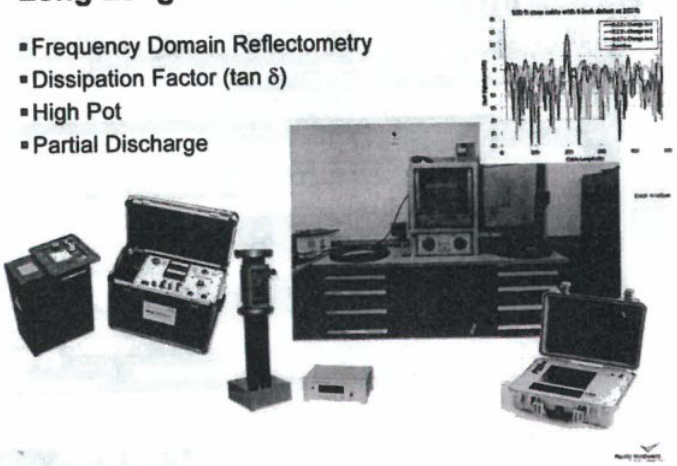
(NRC Reg Guide 1.218)

Test	Applicability	Ends	Damage	Comment
DC High Pot/ Step Voltage	Cable – 2/C	Both	Maybe	Not trendable
Very Low Freq. Tan-Delta	Cable – C/S	Both	Maybe	Common for Med Voltage Cable
Visual / Illum. Borescope	Visible exterior	No	No	Not quantitative
Indenter	Local Jacket	No	No	Trendable
Dielectric Loss Dissipation	Cable – 2/C	Yes	No	Not for long/lrge cble
Insulation Resistance	Cable – 2/C	Both	No	Not trendble/uncrtain
Partial Discharge	Cable – 2/C	Both	Yes	Locates weak point
Time Domain Reflectometry	Cable – 2/C	Both	No	Limited val for insul.
Frequency Domain Reflectometry	Cable – 2/C	Maybe	No	Can ID local flaws
IR Thermography	Under load	No	No	Weak signal for insul.

2/C=2 conductors required
C/S=Co-ax conductor & shield

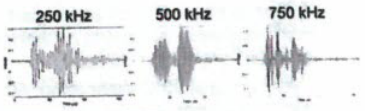
Long Length Cable Measurements

- Frequency Domain Reflectometry
- Dissipation Factor (tan δ)
- High Pot
- Partial Discharge



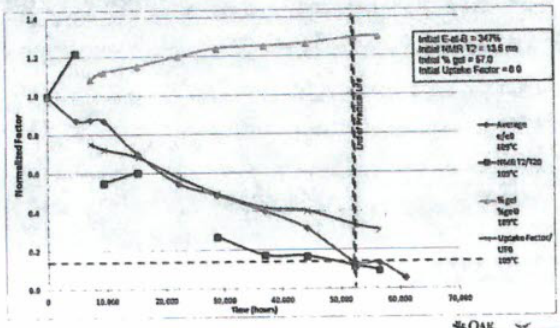
Local Spot Measurements

- Indenter
- Capacitance
- Acoustic
- Dielectric Constant

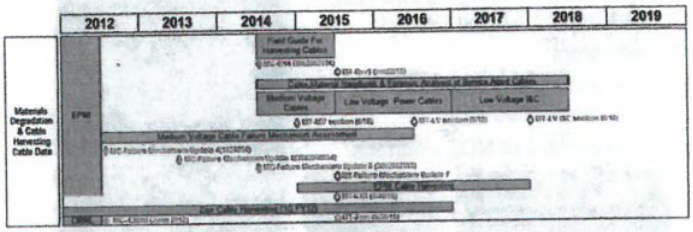


Condition Monitoring: Use of Aging Models to Determining Qualified Condition

- Through correlating cable history with NDE and other examination methods, a better picture of cable aging and remaining useful life begins to emerge.

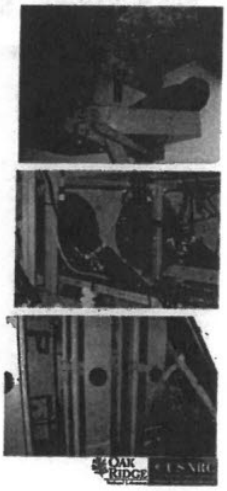


Materials Degradation & Cable Harvesting Cable Data



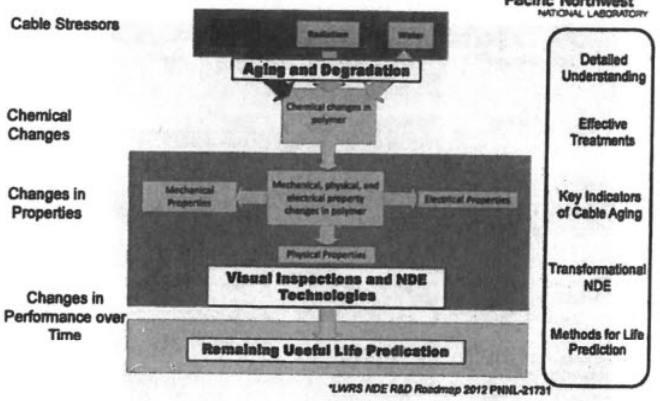
Harvesting of Service Aged Cables: Zion Unit 1 and 2

- LWRS and NRC have requested sets of low voltage cables from the Zion Station Units 1 and 2 for harvesting -
- Following EMDA recommendations for service aged cables.
- Current Work: Six 25 to 30-ft lengths of Control Rod Drive Mechanism power and position indicator cables, harvested from Unit 1 in 2012 . Testing of the NRC cables has begun at the National Institute of Standards and Technology.
- Spring 2016: Six sets of 20 to 60-ft length cables to be harvested from Zion Unit 2.
- Cable exposure conditions of interest:
  - Thermal : steam tunnels
  - Thermal / radiation : in-containment cables
  - Benign environment (cable spreading room) : baseline comparison



Cable Program Summary

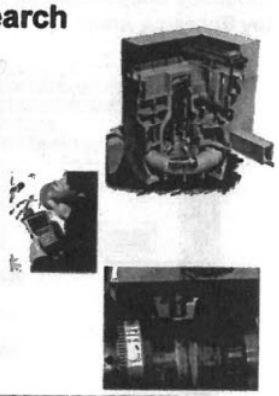
Pacific Northwest NATIONAL LABORATORY



*LWRS NDE R&D Roadmap 2012 PNNL-21731

Conclusion from the Research

- ✓ Technical basis is established and in use for aging management
- ✓ Continuous improvements based on research results, inspections and operating experience
- ✓ Coordination and collaboration with global research partners



No show stoppers have been identified based on R&D to date.

Questions

Existing Nuclear Sector- Medium Voltage Cable Research

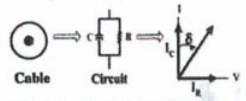
Research Area	Subject	EPRI Report
Cable Aging Management	Aging management program guidance and harvesting guide	3002000557, 102107, 3002002994
Condition Monitoring-	Test applicability matrix: Tan Delta test evaluations:	1022969 1025262, 3002005321
Stressor/Degradation Modes-MV Cable Failure Mechanism Research	Evaluation of wet aging of various MV cable types	1018777,1021069, 1022965, 1024894, 3002000554, 3002002993, 3002005323
Mitigation- Life cycle management	End of life guide for MV cable and accessories Black EPR Rejuvenation	1025259 3002000551
Operating Environments and Improved Condition Monitoring-Cable LTO Research	In-containment radiation and temperature data, Kema On-Line PD measurement	3002000816, 3002003001

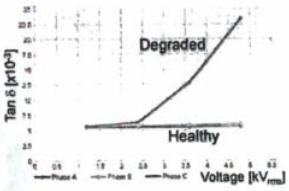
Existing Nuclear Sector- Low Voltage Cable Research

Research Area	Subject	EPRI Report
Cable Aging Management	Aging management program guidance and harvesting guide	1020804, 1021629, 3002002994
Condition Monitoring- Cable Testing	Test applicability matrix: LIRA testing:	1022969 1015209
Stressors and Degradation Modes and Condition Monitoring- LV Cable Failure Mechanism Research	Adverse environment, indenter, visual tactile, acceptance criteria, polymer condition monitoring date (CPAD, NEPO)	TR-109619, TR-104075, 1001391, 1008211, 1011874, 1011873
All- Training	Low voltage training course, CBT on visual tactile, ALEE	Held every July in CLT 1022979
Operating Environments - Cable LTO Research	In-containment radiation and temperature data	3002000816 (phase I). Phase II in progress

NDE Tools: Effective in Detecting Degradation

Tan δ: loss angle / dissipation factor

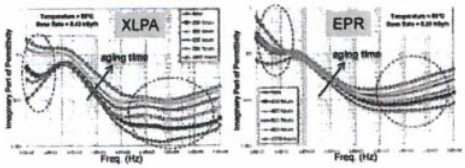




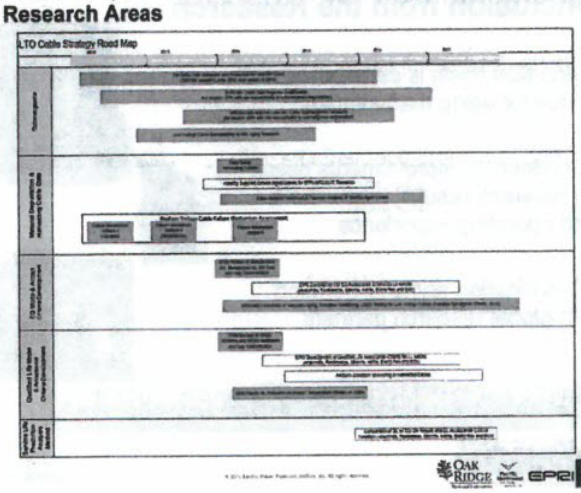
- Healthy cable: I_c is large and Tan δ is small.
- Defects change the capacitive/resistive nature of the insulation resulting in increased Tan δ values.

