

# Model Error Resolution Document

*Complete only applicable items.*

QA: NA JJ  
QA 12-23-08

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|                                  |  |                              |    |                |        |
|----------------------------------|--|------------------------------|----|----------------|--------|
| <b>1. Document Number:</b>       | ANL-EBS-MD-000005  | <b>2. Revision/Addendum:</b> | 04 | <b>3. ERD:</b> | ERD 03 |
| <b>4. Title:</b>                 | Stress Corrosion Cracking of Waste Package Outer Barrier and Drip Shield Materials |                              |    |                |        |
| <b>5. No. of Pages Attached:</b> | 3  |                              |    |                |        |

**6. Description of and Justification for Change (Identify affected pages, applicable CRs and TBVs):**

Description of Changes

In regard to CR 12520, it was found that ANL-EBS-MD-000005 REV 04, Table 6-19, indicated that the listed value for maximum carbon content for Ti Grade 7 is 0.10 wt% with a source of ASTM B 265-02 [DIRS 162726], Table 2. ASTM B 265-02 [DIRS 162726], Table 2 lists 0.08 wt% rather than 0.10 wt% as the maximum carbon content for Ti Grade 7. To address this inconsistency, a note to the reader is added that states:

The maximum carbon content value (0.10 wt%) listed in Tables 6-19 for Ti Grade 7 should be 0.08 wt%, consistent with the referenced ASTM specification, i.e., ASTM B 265-02 [DIRS 162726], Table 2.

In response to CR 11919 unqualified software (Geochemists Workbench Version 2.0) was used to estimate the target compositions of standard test solutions in DTN: LL040803112251.117 [DIRS 171362] and should be replaced with a qualified DTN: LL081002312251.202 [DIRS 185793], containing the measured compositions of standard test solutions as follows:

Section 6.2.1.2.1 (pg. 6-9): Replace "The brine compositions used in these experiments are listed in DTN: LL040803112251.117 [DIRS 171362]."

With

"The brine compositions used in these experiments are listed in DTN: LL081002312251.202 [DIRS 185793], file: Revised\_Vessel\_Chem\_02and04v4.xls, worksheet: range."

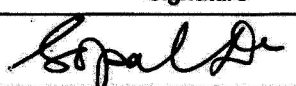

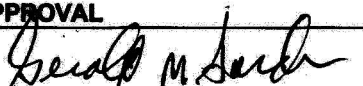
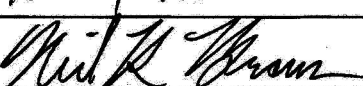
In response to CR 12553, this ERD addresses and corrects incorrectly listed exposure times for two U-bend specimens listed in tables contained in ANL-EBS-MD-000005 REV 04, unqualified output DTN: MO0705CREEPSCC.000, and qualified output DTN: MO0702PASTRESS.002.

The U-bend specimen exposure times corrected by this ERD are contained in Table 4-9 (p. 4-22), Table 6-29 (p. 6-150), Table 6-30 (p. 6-154) and in Figure 6-71 (p. 6-150) of ANL-EBS-MD-000005 REV 04. Table 4-9 indicates that the exposure time for specimen NUE 136 is 2.4 years. Table 6-29 indicates that the exposure time for specimen NUA 148 is 0.5 years and the exposure time for specimen NUE 136 is 1 year. The exposure time for both specimens is actually about 2.5 years as indicated in Evans and Rebak 2008 ([DIRS 185882], p. 20).

Table 6-30, which cites Table 4-9 as a source, erroneously lists U-bend specimen NUE 136 as the maximum stressed (197 MPa), one-year-exposed specimen examined instead of the intended specimen FUA 124 (209 MPa). The related Figures 6-72, 6-73, and 8-1 which contain U-bend specimen data points from the last column (the maximum measured U-bend stresses for each exposure time interval) of Table 6-29 and/or Table 4-9 are correct.

