SAVANNAH RIVER NATIONAL LABORATORY

SRNL-STI-2018-00038, Rev. 1

Date: September 29, 2022

TO: V. P. Rigsby, 704-59E

FROM: K. L. Dixon, 773-42A
H. H. VerMeulen, 773-42A

TECHNICAL REVIEW J. A. Dyer, 773-42A

E-Area Corrosion Coupon Recovery and Evaluation

Scope Abstract: The recovery and evaluation of selected E-Area corrosion coupons were completed in FY2022. This is the second time coupons have been recovered from the E-Area Corrosion Monitoring Test Site, with the first recovery effort occurring in FY2017. Coupons recovered during the FY2022 extraction have now been exposed to the subsurface for approximately 17 years. This effort is part of an ongoing study where a subset of coupons is recovered at each determined time interval over a 100-year period. Results from this effort, as well as updates to the schedule for future recovery and evaluation efforts, are included in this report revision. This report is issued as a revision to the 2018 report and maintains similar formatting.

Results/Conclusions: Corrosion coupons were recovered from Trench 1 and Trench 3 at the E-Area Corrosion Monitoring Test Site. Coupons were cut from a B-25 box, a SeaLand container, and SeaLand container reinforcing steel. Recovered coupons included both painted and unpainted coupons from each of these materials. The coupons were recovered and evaluated following approximately 17 years of exposure to natural subsurface conditions at the Savannah River Site (SRS).

Recovered painted coupons of each material type showed general corrosion and pitting. Calculated average corrosion rates for all the painted coupons based on total mass loss ranged from 0.23 to 0.61 mils per year (mpy) with a mean of 0.40 mpy. Painted coupons made of Sealand container reinforcing steel showed greater degradation than those cut from a B-25 box or Sealand container. Conversely, unpainted coupons of all material types experienced much more substantial corrosion than the painted coupons. Mass loss and physical deformation was greater for unpainted than painted coupons. Calculated average corrosion rates based on total coupon mass loss for unpainted coupons of all material types ranged from 0.63 to 0.92 mpy with a mean of 0.80 mpy. The corrosion rates for both painted and unpainted coupons calculated in this analysis support the conclusion by Jenkins (2004) that the corrosion rate of carbon steel containers will not exceed 2 mpy for the majority of the 100-year period following burial.

Average corrosion rates for coupons recovered in FY2022 compared to FY2017 differed less for the painted group than the unpainted group. After five additional years in the subsurface (2018-2022), the mean corrosion rate for painted coupons increased by 0.09 mpy from the FY2017 average, while the mean rate for unpainted coupons decreased by 0.23 mpy. This reinforces that additional time is still needed to determine accurate long-term corrosion rates for the containers, particularly for those that are painted. Additional coupon recovery and evaluation efforts on the schedule provided in Table 1 are therefore essential to obtaining long-term corrosion rates and reaching conclusions about the timing and effectiveness of future waste stabilization measures.

Discussion: The E-Area Low-Level Waste Facility (ELLWF) Corrosion Coupon Test Site was established to evaluate the corrosion of low-level waste (LLW) metal containers (Jones, 2005). During September 2005, a total of 100 corrosion coupons were cut from a B-25 box, a SeaLand container, and SeaLand container reinforcing material. The protective paint coatings were removed from a subset of coupons to help accelerate the corrosion process upon burial. Coupons where the protective coatings were removed are referred to as “unpainted”. The corrosion coupons were buried at a two-foot depth in three separate trenches located in the ELLWF (Figures 1 and 2). Following coupon burial, all trenches were backfilled and compacted by hand. One trench (Trench 3) was covered with three layers of 6-mil high-density polyethylene plastic sheeting, while the other two trenches were left uncovered (Jones, 2005).

Jones (2005) presented a schedule for the excavation and evaluation of coupons from the trenches. Table 1 provides both coupon placement information within the trenches and the planned excavation order. Painted coupons are highlighted in light blue for ease of identification. Coupons were recovered by hand digging in the designated trench using the trench layout details provided by Jones (2005). A metal detector was also employed to help locate the buried coupons.

As coupons were recovered, they were visually inspected to confirm the material type. Because the coupons were not initially marked with any identifying information, the sample ID was inferred based on the recovery location, material type, and whether the coupon was painted or unpainted. The recovered coupons were sealed in polyethylene bags and labeled with the sample ID and date of collection. No attempt was made to remove any sediment or debris from the coupons in the field.

Prior to cleaning, each corrosion coupon was photographed and weighed. The corrosion coupons were cleaned according to the requirements of ASTM G1-03 (2011). The purpose of the cleaning procedure was to remove all foreign material (e.g., encrusted sediment) and corrosion products from the coupons. Cleaning consisted of cycles of both mechanical and chemical procedures that were repeated on each specimen. Mechanical cleaning consisted of brushing, scraping, scrubbing, and washing with deionized water. Sonication of the coupons in DI water was also used as a means of mechanical cleaning. Chemical cleaning was performed according to Cleaning Procedure C 3.5 defined in Table A1.1 of ASTM G1-03 (2011) for iron and steel, including carbon steel. The cleaning solution consisted of dilute hydrochloric acid and a corrosion inhibitor (hexamethylenetetramine). Each corrosion coupon was immersed in the cleaning solution for a period of up to 20 minutes, after which it was rinsed with deionized water and allowed to air dry. Mass loss was determined after each cleaning step by weighing each specimen. When the cleaning process was completed, each corrosion coupon was photographed, and area measurements were made using an electronic digital caliper. Coupons were vacuum sealed for storage.

ASTM G1-03 (2011) provides details for calculating corrosion rates from the mass loss tests. A concern in the calculation method is differentiating between mass loss due to removal of corrosion products and mass loss due to removal of base metal during the coupon cleaning process. ASTM G1-03 (2011) advocates plotting mass loss versus the number of cleaning cycles as a means of differentiating between these causes. A breakpoint (i.e., a sharp change in slope) in the resulting curve denotes when the mass loss shifts from removal of corrosion products to removal of base metal. The ASTM procedure notes that a cleaning procedure should be selected that makes the slope of the latter portion of the curve (i.e., mass loss due to removal of base metal) as close to zero as possible. Cleaning curves were prepared for each coupon plotting incremental mass loss as a function of cleaning step (Appendix A).