Low Voltage Dissipation Factor/Spectroscopy

- Advance results indicate potential for aging assessment (thermal, radiation) for any multi-conductor or shielded cable - *adaptable for different insulation materials.*



Continued Cooperation on Joint R/D Roadmaps Developed for Key Research Areas



Research for Safe Long-Term Operations

Joint EPRI-LTO DOE-LWRS Presentation to ACRS November, 2015

Sherry Bernhoft, EPRI Program Manager

Robin Dyle, EPRI Senior Technical Executive

Richard Reister, DOE Program Manager

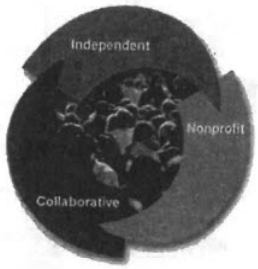
Keith Leonard, LWRS Program Materials Aging and Degradation Pathway Lead

Three Key Aspects of EPRI

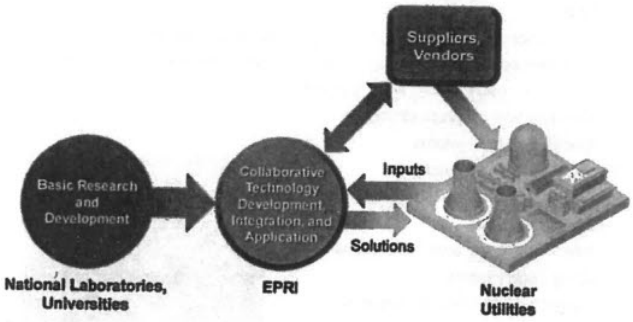
Independent
Objective, scientifically based results address reliability, efficiency, affordability, health, safety and the environment

Nonprofit
Chartered to serve the public benefit

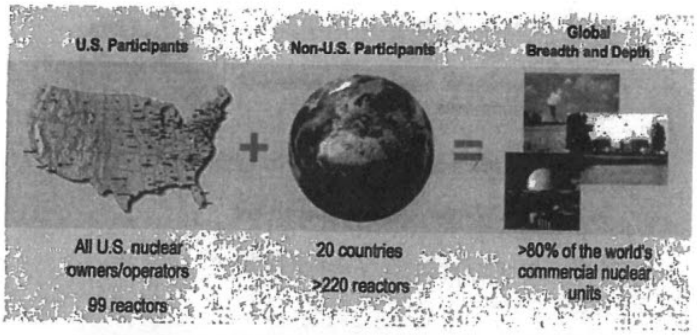
Collaborative
Bring together scientists, engineers, academic researchers, industry experts



EPRI Collaborative Approach

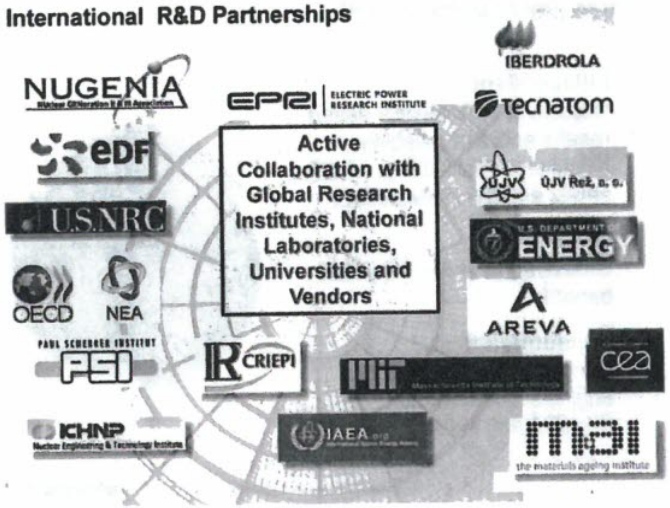


Nuclear Collaboration

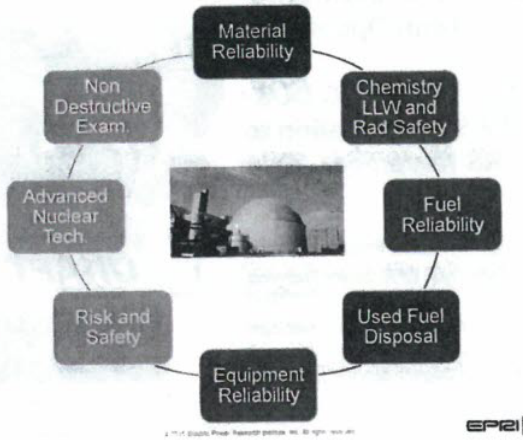


We collect 1 YEAR of operating experience EVERY DAY!

International R&D Partnerships

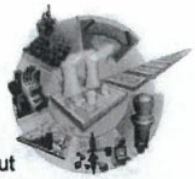


Nuclear Sector Technical Areas ($170M/yr.)



EPRI LTO Program Goals and Objectives

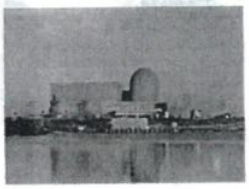
- Technical basis for ***decision*** to operate through extended life time
  - Supports business case for life extension and refurbishments
- Technology to ***manage*** plant assets throughout the lifetime
  - Aging management, asset management and risk management
  - Addresses safety, performance and costs



On track to provide program deliverables in the 2014 through 2019 timeframe.

EPRI LTO R&D Projects

- Aging Management Research
  - RCS primary system metals
    - Advanced welding for highly irradiated materials –repair strategy
    - Advanced radiation resistant materials - future replacement strategy
  - Reactor pressure vessel embrittlement
  - Concrete and concrete structures
  - Electrical cable systems
- Opportunity for Modernization
  - Centralized on-line monitoring
  - Advanced I&C
  - Enhanced safety and risk analysis
- Enabling Technologies
  - Integrated Life Cycle Management
  - Plant Demonstration Projects



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Light Water Reactor Sustainability (LWRS) Program

Program Goal

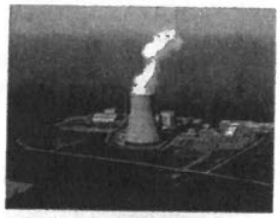
- Develop fundamental scientific basis to allow continued long-term safe operation of existing LWRs (beyond 60 years) and their long-term economic viability

Developing technologies and other solutions to

- Enable long term operation of the existing nuclear power plants
- Improve reliability
- Sustain safety

Focus areas

- Materials Aging and Degradation
- Advanced Instrumentation and Controls
- Risk-Informed Safety Margin Characterization
- Reactor Safety Technology



Nine Mile Point Courtesy Constellation Energy

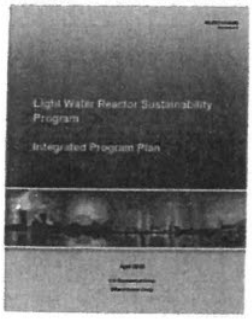
U.S. DEPARTMENT OF ENERGY
Nuclear Energy

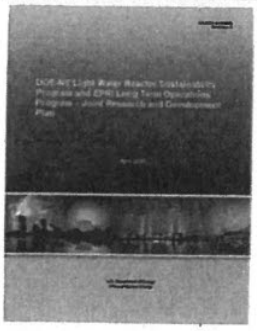
Light Water Reactor Sustainability – Federal Government Role

- National strategic interest in the long-term operation of existing plants
  - Supports the Administration's Climate Action Plan and Clean Power Plan
  - Supports energy security
  - Avoids higher cost to ratepayers for new plant replacements
- Addresses fundamental scientific questions where private investment or capabilities are insufficient to make progress on broadly applicable technology issues
- Government (DOE and its national laboratories) holds a large theoretical, computational, and experimental expertise in nuclear R&D
- Benefits will extend to next generation of reactor technologies
- Federal program reduces uncertainty and risk to provide incentives for industry to make long-term investments
- Industry also has an incentive, so cost-sharing is being employed

U.S. DEPARTMENT OF ENERGY
Nuclear Energy

LWRS Program Planning and Coordination/Integration





LWRS Planning Document available at www.inl.gov/lwrs

U.S. DEPARTMENT OF ENERGY
Nuclear Energy

Materials Aging and Degradation

- **Metals: Including Reactor Pressure Vessels, core internals, steam generators, and balance of plant**
  - Irradiation-Assisted Stress Corrosion Cracking
  - High-fluence phase transformations and swelling of core internals
  - High-fluence effects on RPV steel
  - Crack initiation in Nickel based alloys
  - Thermal Aging of Cast Austenitic Stainless Steels
  - Environmentally Assisted Fatigue
- **Concrete: Joint research plan with EPRI focused on radiation effects (supports and biological shield) and monitoring tools**
- **Cables: Joint research plan with EPRI and NRC to better predict and monitor cable aging**
- **Mitigation, repair, and replacement technologies: Weld repair techniques; Post irradiation annealing; Advanced replacement alloys; and Advanced Non-Destructive Examination techniques**

