CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

TRIP REPORT

SUBJECT: Nuclear Waste Technical Review Board (NWTRB) International Workshop on Long-Term Extrapolation of Passive Behavior and Meeting of the DOE Waste Package Peer Review Panel
Project Number 20.01402.571, AI Number 01402.571.016

DATE/PLACE: July 19–20, 2001
Arlington, VA
July 24, 2001
Cleveland, OH

AUTHOR: Gustavo A. Cragnolino

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PERSONS PRESENT: The NWTRB Workshop was attended by approximately 100 people. Vijay Jain (CNWRA), Tae M. Ahn, Charles Greene and Tamara Bloomer [U.S. Nuclear Regulatory Commission (NRC)] were also present. The meeting of the DOE WP peer review panel was attended by about 40 people. It was also attended by Tae M. Ahn (NRC).

BACKGROUND AND PURPOSE OF TRIP:

The purpose of the trip was to participate as a one of the invited panelists in the NWTRB Workshop. The trip was combined with a visit to the NRC on July 23, 2001 and the presentation as an invited speaker of the Center for Nuclear Waste Regulatory Analyses (CNWRA) work to the DOE WP peer review panel meeting in Cleveland, OH. The agenda of these meetings are attached.

SUMMARY OF PERTINENT POINTS:

Nuclear Waste Technical Review Board Workshop

The purpose of the workshop was to obtain a broad range of views from national and foreign corrosion experts regarding potential issues for extrapolating corrosion resistance of high level waste container materials to many thousand of years.

After introductory remarks by Dan Bullen (NWTRB) and Alberto Sagues (NWTRB), Carl Di Bella (NWTRB staff) presented a brief overview of the waste package design and the expected environments for the proposed repository at Yucca Mountain. This was followed by a brief presentation by A. Sagues (NWTRB) in which he posed as questions the two topics that NWTRB provided in advance to the workshop panelists for the discussion (i) the long-term stability of the passive dissolution rate; (ii) the long-term

preservation of conditions preventing localized corrosion (see attachment). He remarked that the total surface of Alloy 22 exposed to the environment will be about 300,000 m^2 and the total closure weld length of about 60 km.

The initial round of short presentations was initiated by the author of this report with a description of the experimental and modeling approach used and the results obtained at CNWRA, followed by a short discussion of the concerns regarding long-term extrapolation of passive corrosion rates and an assessment of the factors involved in predicting localized corrosion according to their effect on the corrosion and repassivation potentials.

Digby D. Macdonald (The Pennsylvania State University) questioned the validity of any empirical approach to modeling emphasizing the validity of a deterministic approach to predict dissolution rate of passive barrier layer and a damage function for localized corrosion with a parameter expressing a delayed repassivation time.

Jerome Kruger (Johns Hopkins University, Emeritus) provided specific responses to various speculative scenarios presented as part of the questions (see attachment). He dismissed the importance of spalling as a mechanism for accelerating passive corrosion and emphasized the transition from a hot gaseous to an aqueous regime in the possible instability of the passive film.

Alison J. Davenport (University of Birmingham, UK) accentuated the significance of metallurgical factors, including the role of intermetallic particles, grain boundaries, and dislocations as sites for segregation of impurities or depletion of important alloying elements, and their detrimental effect on uniform corrosion rate enhancement, as well as on localized corrosion. In this last process the effects of corrosion product deposits were emphasized.

Roger C. Newman (University of Manchester Institute of Science and Technology, UK) held the view that transpassivity could be the main corrosion process leading to a change in the mechanism of passive film growth since it is predominantly a Cr-rich oxide film. However, if thickening of the film occurs due to dissolution and reprecipitation, he stated that a thicker corrosion product may promote localized corrosion acting as an anion selective membrane concentrating aggressive species.

Hans-Henning Strehblow (Heinrich-Heine University, Duesseldorf, Germany) discussed the importance of Cr in the passive film and noted that local deficiency of Cr as well as radiation damage could lead to film instability.

Philippe Marcus (L'Ecole Nationale Superieure de Chimie de Paris, France) argued that anodic dissolution may promote segregation of impurities such as sulfur at the metal/oxide interface promoting enhanced dissolution or preferential dissolution at grain boundaries. He noted that even thermal segregation may be possible at 200 °C and the effect of fluoride on localized corrosion of Alloy 22 should be investigated..

