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Sandia National Laboratories

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Sandia Corporation
Defense Waste Management Programs
4100 National Parks Highway
Carlsbad, New Mexico 88220

To: Records Center

From: Todd R. Zeitler

Subject: Cumulative distribution for STEEL:CORRMCO2 for the CRA-2019 PA

As part of addressing a comment received from the EPA regarding the CRA-2014, a cumulative distribution of values for the STEEL:CORRMCO2 parameter was developed from data provided by Roselle (2013) for the corrosion of iron under inundated brine conditions (Zeitler and Hansen 2015). The distribution was based on an aggregation of observed non-zero rates for corrosion experiments performed on steel coupons fully or partially submerged in four anoxic brines in an atmosphere of 0 ppm and 350 ppm CO_2 (the only other gas being N_2) at 26 °C for time periods of 6, 12, 18, and 24 months (pH was recorded, but not controlled). The four brines were the GWB and ERDA-6 brines, with and without organic additions, as described in Roselle (2013). The brines were principally aqueous NaCl solutions with additional minor components. After the submittal of the Zeitler and Hansen (2015) memo to the EPA, the EPA published a technical support document (TSD) on chemistry-related issues (U.S. EPA 2017a) that supported their 2017 recertification decision (U.S. EPA 2017b).

In that TSD, the EPA recalled that they had requested a doubling of the upper bound of the DOE's inundated corrosion rate range following submittal of the CCA (the lower bound was zero) to account for observed corrosion rate increases at pressures comparable to WIPP repository gas pressures (Telander and Westerman 1997). The Telander and Westerman experiments showed that, while various underlying corrosion mechanisms may be at play depending on testing environments, under some conditions, increased pressures could lead to increased iron corrosion rates. To accommodate the uncertainty associated with predicted future repository conditions, a doubling of the observed rates was recommended by the EPA for performance assessment (PA) calculations that consider the evolution of repository conditions over 10,000 y. That is, since the corrosion rates presented by the DOE at that time were based on experiments performed at pressures lower than those expected at the WIPP, a factor of two should be applied to the rates used in CCA calculations. As a result, the DOE doubled the range of values sampled for the CORRMCO2 parameter for PAVT, PABC-2004, and PABC-2009 calculations (Fox 2008).

Additionally, the EPA also noted in their TSD that since the Roselle data had not been collected at repository pressures, a factor of two should be applied to the distribution provided in the Zeitler and Hansen (2015) memo: "*This data analysis and distribution is reasonable, but does not account for the previously noted effects of higher repository pressure on the inundated corrosion rate. Consequently, EPA recommends the inundated corrosion rates measured by*

Roselle (2013) and accumulated into the CDF for PA be increased by a factor of two, as previously directed by EPA for the CCA PAVT (Table 3-2)."

Recognizing that corrosion rates are pressure-dependent, the CORRMCO2 parameter distribution provided by Zeitler and Hansen (2015) has been adjusted for use in the CRA-2019 PA by multiplying each rate from Roselle's data by a factor of two. The effect of the adjustment is to increase each value in the cumulative distribution by a factor of two. Additionally, the rate values from Zeitler and Hansen (2015) have been reduced to having only three significant digits, in order to match the three significant digits provided for corrosion rates in Roselle (2013). The resulting values that comprise the recommended distribution are listed in Table 1.

Table 1. Cumulative Distribution Function (CDF) Data for the STEEL:CORRMCO2 Parameter that Describes Inundated Iron Corrosion Rates.

Rank	Value (m/s)	Cumulative Probability
1	0	0
2	6.34E-16	0.008065
3	7.61E-16	0.016129
4	1.84E-15	0.024194
5	2.16E-15	0.032258
6	3.04E-15	0.040323
7	3.30E-15	0.048387
8	3.68E-15	0.056452
9	3.81E-15	0.064516
10	4.50E-15	0.072581
11	4.50E-15	0.080645
12	4.95E-15	0.088710
13	5.64E-15	0.096774
14	5.71E-15	0.104839
15	5.71E-15	0.112903
16	5.77E-15	0.120968
17	5.90E-15	0.129032
18	6.15E-15	0.137097
19	6.41E-15	0.145161
20	6.47E-15	0.153226
21	6.47E-15	0.161290
22	6.53E-15	0.169355
23	6.60E-15	0.177419
24	6.72E-15	0.185484
25	6.79E-15	0.193548
26	6.79E-15	0.201613
27	6.79E-15	0.209677
28	6.98E-15	0.217742
29	7.23E-15	0.225806