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Materials Aging and Degradation

- ***Measurements of degradation:*** Collect high quality data
- ***Mechanisms of degradation***: Understand the underlying mechanisms for better prediction and mitigation
- ***Modeling and simulation***: Use mechanistic models to explore data trends for extended life
- ***Monitoring***: Monitor and validate predicted degradation
- ***Mitigation strategies***: Develop technologies to reduce the rate of degradation, facilitate economic repair, and potentially replace with advanced materials that are less susceptible

R&D Supports Aging Management Program Implementation

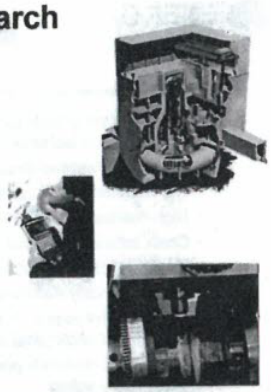
- R&D to understand aging degradation
  - Mechanism and failure modes
  - Initiation and growth rates
  - Inspection and Evaluation GLs
- Inspection methods
  - Detection and measurement
  - Non destructive examination and qualification
- Mitigation strategies
  - Chemistry
  - Stress relieving techniques
- Condition Monitoring
  - On-line monitoring
  - In-field detection
- Prediction of Remaining Useful Life
  - Health Monitoring software and algorithms
- Repair & Replacement Decisions
  - Life Cycle Management GLs
  - Integrated Life Cycle Management (ILCM)

ENERGY

EPRI

Conclusion from the Research

- ✓ Technical basis is established and in use for aging management
- ✓ Continuous improvements based on research results, inspections and operating experience
- ✓ Coordination and collaboration with global research partners



No show stoppers have been identified based on R&D to date.

ENERGY

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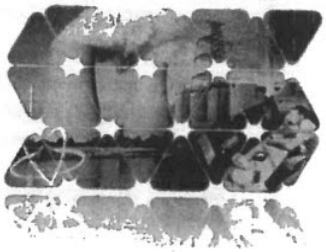
Concrete – Aging Management Research
Joint EPRI-LTO DOE-LWRS Presentation to ACRS
November 17, 2015

Sherry Bernhoft
EPRI LTO Program Manager
Keith Leonard
LWRS Program Materials Aging and Degradation Pathway Lead

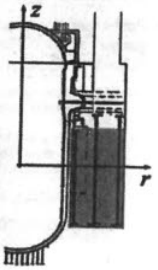


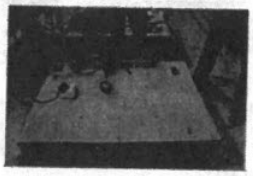
Containment and Concrete Structures

- Monitoring and aging management of concrete structures due to radiation and environmental exposure
- EPRI Technical Reports:
  - ✓ Nuclear Concrete Structures Aging Reference Manual (1023035)
  - ✓ Nondestructive Evaluation Inspection of Concrete Structures (1025627)
  - ✓ Literature Survey of Effects of Radiation on Concrete (1025584)
  - ✓ Expected Conditions of Reactor Cavity Concrete at 80 Years of Radiation Exposure (3002002676)
  - ✓ Boric Acid Attack of Concrete and Rebar in PWR Spent Fuel Pools (1025166)
  - ✓ Nonlinear Ultrasound to Evaluate Integrity of Aged Concrete (1026501)
  - ✓ Pilot Plant Augmented Containment Inspection Results (3002002335)
  - ✓ Literature Survey of Concrete Creep (3002003220)
  - ✓ ASR Risk Screening (3002005389)

R&D Topics

- Effects of Irradiation on Concrete
- Concrete Degradation due to Alkali-Silica Reactions
- Boric Acid Damage of Spent Fuel Pools
- Creep Impact on Post-tensioned Containment





Effects of Irradiation on Concrete

Irradiation

Problem Statement:

Fast neutrons from the reactor core exit the RPV and interact with the concrete in the reactor cavity.

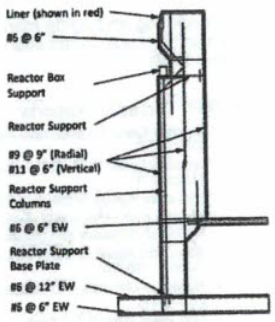
Issue:

Understand the impact on the structural stability of the reactor cavity and vessel supports

Duration: 2012 – 2018

TR 3002002676: Expected Condition of Reactor Cavity Concrete After 80 Years of Radiation Exposure (published 2014)

Technical Report: Structural Effects of Chronic Radiation Exposure in RPV Support Structure



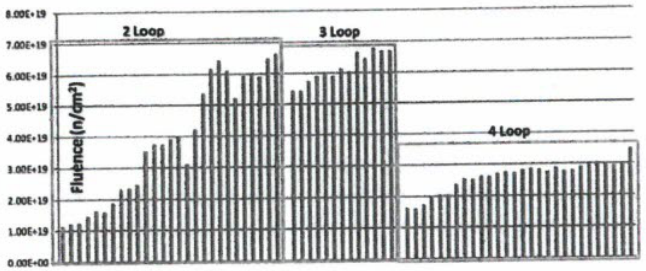
Schematic of RPV support structure

Irradiation Damage of Concrete – Ongoing Research

- EPRI and LWRS have partnered to study the effects of radiation damage on reactor cavity concrete
  - LWRS Tasks at ORNL
    - Fundamentals of radiation damage
    - Modeling of fluence through the biological shield (complete)
    - Neutron and ion irradiation of mineral analogues to characterize swelling
    - Structural significance of radiation damage including swelling due to irradiation
  - EPRI Tasks
    - Estimation of bounding fluence (complete)
    - Structural significance of radiation damage including swelling and changing mechanical properties due to irradiation

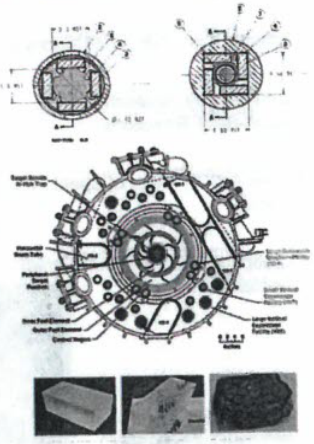
PWR 1T Fluence for 80 y Operation (E > 0.1 MeV)

- Neutron fluence in operating US PWRs at 80 years operation (data extrapolated from ex-vessel fluence reported in ADAMS).
- BWR fluence is ~ an order of magnitude lower than PWR.

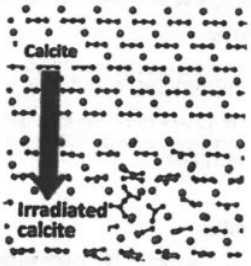


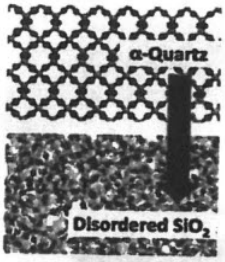
Neutron Irradiation of Monocrystals at HFIR (Test Reactor)

- Neutron fluences (E > 0.1 MeV): 0.5, 4 and 20 x 10^{19} n.cm^{-2}
- Two different irradiation capsule designs to test effects of irradiation temperature:
  - Sealed ~150 °C
  - Perforated ~50 °C (hydraulic port fluid)
- Post-irradiation examination has initiated to gauge degree of Radiation Induced Volumetric Expansion (RIVE) susceptibility
  - XRD, optical microscopy, dimensional / density measurements, hardness, modulus.
  - Quartz, SiO_2, exhibits directional (crystal structure) dependent swelling as well as possible temperature dependence.
  - Calcite, $Ca(CO_3)_2$, limited swelling.
  - Dolomite, $CaMg(CO_3)_2$, limited swelling.



Molecular Dynamics Simulation of Irradiated Minerals





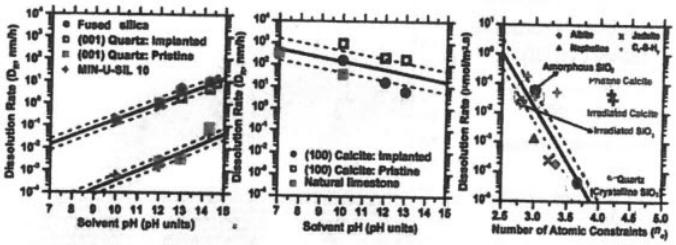
- Carbonate groups experiencing random rotations and distortion in the irradiated structure.
- Blue: Ca atoms, Red: O atoms, Brown: C atoms

- Progressive disordering of -quartz to disordered silica under energetic
- particle exposure. Red: O atoms, Yellow: Si atoms

The covalent nature of silica bonds (and thus, siliceous aggregate) explains its susceptibility to neutron irradiation, as opposed to the ionic nature of calcite.

