OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT
CALCULATION COVER SHEET

1. QA: QA
Page: 1 Of: 13

2. Calculation Title

Calculation of General Corrosion Rate of Drip Shield and Waste Package Outer Barrier to Support WAPDEG Analysis

3. Document Identifier (including Revision Number)

CAL-EBS-PA-000002 REV 01

4. Total Attachments	5. Attachment Numbers – Number of pages in each
2	I – 18 pages, II – 3 pages

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9. Remarks

Source data: Weight loss and crevice sample penetration rate data for Alloy C-22 and titanium grade 16 (DTN: LL990610605924.079 (6 month and 12 month data), and DTN: LL000112205924.112 (24 month data, TBV-4058)).

Calculation results are tracked by DTN: MO0001SPASUP03.001 and DTN: MO0010SPASIL02.002.

For TSPA-SR.

Revision History

10. Revision No.	11. Description of Revision
00	Initial issue.
01	Additional calculations are performed to adjust general corrosion rates to account for silica deposits.

CONTENTS

FIGURES

1. PURPOSE

The objective and scope of this calculation is to produce cumulative distribution functions (CDFs), each representing the general corrosion (GC) rate distribution of one of two alloys, Alloy 22 or titanium grade 7. This calculation supports Performance Assessment and was prepared under Technical Product Development Plan TDP-EBS-PA-000001 (CRWMS M&O 1999) in accordance with the AP-3.12Q, Rev. 0, ICN 2 *Calculations* procedure.

2. METHOD

Weight loss and crevice sample penetration rate data for Alloy C-22 (DTN: LL990610605924.079 (6 month and 12 month data), LL000112205924.112 (24 month data)) and titanium grade 16 (DTN: LL990610605924.079 (1 year data)) were obtained. Alloy C-22 is a brand name for an alloy generically referred to as Alloy 22 in this calculation. General corrosion rates of titanium grade 16 are representative of those for titanium grade 7 (CRWMS M&O 2000b, Section 6.5.2 paragraph 1).

For Alloy 22, four separate general corrosion rate CDFs were produced; one based on 6-month data, one based on 12-month data, one based on 24-month data, and one based on all of the data combined. For titanium grade 7, a general corrosion rate CDF was produced based on 12-month (titanium grade 16) data.

For each CDF, the weight loss and crevice sample penetration rate data were combined to yield a general corrosion rate data set for each alloy. The general corrosion rate data were then sorted in ascending order. Any negative or zero general corrosion rates were then deleted from the data set. Based on the Weibull plotting positions (Stedinger et al., 1993, Section 18.3.2) cumulative probabilities were assigned to each general corrosion data point based on its rank (position) in the sorted data set. This yielded an empirical cumulative distribution function (CDF) table. An upper and lower bound (corresponding to the 100^{th} and zero percentile cumulative probability) was also applied to the resulting general corrosion rate CDFs. These CDFs (four for Alloy 22 and one for titanium grade 7) are the first set of CDF outputs of this calculation.

Due to potential silica (SiO_2) deposits forming on the samples from which the GC rates were calculated, these rates are possibly too low. A GC rate may be corrected for this reduction due to silica deposition by adding to it a uniform random value distributed from zero to the maximum correction rate (63.0×10^{-6} mm/yr for Alloy 22). This process is equivalent to convoluting the GC rate distribution with the uniform distribution representing the silica correction rate (ranging from zero to the maximum correction rate). This convolution is performed numerically in this calculation for each GC rate distribution in the first set of CDFs. Performing this convolution produces a second set of GC rate CDFs adjusted for the silica deposits.

The methods used to control the electronic management of data as required by AP-SV.1Q, *Control of the Electronic Management of Information*, were not specified in the Development Plan, *Calculations to Support WAPDEG Analysis of Waste Package and Drip Shield Degradation* (CRWMS M&O 1999). With regard to the development of this calculation, the control of electronic management of data was evaluated in accordance with YAP-SV.1Q,

Control of the Electronic Management of Data. The evaluation (CRWMS M&O 2000c) determined that current work processes and procedures are adequate for the control of electronic management of data for this activity. Though YAP-SV.1Q has been replaced by AP-SV.1Q, this evaluation remains in effect.

3. ASSUMPTIONS

The following assumptions were made:

3.1 For both alloys considered (Alloy 22 and titanium grade 7), corrosion penetration rate data from the weight loss of both plain and creviced geometry test coupons were considered to represent general corrosion penetration rates. This assumption is reasonably bounding as penetration rates for coupons with a creviced geometry are generally higher than those of plain (or with no crevice) test coupons (For Alloy 22, see CRWMS M&O 2000a, Figures 23 and 25) (For titanium grade 7, see CRWMS M&O 2000b, Figures 19 and 20). No additional confirmation of this assumption is necessary. This assumption is used in Attachment I.

3.2 General corrosion rates of titanium grade 16 are assumed to be representative of those for titanium grade 7. This assumption is reasonable, as the material properties for both alloys are similar with the primary difference between these two alloys being the palladium content. Titanium grade 7 has 0.12 to 0.25 percent by weight palladium, whereas titanium grade 16 has only 0.04 to 0.08 percent by weight palladium (CRWMS M&O 2000b, Section 6.5.2 paragraph 1). No additional confirmation of this assumption is necessary. This assumption is used in Attachment I.

3.3 The minimum possible general corrosion rate for both Alloy 22 and titanium grade 7 was assumed to be 1E-12 mm/year. This was accomplished by truncating the general corrosion rate data sets at a general corrosion rate of zero (i.e., deleting all negative and zero general corrosion rates) and applying a lower bound general corrosion rate of 1E-12 mm/year with a cumulative probability of zero. The basis for this assumption is that it is conservative; a general corrosion rate of 1E-12 mm/year is larger than any negative general corrosion rate. No additional confirmation of this assumption is necessary. This assumption is used in Attachment I.

3.4 The cumulative probability values were assumed (with the exception of the upper and lower bounds discussed in the previous and next four assumptions, respectively) to be given by the Weibull Plotting positions (Stedinger et al., 1993, Section 18.3.2), i.e.,

$$q_i = \frac{i}{n+1} \qquad \text{(Eq. 1)}$$

where q_i is the cumulative probability of the i^{th} smallest event (e.g., general corrosion rate) and n is the total number of events. The basis of this assumption is that the Weibull Plotting positions provide probability-unbiased plotting positions which are appropriate for estimating probabilities associated with the largest values (Stedinger et al., 1993,

Section 18.3.2). No additional confirmation of this assumption is necessary. This assumption is used in Attachment I.

3.5 The maximum (100th percentile) general corrosion rate for the Alloy 22 6 month data was assumed to be 7.50E-4 mm/year. This assumed upper bound is greater than the maximum penetration rate of 7.31E-4 mm/year (DTN: LL990610605924.079) observed in the Project's Long-Term Corrosion Testing Facility and is thus a reasonable upper bound. No additional confirmation of this assumption is necessary. This assumption is used in Attachment I.

3.6 The maximum (100th percentile) general corrosion rate for the Alloy 22 12 month data was assumed to be 1.00E-4 mm/year. This assumed upper bound is greater than the maximum penetration rate of 9.78E-5 mm/year (DTN: LL990610605924.079) observed in the Project's Long-Term Corrosion Testing Facility and is thus a reasonable upper bound. No additional confirmation of this assumption is necessary. This assumption is used in Attachment I.

3.7 The maximum (100th percentile) general corrosion rate for the Alloy 22 24 month data was assumed to be 7.30E-5 mm/year. This assumed upper bound is greater than the maximum penetration rate of 7.27E-5 mm/year (DTN: LL000112205924.112) observed in the Project's Long-Term Corrosion Testing Facility and is thus a reasonable upper bound. No additional confirmation of this assumption is necessary. This assumption is used in Attachment I.

3.8 The maximum general corrosion rate of titanium grade 7 was assumed to be 3.25E-4 mm/year. This assumed upper bound is greater than the maximum penetration rate of 3.19E-4 mm/year (DTN: LL990610605924.079) observed in the Project's Long-Term Corrosion Testing Facility and is thus a reasonable upper bound. This assumption is consistent with the discussion found in the AMR discussing general corrosion and localized corrosion of the drip shield (CRWMS M&O 2000b, Section 6.5.2, page 62). No additional confirmation of this assumption is necessary. This assumption is used in Attachment I.

3.9 The GC rate values can be corrected for silica deposits forming on the sample coupons by adding to it a correction rate due to the weight of the silica. This correction rate is assumed uniform from zero (i.e. no correction) to a maximum bias correction rate of 63.0E-6 mm/yr for Alloy 22 and titanium grade 7. This assumption is consistent with the discussion found in the general corrosion and localized corrosion of the waste package outer barrier AMR (CRWMS M&O 2000a, Section 6.5.5). No additional confirmation of this assumption is necessary. This assumption is used in the convolution integrals used to adjust for silica deposits in Section 5.

4. USE OF COMPUTER SOFTWARE AND MODELS

Microsoft Excel 97 SR-2 is commercially available software used in this calculation. This software is appropriate for this application as it offers all of the mathematical and graphical functionality necessary to perform and document the numerical manipulations used in this calculation. No macros were used and no numerical manipulations of sufficient complexity to qualify as a software routine (as defined by the AP-SI.1Q *Software Management* procedure) were implemented within Microsoft Excel. Microsoft Excel 97 SR-2 was executed on a DELL PowerEdge 2200 Workstation equipped with two Pentium II 266 MHz processors (CRWMS M&O tag 112371) in the Windows NT 4.0 operating system. Details of the Excel manipulations performed are discussed throughout this calculation.