The cumulative mass loss due to corrosion for each coupon was then determined from the cleaning curves. For coupons where there was no obvious breakpoint in the mass loss curve (e.g., BU-11), the cumulative mass loss after the final cleaning cycle was used to calculate corrosion rates. Table 2 presents the coupon weights as buried, as recovered, and the coupon mass after each cleaning cycle. Once the cumulative mass loss due to corrosion was determined, annual average corrosion rates were calculated using Equation 1 from ASTM G1-03 (2011), Section 8.1. Table 3 presents the corrosion rates calculated using ASTM G1-03 (2011).

$$\text{Corrosion Rate} = (K * \Delta M)/(A * T * D) \qquad \text{(Equation 1)}$$

where:

K = conversion constant
ΔM = mass loss in grams (g)
A = exposed surface area (cm^2)
T = exposure time in hours (h)
D = density in grams per cubic centimeter (g/cm^3)

Calculated corrosion rates for all unpainted coupons, regardless of material type, were typically about two times greater than rates for the painted coupons. This was expected, because the purpose of including unpainted coupons in the study is to help accelerate the corrosion process upon burial. Because there were not enough corrosion coupons to conduct a meaningful statistical analysis of corrosion rates within each material type, the data were grouped based only on whether the coupon is painted or unpainted. A Mann-Whitney test was conducted to compare the difference between painted and unpainted corrosion coupons. The Mann-Whitney test is nonparametric and tests whether two independent sample sets are drawn from the same distribution (i.e., if they are statistically different or not). If the means of the ranks in the two groups are different, the P value will be small (less than the significance value). The results of this analysis displayed a statistically significant difference ($P = 0.001$) between the painted and unpainted corrosion rates, thus reinforcing that the corrosion rates for painted coupons are, statistically, significantly different from rates for the unpainted coupons.

Figure 3 through Figure 6 show the painted B-25 coupons before burial, after excavation but before cleaning, and after cleaning was complete. The four painted B-25 coupons exhibited similar corrosion rates. The arithmetic mean for this subset was 0.40 mpy. As buried, the initial thickness of the painted B-25 coupons was about 112.3 mil. Assuming a uniform corrosion rate of 0.40 mpy, it will take approximately 283 years to penetrate the entire thickness of the coupon. Two of the four painted coupons (BP-2C and BP-3C) were retrieved from the covered trench (Trench 3). The calculated corrosion rates for these coupons were comparable to rates for the coupons collected from the uncovered trench, but BP-3C experienced the largest amount of corrosion within that grouping (0.48 mpy). The corrosion rates for the other three coupons (BP-3, BP-4, and BP-2C) were more tightly clustered, exhibiting corrosion rates between 0.33 and 0.40 mpy.

The B-25 box specification requires the interior and exterior of the box to be coated with a rust-inhibiting, gray-colored primer. The exterior of the box is covered with a yellow alkyd enamel coating. Some blistering and delamination of the alkyd enamel coating is noted for all four coupons. Dunn (2001) describes the alkyd enamel coating as water permeable and observed similar blistering and delamination of the coating on the lid of a buried B-25 box. As with the B-25 box evaluated by Dunn (2001), pitting is observed on the coupons at the locations where the alkyd enamel coating degraded. The backside of the coupons is coated with the gray rust-inhibiting primer which also showed signs of minor general corrosion.

Dunn (2001) estimated corrosion rates of 1.1 to 2.6 mpy for the lid, bottom, and sides of a B-25 box buried for eight years. The Dunn (2001) rates were calculated by dividing the average penetration depth due to corrosion by the number of years of exposure (8 years). The resulting corrosion rates are higher than rates calculated for the painted corrosion coupons in this field study based on cumulative mass loss over an approximately 17-year period (ASTM G1-03, 2011). Depth of penetration of corrosion pitting was not evaluated for this project; therefore, a direct comparison to the results presented by Dunn (2001) is not meaningful. In addition to the difference in test methods, a possible explanation for the higher corrosion rates measured by Dunn (2001) is that their B-25 box had been damaged by dynamic compaction. The damage may have accelerated corrosion, particularly on the lid. Dunn (2001) also noted forklift damage to the paint on the bottom of the B-25 box, which may have also accelerated corrosion of this surface. Evaluations following future coupon excavations may provide more insight into the differences in corrosion rates noted between the coupons and the B-25 box.

Figure 7 through Figure 10 display the recovered unpainted B-25 coupons. Calculated coupon-averaged corrosion rates for the four unpainted coupons were similar for both covered and uncovered trenches and had an arithmetic mean of 0.73 mpy. This average corrosion rate is about 43% higher than that of the painted B-25 coupons. The more aggressive rate determined for the unpainted coupons is corroborated by visual inspection as these coupons are much more noticeably degraded than the painted coupons. The unpainted B-25 coupons were estimated to have an initial thickness of 109 mil before burial. Therefore, at a mean uniform corrosion rate of 0.73 mpy, it will take approximately 149 years to penetrate the full thickness of the coupon. All unpainted B-25 coupons also showed signs of substantial degradation around the edges of the coupons. Loss of material from the edges of each coupon in this grouping was experienced. The edges of all coupons were coated with an epoxy prior to burial to prevent corrosion on the edge surfaces; however, the degradation observed on the edges of the coupons is due to corrosion of the exposed surfaces instead of a breakdown of the epoxy coating.

Figure 11 through Figure 14 show the painted and unpainted SeaLand coupons. The coupon-averaged corrosion rates for the two painted SeaLand coupons (SP-3 and SP-4) had an arithmetic mean of 0.25 mpy. With an estimated thickness of 87 mil, it will take approximately 344 years to penetrate the entire thickness of the coupons at this corrosion rate. Both coupons show signs of both general and pitting corrosion; particularly where the paint is no longer present. Coupon SP-3 shows material loss around the edges, but the loss from SP-4 is much more severe. The unpainted coupons (SU-10 and SU-11) show much more substantial degradation, which is indicative of extensive corrosion. Extensive degradation of this material type was also observed during the previous excavation effort. The arithmetic mean of the coupon-averaged corrosion rates for the unpainted Sealand coupons was 0.87 mpy. With an estimated thickness of 85 mil, it will take approximately 97 years to fully penetrate the coupon at this corrosion rate. Some coupon material was lost during cleaning as a result of the metal becoming thin and brittle. Areas where metal had broken off these samples were excluded during surface area measurements to prevent them from biasing the corrosion rate calculations. Interestingly, the calculated corrosion rates for these two coupons (average of 0.87 mpy) are comparable to the unpainted B-25 coupons (average of 0.73 mpy), which visibly fared much better. This is attributed to the fact that the B-25 coupons are thicker (109 mil) than the SeaLand coupons (85 mil).