LMRS ENERGY OAK RIDGE UCLA

Chemical Consequences of Neutron-Induced Amorphization



- Increase of the dissolution rate of irradiated silica in alkali solution
- Possibility of Irradiated-Assisted Alkali-silica Reaction

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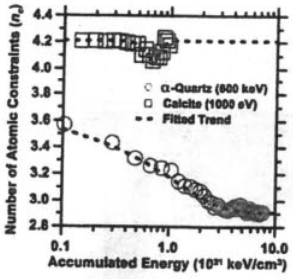
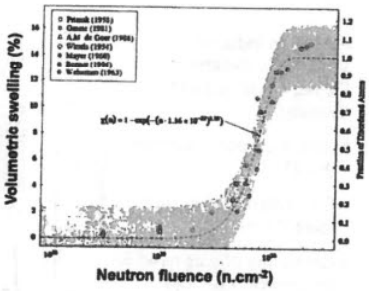
Mechanical Consequences of Neutron-Induced Amorphization





- Loss of atomic constraint, i.e., loss of rigidity and Young modulus
- Radiation-Induced Volumetric Expansion (RIVE)

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Effects of Aggregate Amorphization on Concrete

RIVE of silicate minerals

⬇

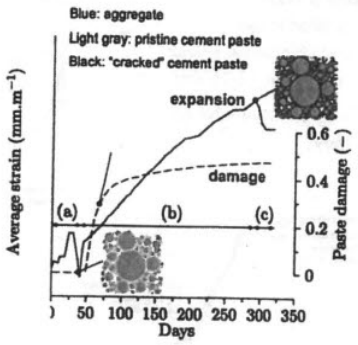
Expansion of aggregate

⬇

Damage/cracking of the cement paste

⬇

Loss of mechanical properties



Meso-scale finite element simulation with Automated Mechanics Integrated Environment (AMIE)

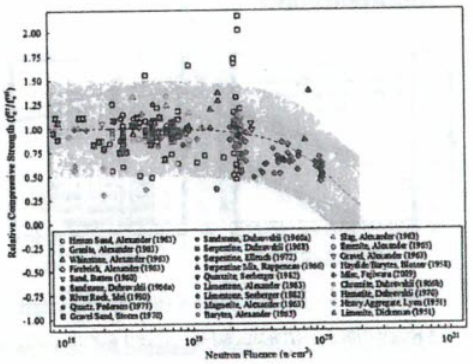
OAK RIDGE

LMRS ENERGY

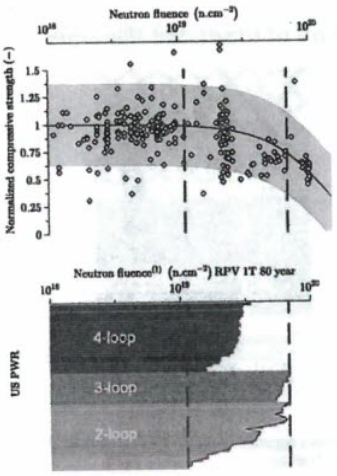
Effect of Irradiation on Concrete Properties

Literature review updates Hilsdorf's curve (1978):

- 307 compression strength data
- 62 tensile strength data
- 138 elastic modulus data
- 114 linear expansion data



Red: silicate
Blue: limestone
Green: miscellaneous and heavy aggregate



Radiation Exposure of Concrete Biological Shield

PWR's:

- Inner diameter fluence 10^{19} to 7.0×10^{19} n/cm² (E > 0.1 MeV)
- For 80 year PWR operation (92% capacity)[1], a 4-loop PWR < 4.0×10^{19} n/cm².

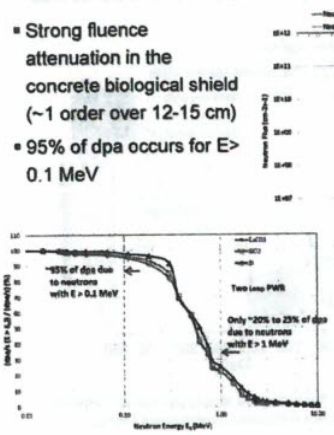
BWR's:

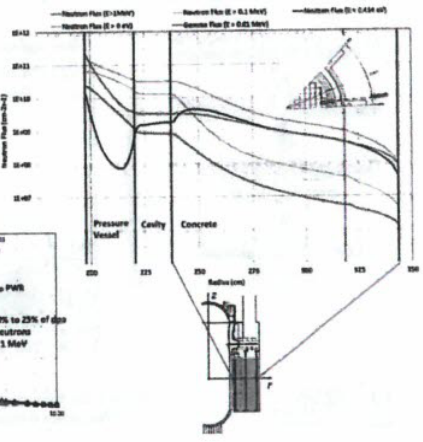
- Max. fluence ~ 10^{19} n/cm² at 80 years of operation.

Flux attenuation [2] : one order of magnitude per 12 to 15 cm (4 to 5 in.).

Neutron Attenuation and Energy Cut-Off

- Strong fluence attenuation in the concrete biological shield (~1 order over 12-15 cm)
- 95% of dpa occurs for E> 0.1 MeV

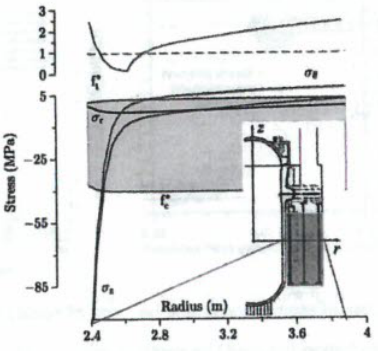




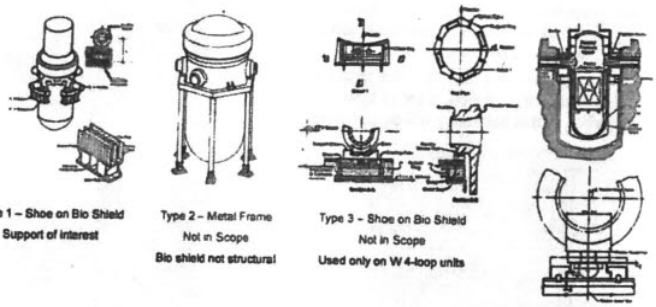
Structural Effects of Irradiation on Concrete Biological Shield (preliminary)

Radiation Induced Volumetric Expansion (RIVE) creating elastic stresses:

- Biaxial compression near the ID
- Circumferential tension toward the back
- Constraint effects need to be incorporated into model.



Engineering Structural Evaluation: Supports designs – PWR type 1/2/3/4



Type 1 – Shoe on Bio Shield
Support of interest

Type 2 – Metal Frame
Not in Scope
Bio shield not structural

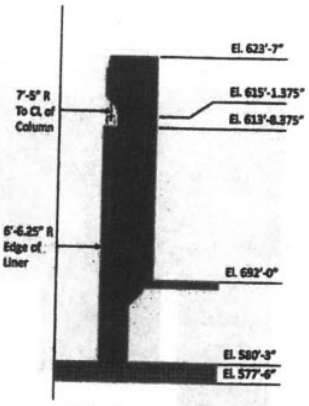
Type 3 – Shoe on Bio Shield
Not in Scope
Used only on W 4-loop units

- 11 units are in scope for this study (2 or 3-loop, Type 1 supports)
- Documentation of the choice of Type 1 will be included in the 2016 report.

Type 4 – Shoe on Shield Tank
Not in scope
Neutron shield tank – low fluence

Engineering Structural Evaluation

- EPRI is working with structural vendor to perform a detailed analysis of the type 1 support design
  - Detailed drawings from a 2-loop and 3-loop PWR
  - Modeling the reduction in margin due to neutron irradiation:
    - Swelling of aggregates/concrete
    - Change in mechanical properties
  - Results of the analysis will be published as an EPRI Technical Report in Q4, 2016.