Microsoft Notepad 4.0 is used in this calculation. Notepad 4.0 is a text editor (word processing program) supplied with the Windows NT 4.0 operating system and is thus exempt from the AP-SI.1Q *Software Management* procedure. The CDFs resulting from this calculation are cut and paste from Excel 97 SR-2 into Notepad 4.0 for final archiving as ASCII text files. This software is appropriate for this application as it offers all of the text manipulation functionality necessary to perform the text manipulations used in this calculation. Notepad 4.0 was executed on a DELL PowerEdge 2200 Workstation equipped with two Pentium II 266 MHz processors (CRWMS M&O tag 112371) in the Windows NT 4.0 operating system. Details of the Notepad manipulations performed are discussed in Section 5.

Mathcad 2000 is commercially available software used in this calculation. This software is appropriate for this application as it offers all of the mathematical functionality necessary to perform and document the numerical manipulations used in this calculation. A Mathcad program, Silica version 1.0, used qualifies as a software routine (under the AP-SI.1Q *Software Management* procedure) that was implemented within Mathcad. Mathcad was executed on a DELL PowerEdge 2200 Workstation equipped with two Pentium II 266 MHz processors (CRWMS M&O tag 112517) in the Windows NT 4.0 operating system. Details of the Mathcad software routine, Silica version 1.0, are documented in Attachment II.

5. CALCULATION

The bulk of this calculation was accomplished in the Excel worksheets included in Attachment I. For each alloy considered (Alloy 22 and titanium grade 7), the weight loss and crevice penetration rate data (Alloy 22 DTN: LL990610605924.079, LL000112205924.112) (titanium grade 7 DTN: LL990610605924.079) were combined to yield general corrosion rate data sets for each alloy (see Assumption 3.1). The general corrosion rate data were then sorted in ascending order. Any negative general corrosion rates and zero general corrosion rate data points were then deleted from the data set. A 1E-12 mm/yr general corrosion rate data point was considered to be the lower bound of the distribution and assigned zero cumulative probability (see Assumption 3.3). Cumulative probabilities based on the Weibull plotting positions (Stedinger et al., 1993, Section 18) were assigned to each general corrosion data point (with the exception of the upper and lower bounds) based on its rank (position) in the sorted data set yielding a cumulative distribution function (CDF) (see Assumption 3.4). The units of the general corrosion rates were converted to mm/year. An upper bound (corresponding to the 100^{th} percentile cumulative

probability) was also applied to the resulting general corrosion rate CDFs. These CDFs (four for Alloy 22 and one for titanium grade 7) are the outputs of this calculation.

The resulting CDFs were then cut and paste from Excel 97 SR-2 to Notepad 4.0 for final archiving as ASCII text files. The number of CDF pairs (general corrosion rate value (mm/year) and corresponding cumulative probability value) contained in each CDF file was entered on the first line of each CDF file. The CDF representing the general corrosion rate distribution of Alloy 22 based on only 6 month data was named gA226Month.cdf (see Attachment I, worksheet A22-6 worksheet) and contains 123 CDF pairs. The CDF representing the general corrosion rate distribution of Alloy 22 based on only 12 month data was named gA2212Month.cdf (see Attachment I, worksheet A22-12) and contains 45 CDF pairs. The CDF representing the general corrosion rate distribution of Alloy 22 based on only 24 month data was named gA22SR00.cdf (see Attachment I, worksheet A22-24) and contains 79 CDF pairs. The CDF representing the general corrosion rate distribution of Alloy 22 based on 6, 12, and 24 month data (not considering the upper and lower bounding points that were added) was named gA2261224.cdf (see Attachment I, worksheet A22-All) and contains 243 CDF pairs. The upper bound for this CDF was chosen to be the maximum of the upper bound values used for Alloy 22, 7.50E-4 mm/year, and the lower bound was chosen to be 1.0E-12 mm/year. The CDF representing the general corrosion rate distribution of titanium grade 7 was named gTi7SR00.cdf (see Attachment I, Ti-7 worksheet) and contains 27 CDF pairs. These CDFs are the first set of outputs of this calculation.

The silica adjusted rate CDFs are calculated in the Mathcad listing below this paragraph. The input CDFs (results from the first set) are read directly from the Excel sheets where they were created.

$$\begin{pmatrix} \text{A22cdf06} \\ \text{A22cdf12} \\ \text{A22cdf24} \\ \text{A22cdfall} \\ \text{Ti7cdf} \end{pmatrix} :=$$

Att2.xls

Worksheet

A22-6 ! D20:E142
A22-12 ! D23:E67
A22-24 ! D26:E104
A22-All ! C64:D306
Ti-7 ! C46:D72

$A := 63.0 \cdot 10^{-6}$ Maximum silica correction rate

$m := 200$ Number of linearly spaced intervals calculated

$$Fcdf(x, CDF) := \begin{cases} 0 & \text{if } x \le CDF_{0,0} \\ 1 & \text{if } x \ge CDF_{rows(CDF)-1,0} \\ linterp\left(CDF^{\langle 0 \rangle}, CDF^{\langle 1 \rangle}, x\right) & \text{otherwise} \end{cases}$$

$$Silica(CDF, A, m) := \begin{cases} a \leftarrow CDF_{0,0} \\ b \leftarrow CDF_{rows(CDF)-1,0} + A \\ \text{for } ii \in 0..m \\ \quad r_{ii} \leftarrow (b-a)\cdot\frac{ii}{m} + a \\ \quad H_{ii} \leftarrow \dfrac{\int_0^A Fcdf(r_{ii} - y, CDF)\, dy}{A} \\ dataout \leftarrow stack[(m+1 \;\; 2), augment(r, H)] \end{cases}$$

$A22\_06 := Silica(A22cdf06, A, m)$ WRITEPRN("WDgA22Sand_06.cdf") := A22_06

$A22\_12 := Silica(A22cdf12, A, m)$ WRITEPRN("WDgA22Sand_12.cdf") := A22_12

$A22\_24 := Silica(A22cdf24, A, m)$ WRITEPRN("WDgA22Sand_24.cdf") := A22_24

$A22\_all := Silica(A22cdfall, A, m)$ WRITEPRN("WDgA22Sand_all.cdf") := A22_all

$Ti7 := Silica(Ti7cdf, A, m)$ WRITEPRN("WDgTi7Sand.cdf") := Ti7

Each of the silica adjusted CDFs is a table of 201 rate values linearly spaced between the minimum rate and the maximum rate (the input CDF maximum rate plus input value A, the maximum silica correction rate). A full description of the routines above can be found in Attachment II. All silica adjusted CDF file names contain the sub-string, Sand. The Alloy 22 GC rate CDFs based on six month, twelve month, twenty-four month, and combined data sets contain the sub-strings, 06, 12, 24, and all respectively. The silica adjusted titanium grade 7 GC rates based on one-year data are in the CDF file named WDgTi7Sand.cdf. These CDFs are the second set of outputs of this calculation.

6. RESULTS

This document may be affected by technical input information that requires confirmation. Any changes to the document that may occur as a result of completing confirmation activities will be reflected in subsequent revisions. The status of input information quality may be confirmed by review of the Document Input Reference System database.

The cumulative distribution functions (CDFs) representing the general corrosion rate distribution for each alloy (Alloy 22 and titanium grade 7) are the results of this calculation. These results are based on qualified data inputs; DTN: LL990610605924.079 and LL000112205924.112. The two-year information, DTN: LL000112205924.112, is tracked by TBV-4058. Therefore, analyses or calculations using the results of this calculation will need evaluation of any impacts when these input data are confirmed.

The data developed in this calculation are two sets of five CDFs. The first set have file names gA226Month.cdf, gA2212Month.cdf, gA226SR00.cdf, gA2261224.cdf, and gTi7SR00.cdf. These CDFs are tracked by DTN: MO0003SPASUP02.003. A file listing of this DTN data set appears here.

```
03/07/00  02:34p                88,064 A22GC.JNB               SigmaPlot file
02/29/00  06:07p                98,304 Att2.XLS                Excell file

General Corrosion Rate CDF files (Set 1)
02/28/00  06:18p                 2,835 gA226Month.cdf          ( 6 month data)
02/28/00  06:18p                 1,310 gA2212Month.cdf         (12 month data)
02/28/00  06:17p                 2,691 gA22SR00.cdf            (24 month data)
02/28/00  06:18p                 5,595 gA2261224.cdf           (combined data)
03/01/00  03:09p                   976 gTi7SR00.cdf            (titanium 1 year data)
```

The second set for silica adjusted rates have file names WDgA22Sand_06.cdf, WDgA22Sand_12.cdf, WDgA22Sand_24.cdf, WDgA22Sand_all.cdf, and WDgTi7Sand.cdf. These CDFs are tracked by DTN: MO0010SPASIL02.002. A file listing of this DTN data set appears here.

```
10/04/00  12:22p               119,808 A22GC.JNB               SigmaPlot file

Silica Adjusted General Corrosion Rate CDF files (Set 2)
09/08/00  12:24p                12,524 WDgA22Sand_06.cdf       ( 6 month data)
09/08/00  12:07p                12,524 WDgA22Sand_12.cdf       (12 month data)
09/08/00  12:07p                12,524 WDgA22Sand_24.cdf       (24 month data)
09/08/00  12:24p                12,524 WDgA22Sand_all.cdf      (combined data)
09/08/00  12:08p                12,524 WDgTi7Sand.cdf          (titanium 1 year data)
```

Each row of each CDF (with the exception of the first row containing the number of CDF pairs), contains a general corrosion rate (mm/year) in column 1 and the corresponding cumulative probability value in column 2. For example, the CDF representing the general corrosion rate distribution for Alloy 22 based only on 24 month data (filename: gA22SR00.cdf) is shown below:

```
79
1.000000000E-12   0.000000000E+00
1.729006361E-06   1.282051282E-02
1.775848974E-06   2.564102564E-02
1.928234050E-06   3.846153846E-02
2.074163440E-06   5.128205128E-02
```