Robert A. Rapp (The Ohio State University, Emeritus) presented aspects associated to the review on low temperature oxidation that he conducted for the CNWRA to emphasize his point that at a metal/oxide interface misfit and misorientation dislocation may act as a sink for vacancies generated during the growth of the oxide. He noted that surface cold work and accumulation of impurities through wet/dry cycles may increase the corrosion rate.

Susan Smialowska (The Ohio State University, Emeritus) stated the importance of dry/wet cycles as a means to destabilize the passive film by altering the composition of the thin aqueous layer formed on the metal surface but noted that aging tend to improve protective properties of passive films even though stress and associated cracks may occur in thicker films. She remarked that the use of repassivation potential is a valid approach to determine the occurrence of localized corrosion.

Ugo Bertocci (formerly with NIST) discussed the importance of radiation damage in altering film stability whereas Barry R. MacDougall (National Research Council, Canada) expressed concern for the combined effect of chloride and fluoride in disrupting the film claiming that the number of defects in a film and the passive current may decrease with aging time, but not necessarily the activity of individual defects. Howard Pickering (The Pennsylvania State University) mostly presented his model of crevice corrosion due to ohmic drop effects.

Toshio Shibata (Osaka University, Emeritus, Japan) while noting that there is no evidence or argument to support the concept of an increase in passive current density, the fact that it is not an equilibrium system implies that non-selective dissolution may occur and the passive current may increase due to compositional changes in the film or in the subsurface. He strongly advocated the validity of the repassivation potential concept but supported the need for the evaluation of the distribution in values reflecting uncertainty and variability

Norio Sato (Hokkaido University, Emeritus, Japan) provided a fundamental discussion emphasizing that p-type of semiconductive oxides deposited on a passive metal may induce significant increases in corrosion potential in the presence of radiation due to its effect in exciting electrons and holes even in the absence of oxygen or oxidizing radicals. The corrosion potential may increase over the repassivation potential and promote localized corrosion. He pointed out however, that this theoretical evaluation should be confirmed experimentally, because it has been demonstrated only for TiO_2.

Hans Boehni (Swiss Federal Institute of Technology, Switzerland) was not present but reported results claiming that passive film stability is affected by breakdown due to debris accumulation from environmental influences. After a 25 year exposure in road tunnels and 8 years of specific tests at high relative humidity (RH) in polluted atmospheres and 35 °C it was found circumscribed to stainless steels but not observed in high-nickel base alloys. He discussed aspects of metastable pitting that may be necessary to consider.

As a member of the public, Roger Staehle (University of Minnesota, consultant to the State of Nevada) argued that the environment in contact with the WPs in the emplacement drifts cannot be bounded, that temperatures up to 160 °C can be reached in the aqueous phase in contact with WPs, and that the use of ventilation to control temperature and the level of RH will not be practicable due to concern that airborne radioactive particles will be spread to the atmosphere from the ventilation shafts. He argued that a cooler and dryer repository would be better but not necessarily achievable.

The author of this report confronted the view that the in-drift environment cannot be bounded but noted that additional focused and well defined work by the DOE will be required to reduce the current uncertainties in the definition of the environment in contact with the drip shield and the WPs. The chemical divide approach can be used, in addition to accurate estimates of temperature, to determine the concentrations ranges of major aggressive species (e.g., chloride and fluoride), pH, and trace elements if they can be concentrated to dangerous levels.

A roundtable table of discussion regarding Question 1 followed where several issues of concern were raised. They include the following points:

- More mechanistic modeling of passivity combined with appropriate experimental validation
- Reproducibility of the experimental measurements and the validity of small specimens or coupons to represent the variability from heat to heat and the need to scale-up laboratory measurements to a large number of containers
- Metallurgical features associated to fabrication processes and closure operations as a potential source of problems, as well as the potential for anodic segregation of alloy impurities such as sulfur
- Evolution of the corrosion potential to the regime of transpassivity, either by peroxide generation as catalyzed by transition metal cations or by deposition of semiconductive oxide in the presence of irradiation
- Better understanding of cathodic reactions and the possibility that transpassivity can be more easily achieved at alkaline pHs

  Better understanding of the makeup of the passive films in terms of chemical composition, including crystalinity vs amorphous character
- Development of strain and possibility of spalling in thick oxide films

Finally Paul Craig (NWTRB) made a summary of his assessment of the discussion and concluded that the panel didn't feel comfortable with the long-term extrapolation based on a limited set of data and the lack of an accepted mechanism for passive corrosion. He found that particular concerns were related to the influence of the wet/dry cycling regime, the effects of manufacturing and fabrication processes, and the lack of an extended experience with kinetically passive metals contrary to metals that are thermodyinamically stable.