Figure 15 through Figure 18 show the SeaLand reinforcing material coupons. The calculated corrosion rates for these coupons (both painted and unpainted) were comparable to those calculated for the coupons of other material types. The coupon-averaged corrosion rates for the two painted SeaLand reinforcing material coupons had an arithmetic mean of 0.57 mpy. The thickness of the painted SeaLand reinforcing coupons was estimated to be 194 mil, so at a mean corrosion rate of 0.57 mpy it will take approximately 343 years to fully penetrate the coupon. Paint is delaminated from a majority of the coupons' surface. Pitting is noted for both coupons in places where the paint has been delaminated. The coupon-averaged corrosion rates for the two unpainted Sealand reinforcing coupons had an arithmetic mean of 0.86 mpy. With an estimated thickness of 192 mil, it will take approximately 223 years to fully penetrate the coupon at this corrosion rate. In contrast to the painted coupons, the unpainted coupons appear more affected by general corrosion than by pitting.

It is important to note that the corrosion rates and times to penetration presented in Table 3 assume uniform corrosion at a constant rate. Corrosion rates calculated using mass loss may substantially underestimate corrosion penetration caused by localized processes, such as pitting (ASTM G1-03, 2011). Net long-term corrosion rate estimates will likely improve with each subsequent retrieval of corrosion coupons. In addition, time to full penetration of the coupon is likely not needed before loss of structural integrity occurs for B-25 boxes and SeaLand containers under the stresses produced during dynamic compaction. In the future, if pitting is observed to be significant, pit depth should be directly measured to provide the maximum penetration rate due to corrosion.

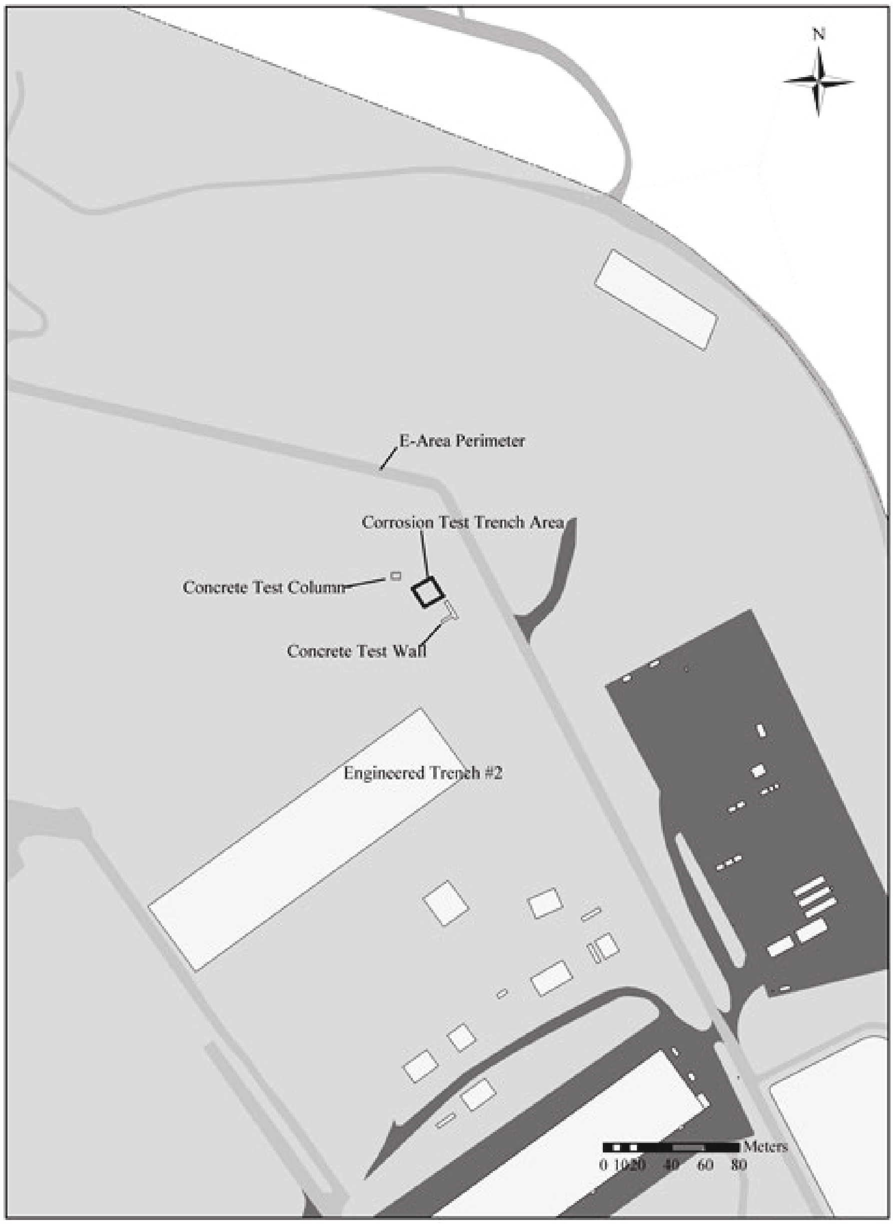
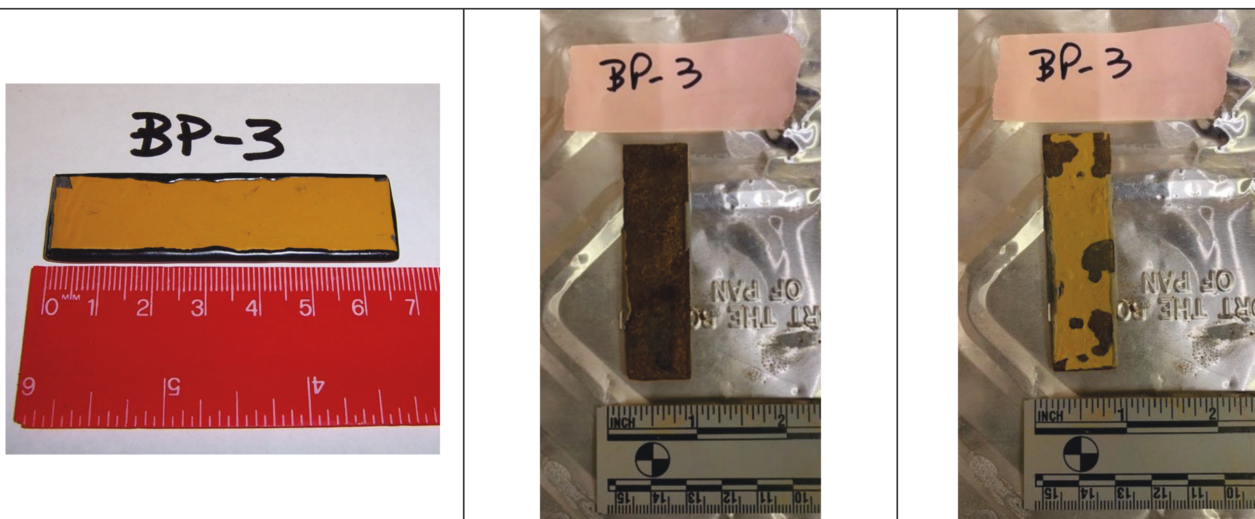


Figure 1. SRNL Corrosion Monitoring Site Location Map.