2.139364625E-06	6.410256410E-02
2.144906822E-06	7.692307692E-02
2.924459214E-06	8.974358974E-02
3.555035555E-06	1.025641026E-01
3.675322980E-06	1.153846154E-01
3.760267562E-06	1.282051282E-01
4.150551889E-06	1.410256410E-01
5.242898761E-06	1.538461538E-01
5.275799378E-06	1.666666667E-01
5.282302152E-06	1.794871795E-01
5.478181203E-06	1.923076923E-01
5.670997827E-06	2.051282051E-01
5.986699690E-06	2.179487179E-01
7.075064863E-06	2.307692308E-01
7.090882269E-06	2.435897436E-01
7.111675664E-06	2.564102564E-01
7.113751916E-06	2.692307692E-01
7.246541076E-06	2.820512821E-01
7.345938332E-06	2.948717949E-01
7.610983474E-06	3.076923077E-01
7.625157177E-06	3.205128205E-01
7.664251639E-06	3.333333333E-01
8.234945394E-06	3.461538462E-01
8.479184284E-06	3.589743590E-01
8.638577596E-06	3.717948718E-01
8.744965783E-06	3.846153846E-01
8.856665432E-06	3.974358974E-01
9.097049113E-06	4.102564103E-01
9.217181606E-06	4.230769231E-01
9.443293172E-06	4.358974359E-01
9.486149488E-06	4.487179487E-01
9.663726681E-06	4.615384615E-01
1.013975761E-05	4.743589744E-01
1.029368174E-05	4.871794872E-01
1.034067439E-05	5.000000000E-01
1.043668318E-05	5.128205128E-01
1.144111604E-05	5.256410256E-01
1.218598381E-05	5.384615385E-01
1.267728256E-05	5.512820513E-01
1.338754194E-05	5.641025641E-01
1.381880679E-05	5.769230769E-01
1.393546104E-05	5.897435897E-01
1.430836915E-05	6.025641026E-01
1.440206743E-05	6.153846154E-01
1.446471292E-05	6.282051282E-01
1.448547668E-05	6.410256410E-01
1.454486755E-05	6.538461538E-01
1.457946831E-05	6.666666667E-01
1.469970980E-05	6.794871795E-01
1.554689265E-05	6.923076923E-01
1.626229817E-05	7.051282051E-01
1.677927408E-05	7.179487179E-01
1.686625624E-05	7.307692308E-01
1.734180687E-05	7.435897436E-01
1.749756568E-05	7.564102564E-01
1.755628753E-05	7.692307692E-01
1.785696214E-05	7.820512821E-01

1.826282675E-05	7.948717949E-01
2.001297034E-05	8.076923077E-01
2.058643185E-05	8.205128205E-01
2.179494392E-05	8.333333333E-01
2.244345296E-05	8.461538462E-01
2.285844013E-05	8.589743590E-01
2.330359463E-05	8.717948718E-01
2.333816674E-05	8.846153846E-01
2.385929433E-05	8.974358974E-01
2.417024083E-05	9.102564103E-01
2.855651384E-05	9.230769231E-01
2.978308321E-05	9.358974359E-01
3.657445250E-05	9.487179487E-01
4.530905968E-05	9.615384615E-01
5.362889572E-05	9.743589744E-01
7.269151529E-05	9.871794872E-01
7.300000000E-05	1.000000000E+00

Shown below is a graph of the CDFs for 24 month combined crevice and weight loss general corrosion data for Alloy 22.

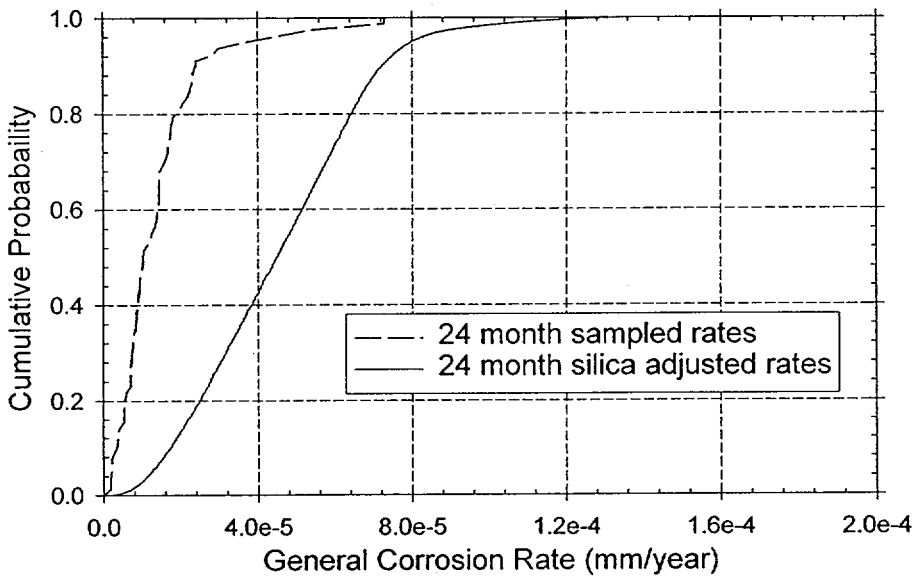

Figure 1. Plot of cumulative probability versus general corrosion rate for Alloy 22 24 month data.

Shown below is a graph of the CDF of combined crevice and weight loss general corrosion data for titanium grade 7.

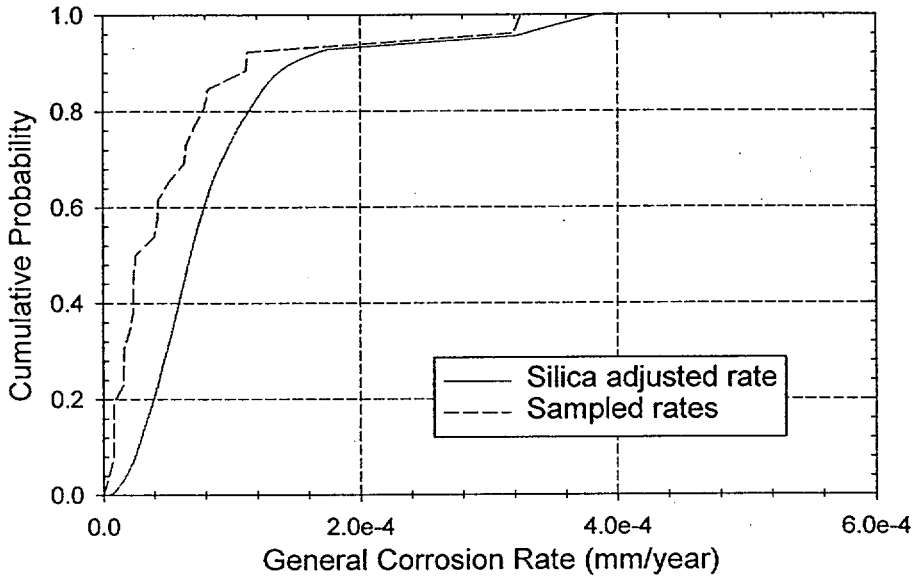

Figure 2. Plot of cumulative probability versus general corrosion rate for titanium grade 7.

7. REFERENCES

7.1 DOCUMENTS CITED

CRWMS M&O (Civilian Radioactive Waste Management System Management and Operating Contractor) 1999. *Calculations to Support WAPDEG Analysis of Waste Package and Drip Shield Degradation.* TDP-EBS-PA-000001 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19990922.0220.

CRWMS M&O 2000a. *General Corrosion and Localized Corrosion of Waste Package Outer Barrier.* ANL-EBS-MD-000003 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000202.0172.

CRWMS M&O 2000b. *General Corrosion and Localized Corrosion of the Drip Shield.* ANL-EBS-MD-000004 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000329.1185.

CRWMS M&O 2000c. Process Control Evaluation For Supplement V: "Performance Assessment Operations. (Reference QAP-2-0 Activity Evaluation Form. Conduct of Performance Assessment, November 9, 1999)". Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000128.0236.

Stedinger, J.R.; Vogel, R.M.; and Foufoula-Georgiou, E. 1993. "Frequency Analysis of Extreme Events." Chapter 18 of *Handbook of Hydrology.* Maidment, D.R., ed. New York, New York: McGraw-Hill. TIC: 236568

7.2 CODES, STANDARDS, REGULATIONS, AND PROCEDURES

AP-3.12Q, Rev. 0, ICN 2. *Calculations.* Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: MOL.20000620.0068

AP-SI.1Q, Rev. 2, ICN 4. *Software Management.* Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: MOL.20000223.0508.

YAP-SV.1Q, Rev. 0, ICN 1. *Control of the Electronic Management of Data.* Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: MOL.19991008.0209.

AP-SV.1Q, Rev. 0, ICN 2. *Control of the Electronic Management of Information.* Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: MOL.20000831.0065.

7.3 SOURCE DATA, LISTED BY DATA TRACKING NUMBER

LL990610605924.079. LTCTF Data for C-22, TiGr7, TiGr12 and TiGr16. Submittal Date: 06/13/1999.

LL000112205924.112. Long Term Corrosion Test Facility Data. Submittal Date: 01/25/2000.

8. ATTACHMENTS

Attachment	Title
I	EXCEL WORKBOOK (ATT2.XLS).
II	SILICA Software Routine Report.