The discussion related to Question 2 continued during the morning of the following day.

MacDougall noted that localized corrosion is clearly related to passive film thickness, the defect character of the film, and the presence of strain. Macdonald presented results of pitting of Alloy 22 in saturated NaCl (pH 3) at 80 °C and questioned any approach founded on the use of a repassivation potential based on the empirical character of this parameter, postulating instead a parameter to characterize delay of repassivation as a 1st order process for the transition from metastable to stable pitting. Macdonald also remarked that reliable reference electrodes should be used in all these studies. Marcus claimed that only short time aging of films has been studied and breakdown of the film could be modified by aging. He added the sulfur species are detrimental for pitting of Ni alloys and microbially influenced corrosion needs additional studies, noting that outer deposit films which are usually hydrated could be dried out during a dry cycle and become affected by further wetting. Kruger dismissed the importance of metastable pits indicating that the repassivation potential is the important factor as a threshold value for stable pit, a concept supported by Shibata mainly in terms of

crevice corrosion. The author of this report presented the table of the factors affecting corrosion and repassivation potentials used in his presentation modified to include several aspects of the other panelists views as well as some elements of the discussion.

In the final round several other aspects were discussed and Joe Payer (Chairman of DOE WP Peer Review Panel) as a member of the public reviewed several of the points raised before the final closing remarks by Sagues , who indicated that the transcripts of the meeting will be available as well as the written responses of the workshop panelists.

DOE Waste Package Peer Review Panel Meeting

This meeting took place in Case Western Reserve University on July 24, 2001 with the assistance of all the members of the panel, which is composed of the following corrosion experts: Joe Payer (Case Wester Reserve University and Chairman), John A. Beavers (CC Technologies Laboratory), Thomas M. Devine (University of California at Berkeley), Gerald S. Frankel (The Ohio Sate University), Russell H. Jones (Pacific Northwest National Laboratory), Robert G. Kelly (University of Virginia) and Ronald M. Latanision (Massachusetts Institute of Technology).

After introductory remarks by Joe Payer, Roger Staehle (University of Minnesota and consultant to the State of Nevada) introduced the members of team working for the State of Nevada and made the first presentation on the Evaluation of the Natural and Engineered Barrier Performance of the Proposed High-Level Nuclear Waste Repository at Yucca Mountain, Nye County, Nevada. This extended presentation was developed along the lines of the Corrosion Based Design Approach formulated by Staehle several years ago. It was an extremely well articulated presentations in which a very strong criticism of the approach and corrosion-related program adopted by the DOE was presented, backed up by an extensive array of examples arising from corrosion failures in the nuclear power industry. This overview was coupled with a rather superficial but effective review of the geology and the environmental factors that may influence WP life.

Aaron Barkatt (Catholic University of America) presented an overview of the experimental program being carried out by the State of Nevada at CAU justifying the use of accelerated tests and considering three types of environments for testing: expected typical service conditions, extreme service conditions and beyond service conditions. He discussed briefly the type of corrosion and stress corrosion cracking (SCC) tests for both Alloy 22 and Ti grade 7, as well as the environments for some tests on glass.

April Pulvirenti (CUA) presented the results of screening tests on disks and U- bend specimens of Ti Grade 7 using as environments variations of J–13 Well Water (1X, 1000X, and !0,000X in concentrations) with the addition of various aggressive species (Pb, Hg, Cd, and S, 80 percent NaOH paste, Cl^- and F^-), over an extended range of pHs (1 to 14) and temperatures (90 to 250 °C). No SCC was observed in U-bend on 30-day tests and only non-uniform, shallow corrosion was observed in disks at relatively large concentrations of Cl^- and F^- .

Jeff Gorman (Dominion Engineering) presented preliminary tests results regarding the effects of Pb and Hg on Alloy C–22. The most important observation from this work is that U-bend tests were conducted in 1000X J–13 Well Water with the addition of 18g/L silica, 5000 ppm Pb in the form of lead acetate hydrate and HCl for pH adjustment. No SCC was observed in a series of tests in which the temperature ranged from 210 to 250 °C and the pH from 0.5 to 5 (one test at pH 14) with a duration of 4 to 6 weeks in most of the cases.