Figure 2. Trench with Corrosion Coupons at the SRNL E-Area Corrosion Monitoring Site (September 2005).

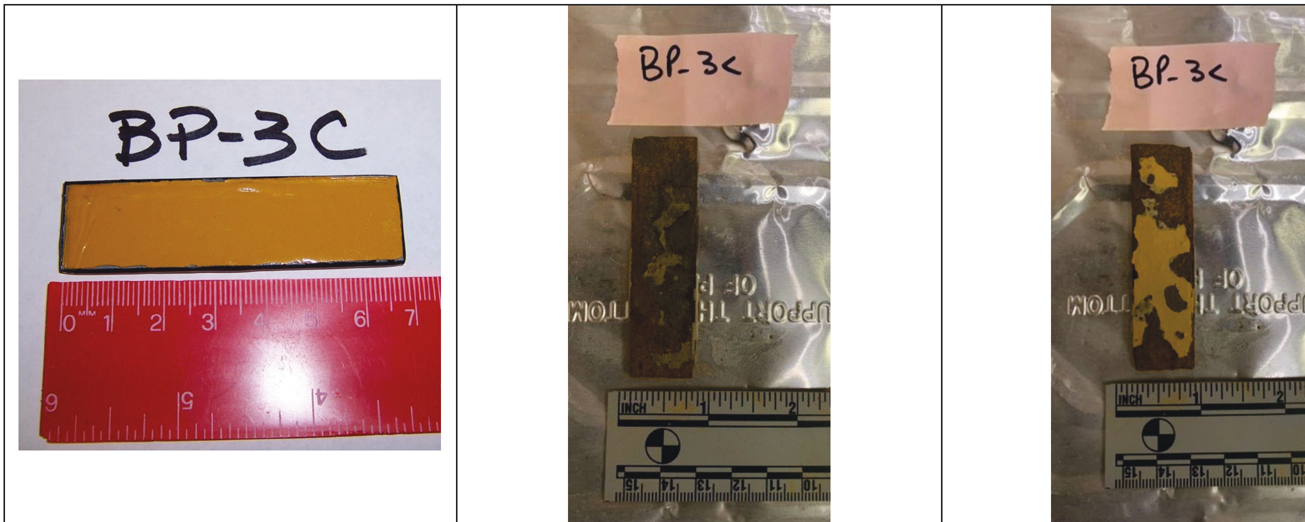
(a) (b) (c)

Figure 3. Coupon BP-2C prior to installation (a) and following recovery in 2022 (front and back views, b and c).



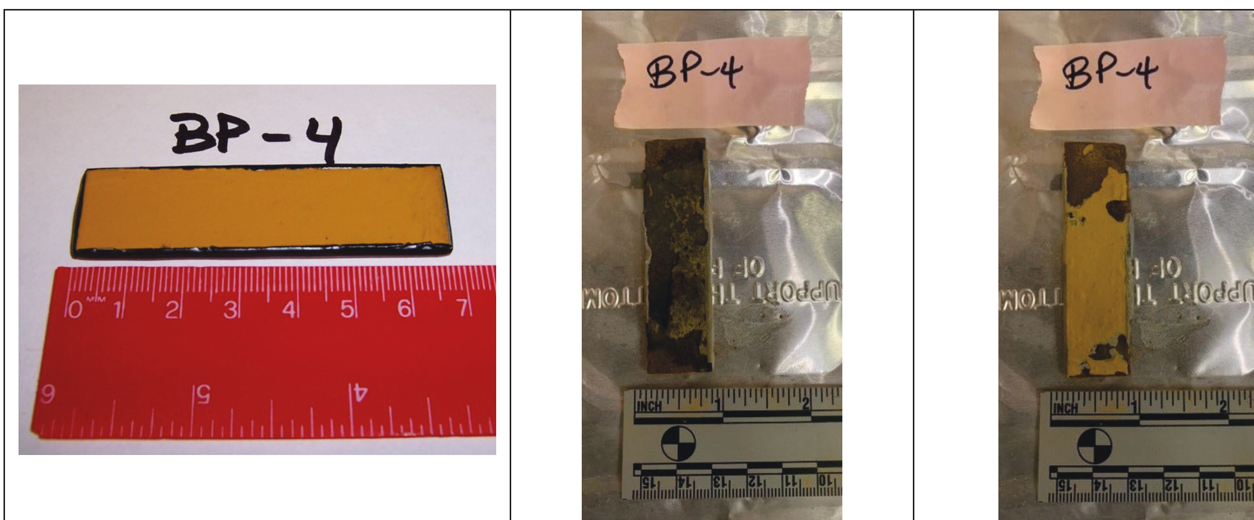
(a) (b) (c)

Figure 4. Coupon BP-3 prior to installation (a) and following recovery in 2022 (front and back views, b and c).



(a) (b) (c)

Figure 5. Coupon BP-3C prior to installation (a) and following recovery in 2022 (front and back views, b and c).



(a) (b) (c)

Figure 6. Coupon BP-4 prior to installation (a) and following recovery in 2022 (front and back views, b and c).