ATTACHMENT I

EXCEL WORKBOOK (ATT2.XLS)

LL990610605924.079 s99359_032 DATA REPORT (weight-loss) and s99359_031 DATA REPORT (crevice) Sorted

A22-6 Worksheet

Alloy 22 - 6 month (μm/yr)	Alloy 22 - 6 month (mm/yr)	Alloy 22 - 6 month statisitics (mm/yr)	6 Month Alloy 22 Corrosion Rate (mm/yr)	Weibull Probabilities qi Refit CDF	
-5.9236E-02	-5.9236E-05	Average			
-5.0539E-02	-5.0539E-05	6.3599E-05			
-4.1763E-02	-4.1763E-05				
-3.4357E-02	-3.4357E-05	STDEV			
-3.4146E-02	-3.4146E-05	8.3055E-05			
-3.3839E-02	-3.3839E-05				
-3.3367E-02	-3.3367E-05				
-2.5204E-02	-2.5204E-05				
-1.7456E-02	-1.7456E-05				
-1.6179E-02	-1.6179E-05				
-1.6162E-02	-1.6162E-05				
-8.6462E-03	-8.6462E-06				
-8.5743E-03	-8.5743E-06				
-8.0901E-03	-8.0901E-06				
0.0000E+00	0.0000E+00				
0.0000E+00	0.0000E+00				
0.0000E+00	0.0000E+00				
0.0000E+00	0.0000E+00		1.0000E-12	0.0000E+00	Lower Bound
8.1101E-03	8.1101E-06		8.1101E-06	8.1967E-03	
8.2453E-03	8.2453E-06		8.2453E-06	1.6393E-02	
8.3155E-03	8.3155E-06		8.3155E-06	2.4590E-02	
8.3492E-03	8.3492E-06		8.3492E-06	3.2787E-02	
8.5121E-03	8.5121E-06		8.5121E-06	4.0984E-02	
9.3073E-03	9.3073E-06		9.3073E-06	4.9180E-02	
1.6090E-02	1.6090E-05		1.6090E-05	5.7377E-02	
1.6163E-02	1.6163E-05		1.6163E-05	6.5574E-02	
1.6232E-02	1.6232E-05		1.6232E-05	7.3770E-02	
1.6801E-02	1.6801E-05		1.6801E-05	8.1967E-02	
1.6817E-02	1.6817E-05		1.6817E-05	9.0164E-02	
1.6968E-02	1.6968E-05		1.6968E-05	9.8361E-02	
1.8732E-02	1.8732E-05		1.8732E-05	1.0656E-01	
2.4331E-02	2.4331E-05		2.4331E-05	1.1475E-01	
2.4675E-02	2.4675E-05		2.4675E-05	1.2295E-01	
2.4684E-02	2.4684E-05		2.4684E-05	1.3115E-01	
2.5199E-02	2.5199E-05		2.5199E-05	1.3934E-01	
2.5252E-02	2.5252E-05		2.5252E-05	1.4754E-01	
2.5544E-02	2.5544E-05		2.5544E-05	1.5574E-01	
2.6639E-02	2.6639E-05		2.6639E-05	1.6393E-01	
2.8054E-02	2.8054E-05		2.8054E-05	1.7213E-01	
3.2457E-02	3.2457E-05		3.2457E-05	1.8033E-01	
3.2520E-02	3.2520E-05		3.2520E-05	1.8852E-01	

3.2916E-02	3.2916E-05	3.2916E-05	1.9672E-01
3.3019E-02	3.3019E-05	3.3019E-05	2.0492E-01
3.3053E-02	3.3053E-05	3.3053E-05	2.1311E-01
3.3228E-02	3.3228E-05	3.3228E-05	2.2131E-01
3.3651E-02	3.3651E-05	3.3651E-05	2.2951E-01
3.3760E-02	3.3760E-05	3.3760E-05	2.3770E-01
3.4536E-02	3.4536E-05	3.4536E-05	2.4590E-01
3.4712E-02	3.4712E-05	3.4712E-05	2.5410E-01
4.0102E-02	4.0102E-05	4.0102E-05	2.6230E-01
4.0988E-02	4.0988E-05	4.0988E-05	2.7049E-01
4.1123E-02	4.1123E-05	4.1123E-05	2.7869E-01
4.1564E-02	4.1564E-05	4.1564E-05	2.8689E-01
4.1624E-02	4.1624E-05	4.1624E-05	2.9508E-01
4.2259E-02	4.2259E-05	4.2259E-05	3.0328E-01
4.2842E-02	4.2842E-05	4.2842E-05	3.1148E-01
4.6701E-02	4.6701E-05	4.6701E-05	3.1967E-01
4.7065E-02	4.7065E-05	4.7065E-05	3.2787E-01
4.8312E-02	4.8312E-05	4.8312E-05	3.3607E-01
4.9057E-02	4.9057E-05	4.9057E-05	3.4426E-01
4.9297E-02	4.9297E-05	4.9297E-05	3.5246E-01
4.9337E-02	4.9337E-05	4.9337E-05	3.6066E-01
5.0048E-02	5.0048E-05	5.0048E-05	3.6885E-01
5.0735E-02	5.0735E-05	5.0735E-05	3.7705E-01
5.1182E-02	5.1182E-05	5.1182E-05	3.8525E-01
5.4572E-02	5.4572E-05	5.4572E-05	3.9344E-01
5.5207E-02	5.5207E-05	5.5207E-05	4.0164E-01
5.6340E-02	5.6340E-05	5.6340E-05	4.0984E-01
5.7979E-02	5.7979E-05	5.7979E-05	4.1803E-01
5.8012E-02	5.8012E-05	5.8012E-05	4.2623E-01
5.8437E-02	5.8437E-05	5.8437E-05	4.3443E-01
5.9070E-02	5.9070E-05	5.9070E-05	4.4262E-01
6.0276E-02	6.0276E-05	6.0276E-05	4.5082E-01
6.2126E-02	6.2126E-05	6.2126E-05	4.5902E-01
6.3807E-02	6.3807E-05	6.3807E-05	4.6721E-01
6.5123E-02	6.5123E-05	6.5123E-05	4.7541E-01
6.5325E-02	6.5325E-05	6.5325E-05	4.8361E-01
6.5572E-02	6.5572E-05	6.5572E-05	4.9180E-01
6.6118E-02	6.6118E-05	6.6118E-05	5.0000E-01
6.6526E-02	6.6526E-05	6.6526E-05	5.0820E-01
6.6829E-02	6.6829E-05	6.6829E-05	5.1639E-01
6.6968E-02	6.6968E-05	6.6968E-05	5.2459E-01
6.7566E-02	6.7566E-05	6.7566E-05	5.3279E-01
6.7631E-02	6.7631E-05	6.7631E-05	5.4098E-01
6.9077E-02	6.9077E-05	6.9077E-05	5.4918E-01
6.9713E-02	6.9713E-05	6.9713E-05	5.5738E-01
7.1808E-02	7.1808E-05	7.1808E-05	5.6557E-01

7.3008E-02	7.3008E-05	7.3008E-05	5.7377E-01
7.3492E-02	7.3492E-05	7.3492E-05	5.8197E-01
7.3821E-02	7.3821E-05	7.3821E-05	5.9016E-01
7.4186E-02	7.4186E-05	7.4186E-05	5.9836E-01
7.4576E-02	7.4576E-05	7.4576E-05	6.0656E-01
7.5730E-02	7.5730E-05	7.5730E-05	6.1475E-01
7.5896E-02	7.5896E-05	7.5896E-05	6.2295E-01
7.6989E-02	7.6989E-05	7.6989E-05	6.3115E-01
7.7605E-02	7.7605E-05	7.7605E-05	6.3934E-01
7.9686E-02	7.9686E-05	7.9686E-05	6.4754E-01
8.0764E-02	8.0764E-05	8.0764E-05	6.5574E-01
8.1074E-02	8.1074E-05	8.1074E-05	6.6393E-01
8.2265E-02	8.2265E-05	8.2265E-05	6.7213E-01
8.2668E-02	8.2668E-05	8.2668E-05	6.8033E-01
8.3492E-02	8.3492E-05	8.3492E-05	6.8852E-01
8.5295E-02	8.5295E-05	8.5295E-05	6.9672E-01
8.5780E-02	8.5780E-05	8.5780E-05	7.0492E-01
8.6617E-02	8.6617E-05	8.6617E-05	7.1311E-01
8.6697E-02	8.6697E-05	8.6697E-05	7.2131E-01
8.7415E-02	8.7415E-05	8.7415E-05	7.2951E-01
8.9536E-02	8.9536E-05	8.9536E-05	7.3770E-01
9.0727E-02	9.0727E-05	9.0727E-05	7.4590E-01
9.2141E-02	9.2141E-05	9.2141E-05	7.5410E-01
9.5636E-02	9.5636E-05	9.5636E-05	7.6230E-01
9.7224E-02	9.7224E-05	9.7224E-05	7.7049E-01
9.7650E-02	9.7650E-05	9.7650E-05	7.7869E-01
9.7992E-02	9.7992E-05	9.7992E-05	7.8689E-01
9.8804E-02	9.8804E-05	9.8804E-05	7.9508E-01
1.0014E-01	1.0014E-04	1.0014E-04	8.0328E-01
1.0146E-01	1.0146E-04	1.0146E-04	8.1148E-01
1.0185E-01	1.0185E-04	1.0185E-04	8.1967E-01
1.0185E-01	1.0185E-04	1.0185E-04	8.2787E-01
1.0271E-01	1.0271E-04	1.0271E-04	8.3607E-01
1.0320E-01	1.0320E-04	1.0320E-04	8.4426E-01
1.0374E-01	1.0374E-04	1.0374E-04	8.5246E-01
1.0581E-01	1.0581E-04	1.0581E-04	8.6066E-01
1.0723E-01	1.0723E-04	1.0723E-04	8.6885E-01
1.0800E-01	1.0800E-04	1.0800E-04	8.7705E-01
1.1232E-01	1.1232E-04	1.1232E-04	8.8525E-01
1.1254E-01	1.1254E-04	1.1254E-04	8.9344E-01
1.1260E-01	1.1260E-04	1.1260E-04	9.0164E-01
1.1657E-01	1.1657E-04	1.1657E-04	9.0984E-01
1.2081E-01	1.2081E-04	1.2081E-04	9.1803E-01
1.2099E-01	1.2099E-04	1.2099E-04	9.2623E-01
1.2953E-01	1.2953E-04	1.2953E-04	9.3443E-01
1.4308E-01	1.4308E-04	1.4308E-04	9.4262E-01

