	Model Error Resolution Document *Complete only applicable items.*	QA: QA Page 1 of 10

INITIATION

1. Originator: Jim Cunnane/David C. Sassani	2. Date: 03/21/2008	3. ERD No. ANL-EBS-MD-000016 ERD 01
4. Document Identifier: ANL-EBS-MD-000016 Rev 02	5. Document Title: Defense HLW Glass Degradation Model	

6. Description of and Justification for Change (Identify applicable CRs and TBVs):

Description:

This ERD corrects issues in the subject document based on ***CR 10421*** as documented in the attached pages.

Justification:

All of the issues analyzed and corrected herein have been evaluated and found to have no impacts on the conclusions of the report. The corrected errors do not change any of the output or conclusion of the document, nor do they affect any downstream work. Therefore there is no impact to the conclusion of this AMR nor its usage, and this ERD sufficiently identifies and corrects the issues described.

CONCURRENCE

	Printed Name	Signature	Date
7. Checker	Susan E. Boggs		4/3/08
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APPROVAL

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ANL-EBS-MD-000016 ERD01 ATTACHMENT

This error resolution document (ERD) addresses errors in the model report "Defense HLW Glass Degradation Model" – ANL-EBS-MD-000016 REV02. The errors addressed herein are documented in CR 10421.

I Background Information Summary

CR 10421 documents errors that have been identified in the model report Defense HLW Glass Degradation Model (BSC 2004 [DIRS 169988]). The specific errors involved are identified in an Excel spreadsheet (AEM 16 ISSUES.xls) attachment to the CR. The content of that CR attachment is summarized in Table 1 below for ease of reference in this ERD.

Table 1. Issues Identified in CR 10421

Section	Location	Issue
4.1	Table 4-1	A data source has been omitted. Appendix A (pg. A-3, first paragraph) and Table A-2 reference DIRS 164517 as source documents. The data name is "Composition of leachant solutions."
	Table 4-2	The parameter value for "Specific volume of Saturated Steam at 200°C is the result of a calculation based on the values in the parameter source and should be indicated as such.
	Page 4-5	First paragraph, third sentence states that "these data are used in Section 6.5.2.1 of this report..." The section reference should be **6.5.2.2**.
Appendix A	Table A-1	The DIRS number is incorrect. It should read **164330**.
	Table A-5	The values for Fe for all of the test numbers are incorrect. See DTN MO0306ANLGIM01.525 (DIRS 164329), Table 2.
	Table A-7	The DIRS number is incorrect. It should read **164330**.
	Figure A-1	With reference to the plot identified as "(f)," there seems to be an inconsistency with the plotted data and the data located in Table A-8 in the rows representing Nominal pH 11.9. The data in Table A-8 are footnoted as "c" (excluding result of test GB6-70-1) and "d" (including the result of test GB6-70-1). The equation on the plot represents the data identified on Table A-8 as excluding result of test GB6-70-1.

	Table A-8	Could not confirm the data listed in the columns named "NR(B) g/m^2·d)" and "R^{2,b}" for the second "Nominal pH" value of 11.9 under the "Tests at 70°C." **This has been confirmed and is no longer an issue.**
	Table A-9	In the section of this table entitled "Tests as 90°C in Acidic Solutions," the value ε = -0.00107 should be **ε = 0.00095.**
		The DIRS number for the source was omitted. It is **171314**.
Appendix C	Page C-3	Third paragraph, second sentence. The source reference for Table C-1 is incorrect. It should be **"(DTN MO0306ANLGVH01.526 [DIRS 164331], Table 3).**
	Table C-2	The data provided for Samples A and B for Test Nos. VHT(150)-3 and VHT(150)-4 do NOT match the data provided by the DTN MO0306ANLGVH01.526. (These data are the same as provided in the superseded DTN MO0301ANLGVH01.526)
		Although provided in DTN MO0306ANLGVH01.526, there are no pH values provided for Test Nos. 51S1-1 through 51S2-15.
	Table C-3	The pH values for Test No.s 131-VHT(150)-1, 3, and 5 are incorrect. They should be 10, 9, and 11, respectively.
		The values for Test Nos. 131-11 and 131-14-1 under the columns named "Sample A" and "Sample B" should be "**test failed,**" as indicated in the source DTN.
		The value for Test No. 131-24-1 under the column named "Time (days)" should be **21**. (It currently reads 210.8.)
		The value for Test No. 131-24-1 under the column named "Sample A" should be "**not measured,**" as indicated in the source DTN.
	Table C-4	The value for Sample A for Test No. 165S-VHT(125)-4 should be 9.0 ± 1.2. (Could not find notation as to why this was changed to 1.4.)
	Table C-5	There appears to be duplicates under the column named "Test Number." The duplicates are 131-7.5mL-4 and 131-7.5mL-6. In addition, the value under the column titled "Duration (days)" for the first instance of test number 131-7.5mL-6 should be **87,** not 21.
	Table C-6	The data value for Test Number VHT(125)-6[b] under the column named "Thickness (μm)" is the value for Sample A, not 'B" as footnoted. The data value for Test Number VHT(200)-11[b] under the column named "Thickness (μm)" is the value for Sample A, not 'B" as footnoted.