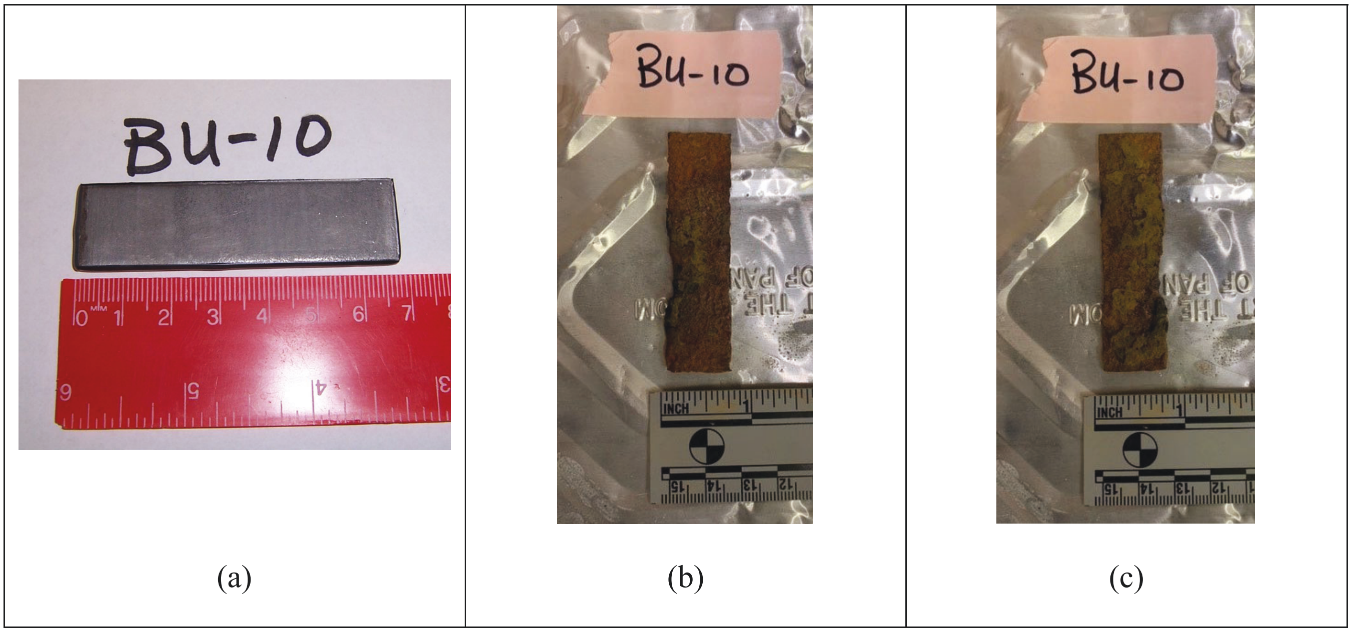


Figure 7. Coupon BU-10 prior to installation (a) and following recovery in 2022 (front and back views, b and c).

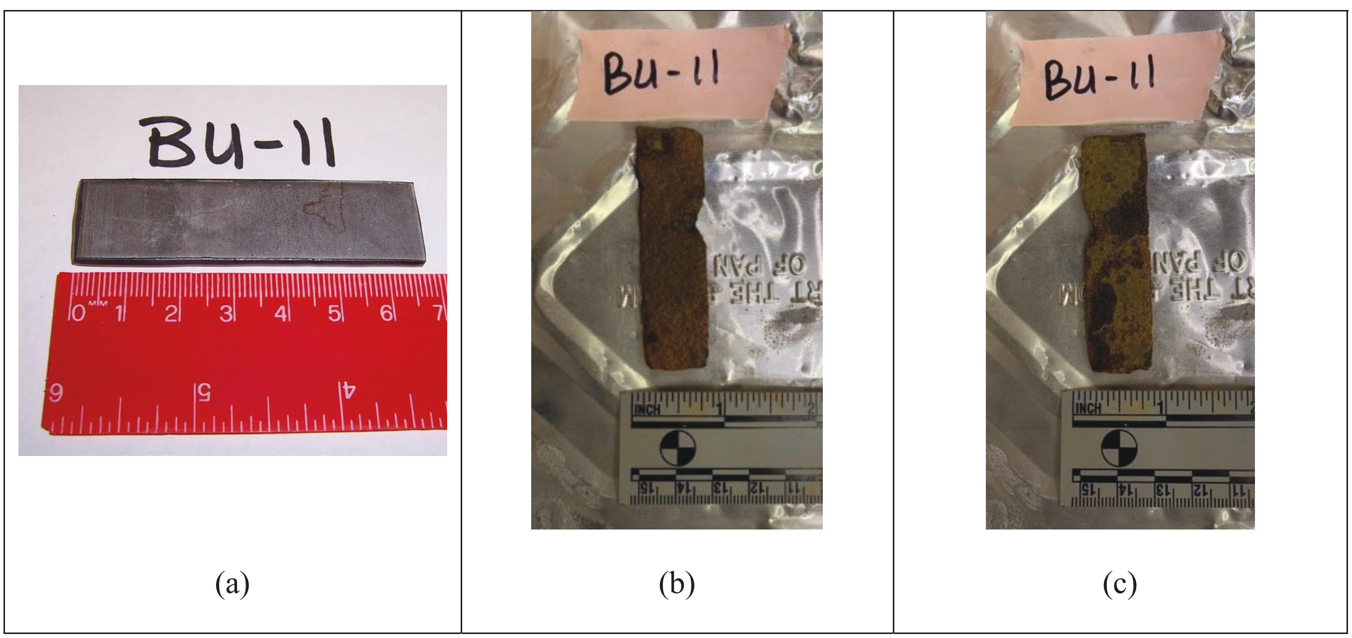


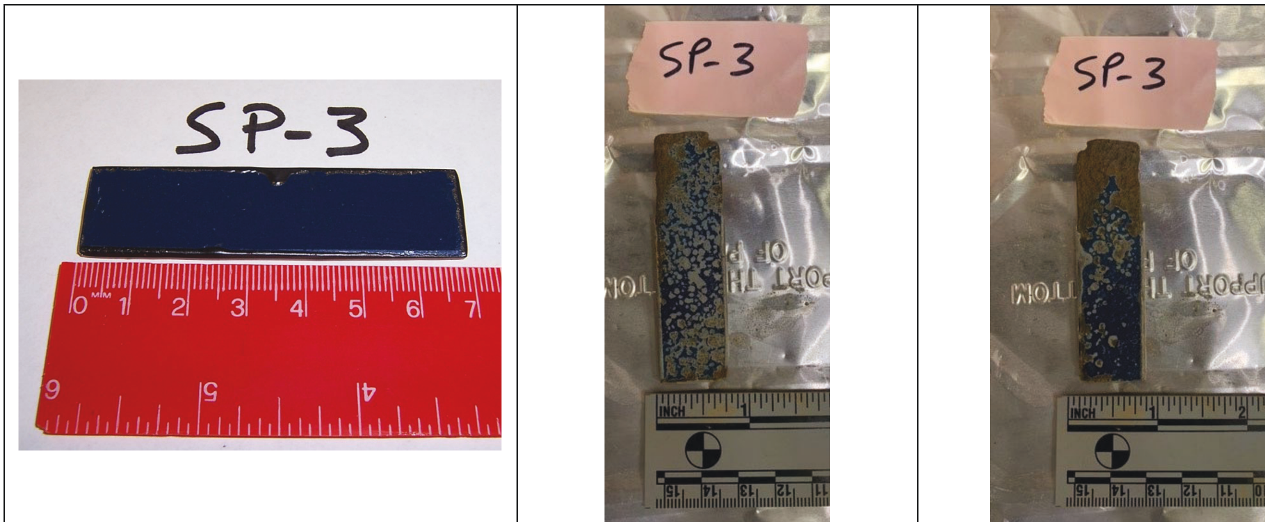
Figure 8. Coupon BU-11 prior to installation (a) and following recovery in 2022 (front and back views, b and c).