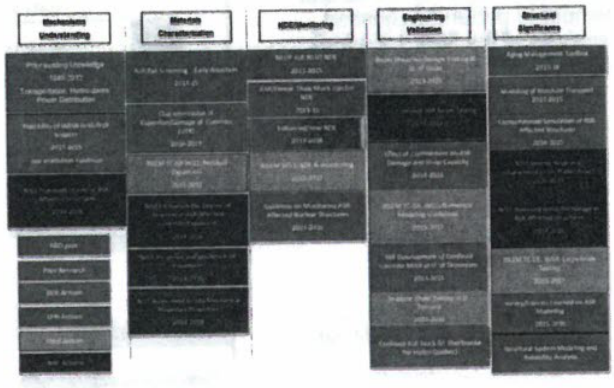
Finite element modeling mesh of Type 1 RPV support

International Committee on Irradiated Concrete (ICIC)

- International Irradiated Concrete Information Exchange Framework Meetings (Barcelona and Helsinki). First General Meeting, Knoxville, TN, Nov 2-5, 2015
- Provide a framework for exchanging information (charter) and aligning research Chair: T. Rosseel (ORNL, USA), Vice-Chair: I. Maruyama (Nagoya U., Japan), Secretary: M. Ferreira (VTT, Finland)
- Technical Areas:
  - Structural Performance and Mechanistic Understanding of the Effects of Radiation on Concrete (Y. Le Pape ORNL, USA)
  - Harvesting and Characterization of Service Irradiated Concrete (M. Ordonez, ENRESA, Spain)
  - Accelerated Irradiation Studies of Concrete & Components (M. Koleska, RC-Rez, Czech Repub.)
  - Characterization of Irradiated Concrete (C. Andrade, CSIC, Spain)
- Members from the US (DOE, EPRI, NRC), Europe and Japan

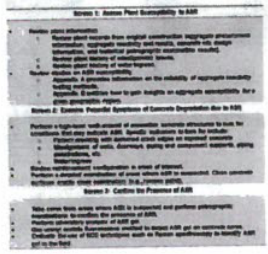
Concrete Degradation due to Alkali-Silica Reactions

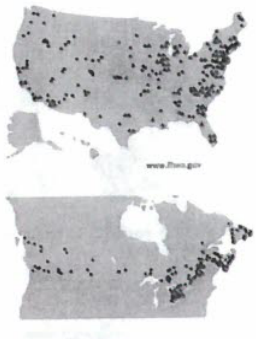
Integrated Efforts for ASR Studies



Risk screening for ASR

- Concrete that previously was considered as non-reactive may be classified differently today due to new improved testing methods.
- For those structures that have the potential to develop this degradation, a set of tools for early detection of this pathology will be provided.



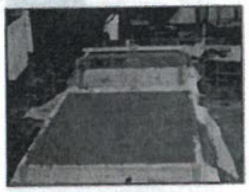


EPRI Technical Report: 3002005389

Inspection of ASR affected structures

As of today there are no NDE tests that can reliably a) identify ASR; b) determine the level of ASR in a structure.

- EPRI has developed 6 large specimens with varying degrees of ASR to be tested by Universities and vendors to evaluate the reliability of NDE techniques
- New inspection techniques are normally developed in small laboratory sized specimens.
- Real structures are larger and behave differently.
- EPRI specimens will be used for testing and validation of new NDE techniques



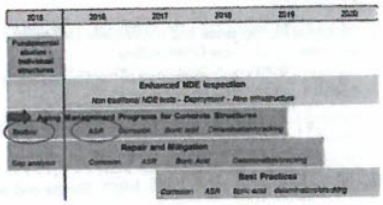
Deliverables

Reliability of commercially available techniques to detect ASR – 2Q 2016

Results form Non-linear UT for detection of ASR – 4Q 2015 (NEUP project)

Aging Management Programs for ASR

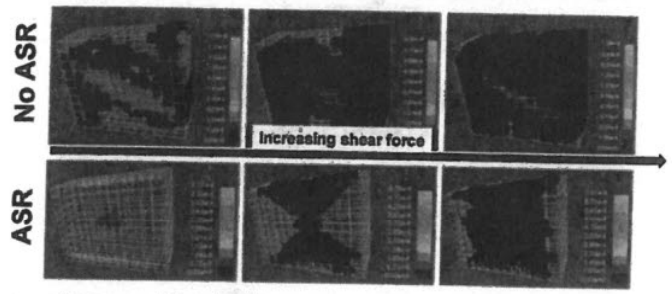
- Project on Aging Management Programs for ASR affected structures starts in 4Q 2015



Coordination with EPRI Nuclear Sector Strategic Initiative on Aging Management

Modeling Shear Resistance of Reinforced Concrete Subjected to Alkali-Silica Reaction

- Cooperation with the University of Colorado, Boulder
- Finite Element Analysis: Code *Merlin* specifically developed to account for ASR effects (Saouma and Perotti, 2006)
- Objective: evaluation of the post-ASR residual bearing capacity

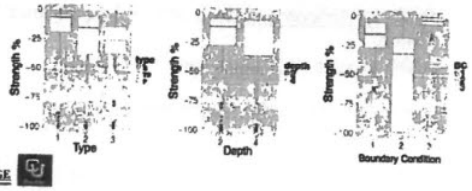


Parametric Study of the Effects of Confinement on the Shear Resistance of ASR-Affected Structural Members.

Parameters

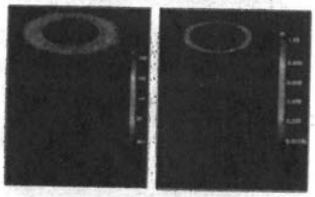
- Geometry Types: Beam (B), Truncated Beam (TB), Panel (P)
- Boundary Conditions: (1) Unrestrained, (2) Restrained, (3) Partially Restrained
- Thickness: 2 ft., 4 ft.
- AAR Expansion 0.1%, 0.2%, 0.3%
- Reinforcement Ratio 0.2%, 0.5%, 1%
- Residual Relative Elastic Modulus 0.7, 0.9
- Residual Relative Tensile Strength 0.7, 0.9

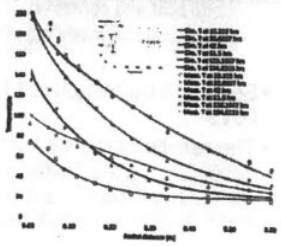
- ***Loss or gain of shear strength results from the competition between material damage (ASR) and structural effects.***



Development of Concrete Modeling Capabilities in GRIZZLY

- **MOOSE** (Multiphysics Object Oriented Simulation Environment)
- **Grizzly:** aging/degradation models
- Concrete related models implemented in 2015:
  - Coupled moisture transport/heat transfer, i.e., Bazant and Thonguthai's model
  - ASR swelling model, i.e., Saouma's model
- Models to be implement in 2016-7:
  - Cracking/damage
  - Radiation-induced volumetric expansion
  - Creep





Status of the Development of the Experimental Mockups at the University of Tennessee

- Objectives: study the effect of structural constraints on the development of ASR and the out-of-plane shear resistance of thick reinforced concrete panel
- Three blocks (1 non reactive, 1 reactive/"free" expansion, 1 reactive/constraint in one plane): size 100" x 80" x 40"
- Monitoring (bulk and surface): expansion, temperature, relative humidity, internal stress, damage
- PI: U. of Tennessee, TPO: ORNL
- Collaborative actions between: U. of TN (Knoxville), U of Alabama, U. of Colorado, U. of South Carolina, ORNL, INL, PNNL and EPRI…
- Kick-of meeting: September 4 2015
- Duration: 4 years

RILEM Technical Committee on Internal Swelling Reactions

- International group of experts
- Activity initiated in June 2014
- Chair V. Saouma, Secretary Y. Le Pape
- State of the Art and Needs for hydro- and nuclear industries (lead. V. Gocevski and F. Amberg)
- WG1. Compilation of test procedures for the Estimation of the Residual Expansion of Concrete in Structures Affected by Alkali Silica Reactions from France, Switzerland and North America. (lead. M. Hassanzadeh and V. Saouma)
- WG2. Survey of existing advanced ASR-models. Benchmark in preparation (lead. A. Sellier)
- WG3. NDE/monitoring. State of the art report (lead. L. Jacobs and P. Rivard)
- WG4. Large-scale testing (lead. Y. Le Pape)

Y. Le Pape. RILEM TC ISR Summer 2015 Activity Report. ORNL/LTR-2015/407. Aug. 2015

Boric Acid Damage of Concrete in Spent Fuel Pools

Creep Impact on Post-tensioned Containment

Boric Acid – Leaking PWR SFPs

Problem Statement:

Leakage of PWR spent fuel pools causes aqueous boric acid to come into contact with the concrete substructure.

Issue:

Impacts of accelerated leaching on concrete

Duration: 2013-2016

Deliverables

TR 1025166. Welding and Repair Technology Center: Boric Acid Attack of Concrete and Reinforcing Steel in PWR Fuel Handling Buildings

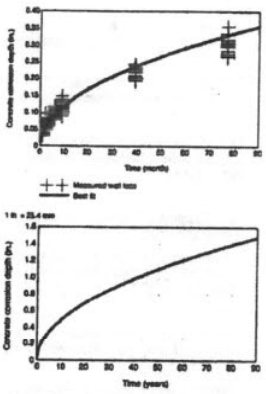
Technical Report: Framework for Aging Management of SFP Concrete Exposure to Aqueous Boric Acid Q4, 2016

Boric Acid on Spent Fuel Pools

- 3 year experimental and modeling study conducted at CEA in Saclay, France.
  - Leaching and reactions of aqueous boric acid with cement paste
  - Reactions between aqueous boric acid and aggregates
  - Leaching and reactions between aqueous boric acid and concrete
  - Computational modeling of reactions
- Study will be completed fourth quarter 2015
- The results of the CEA study will be published by the Materials Aging Institute and used as a basis for the 2016 AMP framework report.

