Distribution:
WM File 109.6
WMEG
NMSS
REBrowning
MJBell
LHBarrett
TCJohnson
TLJungling
HJMiller
MRKnapp
JOBunting
LBHigginbotham
JJLinehan
SMCoplan
JEKennedy
PDR

109.6/TLJ/12/14/84

DEC 17 1984

- 1 -

MEMORANDUM FOR: Lake H. Barrett, Chief
Engineering Branch
Division of Waste Management

THRU: Timothy C. Johnson, Section Leader
Materials Engineering Section
Engineering Branch
Division of Waste Management

FROM: Thomas L. Jungling
Materials Engineering Section
Engineering Branch
Division of Waste Management

SUBJECT: MEETING REPORT - AD HOC CORROSION PANEL
MATERIALS REVIEW BOARD

On November 8 and 9, 1984, I participated in a review of the Material Characterization Center (MCC) Corrosion Program. The review, organized by the Materials Review Board (MRB), was initiated at the behest of the Materials Integration Office (MIO) - DOE. Enclosure 1 outlines the agenda and the MCC program participants. Biographies of the panel members are provided in Enclosure2.

The objective of the review was to determine for the MIO whether the MCC testing program is adequate in quality, scope, and magnitude to provide the data necessary for making predictions of the container lifetime, and to identify any specific areas where the MCC program is apparently deficient. To achieve this objective, a written report is being prepared, documenting the panel conclusions. This report will probably be available by January 1985. My comments and conclusions on the MCC program, which were transmitted to the Chairman of the MRB are attached as Enclosure 3.

If you have any questions, please contact me at x74540.

Original signed by

Thomas L. Jungling
Materials Engineering Section
Engineering Branch
Division of Waste Management

Enclosures:
As stated

WM Record File 109.6 WM Project 1
Docket No.
PDR
LPDR
Distribution:
(Return to WM; 623-SS)

OFC	:WMEG	:WMEG	:	:	:	:
NAME	:TJungling:gh	:TCJohnson	:	:	:	:
DATE	:12/17/84	:12/17/84	:	:	:	:

Enclosure 1

MATERIALS REVIEW BOARD

MEETING OF AD HOC CORROSION PANEL
MATERIALS REVIEW BOARD
PACIFIC NORTHWEST LABORATORIES
NOVEMBER 8 AND 9, 1984

AGENDA FOR REVIEW OF MCC CORROSION PROGRAM

Thursday, November 8

8:00	Introductory Remarks	M. Steindler
8:15	DOE Schedules and Other Bases for MCC Program	J. Mendel
8:30	Background Regulatory Bases Repository Environments Conceptual Design	D. Merz
9:00	Candidate Repository Materials Identification Bases for Material Selection	D. Merz
9:30	Generic Concerns Issues of General and Localized Corrosion Issues of Stress Corrosion Cracking	 D. Shannon B. Anderson
10:15	Break	
10:30	Generic Concerns (Cont'd) Time Extrapolations and Accelerated Testing Pitting-Initiation and Propagation	D. Merz
11:00	Frame of Reference - Open Discussion	J. Mendel
11:15	MCC Program on Testing and Data Task Organization Test Selection: Rationale and Source of Guidance Activities of Repository Projects and Waste Producers Historical Account (MCC-101, MCC-102, MCC-103) Bases for Assessment Identification of Key Data	D. Merz
12:00	Lunch	
1:15	Testing and Data (Cont'd) MCC-105.1 Testing MCC-105.1 Radiation Testing Statistical Analysis of Data MCC-104: Stress Corrosion Cracking Testing	 R. Wang R. Wang M. Bowen B. Anderson

ARGONNE NATIONAL LABORATORY

MATERIALS REVIEW BOARD

MEETING OF AD HOC CORROSION PANEL
MATERIALS REVIEW BOARD
PACIFIC NORTHWEST LABORATORIES
NOVEMBER 8 AND 9, 1984

AGENDA FOR REVIEW OF MCC CORROSION PROGRAM

Thursday, November 8 (Cont'd)