(a) (b) (c)

Figure 9. Coupon BU-11C prior to installation (a) and following recovery in 2022 (front and back views, b and c).

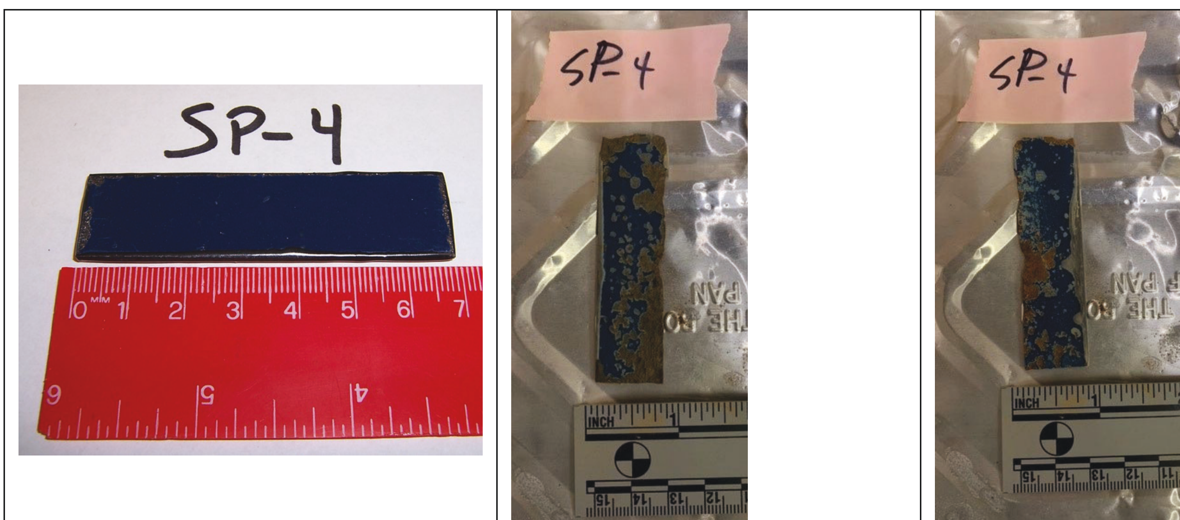
(a) (b) (c)

Figure 10. Coupon BU-12C prior to installation (a) and following recovery in 2022 (front and back views, b and c).



(a) (b) (c)

Figure 11. Coupon SP-3 prior to installation (a) and following recovery in 2022 (front and back views, b and c).



(a) (b) (c)

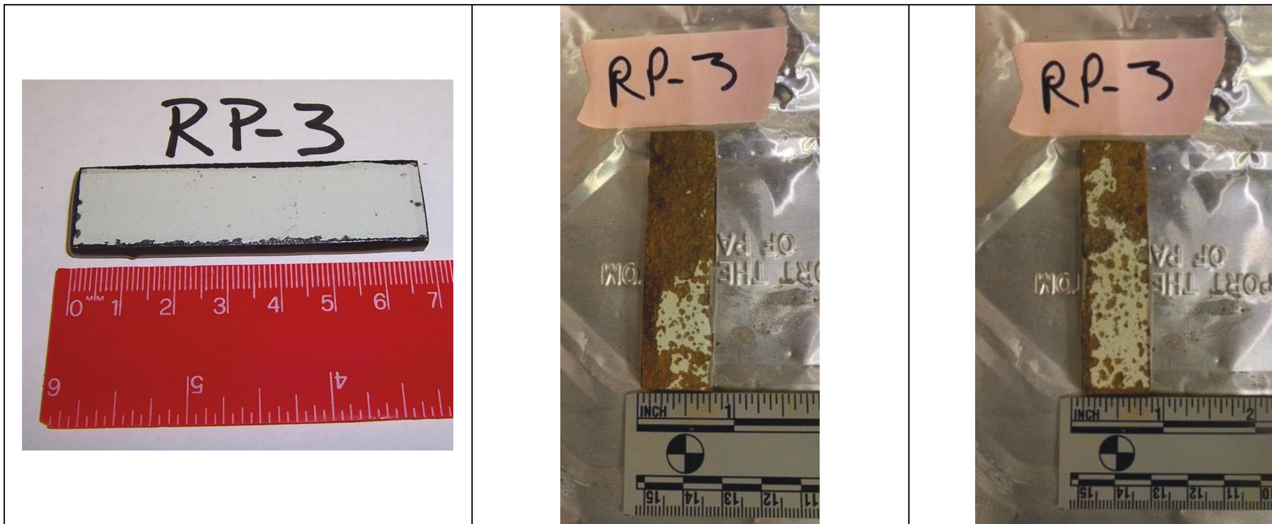
Figure 12. Coupon SP-4 prior to installation (a) and following recovery in 2022 (front and back views, b and c).

(a) (b) (c)

Figure 13. Coupon SU-10 prior to installation (a) and following recovery in 2022 (front and back views, b and c).