Technical Basis for Aging Management of BA on SFP

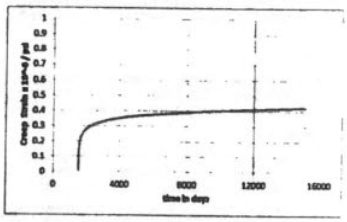
- Currently, a framework for aging management of leaking spent fuel pools is being developed
  - Review of CEA, MPR and Sandia National Laboratory studies.
  - Focus on both groundwater protection and potential structural effects.
  - Overall goal is to give utilities guidance for development of site-specific AMPs for leaking spent fuel pools specific to the concrete substructure.
  - 2016 AMP framework EPRI report



Plots taken from EPRI TR - 1025166

Concrete Creep in Containments

- EPRI published a literature review (3002003220) on creep in concrete containments in 2015
  - Post-tensioned containment structures are designed to allow for creep of the concrete.
  - Several models of creep in concrete are presented.
- Reg Guide 1.35.1 provides guidelines for the prediction of tendon losses – including the effects of long term concrete creep.
  - Creep strain rate decreases as a log function with time.
  - Creep is generally occurring as predicted by models used for containment design.
  - Creep does not appear to be a significant aging effect.



Nonlinear Ultrasound Characterization of Concrete Creep

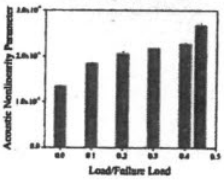
Problem Statement:

Long term creep (deformation) may affect the performance of post-tensioned concrete containment structures and cause deformation of containment liners.

Issue:

Nondestructive evaluation method to characterize creep strain

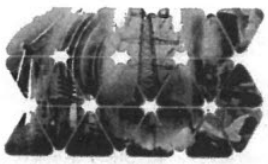
Duration: 2014-2015



Deliverables

TR 3002003220: Program on Technology Innovation: Concrete Creep of Nuclear Plant Containments

Technical Report – Nonlinear Ultrasound Concrete Creep Feasibility Study: Q4 2015



Together…Shaping the Future of Electricity

References

- Slide 8:
  - *T. Rosseel and Y. Le Pape*. Status report on the post-irradiation examination of irradiated mineral analogue specimens from the LWRS / EPRI collaboration on irradiated concrete. Letter Report ORNL/LTR-2014/514, September 2014.
  - *T. Rosseel, et al.* Report on the post-irradiation examination of irradiated mineral analogues of concrete aggregate specimens. Letter Report ORNL/LTR-2015/453, September 2015
- Slide 9:
  - Pignatelli et al., "Direct Experimental Evidence for Differing Reactivity Alterations of Minerals following Irradiation: The Case of Calcite and Quartz", *Scientific Reports - Nature*, 2015 (under review).
- Slide 10:
  - Pignatelli, I.; Kumar, A.; Field, K.; Wang, B.; Yu, Y.; Dobbs, H.; Le Pape, Y.; Israelachvili, J.; Bauchy, M. & Sant, G. Direct Experimental Evidence for Differing Reactivity Alterations of Minerals following Irradiation: The Case of Calcite and Quartz, *Scientific Reports - Nature*, 2015 (under review).
- Slide 11:
  - Pignatelli, I.; Kumar, A.; Field, K.; Wang, B.; Yu, Y.; Dobbs, H.; Le Pape, Y.; Israelachvili, J.; Bauchy, M. & Sant, G. Direct Experimental Evidence for Differing Reactivity Alterations of Minerals following Irradiation: The Case of Calcite and Quartz, *Scientific Reports - Nature*, 2015 (under review).
  - Field, K.; Remec, I. & Le Pape, Y. Radiation Effects on Concrete for Nuclear Power Plants, Part I: Quantification of Radiation Exposure and Radiation Effects, *Nuclear Engineering and Design*, 2015, *282*, 126-143

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- Slide 12:
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  - Giorla, A.; Vaitová, M.; Le Pape, Y. & Štemberk, P. Meso-Scale Modeling of Irradiated Concrete in Test Reactor, *Nuclear Engineering and Design*, 2015, 295, 59-73
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  - Field, K.; Remec, I. & Le Pape, Y. Radiation Effects on Concrete for Nuclear Power Plants, Part I: Quantification of Radiation Exposure and Radiation Effects, *Nuclear Engineering and Design*, 2015, *282*, 126-143
- Slide 14:
  - [1] T. Esselman, P. Bruck, " Expected condition of concrete at age 60 of reactor operation", *Lucius Pitkins, Inc.*, 2013
  - [2] I. Remec, et al. "Characterization of Radiation Fields in Biological Shields of NPPs for Assessing Concrete Degradation", *Proceedings of the Fifteenth International Symposium on Reactor Dosimetry*, 2014
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  - I. Remec et al., "Characterization of Radiation Fields in Biological Shields of NPPs for Assessing Concrete Degradation", *Proceedings of the Fifteenth International Symposium on Reactor Dosimetry*, 2014
  - I. Remec, "Status Report on Defining a Unified Parameter for Characterization of Radiation Intended for Evaluation of Radiation-Induced Degradation of Concrete", *Oak Ridge National Laboratory*, 2013

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- Slide 16:
  - Le Pape, Y. Structural Effects of Radiation-Induced Volumetric Expansion on Unreinforced Concrete Biological Shields, *Nuclear Engineering and Design*, 2015 (accepted for publication)
- Slide 25:
  - Saouma, V.; Hariri-Ardebili, M.; Puatasananon, W. & Le Pape, Y. Preliminary results on the structural significance of alkali-silica reaction in mass reinforced concrete structures, *Oak Ridge National Laboratory*, 2014
- Slide 26:
  - V. Saouma, M. Hariri-Ardebili and Y. Le Pape, Effect of Alkali-Silica Reaction on Shear Strength of Reinforced Concrete Structural Members, ORNL/TM-2015/588, Sep. 2015
- Slide 27:
  - Saouma, V.; Hariri-Ardebili, M.; Puatasananon, W. & Le Pape, Y. Preliminary results on the structural significance of alkali-silica reaction in mass reinforced concrete structures, *Oak Ridge National Laboratory*, 2014
  - Huang, H.; Spencer, B. & Cai, G. Grizzly Model of Multi-Species Reactive Diffusion, Moisture/Heat Transfer, and Alkali-Silica Reaction in Concrete, *Idaho National Laboratory*, 2015

From: Hiser, Matthew
To: (b)(6)
Cc: Tregoning, Robert; (b)(6)
Subject: RE: RE: Harvested Materials at Battelle
Date: Friday, May 18, 2018 10:44:11 AM
Attachments: Harvested materials info template.xlsx

Note to requester: Attachment is immediately following.

(b)(6) Hi

Thank you for the brief call with us on Monday to discuss the materials that remain at Battelle. We appreciate your willingness to provide some assistance in cataloguing the available previously harvested materials that you have.

I have attached an Excel spreadsheet showing how we've captured information for harvested materials that are available at Argonne National Lab. It gives you an idea of the type of information and level of detail we've been getting. Please feel free to adjust the information as appropriate based on what you have / can easily find for your materials. If you'd like to add more columns for more details (if you have them), that would be great as well.

I will be in Columbus at EWI the weeks of June 4-8 and 11-15 with Friday afternoon June 15 looking like the best potential opportunity for a brief visit if that ends up being needed.

Thanks!

Matt

(b)(6) **From:**

Sent: Tuesday, May 08, 2018 8:59 AM

To: Hiser, Matthew <Matthew.Hiser@nrc.gov>

(b)(6) **Cc:**

(b)(6) Tregoning, Robert <Robert.Tregoning@nrc.gov>; (b)(6)

(b)(6)

Subject: [External_Sender] RE: Harvested Materials at Battelle

Matthew,

While I believe we will be able to get everyone together for teleconference, there may be issues with a site visit.

We currently have no projects with the NRC for which to charge time against for this effort. We can discuss this during the teleconference.

Best Regards,

(b)(6)

Connect with me on (b)(6)

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Columbus, OH 43201
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-----Original Appointment-----

From: Hiser, Matthew <Matthew.Hiser@nrc.gov>

Sent: Tuesday, May 08, 2018 8:46 AM

(b)(6)

(b)(6) **To:** [redacted] Tregoning, Robert; [redacted]

Subject: Harvested Materials at Battelle

When: Monday, May 14, 2018 10:00 AM-11:00 AM (UTC-05:00) Eastern Time (US & Canada).

Where: Telecon: to be added

(b)(6) Dear [redacted]

(b)(6)

Following up from Rob's initial contact with [redacted] we'd like to set up a brief telecom sometime in the next few weeks to discuss what harvested materials may be available at Battelle. Please let me know if another time would be better for this call.

I will be attending a training course at Edison Welding Institute in Columbus in early June, which would provide a good opportunity to potentially visit and see what materials are available if there is enough to be worthwhile.

Thanks!

Matt

Matthew Hiser

Materials Engineer

Transformation Team member

US Nuclear Regulatory Commission

Phone: 301-415-2454

Matthew.Hiser@nrc.gov

UNIRRADIATED

Material	GRADE	SOURCE	LOCATION	CURRENT CONDITION	Comments
LOW ALLOY STEEL	A533B	MIDLAND	LOWER HEAD	Bldg. 212	A plate of 13" x 5' x 1"
	~~A212-B~~	~~Shipping Port~~	~~Neutron Shield tank~~	---	Not available.
CASS	CF-3	ESCO Foundry	not from reactors	Bldg. 212	2 blocks of 5"x5"x2", and 4
	CF-8	ESCO Foundry	not from reactors	Bldg. 212	2 blocks of 5"x5"x2", and 3
	CF-8M	ESCO Foundry	not from reactors	Bldg. 212	5 blocks of 2.5"x2.5"x1"
SS WELD	304/308	Grand Gulf	Baffle plate	Bldg. 212	The weldment is a double-V butt weld, and the whole plate is 11.5" x 2" x 2.5". The weld material portion is 1" x 2.5" X 2". However, there is a hole drilled right at the center of the weld material, reducing the usable weld metal to 1"x 0.5" x 2".