		The following Test No. values provided in the column named "Duration (days)" are not from the referenced source DTN. However, the values have been traced to the superseded DTN MO0301ANLGVH01.526. VHT(125)-1 VHT(125)-2
	Table C-7	No distinction is made between the values for Sample A and the values for Sample B. (See Table C-6.)
Appendix D	Table D-1	The value in the column named "Total" for Glass SRL202U totals 14.15, not 14.47 as shown. This may be due to rounding as a result of an equation used in an Excel spreadsheet; however this may need to be researched further.
		Could not confirm the data listed in the row labeled "SRL202G" based on the data source provided (DTN: MO0306ANLGIM01.525 [DIRS 164329], Table 1).

This ERD satisfies the CR action plan to provide additional documentation that evaluates the issues involved and their resolution.

II Inputs and/or Software

No new input sources or software are used in this ERD

III Analysis and Results

As described in this section, the errors identified above were corrected by examination of the source documents cited in the AMR and identifying the corrections needed to address each issue. In the following, each issue is identified using the corresponding Section and Location information from Table 1 above.

Section 4.1, Table 4-1

These data are 25 °C data for the composition of the leachant solutions and are not directly used – the test results for the blank tests and for the 202 G glass tests that were directly-used data are presented in Tables A-3 through A-6 for which the source is DTN: MO0306ANLGIM01.525 [DIRS 164329], which is identified in Table 4-1.

This is not an error and no corrections are needed to address this issue.

Section 4.1, Table 4-2

The source cited in Table 4-2 provides the specific volume of saturated steam at 200 °C in units of ft^3/lb whereas Table 4-2 attributes the corresponding value in units of m^3/kg to the cited source (Weast 1977 [DIRS 106266], p. E-20). To resolve this issue Table 4-2 (BSC 2004 [DIRS 169988]) is revised as follows:

Table 4-2. Input Parameters

Parameter Name	Parameter Source	Parameter Value(s)	Units	Distribution
Gas Constant, R	Weast 1977 [DIRS 106266], p. F-241	8.314	J/mol·K	constant
Specific volume of Saturated Steam at 200°C	Weast 1977 [DIRS 106266], p. E-20	2.0369[a]	ft^3/lbm	constant
Thermal Cracking of HLW Glass	Smith and Baxter 1981 [DIRS 102089]	12×	(no units)	constant
Impact Cracking of HLW Glass	Smith and Ross 1975 [DIRS 102088]	40×	(no units)	constant
Pore Water Content of Glass Alteration Rind Layer	Aines et al. 1987 [DIRS 104318], Abstract	7	mass %	constant

[a] This corresponds to a specific volume of 0.12716 m^3/kg

Section 4.1, Page 4-5

To resolve this issue, the section cross reference in the fifth line on page 4-5 (BSC 2004 [DIRS 169988]) is corrected as follows:

"nine glasses. These data are used in Section 6.5.2.2 of this report to determine the effect"

Appendix A, Table A-1

To resolve this issue, the footnote at the bottom of Table A-1 (BSC 2004 [DIRS 169988]) is corrected as follows:

"Source: DTN: MO0306ANLGIM02.525 [DIRS 164330], Table 1."