Crevice corrosion and pitting were observed in several tests, but clearly no SCC was observed contrary to previous observations of severe cracking with 5,000 ppm Pb at 250 °C and pH 0.5 in 1 to 2 weeks. It was not clear in his presentation that the lack of reproducibility in the SCC data could be due to heat to heat variations using the same alloy or is due to the initial use of Alloy 622 (supplied by INCO Alloys International) and testing of Alloy C–22 (provided by Haynes International) in the recent set of tests.

A final presentation by the State of Nevada consultants was done by Don Shettel (Geosciences Mangement Institute) on natural trace element geochemistry in the near field. Potential sources of Pb, Cd and Sb were evaluated in minerals in the vicinity of Yucca Mountain, as well as dissolved Pb concentrations from wells around Yucca Mountain. The presentation was completed with a series of potential-pH diagrams for Pb and Hg systems where it is shown that both metals can be easily complexed by Cl^- and CO_3^{2-} and the stability is increased with increasing temperature.

In the afternoon, Tae Ahn (NRC) made comprehensive presentation of the NRC approach to a risk-informed, performance-based evaluation of high-level waste (HLW) containers/engineered barriers. The CLST KYI issues were presented, followed by the important subissues related to the engineered barrier performance. The issue resolution process was explained in detail and illustrated with examples. This presentation was followed by a presentation by the author of this report of the corrosion studies on HLW engineered barrier materials currently conducted at the CNWRA.

IMPRESSION/CONCLUSIONS:

The attendance to the NWTRB workshop as invited panelist was highly beneficial because our participation provided an unique opportunity to express our views and discuss our approach for evaluating long-term corrosion performance of engineered barrier materials in a qualified forum integrated by recognized international experts. Our participation may have contributed to increase public confidence in the technical capability of the CNWRA in support of the NRC for the licensing of the proposed repository through the recognition by members of the technical community and the NWTRB of the nature of the research work conducted at the CNWRA.

Similarly, the invited participation in the meeting organized by the DOE WP Peer Review Panel was useful to provide the members of this panel with our insights on many technical issues related to WP and drip shield performance. Above all, the presentation done by Tae Ahn as NRC CLST PEM was extremely valuable to convey to the panel an detailed explanation of the risk-informed, performance based approach being used by the NRC to evaluate the DOE engineered barrier program and eventually the issues that should be resolved in the potential license application process.

PROBLEMS ENCOUNTERED:

None.

PENDING ACTIONS:

Preparation of a 4-page writeup for the NWTRB compilation of the experts opinions on the long-term extrapolation of passive behavior.

RECOMMENDATIONS:

Future attendance to NWTRB meetings is useful to keep track of the positions of the board and be acquainted with progress and changes in the DOE program because it is apparent the DOE is taking very much in consideration the opinion of the NWTRB. Attendance to the DOE WP Peer Review Panel Meetings is extremely important because the author of this report believe that this panel could have an important influence in focusing and prioritizing many aspects of the DOE program in the area of engineered barriers.

REFERENCES:

The handouts of the various presentations and the attendance list are available upon request from the author.

SIGNATURES:

Gustavo Cragnolino
Staff Scientist

9/4/2001
Date

CONCURRENCE:

Vijay Jain, Manager
Corrosion Science & Process Engineering, Element

9/4/01
Date

Budhi Sagar
Technical Director

9/5/2001
Date

Attachment

GC:jg

UNITED STATES
NUCLEAR WASTE TECHNICAL REVIEW BOARD
2300 Clarendon Boulevard, Suite 1300
Arlington, VA 22201-3367

International Workshop on Long-Term Extrapolation of Passive Behavior

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Arlington, VA 22203
Tel (703) 528-6000
Fax (703) 812-5127

July 19-20, 2001

Workshop purpose: to obtain a broad range of views from experts here and abroad regarding potential issues for extrapolating corrosion resistance for many thousands of years

Thursday, July 19

8:30 a.m. **Call to order/welcome**
Daniel Bullen, Member, Nuclear Waste Technical Review Board (NWTRB) and Chair of the NWTRB's Panel on the Repository

8:35 a.m. **Introduction of panelists (Panelists are listed on page 2.)/Background and scope of workshop**
Alberto Sagüés, Member NWTRB

8:50 a.m. **Overview of proposed waste package designs and waste package environments**
Carl Di Bella, NWTRB Professional Staff
9:05 a.m. Questions/discussion

9:15 a.m. **Overview of research on Alloy-22 corrosion/Questions 1 and 2**
Alberto Sagüés
9:35 a.m. Questions/discussion

9:55 a.m. **Initial responses to questions 1 and 2** (Questions are attached.)
Panelists
Each panelist has 5-10 minutes to outline his/her *initial* response to the questions, followed by 1-2 minutes for clarifying queries.