2:45	Break	
3:00	Data Quality	
	Corrosion Testing	D. Shannon
	Analytical Data and Reference Materials	L. Daniel
	Statistical Analysis	M. Bowen
4:00	Special Topics	D. Merz
	Site Specific Conditions	
	Test Limitations, Unresolved Issues	
	Compliance with NRC	
	Future Activities with Repositories	
4:45	Adjourn	

Thursday Evening Session

7:30	Executive Session of Panel	Steindler, Panel
	Identification of Subject Areas for Further Inquiries	
	Discussion of Further Course of Action	
	Panel Member Responsibilities	

Friday, November 9

8:00	Uncompleted Items from Thursday	
9:15	Panel Inquiries to MCC	Steindler, Panel
	Items Identified in Executive Session	
	Other	
11:00	Wrapup Instructions to Panel Members	Steindler, Panel
11:30	Adjourn	

Members of Ad Hoc Panel:	See attached sheet	
Chairman:	M. Steindler	
Executive Secretary:	W. Seefeldt	
MCC:	J. Mendel, Manager	R. Wang
	M. Bowen	L. Daniel
	D. Merz	S. Slate
	R. Strickert	R. Allen
	B. Anderson	
PNL:	D. Shannon	

ARGONNE NATIONAL LABORATORY

Enclosure 2

MATERIALS REVIEW BOARD

MEMBERS OF THE AD HOC CORROSION PANEL

BIRNBAUM, H(OWARD) K(ENT), b New York, NY, Oct 18, 32; m 54; c 3. METALLURGY. Educ: Columbia Univ, BS, 53, MS, 55; Univ Ill, PhD(metall), 59. Prof Exp: From asst to asst prof metall, Univ Chicago, 59-61; assoc prof, 61-63. PROF METALL, UNIV ILL, URBANA-CHAMPAIGN, 63- Mem: Am Inst Mining, Metall & Petrol Engrs; Fel Am Phys Soc. Res: Physical metallurgy; physics of solids; dislocation theory; mechanical properties of solids; hydrogen in solids; interstitial diffusion; hydrogen embrittlement. Mailing Add: Dept of Metall & Mining Eng Univ of Ill Urbana IL 61801

DUQUETTE, DAVID J(OSEPH), b Springfield, Mass, Nov 4, 39; m 61; c 2. METALLURGY, MATERIALS SCIENCE. Educ: US Coast Guard Acad, BS, 61; Mass Inst Technol, PhD(metall), 68. Prof Exp: Res asst metall, corrosion lab, Mass Inst Technol, 65-68; res assoc, adv mat res & develop lab, Pratt & Whitney Div, United Aircraft Corp, 68-70; from asst prof to assoc prof metall eng, 70-76, PROF METALL ENG, RENSSELAER POLYTECH INST, 76- Mem: Am Soc Metals; Am Inst Mining, Metall & Petrol Engrs; Nat Ass Corrosion Engrs. Res: Corrosion science and engineering including the effect of environment on mechanical properties of crystalline materials; mechanical properties of metals and alloys; fatigue. Mailing Add: Dept of Mat Eng Rensselaer Polytech Inst Troy NY 12181