1.6416E-01	1.6416E-04	1.6416E-04	9.5082E-01	
1.7578E-01	1.7578E-04	1.7578E-04	9.5902E-01	
2.4494E-01	2.4494E-04	2.4494E-04	9.6721E-01	
2.5056E-01	2.5056E-04	2.5056E-04	9.7541E-01	
4.6728E-01	4.6728E-04	4.6728E-04	9.8361E-01	
7.3077E-01	7.3077E-04	7.3077E-04	9.9180E-01	
		7.5000E-04	1.0000E+00	Upper Bound

LL990610605924.079 s99359_005 DATA REPORT (crevice data) and s99359_006 DATA REPORT (weight loss data) Sorted

A22-12 Worksheet

Alloy 22 - 12 month (µm/yr)	Alloy 22 - 12 month (mm/yr)	
-4.9471929E-02	-4.9471929E-05	Average
-2.8890495E-02	-2.8890495E-05	1.16089E-05
-2.8826056E-02	-2.8826056E-05	
-2.5453220E-02	-2.5453220E-05	STDEV
-2.4857280E-02	-2.4857280E-05	2.70250E-05
-2.2656160E-02	-2.2656160E-05	
-2.0590021E-02	-2.0590021E-05	
-2.0529395E-02	-2.0529395E-05	
-1.6851811E-02	-1.6851811E-05	
-1.6551174E-02	-1.6551174E-05	
-1.6507508E-02	-1.6507508E-05	
-1.6437791E-02	-1.6437791E-05	
-1.2633305E-02	-1.2633305E-05	
-1.2615527E-02	-1.2615527E-05	
-8.2688040E-03	-8.2688040E-06	
-6.6713400E-03	-6.6713400E-06	
-2.2252900E-03	-2.2252900E-06	
0.0000000E+00	0.0000000E+00	
0.0000000E+00	0.0000000E+00	
0.0000000E+00	0.0000000E+00	
0.0000000E+00	0.0000000E+00	
2.2215190E-03	2.2215190E-06	
2.2739550E-03	2.2739550E-06	
4.1094790E-03	4.1094790E-06	
4.1382160E-03	4.1382160E-06	
4.2072630E-03	4.2072630E-06	
4.2184430E-03	4.2184430E-06	
4.2528930E-03	4.2528930E-06	
4.4645300E-03	4.4645300E-06	
4.5481190E-03	4.5481190E-06	
4.5830730E-03	4.5830730E-06	
8.4379500E-03	8.4379500E-06	
8.9084130E-03	8.9084130E-06	
8.9678890E-03	8.9678890E-06	
1.1082053E-02	1.1082053E-05	
1.2345042E-02	1.2345042E-05	
1.2387548E-02	1.2387548E-05	
1.3710033E-02	1.3710033E-05	
1.5661888E-02	1.5661888E-05	
1.5697415E-02	1.5697415E-05	
1.6511680E-02	1.6511680E-05	
1.6603706E-02	1.6603706E-05	
1.8161943E-02	1.8161943E-05	
2.4626583E-02	2.4626583E-05	
2.4784568E-02	2.4784568E-05	

12 Month Alloy 22 Corrosion Rate (mm/yr)	Weibull Probabilities qi Refit CDF	
1.0000000E-12	0.0000000E+00	Lower Bound
2.2215190E-06	2.2727273E-02	
2.2739550E-06	4.5454545E-02	
4.1094790E-06	6.8181818E-02	
4.1382160E-06	9.0909091E-02	
4.2072630E-06	1.1363636E-01	
4.2184430E-06	1.3636364E-01	
4.2528930E-06	1.5909091E-01	
4.4645300E-06	1.8181818E-01	
4.5481190E-06	2.0454545E-01	
4.5830730E-06	2.2727273E-01	
8.4379500E-06	2.5000000E-01	
8.9084130E-06	2.7272727E-01	
8.9678890E-06	2.9545455E-01	
1.1082053E-05	3.1818182E-01	
1.2345042E-05	3.4090909E-01	
1.2387548E-05	3.6363636E-01	
1.3710033E-05	3.8636364E-01	
1.5661888E-05	4.0909091E-01	
1.5697415E-05	4.3181818E-01	
1.6511680E-05	4.5454545E-01	
1.6603706E-05	4.7727273E-01	
1.8161943E-05	5.0000000E-01	
2.4626583E-05	5.2272727E-01	
2.4784568E-05	5.4545455E-01	

2.5442754E-02	2.5442754E-05	2.5442754E-05	5.6818182E-01	
2.5485151E-02	2.5485151E-05	2.5485151E-05	5.9090909E-01	
2.7787150E-02	2.7787150E-05	2.7787150E-05	6.1363636E-01	
2.9268698E-02	2.9268698E-05	2.9268698E-05	6.3636364E-01	
3.2836129E-02	3.2836129E-05	3.2836129E-05	6.5909091E-01	
3.3186883E-02	3.3186883E-05	3.3186883E-05	6.8181818E-01	
3.4603992E-02	3.4603992E-05	3.4603992E-05	7.0454545E-01	
3.4943699E-02	3.4943699E-05	3.4943699E-05	7.2727273E-01	
3.5789199E-02	3.5789199E-05	3.5789199E-05	7.5000000E-01	
3.6904928E-02	3.6904928E-05	3.6904928E-05	7.7272727E-01	
3.8244252E-02	3.8244252E-05	3.8244252E-05	7.9545455E-01	
4.1083465E-02	4.1083465E-05	4.1083465E-05	8.1818182E-01	
4.2348261E-02	4.2348261E-05	4.2348261E-05	8.4090909E-01	
4.6584977E-02	4.6584977E-05	4.6584977E-05	8.6363636E-01	
4.6828878E-02	4.6828878E-05	4.6828878E-05	8.8636364E-01	
5.3012897E-02	5.3012897E-05	5.3012897E-05	9.0909091E-01	
5.5326023E-02	5.5326023E-05	5.5326023E-05	9.3181818E-01	
8.8591924E-02	8.8591924E-05	8.8591924E-05	9.5454545E-01	
9.7834132E-02	9.7834132E-05	9.7834132E-05	9.7727273E-01	
		1.0000000E-04	1.0000000E+00	Upper Bound

LL000112205924.112 S00041_005 DATA REPORT (Combined crevice and weight loss data)	**A22-24 Worksheet**				
Alloy 22 - 24 month (nm/yr)	Alloy 22 - 24 month (mm/yr)				
-3.109242609E+01	-3.109242609E-05	Average			
-2.980455176E+01	-2.980455176E-05	8.742013622E-06			
-2.230598084E+01	-2.230598084E-05				
-1.921494619E+01	-1.921494619E-05	STDEV			
-1.242252970E+01	-1.242252970E-05	1.435941941E-05			
-1.235039361E+01	-1.235039361E-05				
-1.206946437E+01	-1.206946437E-05				
-8.569968912E+00	-8.569968912E-06				
-8.282229822E+00	-8.282229822E-06				
-7.278519829E+00	-7.278519829E-06				
-4.246717527E+00	-4.246717527E-06				
-3.822998230E+00	-3.822998230E-06				
-1.834045476E+00	-1.834045476E-06				
-1.795461107E+00	-1.795461107E-06				
-1.771202366E+00	-1.771202366E-06				
-1.758100852E+00	-1.758100852E-06				
0.000000000E+00	0.000000000E+00				
0.000000000E+00	0.000000000E+00				
0.000000000E+00	0.000000000E+00				
0.000000000E+00	0.000000000E+00		24 Month	Weibull Probabilities	
0.000000000E+00	0.000000000E+00		Alloy 22	qi	
0.000000000E+00	0.000000000E+00		Corrosion Rate	Refit	
0.000000000E+00	0.000000000E+00		(mm/yr)	CDF	
0.000000000E+00	0.000000000E+00		1.000000000E-12	0.000000000E+00	Lower Bound
1.729006361E+00	1.729006361E-06		1.729006361E-06	1.282051282E-02	
1.775848974E+00	1.775848974E-06		1.775848974E-06	2.564102564E-02	
1.928234050E+00	1.928234050E-06		1.928234050E-06	3.846153846E-02	
2.074163440E+00	2.074163440E-06		2.074163440E-06	5.128205128E-02	
2.139364625E+00	2.139364625E-06		2.139364625E-06	6.410256410E-02	
2.144906822E+00	2.144906822E-06		2.144906822E-06	7.692307692E-02	
2.924459214E+00	2.924459214E-06		2.924459214E-06	8.974358974E-02	
3.555035555E+00	3.555035555E-06		3.555035555E-06	1.025641026E-01	
3.675322980E+00	3.675322980E-06		3.675322980E-06	1.153846154E-01	
3.760267562E+00	3.760267562E-06		3.760267562E-06	1.282051282E-01	
4.150551889E+00	4.150551889E-06		4.150551889E-06	1.410256410E-01	
5.242898761E+00	5.242898761E-06		5.242898761E-06	1.538461538E-01	
5.275799378E+00	5.275799378E-06		5.275799378E-06	1.666666667E-01	
5.282302152E+00	5.282302152E-06		5.282302152E-06	1.794871795E-01	
5.478181203E+00	5.478181203E-06		5.478181203E-06	1.923076923E-01	
5.670997827E+00	5.670997827E-06		5.670997827E-06	2.051282051E-01	
5.986699690E+00	5.986699690E-06		5.986699690E-06	2.179487179E-01	