10:30 a.m. **Break (15 minutes)**

10:45 a.m. **Initial responses to questions 1 and 2 (concluded)**
Panelists

12:30 p.m. **Lunch (1 hour 15 minutes)**

1:45 p.m. **Roundtable discussion of question 1**
Panelists

3:00 p.m.	**Break (15 minutes)**
3:15 p.m.	**Roundtable discussion of question 1 (concluded)** Panelists
5:00 p.m.	**Comments from the public**
5:30 p.m.	**Recess until 8:30 a.m., Friday, July 20**

Friday, July 20

8:30 a.m.	**Reconvene** Dan Bullen
8:40 a.m.	**Roundtable discussion of question 2** Panelists
10:00 a.m.	**Break (15 minutes)**
10:15 a.m.	**Roundtable discussion of question 2 (concluded)** Panelists
11:30 a.m.	**Comments from the public**
12:00 noon	**Closing remarks and adjournment** Alberto Sagüés

List of workshop panelists

Ugo Bertocci		USA
Gustavo A. Cragnolino	Center for Nuclear Waste Regulatory Analyses (Southwest Research Institute)	USA
Alison J. Davenport	University of Birmingham	UK
Jerome Kruger	Johns Hopkins University, Emeritus	USA
Digby D. Macdonald	The Pennsylvania State University	USA
Barry R. MacDougall	National Research Council Canada	Canada
Philippe Marcus	L'Ecole Nationale Superieure de Chimie de Paris	France
Roger C. Newman	University of Manchester Institute of Science and Technology	UK
Howard W. Pickering	The Pennsylvania State University	USA
Robert A. Rapp	Ohio State University, Emeritus	USA
Norio Sato	Hokkaido University, Emeritus	Japan
Toshio Shibata	Osaka University, Emeritus	Japan
Susan Smialowska	Ohio State University, Emeritus	USA
Hans-Henning Strehblow	Heinrich-Heine University Duesseldorf	Germany

Question No.1: On the effects of long-term passive dissolution.

Premise

Laboratory experiments and industrial experience indicate that, under many of the expected waste package service environments, a recently prepared Alloy 22 surface is likely to spontaneously passivate and remain passive for many years *(that expectation will be challenged in Question 2 but not here)*. Fundamental knowledge suggests that the passive layer on such material is thermodynamically stable and self-repairing under many of the expected operating regimes. Present short-term (years) empirical evidence indicates that passive corrosion under such conditions is essentially uniform and proceeds at a rate $\sim< 0.1$ micrometer/y. Those observations have led to predicting times on the order of $>\sim 10^5$ years for penetration of the 2 cm thick WP wall when localized corrosion is not expected. Assume now that the passive regime thus initiated has continued for several hundreds or even thousands of years, so that the passive corrosion penetration has reached a substantial depth (e.g., > 10 micrometer).

Question

a) Can you propose any plausible mechanism(s) that would cause the long term corrosion rate to increase, once penetration under passive conditions reaches significant values, so that sustained corrosion rates (maybe no longer uniform) exceed ~1 micrometer/y? (Such a seemingly small absolute increase in corrosion rate would seriously compromise the present expectations for WP performance.) Examples of scenarios that have been proposed for possible consideration are given in the *Speculative Scenarios* section below.

b) What experiments and/or theoretical treatment would you propose to assess the validity of the proposed mechanism(s) for Alloy 22 under the proposed repository conditions?

Speculative scenarios

Some speculative scenarios, given below, have been proposed by various investigators for consideration as ways in which passivity might degrade over long time periods, under repository environments that in a shorter time frame would have supported instead very low metal dissolution rates. These items are presented for illustration only. Workshop participants may address any or all of these scenarios if they wish, but are under no obligation to consider them. In the following, it is assumed that either because of dripping or because of condensation and deliquescence a layer of electrolyte is always present on the surface of the WP being considered.