GERBERICH, WILLIAM WARREN, b Wooster, Ohio, Dec 30, 35; m 59; c 3. METALLURGY, MATERIALS SCIENCE. Educ: Case Inst Technol, BS, 57; Syracuse Univ, MS, 59; Univ Calif, Berkeley, PhD(mat sci & eng), 71. Prof Exp: Proj eng metall, Jet Propulsion Lab, Pasadena, Calif, 59-62; sr res scientist, Aeronutronic, Newport Beach, Calif, 62-63; eng specialist, Aerojet Gen Corp, Sacramento, Calif, 63-67; res scientist mat sci, Lawrence Radiation Lab, Univ Calif, Berkeley, 67-71; PROF MAT SCI, UNIV MINN, MINNEAPOLIS, 71- Concurrent Pos: Lectr mat sci, Univ Calif, Berkeley, 67-71; consult, Standard Oil Calif, 68-69 & Meyer Indust, Int Tel & Tel Corp, 76-; mem comt, Adv Army Res Off, 70-74, Nat Mat Adv Bd, Nat Res Coun, 73-76 & Bd Publ, Metall Trans, 77-; adv, Minn Pollution Control Agency, 74-76; chmn fracture mech comt, Am Soc Metals, 78-; chmn fatigue res comt, Am Soc Testing & Mat, 78- Honors & Awards: William Spraragen Award, Am Welding Soc, 68. Mem: Am Inst Mining, Metall & Petrol Engrs; Am Soc Metals; Am Soc Testing & Mat; Sigma Xi. Res: Strengthening mechanisms and fracture phenomena including hydrogen embrittlement, polymer fracture, elastic-plastic fracture mechanics, microscopic crack growth and dislocation dynamics. Mailing Add: Dept of Chem Eng & Mat Sci Univ of Minn Minneapolis MN 55455

JUNGLING, THOMAS LEE, METALLURGICAL ENGINEERING. Educ: MS, Ohio State, 83; BS, U of Pittsburgh, 81. Prof Exp: Res Technician, U of Pittsburgh, 79-80; Summer Eng, Westinghouse, 81; MATERIALS ENGINEER, US NUCLEAR REGULATORY COMMISSION, 83. Mem: Am Soc Metals, Am Inst Metall Engrs, Mat Res Soc. Res: Materials for nuclear waste packages, failure analysis of austenitic steels, high temperature oxidation. Mailing Add: U.S. Nuclear Regulatory Commission Washington DC 20555.

KRUGER, JEROME, b Atlanta, Ga, Feb 7, 27; m 55; c 2. PHYSICAL CHEMISTRY, CORROSION. Educ: Ga Inst Technol, BS, 48, MS, 50; Univ Va, PhD(chem), 53. Prof Exp: Phys chemist, Naval Res Lab, 52-55; phys chemist, 55-66, CHIEF CORROSION & ELECTRODEPOSITION SECT, NAT BUR STANDARDS, 66- Concurrent Pos: Lectr, Univ Md, 59-69, prof, 69- Honors & Awards: Silver Medal, US Dept Com, 62, Gold Medal, 72; Blum Award, Electrochem Soc; Willis R Whitney Award, Nat Ass Corrosion Eng, 76. Mem: AAAS; Am Chem Soc; Electrochem Soc; Sigma Xi; Nat Ass Corrosion Eng. Res: Corrosion; metallic oxidation; ellipsometry; electrochemistry; Mailing Add: Corrosion & Electrodepos Sect Nat Bur of Standards Washington DC 20234

STEINDLER, MARTIN JOSEPH, b Vienna, Austria, Jan 3, 28; nat US; m 52; c 2. INORGANIC CHEMISTRY, RESEARCH ADMINISTRATION. Educ: Univ Chicago, PhB, 47, BS, 48, MS, 49, PhD(chem), 52. Prof Exp: Res asst, US Navy Inorg Proj, Univ Chicago, 48-52, consult, 53; Argonne Nat Lab, 53; assoc chemist, 53-74, sr chemist, ASSOC DIR CHEM ENG DIV, ARGONNE NAT LAB, 77- Concurrent Pos: Mem, Atomic Safety & Licensing Bd Panel, 72-; consult, Adv Comt Reactor Safeguards, 67- Mem: Am Chem Soc; Am Nuclear Soc; Brit Chem Soc. Res: Nuclear fuel cycle; radiological safety; nuclear waste disposal; fluorine chemistry of the actinide elements and fission product elements; reactor fuel reprocessing; non-aqueous inorganic kinetics. Mailing Add: Argonne Nat Lab Bldg 205 RmC227 9700 S Cass Ave Argonne IL 60439