7.075064863E+00	7.075064863E-06	7.075064863E-06	2.307692308E-01
7.090882269E+00	7.090882269E-06	7.090882269E-06	2.435897436E-01
7.111675664E+00	7.111675664E-06	7.111675664E-06	2.564102564E-01
7.113751916E+00	7.113751916E-06	7.113751916E-06	2.692307692E-01
7.246541076E+00	7.246541076E-06	7.246541076E-06	2.820512821E-01
7.345938332E+00	7.345938332E-06	7.345938332E-06	2.948717949E-01
7.610983474E+00	7.610983474E-06	7.610983474E-06	3.076923077E-01
7.625157177E+00	7.625157177E-06	7.625157177E-06	3.205128205E-01
7.664251639E+00	7.664251639E-06	7.664251639E-06	3.333333333E-01
8.234945394E+00	8.234945394E-06	8.234945394E-06	3.461538462E-01
8.479184284E+00	8.479184284E-06	8.479184284E-06	3.589743590E-01
8.638577596E+00	8.638577596E-06	8.638577596E-06	3.717948718E-01
8.744965783E+00	8.744965783E-06	8.744965783E-06	3.846153846E-01
8.856665432E+00	8.856665432E-06	8.856665432E-06	3.974358974E-01
9.097049113E+00	9.097049113E-06	9.097049113E-06	4.102564103E-01
9.217181606E+00	9.217181606E-06	9.217181606E-06	4.230769231E-01
9.443293172E+00	9.443293172E-06	9.443293172E-06	4.358974359E-01
9.486149488E+00	9.486149488E-06	9.486149488E-06	4.487179487E-01
9.663726681E+00	9.663726681E-06	9.663726681E-06	4.615384615E-01
1.013975761E+01	1.013975761E-05	1.013975761E-05	4.743589744E-01
1.029368174E+01	1.029368174E-05	1.029368174E-05	4.871794872E-01
1.034067439E+01	1.034067439E-05	1.034067439E-05	5.000000000E-01
1.043668318E+01	1.043668318E-05	1.043668318E-05	5.128205128E-01
1.144111604E+01	1.144111604E-05	1.144111604E-05	5.256410256E-01
1.218598381E+01	1.218598381E-05	1.218598381E-05	5.384615385E-01
1.267728256E+01	1.267728256E-05	1.267728256E-05	5.512820513E-01
1.338754194E+01	1.338754194E-05	1.338754194E-05	5.641025641E-01
1.381880679E+01	1.381880679E-05	1.381880679E-05	5.769230769E-01
1.393546104E+01	1.393546104E-05	1.393546104E-05	5.897435897E-01
1.430836915E+01	1.430836915E-05	1.430836915E-05	6.025641026E-01
1.440206743E+01	1.440206743E-05	1.440206743E-05	6.153846154E-01
1.446471292E+01	1.446471292E-05	1.446471292E-05	6.282051282E-01
1.448547668E+01	1.448547668E-05	1.448547668E-05	6.410256410E-01
1.454486755E+01	1.454486755E-05	1.454486755E-05	6.538461538E-01
1.457946831E+01	1.457946831E-05	1.457946831E-05	6.666666667E-01
1.469970980E+01	1.469970980E-05	1.469970980E-05	6.794871795E-01
1.554689265E+01	1.554689265E-05	1.554689265E-05	6.923076923E-01
1.626229817E+01	1.626229817E-05	1.626229817E-05	7.051282051E-01
1.677927408E+01	1.677927408E-05	1.677927408E-05	7.179487179E-01
1.686625624E+01	1.686625624E-05	1.686625624E-05	7.307692308E-01
1.734180687E+01	1.734180687E-05	1.734180687E-05	7.435897436E-01
1.749756568E+01	1.749756568E-05	1.749756568E-05	7.564102564E-01
1.755628753E+01	1.755628753E-05	1.755628753E-05	7.692307692E-01
1.785696214E+01	1.785696214E-05	1.785696214E-05	7.820512821E-01
1.826282675E+01	1.826282675E-05	1.826282675E-05	7.948717949E-01
2.001297034E+01	2.001297034E-05	2.001297034E-05	8.076923077E-01

2.058643185E+01	2.058643185E-05	2.058643185E-05	8.205128205E-01	
2.179494392E+01	2.179494392E-05	2.179494392E-05	8.333333333E-01	
2.244345296E+01	2.244345296E-05	2.244345296E-05	8.461538462E-01	
2.285844013E+01	2.285844013E-05	2.285844013E-05	8.589743590E-01	
2.330359463E+01	2.330359463E-05	2.330359463E-05	8.717948718E-01	
2.333816674E+01	2.333816674E-05	2.333816674E-05	8.846153846E-01	
2.385929433E+01	2.385929433E-05	2.385929433E-05	8.974358974E-01	
2.417024083E+01	2.417024083E-05	2.417024083E-05	9.102564103E-01	
2.855651384E+01	2.855651384E-05	2.855651384E-05	9.230769231E-01	
2.978308321E+01	2.978308321E-05	2.978308321E-05	9.358974359E-01	
3.657445250E+01	3.657445250E-05	3.657445250E-05	9.487179487E-01	
4.530905968E+01	4.530905968E-05	4.530905968E-05	9.615384615E-01	
5.362889572E+01	5.362889572E-05	5.362889572E-05	9.743589744E-01	
7.269151529E+01	7.269151529E-05	7.269151529E-05	9.871794872E-01	
		7.300000000E-05	1.000000000E+00	Upper Bound

All Alloy 22 Data Sorted (mm/yr)		A22-All WorkSheet
-5.9236E-05	Average	
-5.0539E-05	3.44284E-05	
-4.9472E-05		
-4.1763E-05	STDEV	
-3.4357E-05	6.38901E-05	
-3.4146E-05		
-3.3839E-05		
-3.3367E-05		
-3.1092E-05		
-2.9805E-05		
-2.8890E-05		
-2.8826E-05		
-2.5453E-05		
-2.5204E-05		
-2.4857E-05		
-2.2656E-05		
-2.2306E-05		
-2.0590E-05		
-2.0529E-05		
-1.9215E-05		
-1.7456E-05		
-1.6852E-05		
-1.6551E-05		
-1.6508E-05		
-1.6438E-05		
-1.6179E-05		
-1.6162E-05		
-1.2633E-05		
-1.2616E-05		
-1.2423E-05		
-1.2350E-05		
-1.2069E-05		
-8.6462E-06		
-8.5743E-06		
-8.5700E-06		
-8.2822E-06		
-8.2688E-06		
-8.0901E-06		
-7.2785E-06		
-6.6713E-06		
-4.2467E-06		
-3.8230E-06		
-2.2253E-06		
-1.8340E-06		
-1.7955E-06		

-1.7712E-06			
-1.7581E-06			
0.0000E+00			
0.0000E+00			
0.0000E+00			
0.0000E+00			
0.0000E+00			
0.0000E+00			
0.0000E+00			
0.0000E+00			
0.0000E+00			
0.0000E+00			
0.0000E+00			
0.0000E+00	6, 12, and 24 Month	Weibull Probabilities	
0.0000E+00	Alloy 22	qi	
0.0000E+00	Corrosion Rate	Refit	
0.0000E+00	(mm/yr)	CDF	
0.0000E+00	1.0000E-12	0.0000E+00	Lower Bound
1.7290E-06	1.7290E-06	4.1322E-03	
1.7758E-06	1.7758E-06	8.2645E-03	
1.9282E-06	1.9282E-06	1.2397E-02	
2.0742E-06	2.0742E-06	1.6529E-02	
2.1394E-06	2.1394E-06	2.0661E-02	
2.1449E-06	2.1449E-06	2.4793E-02	
2.2215E-06	2.2215E-06	2.8926E-02	
2.2740E-06	2.2740E-06	3.3058E-02	
2.9245E-06	2.9245E-06	3.7190E-02	
3.5550E-06	3.5550E-06	4.1322E-02	
3.6753E-06	3.6753E-06	4.5455E-02	
3.7603E-06	3.7603E-06	4.9587E-02	
4.1095E-06	4.1095E-06	5.3719E-02	
4.1382E-06	4.1382E-06	5.7851E-02	
4.1506E-06	4.1506E-06	6.1983E-02	
4.2073E-06	4.2073E-06	6.6116E-02	
4.2184E-06	4.2184E-06	7.0248E-02	
4.2529E-06	4.2529E-06	7.4380E-02	
4.4645E-06	4.4645E-06	7.8512E-02	
4.5481E-06	4.5481E-06	8.2645E-02	
4.5831E-06	4.5831E-06	8.6777E-02	
5.2429E-06	5.2429E-06	9.0909E-02	
5.2758E-06	5.2758E-06	9.5041E-02	
5.2823E-06	5.2823E-06	9.9174E-02	
5.4782E-06	5.4782E-06	1.0331E-01	
5.6710E-06	5.6710E-06	1.0744E-01	
5.9867E-06	5.9867E-06	1.1157E-01	
7.0751E-06	7.0751E-06	1.1570E-01	
7.0909E-06	7.0909E-06	1.1983E-01	
7.1117E-06	7.1117E-06	1.2397E-01	