1) *Defect sweeping.* As passive corrosion proceeds, the barrier layer dissolves on the electrolyte side and builds up on the alloy bulk side, effectively sweeping into the metal. In this sweeping action the layer encounters a growing number of precipitates or other microstructural features. If those features leave an adverse cumulative effect on the layer (for example, increasing crystal defect density), after enough time there could

be a significant increase in the rate of passive corrosion because of enhanced ionic transport across the layer.

2) *Vacancy buildup*. Passive corrosion may proceed at different rates for various alloy components. This imbalance could lead to accumulation of vacancies at the barrier layer-metal interface, which after a long enough time would cause oxide spalling and consequent increase of the average rate of corrosion compared with that at earlier times.

3) *Debris accumulation*. As time progresses the corrosion products from passive dissolution accumulate on the WP surface creating a macroscopically thick layer of likely hydrated metal ions. If this layer acts as an anion-selective membrane it may promote localized corrosion.

4) *Incipient transpassive behavior*. Because of the high Mo content of Alloy 22, transpassive dissolution may already develop at modestly noble potentials at a rate that would be negligible in an industrial application, but unacceptable in the repository. The neutral-to-high solution pH projected by some performance analysis calculations could be a factor in promoting this mode of degradation. Slow, long term excursion of the open circuit potential in the noble direction could result from, for example, deposition over long times of passive corrosion debris on the WP surface with consequent increase in cathodic efficiency.

Question No. 2: On the long-term preservation of conditions preventing localized corrosion.

Premise

The evidence from present testing suggests that under expected service conditions the open circuit potential at the package surface stays significantly more negative (by a few hundred mV or more) than the critical potential deemed necessary for development of stable localized corrosion. That evidence has led to predicting the absence of significant localized corrosion of Alloy 22, for unstressed portions of the WP, over a performance period stretching to 10^4 years and beyond. For simplicity, assume that no significant residual or externally imposed stresses affect the waste packages.

Question

a) Can you propose any plausible mechanism(s) relevant to the waste package that would cause, over long periods of time, shifts in the open circuit and/or the critical potential such that stable localized corrosion could develop? (If you wish, you may consider both potentials as distributed parameters.)

b) In addition, or as an alternative to (a), can you propose a localized corrosion process that could develop over long times such that initiation and propagation are not amenable to description in terms of a critical potential?

c) What experiments and/or theoretical treatment would you propose to investigate the issues identified under (a) or (b) for Alloy 22 under the proposed repository conditions?

CONTRACT NO. DE-AC08-01RW1201—WASTE PACKAGE MATERIALS PERFORMANCE PEER REVIEW PANEL MEETING, TUESDAY, JULY 24 2001

AGENDA

Morning session

8:30 – 12 noon	Contractors for the State of Nevada, Agency for Nuclear Projects
Dr. Don Shettel	Natural Trace Element Geochemistry in the Near Field (15minutes)
Dr. Roger Staehle	(a) Environmental Definition as it affects the Choice and Life of Materials (b) Material Definition as it affects the Performance of C-22 (c) Mode Definition (SCC, Pitting, Etc.) of C-22 (d) Statistical Aspects of Prediction (e) Existing Paradigms from the Commercial Nuclear Program (2 hours)
Dr. Aaron Barkatt	Overview of the Experimental Program of the State of Nevada on EBS Materials (15 minutes)
Dr. April Pulvirenti	Results of Screening Tests on Titanium Grade 7 (30 minutes)
Dr. Jeff Gorman	Preliminary Tests on C-22 and Extrapolation to Service Conditions (30 minutes)

Afternoon session

1:30 – 5:00 p.m.	Representatives of NRC and CNWRA
Dr. Tae Ahn, NRC	Approach to a risk-informed performance-based evaluation of IILW Containers/engineered barriers
Dr. Gustavo A. Cragnolino, CNWRA	Corrosion studies of HLW container/engineered barrier materials
5:00 – 5:30 p.m.	**Public Comment Period**

The meeting will be at CWRU in Wickenden Bldg., Room 322. Please refer to the following web page www.cwru.edu/pubs/maps/case.html for a map of the location. Wickenden building is listed as #98 on the map.

For technical questions, contact Joe H. Payer (216) 368-4218, jhp@po.cwru.edu, and for local Arrangements, contact Bernie Strong at 216-368-6525, brs@po.cwru.edu