Appendix A, Table A-5

As discussed at some length in CR 10421, the Fe concentration values for the pH 11.9 portion of Table A-5 (BSC 2004 [DIRS 169988]) are not the values given in the source DTN cited; they are earlier values that were subsequently updated by those in the cited source DTN. To correct this issue, the part of Table A-5 on page A-10 is revised as follows:

Table A-5. Solution Compositions for Tests with SRL 202G Glass at 90°C (Continued)

Test No.	Time (days)	pH[a]	Concentration (µg/L)			
			B	Fe	Si	U
GB5-21	21	9.94	2,450	279	15,500	157
pH 11.9						
GB6-2	2	11.94	2,450	298	16,500	817
GB6-3	3	11.91	3,440	209	22,900	1,080
GB6-5	5	12.00	4,390	178	28,200	1,160
GB6-7	7	12.00	4,870	170	29,200	1,260
GB6-10	10	11.91	5,910	147	36,000	1,240
GB6-21	21	11.90	8,950	114	51,400	2,130

Source: DTN: MO0306ANLGIM01.525 [DIRS 164329], Table 2.

NOTE: [a] pH measured at room temperature.

Appendix A, Table A-7

To resolve this issue, the footnote at the bottom of Table A-7 (BSC 2004 [DIRS 169988]) is corrected as follows:

"Source: DTN: MO0306ANLGIM02.525 [DIRS 164330], Tables 2, 3, and 4."

Related to this is the same error on page A-4 in the 2nd sentence after Eq. A-1 that states:

"...summarized in Table A-7 (DTN: MO0306ANLGIM02.525 [DIRS 164329]..."

This is corrected to read:
"...summarized in Table A-7 (DTN: MO0306ANLGIM02.525 [DIRS 164330]..."

An additional issue identified in Table A-7 is that on page A-12, the Table A-7 continuation has incorrect column labels in the third header row given as:

pH 1.3^a ; pH 1.3^a ; and pH 1.0^a + 0.1 m $FeCl_3$

These are corrected to read:
pH 3.7^a ; pH 3.7^a ; and pH 3.7^a + 0.1 m $FeCl_3$

Appendix A, Figure A-1

To resolve this issue, the footnote at the bottom of Table A-8 (BSC 2004 [DIRS 169988]) is corrected as follows:

NOTES: [a] pH measured at room temperature.
[b] Linear correlation coefficient squared.
[c] Excluding result of test GB6-70-1 and GB6-70-7.
[d] Including result of test GB6-70-1 and excluding GB6-70-7.

A related issue was corrected in the text of the last sentence on page A-4 and first sentence on page A-5 that states:

"...with the result of test GB6-70-1 included in the regression."

This is corrected to read:
"...with the result of test GB6-70-1 included in the regression (though still excluding GB6-70-7)."

This additive correction is made primarily for clarification purposes because all of the regressions excluded the longer test results and this is stated generally at the top of the appendix discussion.

Appendix A, Table A-9

To resolve this issue, the first row of Table A-9, and the footnote at the bottom of Table A-9 (BSC 2004 [DIRS 169988]) are corrected as follows:

Nominal pH	Measured Rate, g/(m^2·d)	log(rate)	$\log_{10}$(rate) = –0.49 pH + 2.60 + ε				Residuals			
			ε = 0	ε = 0.01	ε = -0.01	ε = -0.00095	ε = 0	ε = 0.01	ε = -0.01	ε = -0.00107

Source: DTN: MO0307ANLGAMR3.016. [DIRS 171314]

Appendix C, Page C-3

To resolve this issue, the sixth line on page C-3 is corrected as follows:

"…(DTN: MO0306ANLGVH01.526 [DIRS 164331], Table 3). Analytical results that show a mass…"

Appendix C, Table C-2

To resolve these issues, the data for test numbers VHT(150)-3 and VHT(150)-4 are corrected as follows:

VHT(150)-3	150	91	0.1510	9	13 ± 3	21 ± 3
VHT(150)-4	150	182	0.1503	9	41 ± 2	36 ± 3

Also, the missing pH values are not used in the AMR, however, the pertinent portion of Table C-2 (BSC 2004 [DIRS 169988]) is revised as follows:

51S1-1	200	2.8	0.2525	8	1.7 ± 0.2	1.7 ± 0.3
51S1-1A	200	13.8	0.2502	9	12 ± 1	17 ± 5
51S1-1S	200	13.8	0.2495	11	136 ± 8	not measured
51S1-2	200	21	0.2529	10	24 ± 1	24 ± 1
51S1-2A	200	6.8	0.2509	9	3.6 ± 0.6	11 ± 3
51S1-2S	200	2.6	0.2518	10	15 ± 1	17 ± 1
51S1-3	200	9.7	0.2501	9	14 ± 1	13 ± 1
51S1-3T	200	9.9	0.2511	9	7.7 ± 0.3	9.4 ± 0.7
51S1-4	200	0.9	0.2522	8	1.5 ± 0.1	not measured
51S1-4T	200	2.9	0.2516	8	1.3 ± 0.2	1.6 ± 0.2
51S1-5	200	35	0.2501	10	68 ± 3	69 ± 4
51S1-5A	200	21	0.2514	9	19 ± 1	24 ± 2
51S1-6	200	60	0.2509	10	409 ± 28	649 ± 79
51S1-6A	200	9.9	0.2505	9	8.5 ± 0.4	8.6 ± 1.6
51S1-7	200	6.8	0.2585	9	2.8 ± 0.3	7.9 ± 1.4
51S1-7A	200	2.6	0.2491	7	2.8 ± 0.5	2.5 ± 0.4
51S1-8	200	13.8	0.2500	9	15 ± 1	15 ± 1
51S1-8A	200	16.8	0.2516	9	32 ± 1	32 ± 2
51S1-9	200	49	0.2512	10	180 ± 12	145 ± 22
51S1-10	200	16.8	0.2507	9	18 ± 1	15± 1
51S2-11	200	4.9	0.2543	7	2.6 ± 0.2	not measured
51S2-12	200	35	0.2530	10	69 ± 2	67 ± 2
51S2-13	200	28	0.2498	8	not measured	not measured
51S2-14	200	49	0.2475	9	225 ± 10	277 ± 17
51S2-15	200	28	0.2492	9	44 ± 2	43 ± 4

Appendix C, Table C-3

To correct these issues, the pertinent portions of Table C-3 (BSC 2004 [DIRS 169988]) are revised as follows:

131-VHT(150)-1	150	28	0.1495	10	11 ± 1	10 ± 1
131-VHT(150)-2	150	56	0.1490	10	17 ± 1	18 ± 1
131-VHT(150)-3	150	91	0.1540	9	20 ± 1	23 ± 1
131-VHT(150)-4	150	182	0.1501	9	29 ± 1	30 ± 1
131-VHT(150)-5	150	241	0.1475	11	43	50

131-11	200	28	0.2529	12	Test failed	Test failed
131-12	200	0.2	0.2492	7	1.4 ± 0.2	not measured
131-13	200	0.3	0.2504	10	3.5 ± 0.3	2.3 ± 0.2
1312-14	200	31	0.2502	12	273 ± 14	310 ± 13
131-14-1	200	21	0.1414	dry	Test failed	Test failed

131-24-1	200	21	0.2414	8	Not measured	completely reacted

Appendix C, Table C-4

To correct this issue, the pertinent portion of Table C-4 (BSC 2004 [DIRS 169988]) is revised as follows:

165S-VHT(125)-4	125	511	0.1312	9	9.0 ± 1.2	23 ± 2

Appendix C, Table C-5

To correct this issue, the pertinent portion of Table C-5 (BSC 2004 [DIRS 169988]) is revised as follows:

131-7.5mL-6	87	7.5229	130	126

Appendix C, Table C-6

To correct these issues, the pertinent portions of Table C-6 (BSC 2004 [DIRS 169988]) are revised as follows:

VHT(125)-1[b]	56	3.2	VHT(125)-6[a]	245	14
VHT(125)-2[b]	91	8.8	VHT(125)-7[b]	1,326	33

VHT(200)-5[a]	16.9	27	VHT(200)-11[a]	70	514

Appendix C, Table C-7

The "A" and "B" samples are not specifically identified in this table because the greater value of the measured thickness was selected for plotting in all cases. The issue is addressed by adding a statement to this effect in the table footnote as follows:

Source: DTN: MO0306ANLGVH01.526 [DIRS 164331].
NOTE: The greater of the two measured layer thicknesses for the "A" and "B" samples was selected for plotting purposes.