7.1138E-06	7.1138E-06	1.2810E-01
7.2465E-06	7.2465E-06	1.3223E-01
7.3459E-06	7.3459E-06	1.3636E-01
7.6110E-06	7.6110E-06	1.4050E-01
7.6252E-06	7.6252E-06	1.4463E-01
7.6643E-06	7.6643E-06	1.4876E-01
8.1101E-06	8.1101E-06	1.5289E-01
8.2349E-06	8.2349E-06	1.5702E-01
8.2453E-06	8.2453E-06	1.6116E-01
8.3155E-06	8.3155E-06	1.6529E-01
8.3492E-06	8.3492E-06	1.6942E-01
8.4380E-06	8.4380E-06	1.7355E-01
8.4792E-06	8.4792E-06	1.7769E-01
8.5121E-06	8.5121E-06	1.8182E-01
8.6386E-06	8.6386E-06	1.8595E-01
8.7450E-06	8.7450E-06	1.9008E-01
8.8567E-06	8.8567E-06	1.9421E-01
8.9084E-06	8.9084E-06	1.9835E-01
8.9679E-06	8.9679E-06	2.0248E-01
9.0970E-06	9.0970E-06	2.0661E-01
9.2172E-06	9.2172E-06	2.1074E-01
9.3073E-06	9.3073E-06	2.1488E-01
9.4433E-06	9.4433E-06	2.1901E-01
9.4861E-06	9.4861E-06	2.2314E-01
9.6637E-06	9.6637E-06	2.2727E-01
1.0140E-05	1.0140E-05	2.3140E-01
1.0294E-05	1.0294E-05	2.3554E-01
1.0341E-05	1.0341E-05	2.3967E-01
1.0437E-05	1.0437E-05	2.4380E-01
1.1082E-05	1.1082E-05	2.4793E-01
1.1441E-05	1.1441E-05	2.5207E-01
1.2186E-05	1.2186E-05	2.5620E-01
1.2345E-05	1.2345E-05	2.6033E-01
1.2388E-05	1.2388E-05	2.6446E-01
1.2677E-05	1.2677E-05	2.6860E-01
1.3388E-05	1.3388E-05	2.7273E-01
1.3710E-05	1.3710E-05	2.7686E-01
1.3819E-05	1.3819E-05	2.8099E-01
1.3935E-05	1.3935E-05	2.8512E-01
1.4308E-05	1.4308E-05	2.8926E-01
1.4402E-05	1.4402E-05	2.9339E-01
1.4465E-05	1.4465E-05	2.9752E-01
1.4485E-05	1.4485E-05	3.0165E-01
1.4545E-05	1.4545E-05	3.0579E-01
1.4579E-05	1.4579E-05	3.0992E-01
1.4700E-05	1.4700E-05	3.1405E-01
1.5547E-05	1.5547E-05	3.1818E-01
1.5662E-05	1.5662E-05	3.2231E-01
1.5697E-05	1.5697E-05	3.2645E-01
1.6090E-05	1.6090E-05	3.3058E-01
1.6163E-05	1.6163E-05	3.3471E-01
1.6232E-05	1.6232E-05	3.3884E-01
1.6262E-05	1.6262E-05	3.4298E-01
1.6512E-05	1.6512E-05	3.4711E-01
1.6604E-05	1.6604E-05	3.5124E-01
1.6779E-05	1.6779E-05	3.5537E-01

1.6801E-05	1.6801E-05	3.5950E-01
1.6817E-05	1.6817E-05	3.6364E-01
1.6866E-05	1.6866E-05	3.6777E-01
1.6968E-05	1.6968E-05	3.7190E-01
1.7342E-05	1.7342E-05	3.7603E-01
1.7498E-05	1.7498E-05	3.8017E-01
1.7556E-05	1.7556E-05	3.8430E-01
1.7857E-05	1.7857E-05	3.8843E-01
1.8162E-05	1.8162E-05	3.9256E-01
1.8263E-05	1.8263E-05	3.9669E-01
1.8732E-05	1.8732E-05	4.0083E-01
2.0013E-05	2.0013E-05	4.0496E-01
2.0586E-05	2.0586E-05	4.0909E-01
2.1795E-05	2.1795E-05	4.1322E-01
2.2443E-05	2.2443E-05	4.1736E-01
2.2858E-05	2.2858E-05	4.2149E-01
2.3304E-05	2.3304E-05	4.2562E-01
2.3338E-05	2.3338E-05	4.2975E-01
2.3859E-05	2.3859E-05	4.3388E-01
2.4170E-05	2.4170E-05	4.3802E-01
2.4331E-05	2.4331E-05	4.4215E-01
2.4627E-05	2.4627E-05	4.4628E-01
2.4675E-05	2.4675E-05	4.5041E-01
2.4684E-05	2.4684E-05	4.5455E-01
2.4785E-05	2.4785E-05	4.5868E-01
2.5199E-05	2.5199E-05	4.6281E-01
2.5252E-05	2.5252E-05	4.6694E-01
2.5443E-05	2.5443E-05	4.7107E-01
2.5485E-05	2.5485E-05	4.7521E-01
2.5544E-05	2.5544E-05	4.7934E-01
2.6639E-05	2.6639E-05	4.8347E-01
2.7787E-05	2.7787E-05	4.8760E-01
2.8054E-05	2.8054E-05	4.9174E-01
2.8557E-05	2.8557E-05	4.9587E-01
2.9269E-05	2.9269E-05	5.0000E-01
2.9783E-05	2.9783E-05	5.0413E-01
3.2457E-05	3.2457E-05	5.0826E-01
3.2520E-05	3.2520E-05	5.1240E-01
3.2836E-05	3.2836E-05	5.1653E-01
3.2916E-05	3.2916E-05	5.2066E-01
3.3019E-05	3.3019E-05	5.2479E-01
3.3053E-05	3.3053E-05	5.2893E-01
3.3187E-05	3.3187E-05	5.3306E-01
3.3228E-05	3.3228E-05	5.3719E-01
3.3651E-05	3.3651E-05	5.4132E-01
3.3760E-05	3.3760E-05	5.4545E-01
3.4536E-05	3.4536E-05	5.4959E-01
3.4604E-05	3.4604E-05	5.5372E-01
3.4712E-05	3.4712E-05	5.5785E-01
3.4944E-05	3.4944E-05	5.6198E-01
3.5789E-05	3.5789E-05	5.6612E-01
3.6574E-05	3.6574E-05	5.7025E-01
3.6905E-05	3.6905E-05	5.7438E-01
3.8244E-05	3.8244E-05	5.7851E-01
4.0102E-05	4.0102E-05	5.8264E-01
4.0988E-05	4.0988E-05	5.8678E-01
4.1083E-05	4.1083E-05	5.9091E-01
4.1123E-05	4.1123E-05	5.9504E-01
4.1564E-05	4.1564E-05	5.9917E-01

4.1624E-05	4.1624E-05	6.0331E-01
4.2259E-05	4.2259E-05	6.0744E-01
4.2348E-05	4.2348E-05	6.1157E-01
4.2842E-05	4.2842E-05	6.1570E-01
4.5309E-05	4.5309E-05	6.1983E-01
4.6585E-05	4.6585E-05	6.2397E-01
4.6701E-05	4.6701E-05	6.2810E-01
4.6829E-05	4.6829E-05	6.3223E-01
4.7065E-05	4.7065E-05	6.3636E-01
4.8312E-05	4.8312E-05	6.4050E-01
4.9057E-05	4.9057E-05	6.4463E-01
4.9297E-05	4.9297E-05	6.4876E-01
4.9337E-05	4.9337E-05	6.5289E-01
5.0048E-05	5.0048E-05	6.5702E-01
5.0735E-05	5.0735E-05	6.6116E-01
5.1182E-05	5.1182E-05	6.6529E-01
5.3013E-05	5.3013E-05	6.6942E-01
5.3629E-05	5.3629E-05	6.7355E-01
5.4572E-05	5.4572E-05	6.7769E-01
5.5207E-05	5.5207E-05	6.8182E-01
5.5326E-05	5.5326E-05	6.8595E-01
5.6340E-05	5.6340E-05	6.9008E-01
5.7979E-05	5.7979E-05	6.9421E-01
5.8012E-05	5.8012E-05	6.9835E-01
5.8437E-05	5.8437E-05	7.0248E-01
5.9070E-05	5.9070E-05	7.0661E-01
6.0276E-05	6.0276E-05	7.1074E-01
6.2126E-05	6.2126E-05	7.1488E-01
6.3807E-05	6.3807E-05	7.1901E-01
6.5123E-05	6.5123E-05	7.2314E-01
6.5325E-05	6.5325E-05	7.2727E-01
6.5572E-05	6.5572E-05	7.3140E-01
6.6118E-05	6.6118E-05	7.3554E-01
6.6526E-05	6.6526E-05	7.3967E-01
6.6829E-05	6.6829E-05	7.4380E-01
6.6968E-05	6.6968E-05	7.4793E-01
6.7566E-05	6.7566E-05	7.5207E-01
6.7631E-05	6.7631E-05	7.5620E-01
6.9077E-05	6.9077E-05	7.6033E-01
6.9713E-05	6.9713E-05	7.6446E-01
7.1808E-05	7.1808E-05	7.6860E-01
7.2692E-05	7.2692E-05	7.7273E-01
7.3008E-05	7.3008E-05	7.7686E-01
7.3492E-05	7.3492E-05	7.8099E-01
7.3821E-05	7.3821E-05	7.8512E-01
7.4186E-05	7.4186E-05	7.8926E-01
7.4576E-05	7.4576E-05	7.9339E-01
7.5730E-05	7.5730E-05	7.9752E-01
7.5896E-05	7.5896E-05	8.0165E-01
7.6989E-05	7.6989E-05	8.0579E-01
7.7605E-05	7.7605E-05	8.0992E-01
7.9686E-05	7.9686E-05	8.1405E-01
8.0764E-05	8.0764E-05	8.1818E-01
8.1074E-05	8.1074E-05	8.2231E-01
8.2265E-05	8.2265E-05	8.2645E-01
8.2668E-05	8.2668E-05	8.3058E-01
8.3492E-05	8.3492E-05	8.3471E-01
8.5295E-05	8.5295E-05	8.3884E-01
8.5780E-05	8.5780E-05	8.4298E-01