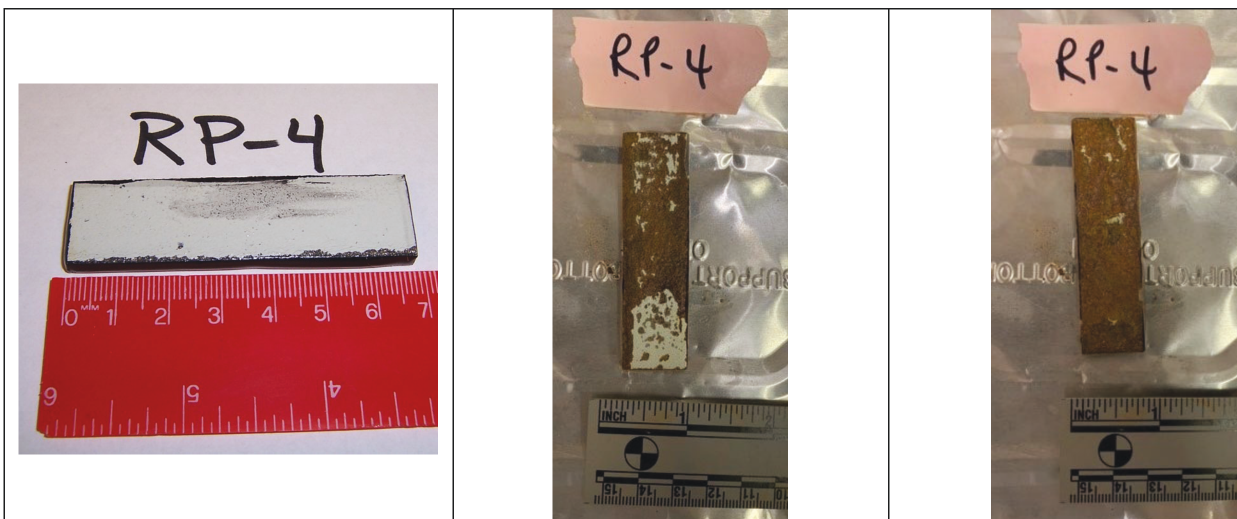
(a) (b) (c)

Figure 14. Coupon SU-11 prior to installation (a) and following recovery in 2022 (front and back views, b and c)



(a) (b) (c)

Figure 15. Coupon RP-3 prior to installation (a) and following recovery in 2022 (front and back views, b and c).



(a) (b) (c)

Figure 16. Coupon RP-4 prior to installation (a) and following recovery in 2022 (front and back views, b and c).

(a) (b) (c)

Figure 17. Coupon RU-10 prior to installation (a) and following recovery in 2022 (front and back views, b and c).

(a) (b) (c)

Figure 18. Coupon RU-11 prior to installation (a) and following recovery in 2022 (front and back views, b and c).

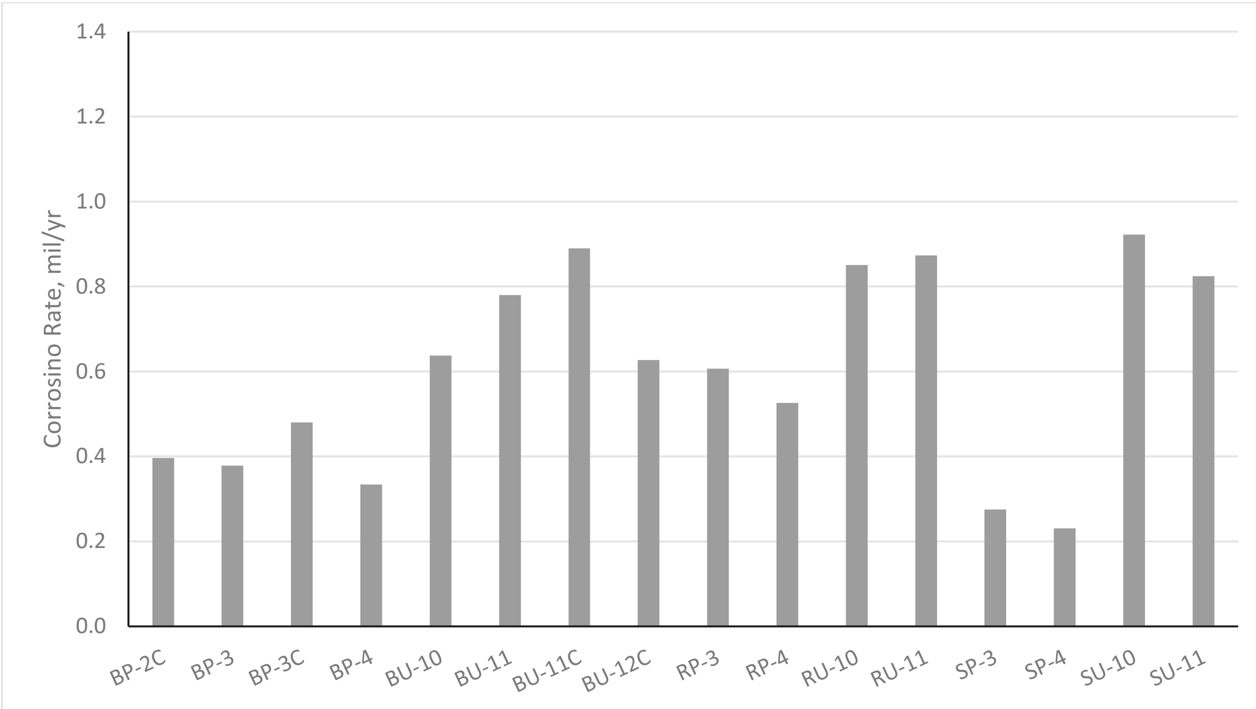


Figure 19. Corrosion rates using ASMT G1-03 for all coupons recovered in 2022.