Rank	Value (m/s)	Cumulative Probability
30	7.42E-15	0.233871
31	7.42E-15	0.241935
32	7.55E-15	0.250000
33	7.61E-15	0.258065
34	7.80E-15	0.266129
35	7.93E-15	0.274194
36	7.99E-15	0.282258
37	8.05E-15	0.290323
38	8.05E-15	0.298387
39	8.18E-15	0.306452
40	8.31E-15	0.314516
41	8.37E-15	0.322581
42	8.37E-15	0.330645
43	8.43E-15	0.338710
44	8.56E-15	0.346774
45	8.63E-15	0.354839
46	8.82E-15	0.362903
47	8.82E-15	0.370968
48	9.07E-15	0.379032
49	9.07E-15	0.387097
50	9.07E-15	0.395161
51	9.32E-15	0.403226
52	9.32E-15	0.411290
53	9.39E-15	0.419355
54	9.45E-15	0.427419
55	9.45E-15	0.435484
56	9.70E-15	0.443548
57	1.03E-14	0.451613
58	1.06E-14	0.459677
59	1.07E-14	0.467742
60	1.07E-14	0.475806
61	1.07E-14	0.483871
62	1.08E-14	0.491935
63	1.12E-14	0.500000
64	1.12E-14	0.508065
65	1.13E-14	0.516129
66	1.13E-14	0.524194
67	1.13E-14	0.532258
68	1.14E-14	0.540323
69	1.15E-14	0.548387

Rank	Value (m/s)	Cumulative Probability
70	1.17E-14	0.556452
71	1.18E-14	0.564516
72	1.19E-14	0.572581
73	1.19E-14	0.580645
74	1.20E-14	0.588710
75	1.22E-14	0.596774
76	1.22E-14	0.604839
77	1.26E-14	0.612903
78	1.27E-14	0.620968
79	1.27E-14	0.629032
80	1.27E-14	0.637097
81	1.28E-14	0.645161
82	1.29E-14	0.653226
83	1.31E-14	0.661290
84	1.31E-14	0.669355
85	1.31E-14	0.677419
86	1.33E-14	0.685484
87	1.36E-14	0.693548
88	1.36E-14	0.701613
89	1.36E-14	0.709677
90	1.38E-14	0.717742
91	1.39E-14	0.725806
92	1.42E-14	0.733871
93	1.43E-14	0.741935
94	1.45E-14	0.750000
95	1.45E-14	0.758065
96	1.48E-14	0.766129
97	1.49E-14	0.774194
98	1.50E-14	0.782258
99	1.52E-14	0.790323
100	1.53E-14	0.798387
101	1.57E-14	0.806452
102	1.59E-14	0.814516
103	1.60E-14	0.822581
104	1.65E-14	0.830645
105	1.71E-14	0.838710
106	1.73E-14	0.846774
107	1.78E-14	0.854839
108	1.85E-14	0.862903
109	1.86E-14	0.870968

Rank	Value (m/s)	Cumulative Probability
110	1.95E-14	0.879032
111	1.97E-14	0.887097
112	2.58E-14	0.895161
113	2.78E-14	0.903226
114	2.93E-14	0.911290
115	2.95E-14	0.919355
116	3.02E-14	0.927419
117	3.11E-14	0.935484
118	3.33E-14	0.943548
119	3.61E-14	0.951613
120	3.67E-14	0.959677
121	3.73E-14	0.967742
122	4.92E-14	0.975806
123	5.66E-14	0.983871
124	6.59E-14	0.991935
125	7.92E-14	1.000000

Table 2. Statistics for the CDF of STEEL:CORRMCO2.

Mean	1.35E-14
Median	1.12E-14
St. Dev.	1.17E-14
Min.	0.00E+00
Max.	7.92E-14

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