WEI, ROBERT PEH-YING, b Nanking, China, Sept 16, 31; m 54; c 2. APPLIED MECHANICS, MATERIALS SCIENCE. Educ: Princeton Univ, BSE, 53, MSE, 54, PhD(mech eng), 60. Prof Exp: Instr mech eng, Princeton Univ, 54-57, res asst aeronaut eng, 58-59; assoc technologist, fracture mech, Appl Res Lab, US Steel Corp, 59-61, technologist, 61-62, sr res engr, 62-64, assoc res consult, 64-66; assoc prof mech, 66-70, PROF MECH, LEHIGH UNIV, 70- Mem: Am Soc Testing & Mat. Res: Fracture mechanics; mechanics and metallurgical aspects of fatigue crack growth and stress corrosion cracking; experimental stress analysis. Mailing Add: Dept of Mech Eng & Mech Lehigh Univ Bethlehem PA 18015

WILDE, BRYAN EDMUND, b. Salford, Eng, Nov. 6, 34; m. 58; c. 4. CHEMISTRY. A.R.I.C, London, 61, res. dipl. electrochem, 64; Ph.D.(mat. sci), Rensselaer Polytech, 68. Asst. analyst, Chloride Elec. Storage Co, Ltd, Eng, 51-54; anal. chemist, Brit. Cotton Industs. Res. Ass, 54-55; Magnesium Electron, Ltd, 55-57, dep. chief analyst, 57-60, mgr. phys. chem, 60-63; supvr. corrosion res. lab, Rensselaer Polytech, 63-65; lead scientist, corrosion res. center, Vallecitos Nuclear Lab, Gen. Elec. Co, Calif, 65-68; SECT. MGR. CORROSION, RES. CTR, U.S. STEEL CORP, 68- Fel, Rensselaer Polytech, 63-65. Electrochem. Soc; Nat. Ass. Corrosion Eng; assoc. Royal Inst. Chem. Electroanalytical chemistry; electrochemistry; electrode kinetics and physical metallurgy of corrosion processes. Address: Corrosion Technology Division, Research Center, U.S. Steel Corp, Monroeville, PA 15146.

Executive Secretary:

SEEFELDT, WALDEMAR B(ERNHARD), b. Milwaukee, Wis, Apr. 4, 25; m. 50; c. 3. CHEMICAL ENGINEERING. B.S, Purdue, 47, M.S, 48. ASSOC. CHEM. ENGR, ARGONNE NAT. LAB, 48- U.S.N.R, 44-46. Research Soc; Inst. Chem. Eng; Nuclear Soc. Nuclear fuel cycle; cost evaluations; processing of nuclear fuels; criticality hazards. Address: 417 E. Kensington Ave, La Grange, Ill. 60525.

ARGONNE NATIONAL LABORATORY

COMMENTS ON THE MATERIAL CHARACTERIZATION CENTER CORROSION PROGRAM

To provide a starting point for these comments, I will first address the three questions posed by the DOE in the July 11, 1984 letter (Attachment to MRB-350), then provide comments on corrosion mechanisms, long-term predictability and time constraints.

1. Are all the corrosion mechanisms that are likely to be operative in the repository environments being addressed, either by the MCC or included among the "key data"to be reviewed by the MRB?

   The corrosion mechanisms likely to be operative in the repository are not being addressed, i.e., forms of localized corrosion with the exception of stress corrosion cracking (MCC 104), which is still in the development stage.

2. Are the tests being developed by the MCC and those proposed by the projects adequate to quantify the corrosion or penetration rates associated with those mechanisms?; and

   The tests that are being developed are almost exclusively for uniform corrosion. Uniform corrosion tests may be inadequate to quantify the corrosion or penetration rates associated with the likely corrosion mechanisms. More information on the tests proposed by the projects is needed to evaluate their ability to quantify corrosion rates.