These CASS materials are not materials harvested from actual reactors. They were cast by companies who were reactor materials suppliers.

ex-plant untested irradiated materials at IML

SOURCE	Sample form	SPECIMEN	Dose, dpa	Number of samples	Comments
304 ZORITA	PLATE	TEM	0.1 - 50	2	ID?
		Small tensile	0.1 - 50	5	
		1/4T	0.1 - 50	10	
	WELD	TEM	0.1 - 50	2	
		Small tensile	0.1 - 50	2	
		1/4T	0.1 - 52?	4	
VC SUMMER	DISSIMILAR WELD	1/2T-CT	negligible	5	ID?
		tensile	negligible	3	ID?
DAVIS BESSE	DISSIMILAR WELD	1/2T-CT	negligible	3	ID?
		1/4T CT	negligible	3	

DISSIMILAR WELD = Alloy 82+Alloy 182
VC SUMMER = hotleg nozzle-to-pipe weld
DAVIS BESSE = CRDM nozzole #3

Note to requester: The attached email is immediately following.

From: Hiser, Matthew
To: [redacted] Tregoning, Robert; [redacted]
Subject: Harvested Materials at Battelle
Attachments: FW RE RE Couple of things.msg

Passcodes/Pin codes:
Participant passcode: [redacted]

For security reasons, the passcode will be required to join the conference.

Dial in numbers:
Country

Toll Numbers
Freephone/
Toll Free Number

USA

888-677-8615

Dear [redacted]

Following up from Rob's initial contact with [redacted] we'd like to set up a brief telecom sometime in the next few weeks to discuss what harvested materials may be available at Battelle. Please let me know if another time would be better for this call.

I will be attending a training course at Edison Welding Institute in Columbus in early June, which would provide a good opportunity to potentially visit and see what materials are available if there is enough to be worthwhile.

Thanks!
Matt

Matthew Hiser
Materials Engineer
Transformation Team member
US Nuclear Regulatory Commission
Phone: 301-415-2454
Matthew.Hiser@nrc.gov <mailto:Matthew.Hiser@nrc.gov>

From: Tregoning, Robert
Sent: Mon, 7 May 2018 14:53:38 +0000
To: Hiser, Matthew
Cc: Audrain, Margaret;Purtscher, Patrick
Subject: FW: RE: RE: Couple of things
Importance: High

Matt:

This email has the entire thread of our discussion.

Rob

Robert Tregoning
Technical Advisor for Materials
US Nuclear Regulatory Commission
Two White Flint North, M/S T-10 A36
11545 Rockville Pike
Rockville, MD 20852-2738
ph: 301-415-2324
fax: 301-415-6671

From: (b)(6)
Sent: Wednesday, March 28, 2018 9:28 AM
To: Tregoning, Robert <Robert.Tregoning@nrc.gov>
Subject: [External_Sender] RE: RE: Couple of things
Importance: High

Rob,

I have pictures from our WJ pipe facility.
It is mainly cold-leg pipe with one section of a nozzle branch.

I will try to get you the pictures today.

We could support a call next week.

Regards,

(b)(6)

Connect with me on (b)(6)

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From: Tregoning, Robert <Robert.Tregoning@nrc.gov>
Sent: Wednesday, March 28, 2018 9:26 AM
(b)(6) **To:** [redacted]
Subject: FW: RE: Couple of things

(b)(6)

I just wanted to follow-up on our activity to develop an inventory of ex-plant materials that may still exist at Battelle. We would ultimately like to possibly travel up for a day to see what's left but it might be good to have a call initially with you, [redacted] to see if a trip is worthwhile. (b)(6)
Is this something that you could support?

Thanks,

Rob

Robert Tregoning
Technical Advisor for Materials
US Nuclear Regulatory Commission
Two White Flint North, M/S T-10 A36
11545 Rockville Pike
Rockville, MD 20852-2738
ph: 301-415-2324
fax: 301-415-6671

From: Tregoning, Robert
Sent: Wednesday, February 07, 2018 1:46 PM
(b)(6) **To:** [redacted]
Cc: Wallace, Jay <Jay.Wallace@nrc.gov>
Subject: RE: RE: Couple of things

(b)(6)

Thanks for getting back to me so quickly. I appreciate your comments and welcome further discussion. See my responses to your initial questions/comments below, in red.

Cheers,

Rob

Robert Tregoning
Technical Advisor for Materials
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Two White Flint North, M/S T-10 A36
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Rockville, MD 20852-2738
ph: 301-415-2324
fax: 301-415-6671

(b)(6) **From:** [redacted]
Sent: Wednesday, February 07, 2018 1:01 PM
To: Tregoning, Robert <Robert.Tregoning@nrc.gov>
(b)(6) **Cc:** [redacted]
Subject: [External_Sender] RE: Couple of things
Importance: High

Rob,

Great to hear from you!! Things are well here at Battelle and also personally; I hope the same for you.

I have a couple of comments about the questions on the Round Robins and Components.

1) It is difficult for us these days to do anything without a contract. I would love to see the results of the round robins, but I am not sure we can participate (Trying to convince management that it is the right thing without even a hint of billable hours from the NRC in the future is a tough sell.)

Believe me, I understand the climate but I just thought you would be interested. The final report for both projects will be made public and I can share them with you when they are complete.

2) As for the LBB Analysis Round robin, I definitely have some opinions on Cases 3 and 4 that I would like to share (hoping you can provide some insight):
   a. These are SCC cracks with a morphology parameter which make take care of "twists and turns" but the COD will still be calculated for a planar crack, not a porous media (which I am not sure what COD even means for porous media).

Agreed that this is a gross simplification of the actual geometry of a complex crack. I think we're still a little ways away from effectively modeling the effects of such a crack on COD (or leak rate for that matter) but could use sensitivity analyses to study. This is well outside the scope of the current benchmark

   b. The morphology knock-down factors only effect the leak rate, not the driving force, so what is the driving force for a SCC crack which has connected ligaments?

Agreed that the knock-down factors only affect leak rate; those knock-down factors also don't consider the effect of connected ligaments. As above, this is another simplification. This one, at least, is a conservative assumption.

c. Real plants have high restraint on the pipes (pumps, pressure vessels…etc.) which restrain the crack opening (and reduce the driving force) – do any of the codes have a Restraint of Pressure Induced Bending module?

Some codes do consider the effect of end restraints on the stress state. The benchmark problem assumes freely rotated ends, again, as a simplification.

d. To my knowledge in xLPR and Pro-LOCA, WRS's only effect the K-solutions up until a TWC occurs. WRS are not accounted for in either COD or K-solutions for TWC.

You are correct; for this exercise, we plan on calculating the effect of WRS on COD outside of xLPR and then using the CODs as input to the LEAPOR (or other) leak rate code.

e. *My major concern is "How can we determine the effects of Leak Rate on LBB if we are not modeling the behavior correctly or even using the correct models?" (not saying conservative / non-conservative, just not correctly). It is kind of like inferring how fast you are going by counting the number of dead bugs on your car window.*

Philosophically I agree with your concern that we need to understand model uncertainty in order to properly evaluate the results of any calculation. This is been a principle concern for the xLPR program which has the objective of developing a "best estimate model". In reality, such a model is not achievable because a whole host of simplifying assumptions are required along the way (you've indicated as few of them). The best we're able to do at this point is to qualitatively assess each aspect of model uncertainly in an attempt to understand what the true biases are. LBB analyses, however, have never pretended to be best estimate analyses and they have always intended to be conservative simplifications of reality. The factors of 10 on leak rate and 1.4 on loading and 2 on crack size are intended to conservatively account for such uncertainties. This round robin obviously will not address such complexities and it is only intended to take a small step by considering the effects that different models and modeling assumptions have on an LBB problem. I recognize that such sensitivity studies are not new and that Battelle and EMCC (among others) have performed such studies around 20 years ago. However, the hope here is that we'll be able to look at these effects in other leak rate codes (e.g., PICEP) to better understand sensitive parameters.

By the way, if you know the density of live bugs that you're traveling through, counting the number of dead bug is actually an effective strategy of measuring speed ☺

(b)(6)

3) I have copied [redacted] on this message because they will have more knowledge on anything "left" here. To my knowledge it was all "abandoned in place", I have nothing I am keeping track of on government tags…etc. As for pipe and or components, it may have been scrapped.

I appreciate you copying (b)(6) on the message. Please let me know if they are able to definitively address what materials/components may or may not be left at Battelle.