With respect to Figure 6-71 in ANL-EBS-MD-000005 REV 04, which is also contained in unqualified output DTN: MO0705CREEPSCC.000 (file: *CreepGraphs.xls*, worksheet: "RemStress"), plotting the correct exposure times (~2.5 years) for specimens NUA 148 and NUE 136 would alter the contents of this figure.

In addition, tables listing U-bend specimens contained in qualified output DTN: MO0702PASTRESS.002 (file: *Figure 6-73 Table 6-31.xls*, table "LTCTF Data") and in unqualified output DTN: MO0705CREEPSCC.000 (file: *CreepGraphs.xls*, worksheet: "RemStress") also contain erroneous exposure times for specimens NUA 148 and NUE 136 and are replaced with corrected tables.

| 7. CONCURRENCE      |                                   |  |            |
|---------------------|-----------------------------------|--|------------|
|                     | Printed Name                      | Signature  | Date       |
| Checker             | Gopal De                          |  | 12/23/2008 |
| QCS/QA Reviewer     | Brian Mitchell                    |  | 12/23/08   |
| 8. APPROVAL         |                                   |  |            |
| Originator          | Gerald M. Gordon and Kevin G. Mon |  | 12/23/08   |
| Responsible Manager | Neil R. Brown                     |  | 12/23/08   |



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To address these errors/inconsistencies, notes to the reader are added that state:

a) Tables 4-9 and 6-29 in ANL-EBS-MD-000005 REV 04 are replaced with the corrected version given below:  
**Tables 4-9 and 6-29 (corrected). Summary of LTCTF Titanium Grades 7 and 16 U-Bend Specimen Maximum Remaining Stress Levels**

| Exposure Time (yrs) | Test Temperature (°C) | Specimen ID                                | Maximum Stress, (MPa) | Maximum of Maximum Stress (MPa) at each exposure time |
|---------------------|-----------------------|--|-----------------------|---|
| N/A                 | RT                    | FUA 141                                    | 192                   |   |
| N/A                 | RT                    | FUE 142                                    | 360                   |   |
| N/A                 | RT                    | NUA 181                                    | 375                   |   |
| N/A                 | RT                    | NUE 182                                    | 370                   | 375   |
| 0.5                 | 60                    | FUA 122                                    | 287                   | 287   |
| 2.5                 | 60                    | NUA 148                                    | 188                   |   |
| 1                   | 60                    | FUA 124                                    | 209                   | 209   |
| 2.3                 | 60                    | FUA 126                                    | 60                    |   |
| 5                   | 60                    | FUA 128                                    | 145                   | 145   |
| 0.5                 | 90                    | FUE 134                                    | 181                   |   |
| 1                   | 90                    | FUE 136                                    | 192                   |   |
| 2.5                 | 60                    | NUE 136                                    | 197                   |   |
| 2.3                 | 90                    | FUE 138                                    | 121                   |   |
| 2.5                 | 90                    | NUA 178                                    | 232                   | 232   |
| 2.5                 | 90                    | NUE 166                                    | 65                    |   |
| 5                   | 90                    | FUE 140                                    | 113                   |   |
|                     | RT                    | Ti Grade 7 Room Temperature Yield Strength |                       | 362   |

Source: Stresses from DTN: MO0708XRAYDRST.000 [DIRS 182572], Exposure times from Evans and Rebak 2008 [DIRS 185882], p. 20. Ti Grade 7 room temperature yield strength from Table 4-7.

Output DTN: MO0702PASTRESS.002, file: *Figure 6-73 Table 6-31.xls*, table "LTCTF Data"

NOTES: The "Maximum of Maximum Stress" in the fifth column is the maximum values from the fourth column under the same exposure time. Exposure times of 2.3 were treated as 2.5 year exposure times.

RT = room temperature.

N/A = Exposure times for these specimens are not used and are not precisely known.