8.6617E-05	8.6617E-05	8.4711E-01	
8.6697E-05	8.6697E-05	8.5124E-01	
8.7415E-05	8.7415E-05	8.5537E-01	
8.8592E-05	8.8592E-05	8.5950E-01	
8.9536E-05	8.9536E-05	8.6364E-01	
9.0727E-05	9.0727E-05	8.6777E-01	
9.2141E-05	9.2141E-05	8.7190E-01	
9.5636E-05	9.5636E-05	8.7603E-01	
9.7224E-05	9.7224E-05	8.8017E-01	
9.7650E-05	9.7650E-05	8.8430E-01	
9.7834E-05	9.7834E-05	8.8843E-01	
9.7992E-05	9.7992E-05	8.9256E-01	
9.8804E-05	9.8804E-05	8.9669E-01	
1.0014E-04	1.0014E-04	9.0083E-01	
1.0146E-04	1.0146E-04	9.0496E-01	
1.0185E-04	1.0185E-04	9.0909E-01	
1.0185E-04	1.0185E-04	9.1322E-01	
1.0271E-04	1.0271E-04	9.1736E-01	
1.0320E-04	1.0320E-04	9.2149E-01	
1.0374E-04	1.0374E-04	9.2562E-01	
1.0581E-04	1.0581E-04	9.2975E-01	
1.0723E-04	1.0723E-04	9.3388E-01	
1.0800E-04	1.0800E-04	9.3802E-01	
1.1232E-04	1.1232E-04	9.4215E-01	
1.1254E-04	1.1254E-04	9.4628E-01	
1.1260E-04	1.1260E-04	9.5041E-01	
1.1657E-04	1.1657E-04	9.5455E-01	
1.2081E-04	1.2081E-04	9.5868E-01	
1.2099E-04	1.2099E-04	9.6281E-01	
1.2953E-04	1.2953E-04	9.6694E-01	
1.4308E-04	1.4308E-04	9.7107E-01	
1.6416E-04	1.6416E-04	9.7521E-01	
1.7578E-04	1.7578E-04	9.7934E-01	
2.4494E-04	2.4494E-04	9.8347E-01	
2.5056E-04	2.5056E-04	9.8760E-01	
4.6728E-04	4.6728E-04	9.9174E-01	
7.3077E-04	7.3077E-04	9.9587E-01	
	7.5000E-04	1.0000E+00	Upper Bound

LL990610605924.079
s99359_035 DATA REPORT
(crevice data) and
s99359_036 DATA REPORT
(weight loss data) Sorted
LTCTF
Ti grade 7

Ti-7 Worksheet

Rate (μm/yr)	Ti-7 Rate (mm/year)	Weibull Probabilities qi Refit CDF	
-1.686192841E+00			
-1.325935258E+00			
-5.358820500E-01			
-4.639706690E-01			
-3.434427330E-01			
-2.284141490E-01			
-1.687868180E-01			
-1.354099430E-01			
-1.281909930E-01			
-9.475888100E-02			
-8.778399700E-02			
-6.015486200E-02			
-5.593836600E-02			
-5.520150200E-02			
-5.146481800E-02			
-5.134197000E-02			
-4.810188800E-02			
-4.715463100E-02			
-4.589399500E-02			
-4.335911800E-02			
-4.194321500E-02			
-3.797525200E-02			
-3.745536000E-02			
-3.440801200E-02			
-3.217080600E-02			
-3.201503500E-02			
-3.165286400E-02			
-3.035342200E-02			
-3.011435700E-02			
-2.965832000E-02			
-2.954260600E-02			
-2.523824300E-02			
-2.520533500E-02			
-1.718749300E-02			
-1.709018100E-02			
-1.695813800E-02			
-1.678781100E-02			
-1.594054200E-02			
-8.405086000E-03			
0.000000000E+00			
0.000000000E+00			
0.000000000E+00	1.000000000E-12	0.000000000E+00	Lower Bound
4.184308000E-03	4.184308000E-06	3.846153846E-02	
7.905401000E-03	7.905401000E-06	7.692307692E-02	
7.908996000E-03	7.908996000E-06	1.153846154E-01	
7.917336000E-03	7.917336000E-06	1.538461538E-01	
7.992055000E-03	7.992055000E-06	1.923076923E-01	
1.596796400E-02	1.596796400E-05	2.307692308E-01	
1.607403600E-02	1.607403600E-05	2.692307692E-01	
1.653897500E-02	1.653897500E-05	3.076923077E-01	

2.104508700E-02	2.104508700E-05	3.461538462E-01	
2.356582400E-02	2.356582400E-05	3.846153846E-01	
2.373021600E-02	2.373021600E-05	4.230769231E-01	
2.403290800E-02	2.403290800E-05	4.615384615E-01	
2.527848900E-02	2.527848900E-05	5.000000000E-01	
3.999769100E-02	3.999769100E-05	5.384615385E-01	
4.262070800E-02	4.262070800E-05	5.769230769E-01	
4.286473100E-02	4.286473100E-05	6.153846154E-01	
5.153030200E-02	5.153030200E-05	6.538461538E-01	
6.336837000E-02	6.336837000E-05	6.923076923E-01	
6.496688300E-02	6.496688300E-05	7.307692308E-01	
7.149610900E-02	7.149610900E-05	7.692307692E-01	
7.916412000E-02	7.916412000E-05	8.076923077E-01	
8.220289600E-02	8.220289600E-05	8.461538462E-01	
1.115632860E-01	1.115632860E-04	8.846153846E-01	
1.127882280E-01	1.127882280E-04	9.230769231E-01	
3.194097040E-01	3.194097040E-04	9.615384615E-01	
	3.250000000E-04	1.000000000E+00	Upper Bound

ATTACHMENT II

SILICA Software Routine Report

1. SOFTWARE ROUTINE IDENTIFICATION

Name and version number: Silica, version 1.0

This routine was developed and executed using Mathcad 2000.

2. DECRIPTION AND TESTING

Silica is a software routine which calculates a convolution integral between a uniform cumulative distribution function (cdf), with range zero to A, and a cdf with values determined by linear interpolation of table values, specified in an array, CDF. The results of the convolution are calculated for a user-specified number of intervals, m, linearly spaced between the maximum and minimum values of the convolution domain. The input arguments to the routine are the array CDF and the scalars A and m. The output argument is a cdf array of m+2 rows and two columns. The first row contains the number of values that will follow and the number of columns in the table, i.e. m+1 and two. The following m+1 rows contain the values of the deviate in column one and the cumulative probability values in column two. See the test results listing below for an example.

The routine, Silica, makes use of a subroutine named Fcdf(x, CDF) which performs the linear interpolation between values of the CDF table-array. The return value of Fcdf is the cumulative probability associated with the input argument, x. The input argument, CDF, is an array with two columns. The first column contains values of the deviate in increasing order. The second column contains cumulative probability values associated with the deviate in column one on a row by row basis.

Silica receives the input parameters (CDF, A, m) from the argument list, and then follows the algorithm steps presented below.

1. The minimum and maximum values are determined by taking the minimum deviate value and the maximum deviate value plus A.
2. For m equally spaced values between the minimum and maximum, the integral function, *H(r)*, is evaluated.

$$H(r) = \frac{1}{A}\int_0^A F(r-y)dy$$

   where *F(x)* is the cdf being evaluated by Fcdf(x,CDF).
3. The results are passed out as the output argument as documented above.

The testing approach involves comparing the results of executing Silica with the analytically known solution for a uniform input cdf. If the input cdf is uniform between 10 and 11 then the convolution performed with A equal to one results in the following function.

$$H(x)=\begin{cases}0 & x<10\\ (x-10)^2/2 & 10\le x<11\\ 1-(12-x)^2/2 & 11\le x<12\\ 1 & x\le 12\end{cases}$$

Results of the test show that the analytical and computational solutions agree.

3. SUPPORTING INFORMATION

Below is a listing of the routines and the test results. Using, m = 4, a five by two table is the result with x evaluated at 10.0, 10.5, 11.0, 11.5, and 12.0 for H(x).

Listing of software subroutines Fcdf and Silica

$$\text{Fcdf}(x,\text{CDF}) := \begin{cases}0 & \text{if } x\le \text{CDF}_{0,0}\\ 1 & \text{if } x\ge \text{CDF}_{\text{rows(CDF)}-1,0}\\ \text{linterp}\left(\text{CDF}^{\langle 0\rangle},\text{CDF}^{\langle 1\rangle},x\right) & \text{otherwise}\end{cases}$$

$$\text{Silica}(\text{CDF},A,m) := \left|\begin{array}{l} a \leftarrow \text{CDF}_{0,0}\\ b \leftarrow \text{CDF}_{\text{rows(CDF)}-1,0} + A\\ \text{for } ii \in 0..m\\ \quad r_{ii} \leftarrow (b-a)\cdot\dfrac{ii}{m} + a\\ \quad H_{ii} \leftarrow \dfrac{\int_0^A \text{Fcdf}\left(r_{ii}-y,\text{CDF}\right)dy}{A}\\ \text{dataout} \leftarrow \text{stack}[(m+1\ \ 2),\text{augment}(r,H)]\end{array}\right.$$

Silica SRR Test Case

$$\text{cdf\_test} := \begin{pmatrix}10.0 & 0.0\\ 10.5 & 0.5\\ 11.0 & 1.0\end{pmatrix} \qquad A := 1.0 \quad m := 4$$

$$\text{testout} := \text{Silica}(\text{cdf\_test},A,m)$$

Silica Results

$$\text{testout} = \begin{pmatrix}5 & 2\\ 10 & 0\\ 10.5 & 0.125\\ 11 & 0.5\\ 11.5 & 0.875\\ 12 & 1\end{pmatrix}$$

Analytical Results

$$H(10.5) = \frac{(10.5-10.0)^2}{2} = 0.125$$

$$H(11.5) = 1 - \frac{(12-11.5)^2}{2} = 0.875$$