3. Are the quality of the MCC work and the MCC/project interactions adequate to assure development and review of "key data" of sufficient scope and quality to show compliance with NRC and EPA criteria?

   Interaction between the MCC and the projects, in order to assure the development of key licensing data seems to be lacking for all three projects, to some degree. Interaction between the basalt (BWIP) and Salt (ONWI) projects and the MCC appears to exist, however, the MCC has been limited thus far to developing uniform corrosion tests which will not provide the critical corrosion data. Of greater concern is the apparent absence of formal interaction between the MCC and the Nevada Nuclear Waste Storage Investigation (NNWSI).

   The quality of the MCC work must be evaluated in terms of the test procedures which have been developed and made available. The tests have the potential to demonstrate compliance with the NRC and EPA criteria, however, the scope of the tests appears to be limited,

partially by financial constraints and partially by MCC's desire to establish prototypic tests. Prototypic tests may not reflect time-dependent changes in the alloy composition and properties as well as waste package induced changes in the environmental conditions, which may result in more severe conditions for corrosion.

Corrosion Mechanisms

It was apparent from the MCC presentation that their emphasis has been towards uniform corrosion. While uniform corrosion tests are very useful in characterizing a large group of materials for performance in the particular environment they will not provide licensing relevant data on the more likely corrosion failure modes, i.e., localized corrosion. These mechanisms which include pitting, crevice corrosion, stress corrosion cracking, intergranular and environmental effects, such as hydrogen-embrittlement, have not received the attention by the MCC that will be necessary to demonstrate the long-term performance required by the NRC. The adequacy with which the individual repository projects are addressing the concern of localized corrosion could not be determined in the context of this meeting, since very little information seemed to be available to the MCC.

The tests currently under development by the MCC are directed towards simulating the expected repository environment (prototypic tests), which appear to be adequate for the determination of the initial uniform corrosion rate. However, in conjunction with some of these tests the MCC is examining the test specimens for pitting corrosion. The chances of developing an accurate idea of the extent or rate of pitting seems small in these relatively short-term tests in the relatively benign environments, especially for materials which may possess long incubation periods. As presented, this is the only type of test planned to study pitting corrosion. The same argument is true for other forms of localized corrosion, i.e., the material may possess a long incubation period in the prototypic environment, and a short-term test may therefore exhibit no susceptibility. By neglecting localized corrosion mechanisms, the type of data likely to be essential at licensing time may not be available, to predict with reasonable assurance that the waste container will survive the containment period.

Long-term Predictability

As a result of the time constraints, the prediction of long-term performance will probably require accelerated testing and time extrapolations of short-term test results. Extrapolations for uniform corrosion rates may be accomplished with

with reasonable agreement in the technical community, however, this may prove difficult, if not impossible for various localized mechanisms. Therefore, unless it has been determined that the reference material is not susceptible to the particular failure mechanism, development of an accelerated test or a technically accepted means for extrapolating short-term results, will be needed. This is obviously not going to be an easy task, so an understanding of the need for, as well as the capabilities and limitation of using accelerated tests/time extrapolations to predict performance is necessary. These items need to be addressed in the MCC activities.

Time Limitations

There are approximately five years in which to collect corrosion data before licensing. A portion of that time will be devoted for the MCC to develop standard test procedures and the review of those procedures by the MRB. It seems imperative that, if the DOE still intends to utilize the MCC and MRB, the MCC begin concentrating on localized corrosion processes.

Conclusion

The ultimate conclusion reached from the MCC presentations, is that the program is currently working on standard test procedures which may yield a minimum of useful corrosion data applicable to licensing. That is, the emphasis of the tests now under development will probably provide data inadequate to demonstrate the long-term performance of the waste container.