- b) The following text is added to the "Data Source" column in row 6 of the continuation of Table 4-1 on p. 4-6: "Exposure times from Evans and Rebak 2008 [DIRS 185882], p. 20."
- c) Figure 6-71 is replaced with the corrected version below



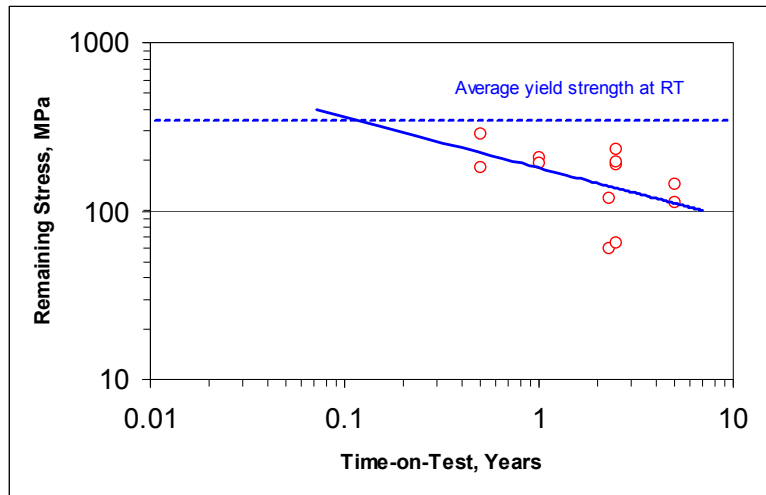
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Source: Table 6-29, Output DTN: MO0705CREEPSCC.000, file *CreepGraphs.xls*, Sheet "RemStress."

Figure 6-71. Maximum Remaining Tensile Stress versus Exposure Time for Each Titanium Grades 7 and 16 U-Bend Test Specimens Exposed to a Range of Brines without Observed SCC Initiation

- d) Unqualified output DTN: MO0705CREEPSCC.000, file *CreepGraphs.xls*, worksheet: "RemStress", is corrected in accordance with the changes discussed above.
  - e) The following reference should be added to Section 9.1:  
185882 Evans, K. and Rebak, R. 2008. Long Term Corrosion Studies of Waste Package Materials and Other Alloys [final submittal]. Scientific Notebook SN-LLNL-SCI-241-V4. Pages 1-63. ACC: LLR.20080403.0215.
  - f) Table 6-30 is corrected as follows:  
Entries in Columns 2, 3, 4 and 5 of line 4 of the lower, U-bend portion of the table (labeled "LTCTF Titanium Grades 7 and 16 U-Bend Specimens (Abstracted from Table 6-29)"), i.e., 90, 197, 1 and NUE 136 are replaced with 60, 209, 1 and FUA 124, respectively.
  - g) Qualified output DTN: MO0702PASTRESS.002, file *Figure 6-73 Table 6-31.xls*, worksheet: "Sheet 1" the included table titled "LTCTF Data" is updated with the corrected version of Table 6-29 contained herein.
1. In Table 8-15 (p. 8-47), the "Parameter Definition/Description" for "Parameter Name" z\_OL\_a is changed from "Uncertainty variation in the yield strength of the outer closure lid" to "Uncertain variation in the residual stress profile of the outer barrier closure lid weld region". This change clarifies the meaning of this parameter. This change was self-identified.
  2. In Section 8.4.2.2 (p. 8-49), last paragraph, The statement "Based on the angular stress variation in Equation 2, the SIF variation with angle is given by:" is replaced with "Based on the angular stress variation in Equation 65, the SIF variation with angle is given by:" This typographic error was self-identified.
- h) Due to the revision of the two output DTNs the submittal date located in Section 9.4 is revised to the new submittal date as follows:
1. For MO0702PASTRESS.002, Replace Submittal date: 04/24/2007 with 12/16/2008
  2. For MO0705CREEPSCC.000, Replace Submittal date: 05/14/2007 with 12/15/2008

Also, in response to CR 11919 in Section 9.3:

Replace

171362 LL040803112251.117. Target Compositions of Aqueous Solutions Used for Corrosion Testing. Submittal date: 08/14/2004.