(b)(6)

(b)(6)

(b)(6) Connect with me on

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From: Tregoning, Robert [mailto:Robert.Tregoning@nrc.gov]
Sent: Wednesday, February 07, 2018 8:24 AM
(b)(6) **To:**
Cc: Wallace, Jay <Jay.Wallace@nrc.gov>; Audrain, Margaret <Margaret.Audrain@nrc.gov>; Purtscher, Patrick <Patrick.Purtscher@nrc.gov>
Subject: Couple of things

(b)(6)

How are things going? It's been awhile since I've seen or talked to you and I hope you and your family are well. I wanted to send you this email to cover a couple of topics. The first is that we (NRC) are involved in a couple of international computational round robins that are being conducted under the auspices of NEA\CSNI. The first attachment describes the xFEM round robin which was recently approved but has yet to formally begin. I've provided the proposal description. This round robin is being coordinated by France (IRSN) and Belgium (BelV). The second attachment is an LBB round robin which was approved a year or so ago, but we're really just getting rolling on this effort as well. The US (me) and Sweden (SSM) are the leads on this round robin. Let me know if you guys have any interest in possibly participating in either activity. I can also answer any questions that you many have on both of these projects.

On another note, we have recently started to compile a database of ex-plant materials/components that we have accumulated through the years at various laboratories. We're trying to get a good accounting of what materials we have left for possible future research projects. Of course, we've sponsored quite a bit of work at Battelle over the years and while I'm generally aware of the projects, I'm not sure how much, if any, excess materials, components, or specimens still remain at Battelle.

Do you have a good handle on what ex-plant materials/components still exist at Battelle?
(b)(6) Would it be worth contacting [redacted] or other past-Battelle workers to help out? We've developed a spreadsheet for the database to capture the information but I think we'd ultimately like to visit so that we can actually view any remains.

Thanks so much for your help with this.

Warm regards,

Rob

Robert Tregoning
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Rockville, MD 20852-2738
ph: 301-415-2324
fax: 301-415-6671

From:	IchiroKOMURA
To:	Prokofiev, Iouri
Cc:	Tregoning, Robert; Iyengar, Raj; Hiser, Matthew
Subject:	[External_Sender] RE: Info about NPP Materials Harvesting Workshop
Date:	Thursday, February 9, 2017 2:26:04 AM

Dear Iouri,
Thank you for the information about Japanese relation with NRC's Harvesting program.
I was relieved to hear your information and your conversation with Dr. Tregoning, which explain that Kazunobu Sakamoto has participated and would participate to your program.
Personally, I am interested in the material degradation under the actual environment compared with accelerated condition.
In the recent situation of Japan/NRA, such NRA's R&D or information gathering would be conducted with JAEA(JAEA is the government organization). And it would be out of scope of JAPEIC unfortunately.
I will ask to Kazu about the future updated situation and information.
Best regards,
Ichiro

From: Prokofiev, Iouri [mailto:Iouri.Prokofiev@nrc.gov]
Sent: Wednesday, February 8, 2017 7:00 AM
To: IchiroKOMURA
Cc: Tregoning, Robert; Iyengar, Raj; Hiser, Matthew
Subject: Info about NPP Materials Harvesting Workshop
Dear Ichiro,
I sent attachments to you to ask your personal opinion. I hope you received the attachments, if a problem- please let me know.
Please contact with Kazunobu Sakamoto about the Harvesting Workshop [redacted] and didn't participate in the NRC/NRAJ Bilateral Meeting on Materials Issues that was organized at NRC Headquarters, Rockville, MD, USA, August 8 - 9, 2016 (b)(6)
I asked Dr. Rob Tregoning for the updated information related to Harvesting. Please see below our conversation.
Best Regards, Iouri
Iouri:
The update is that we have been working with JNRA (K. Sakamoto) on the Japanese workshop participation. We currently will have participants from JNRA (Sakamoto), CRIEPI (Sonada), and JAEA (Chimi). Only CRIEPI is making formal presentations but it is expected that all will participate in the discussion.
Please let me know if you have any other questions.
Rob
Robert Tregoning
Technical Advisor for Materials
US Nuclear Regulatory Commission
Two White Flint North, M/S T-10 A36
11545 Rockville Pike
Rockville, MD 20852-2738
ph: 301-415-2324
fax: 301-415-6671
From: Prokofiev, Iouri Sent**:** Tuesday, February 07, 2017 9:30 AM
To: Hiser, Matthew <Matthew.Hiser@nrc.gov>; Tregoning, Robert <Robert.Tregoning@nrc.gov>
Cc: Iyengar, Raj <Raj.Iyengar@nrc.gov>
Subject: FW: Query Meeting with NRA in Aug
Good Morning,
I am sorry bother you. I am working with PARENT Follow on project proposal and I sent the attached email "*more thoughts: Reflections on PARENT 13 Meeting*" to Dr. Ichiro Komura, Steering

Committee member from JAPEIC komura-ichirou@japeic.or.jp. with the Harvesting info.
It was surprised me, he asked question related to Harvesting; "Can I distribute the attached document you sent me to the people of NRA, MHI, other electric power company in Japan, and University?"
Can you please update the information from NRC/NRAJ Bilateral Meeting on Materials Issues Summary?

From: IchiroKOMURA [mailto:komura-ichirou@japeic.or.jp]
Sent: Monday, February 06, 2017 7:26 PM
To: Prokofiev, Iouri <Iouri.Prokofiev@nrc.gov>
Subject: [External_Sender] FW: more thoughts: Reflections on PARENT 13 Meeting
Dear Iouri,
Can I distribute the attached document you sent me to the people of NRA, MHI, other electric power company in Japan, and University ?
Ichiro

From: Prokofiev, Iouri [mailto:Iouri.Prokofiev@nrc.gov]
Sent: Thursday, February 2, 2017 9:47 AM
To: IchiroKOMURA
Cc: Lin, Bruce; Iyengar, Raj
Subject: more thoughts: Reflections on PARENT 13 Meeting
Good Morning Dear Ichiro,
Thank you very much for taking the initiative and accelerating the process with the Scope of Work preparation. I am working with topics related to 3) and 2).
I have two personal questions:

1. What do you think about this - will it be interesting for JAPEIC/NRA activity with Harvesting (please see the Attachments)?
2. I read *The Mainichi, 2016-12-20; Japan: Gap emerges between gov't, private sector over Monju reactor* and my question is -- did you or our NDE MHI colleagues have experience with components of Fast Reactors examination?

I have really enjoyed knowing and working with you during these past years. It has been a privilege for me. (b)(6) [redacted]
(b)(6) [redacted]
Always my Best regards,
Iouri

From: Lin, Bruce
Sent: Wednesday, February 01, 2017 1:39 PM
To: IchiroKOMURA <komura-ichirou@japeic.or.jp>; Prokofiev, Iouri <Iouri.Prokofiev@nrc.gov>
Subject: RE: RE: Reflections on PARENT 13 Meeting
Dear Ichiro,
Ryan and I are working on the draft work scope for the follow on project. We are hoping to get that out to PARENT members for review soon. Based on PARENT 13 meeting, the three potential topic areas are: 1) NDE Modeling and Simulation, 2) Flaw Relevance Evaluation, and 3) Material Degradation Monitoring.
From NRC perspective, there is strong support for tasks 1 and 2. However, at this point, there is no decision on the follow on project yet. We need to finalize the work scope and then present to the management for approval. It is likely there will be a gap between the end of PARENT extension and the start of the follow-on project. If we don't have an agreement in place prior to the end of PARENT extension, we can continue to work on putting the agreement in place.
Regards,
Bruce

From: IchiroKOMURA [mailto:komura-ichirou@japeic.or.jp]
Sent: Tuesday, January 31, 2017 3:01 AM
To: Prokofiev, Iouri <Iouri.Prokofiev@nrc.gov>; Lin, Bruce <Bruce.Lin@nrc.gov>
Subject: [External_Sender] RE: Reflections on PARENT 13 Meeting

Dear Iouri and Bruce,
Today, I am sending this e-mail to you for requesting to hear your supposition about the schedule for starting the Follow-on Project.
PARENT Extension is scheduled to finish at the end of July in this year. I think that the Follow-on Pj would not be fixed at that time.
In the PARENT-13 meeting, Iouri said that all the organization would work for discussion and planning about Follow-on Pj under the umbrella agreement with NRC. How do you think/schedule the period between the end of PARENT Extension and the decision or the starting of Follow-on Pj ?

(b)(6)

I would like to hear your opinion, if it would be temporary plan.
Best regards,
Ichiro

From: Hiser, Matthew
Sent: Mon, 24 Jul 2017 10:34:48 +0000
To: Purtscher, Patrick
Subject: FW: You have files ready for pickup

Hi Pat,

I assume you received a similar email from Pradeep?

Thanks!
Matt

-----Original Message-----
From: Ramuhalli, Pradeep [mailto:collaboration@pnnl.gov]
Sent: Sunday, July 23, 2017 8:09 PM
To: Hiser, Matthew <Matthew.Hiser@nrc.gov>
Subject: [External_Sender] You have files ready for pickup

Hello,

Ramuhalli, Pradeep (Pradeep.Ramuhalli@pnnl.gov) has sent you the following 1 file(s:)

Subject: TLR

Comments: Patrick,

Looks like the earlier emails have not made it. I am re-sending via FTP. Let me know if you get this.

Pradeep

The following files have been uploaded to the MassTransit Web File Transfer Services. You can download them by going to:

(b)(4)

and selecting the file(s) and clicking Download (All/Selected).
NOTE: This link and contained passkey are only good for 14 days.

Harvesting TLR DRAFT.docx (5.07M bytes)

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