Appendix D, Table D-1

This issue resulted from rounding errors in the "Total" column for the SRL202U glass and from typographical errors in the footnote that identifies the source DTNs. To correct this issue the pertinent parts of Table D-1 are revised as follows:

SRL 202U[b]	2.48	3.09	1.97	6.61	14.15

The SRL 202G issue is resolved by correcting the identification of the source DTN as:

Sources: [a] DTN: MO0306ANLGIM02.525 [DIRS 164330], Table 1.
[b] DTN: MO0308ANLGPC01.528 [DIRS 164790], Table 1.

IV Impact Evaluation

This section evaluates the potential impacts of the corrections made herein to resolve each of the issues addressed in Section III above.

Section 4.1, Table 4-1

There are no corrections needed for this issue because there was no error. Therefore, resolution of this issue has no impact on the conclusions or output from the AMR. The analysis above provides clarification of the use of data and the source DTN, which were correctly identified within the AMR.

Section 4.1, Table 4-2

Because the corrections made to resolve this issue do not affect the value of the parameter involved, they have no impact on the conclusions or output from the AMR (BSC 2004 [DIRS 169988]).

Section 4.1, Page 4-5 and Appendix A, Table A-1

Resolution of these issues involves editorial corrections that have no impact on conclusions or output from the AMR (BSC 2004 [DIRS 169988]).

Appendix A, Table A-5

To address this issue, the Fe concentration data in pH 11.9 portion of Table A-5 are corrected to be consistent with the cited source. In the AMR analysis of the effects of Fe was assessed by comparing the glass corrosion rate (which was determined from the B concentration data in Table A-5) for test conditions with and without Fe addition. This AMR analysis concluded that "The results of tests conducted at 90 °C with and without added iron are indistinguishable at all pH values" (BSC 2004 [DIRS 169988], p 6-16). Because this conclusion does not depend on the Fe concentration values in Table A-5, the changes made to resolve this issue have no impact on the conclusions or output from the AMR (BSC 2004 [DIRS 169988]).

Appendix A, Table A-7, Figure A-1, and Table A-9

Corrections made to resolve these issues are either editorial changes or changes made for clarification purposes; they have no impact on the conclusions or output from the AMR (BSC 2004 [DIRS 169988]).

Appendix C, Page C-3

The editorial corrections made to resolve this issue have no impact on the conclusions or output from the AMR (BSC 2004 [DIRS 169988]); the source is correctly cited in the Table C-1 footnote.

Appendix C, Table C-2

The corrections made to resolve the issues for test numbers VHT(150)-3 and VHT(150)-4 constitute changes to the number of significant digits in the error estimates for the layer thickness measurements to make them consistent with those given in the cited source. The DTN is correctly cited within the AMR as the source for these data. These changes have no impact on the conclusions or output from the AMR.

The addition of the omitted pH values to Table C-2 makes it consistent with that in the cited source, but also has no impact on the conclusions or output from the AMR because the pH values are not used in the AMR.

Appendix C, Table C-3

The corrections made to resolve this issue are editorial changes needed to make the table consistent with the cited source; these changes have no effect on the conclusions or output from the AMR because the cited source data are used in developing the conclusions and output.

Appendix C, Tables C-4, C-5, C-6, and C-7

The corrections made to resolve these issues are editorial changes needed to make the tables consistent with the cited sources; these changes have no effect on the conclusions or output from the AMR because the data source is correctly identified and the correct data from the cited source are used in developing the conclusions and output.

Appendix D, Table D-1

The corrections made to resolve the issue for the SRL 202G glass involve correcting the identification of the source DTN. These changes are editorial changes and have no effect on the conclusions or output from the AMR.

The corrections made to resolve the issue for the SRL 202U glass is to make the entry in the "Total" column consistent with the entries in the rest of the SRL 202U row. This change has no effect on the conclusions or output from the AMR because the values in the "Total" column are not used in developing the AMR's output or conclusions.

In conclusion, all of the issues analyzed and corrected above have been evaluated and support the conclusion that there is no impacts on the outputs or conclusions of the *Defense HLW Glass Degradation Model* (ANL-EBS-MD-000016 Rev 02) report.