With

185793 LL081002312251.202. Chemical Comparison of Corrosion Testing Solutions Used for Alloy C22 and Titanium at LLNL - Developed. Submittal date: 10/03/2008

Justification for Changes

In regard to CR 12520:



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Changing the maximum carbon content of Ti Grade 7 from 0.1 wt% to 0.08 wt% in ANL-EBS-MD-000005 REV 04, Table 6-19 has no impact on the model conclusions or outputs. Further, these changes are not relevant to safety or waste isolation and have no impact on the Total System Performance Assessment.

In regard to CR 12553:

- The threshold stress for SCC initiation is based on Figure 6-73 which, as noted above, is unaffected by the exposure times of specimens NUA 148 and NUE 136. Therefore, the changes outlined above have no impact on the model results or conclusions. As discussed in Section 6.8.3.1.3 of ANL-EBS-MD-000005 REV 04, "A new threshold stress for potential SCC initiation is developed based on Figure 6-73, which is constructed by using data in Table 6-25 and Table 6-29 and the argument illustrated in Figure 6-73." As discussed above, the U-bend data used in Figure 6-73 (and Figure 8-1) to establish a threshold stress value listed in Table 8-4 are those resulting from the "Maximum of Maximum Stress" values listed in column 5 of Table 6-29 which contains correct U-Bend test results and does not include results from specimens NUA 148 or NUE 136. Therefore, the changes being implemented in this ERD have no impact on the model conclusions or output. Further, these changes are not relevant to safety or waste isolation and have no impact on Total System Performance Assessment or the Safety Analysis Report.
- The change in "Parameter Definition/Description" for "Parameter Name" z\_OL\_a is a clarification and has no impact on the model outputs or conclusions reached in ANL-EBS-MD-000005 REV 04.
- The correction of the typographic error identified has no impact on the model outputs or conclusions reached in ANL-EBS-MD-000005 REV 04.

In regard to CR 11919:

Changing the indirect input source DTN from DTN: LL040803112251.117 [DIRS 171362] to DTN: LL081002312251.202 [DIRS 185793], in ANL-EBS-MD-000005 REV 04, Section 6.2.1.2.1 has no impact on the model conclusions or outputs. Further, these changes are not relevant to safety or waste isolation and have no impact on the Total System Performance Assessment.

### Analysis of Impacted Documents:

The changes listed above in response to CR 12520, CR 11919 and CR 12553 as well as the clarification and correction of a typographic error have no impact on the conclusions of or the outputs from ANL-EBS-MD-000005 REV 04. Also, none of the controlled or under-development documents which cite ANL-EBS-MD-000005 REV 04 use the corrected information presented above (Sections, Tables and Figures) as input. Therefore, there is no impact on the following controlled or under-development documents which cite ANL-EBS-MD-000005 REV 04:

Controlled documents: ANL-DS0-NU-000001 Rev. 00; ANL-EBS-MD-000076 Rev. 00, ACN 01; ANL-EBS-PA-000011 Rev. 00; ANL-WIS-MD-000024 Rev. 01; ANL-WIS-MD-000027 Rev. 00; ANL-WIS-PA-000001 Rev. 03; CAL-DN0-NU-000002 Rev. 00C; MDL-WIS-PA-000003 Rev. 03; MDL-WIS-PA-000005 Rev. 00, Addendum 01; MDL-WIS-PA-000005 Rev. 00, MiscId 01; MDL-WIS-PA-000005 Rev. 00, MiscId 02, MDL-WIS-PA-000005 Rev. 00, MiscId 03; TDR-MGR-MD-000056 Rev. 00; TDR-PCS-SE-000001 Rev. 05, Addendum 01; TDR-WIS-PA-000014 Rev. 00

### Under Development Documents

ANL-EBS-MD-000076 ERD 02 Rev. 00; ANL-EBS-PA-000013 Rev. 00; ANL-EBS-PA-000014 Rev. 00; LASAR-1.03.04; LASAR-1.05.02; LASAR-2.01; LASAR-2.02; LASAR-2.03.04; LASAR-2.03.06; LASAR-2.04