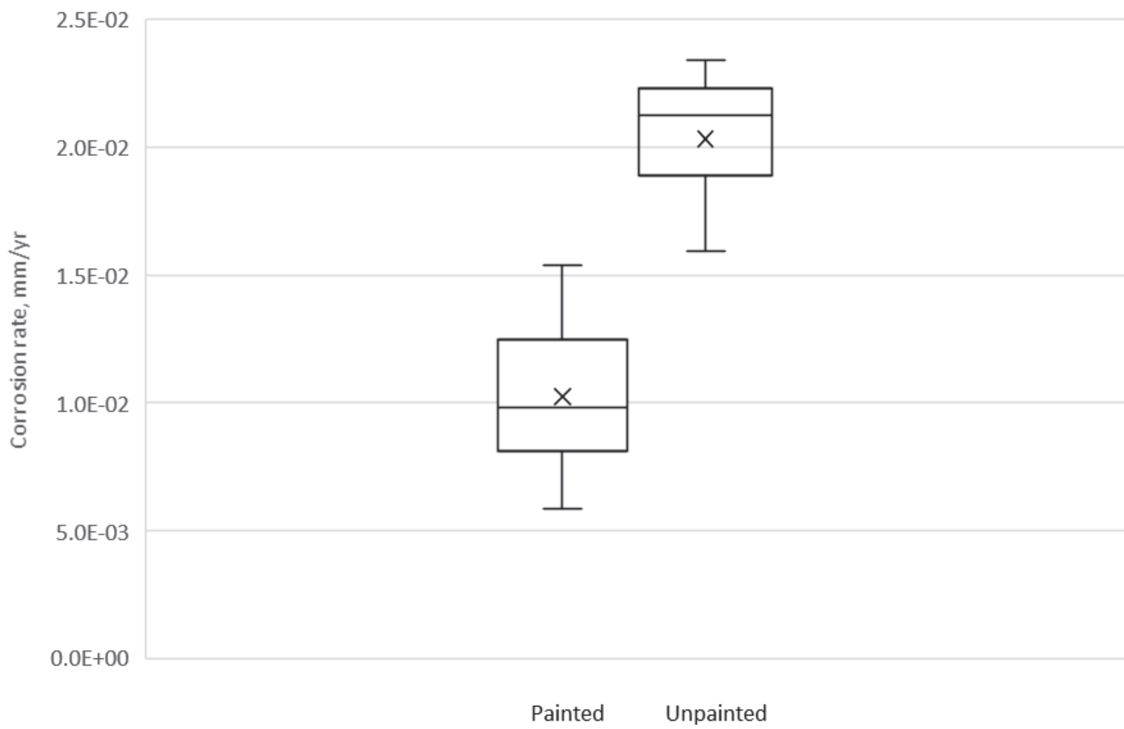


Figure 20. Comparison of median corrosion rates for painted and unpainted coupons.

Table 1. Coupon Locations and Anticipated Excavation Order.

Trench 1 Configuration				
Row (from west end)	Coupon Location Within Row North	Center	South	Anticipated Excavation Order/Years After Burial
1	BP-1	SP-1	RP-1	Recovered 2017
2	BP-2	SP-2	RP-2	Recovered 2017
3	BP-3	SP-3	RP-3	Recovered 2022
4	BP-4	SP-4	RP-4	Recovered 2022
5	BP-5	SP-5	RP-5	TBD
6	BP-6	SP-6	RP-6	TBD
7	BP-7	SP-7	RP-7	TBD
8	BU-13	SU-13	RU-13	7/26 (2031)
9	BU-12	SU-12	RU-12	6/20 (2025)
10	BU-11	SU-11	RU-11	Recovered 2022
11	BU-10	SU-10	RU-10	Recovered 2022
12	BU-9	SU-9	RU-9	Recovered 2017
13	BU-8	SU-8	RU-8	Recovered 2017

Trench 2 Configuration				
Row (from west end)	Coupon Location Within Row North	Center	South	Anticipated Excavation Order/Years After Burial
1	BU-14	RU-15	RU-14	9/32 (2037)
2	BU-15	SU-15	RU-15	10/39 (2044)
3	BU-16	SU-16	RU-16	12/46 (2051)
4	BU-17	SU-17	RU-17	TBD
5	BU-18	SU-18	RU-18	TBD
6	BU-19	SU-19	RU-19	TBD
7	BU-20	SU-20	RU-20	TBD
8	BU-21	SU-21	RU-21	TBD
9	BU-22	SU-22	RU-22	TBD
10	SRS-23[a]	BRS-23[b]	SRS-24[a]	NA
11	BRS-24[b]	SRP-25[c]	BRP-25[d]	NA
12	SRP-26[c]	BRP-26[d]	SRU-27[e]	NA
13	BRU-27[f]	SRU-28[e]	BRU-28[f]	NA

Painted coupons are highlighted in light blue for ease of identification.
[a]SeaLand Resistance Sealed Coupon
[b]B-25 Resistance Sealed Coupon
[c]SeaLand Resistance Painted Coupon
[d]B-25 Resistance Painted Coupon
[e]SeaLand Resistance Unpainted Coupon
[f]B-25 Resistance Unpainted Coupon

Table 1 (continued). Coupon Locations and Anticipated Excavation Order.

Trench 3 Configuration			Anticipated Excavation Order/Years After Burial	
Row	Coupon Location Within Row North	South	North	South
1	BP-1C		Recovered 2017	
2	BP-2C	BP-3C	Recovered 2022	Recovered 2022
3	BP-4C	BP-5C	11/40 (2045)	TBD
4	BP-6C	BP-7C	TBD	TBD
5	BU-21C	BU-22C	TBD	TBD
6	BU-19C	BU-20C	TBD	TBD
7	BU-17C	BU-18C	TBD	TBD
8	BU-15C	BU-16C	10/39 (2044)	12/46 (2051)
9	BU-13C	BU-14C	7/26 (2031)	9/32 (2037)
10	BU-11C	BU-12C	Recovered 2022	Recovered 2022
11	BU-9C	BU-10C	Recovered 2017	Recovered 2017
12	BU-8C		Recovered 2017	

Legend to Table:
Painted coupons are highlighted in light blue for ease of identification.

First Alpha Character

B B-25 Material
S SeaLand Material
R Reinforcing Material

Second and Third Alpha Characters

P Painted
U Unpainted (i.e., paint removed)
RS Resistance Sealed
RP Resistance Painted
RU Resistance Unpainted (i.e., paint removed)

Last Alpha Character Following Numeric Designation

C Covered Trench

TBD = To Be Determined; NA = Not Applicable

Table 2. Corrosion Coupon Weights as Buried, As Recovered, and During Cleaning.

Coupon ID	As Buried Coupon Weight (g)	As Recovered Coupon Weight (g)	Mass Cleaning Cycle 1 (g)	Mass Cleaning Cycle 2 (g)	Mass Cleaning Cycle 3 (g)	Mass Cleaning Cycle 4 (g)	Mass Cleaning Cycle 5 (g)	Mass Cleaning Cycle 6 (g)	Mass Cleaning Cycle 7 (g)	Mass Cleaning Cycle 8 (g)	Mass Loss Due to Corrosion (g)
BP-2C	26.3	45.63	25.30	24.98	24.61	24.02	22.94	22.62	22.46		3.68
BP-3	25.9	47.66	24.70	24.39	24.16	23.84	22.86	22.39	22.21		3.51
BP-3C	26.0	48.04	25.78	25.20	24.69	23.47	22.06	21.54	21.31		4.46
BP-4	25.8	51.82	27.06	25.57	24.85	23.92	22.93	22.70	22.49		3.10
BU-10	24.8	82.73	27.37	21.76	21.43	20.05	18.34	18.56	18.87	18.80	5.93
BU-11	24.9	52.21	26.08	25.78	25.32	21.82	19.81	18.77	18.15	17.65	7.25
BU-11C	25.1	46.00	28.57	28.69	27.89	24.08	21.04	17.31	16.83	16.81	8.27
BU-12C	25.0	39.18	26.09	26.07	25.34	23.89	21.70	19.75	19.17	19.13	5.83
RP-3	46.5	63.77	45.80	44.12	43.58	43.37	41.30	40.86	40.80		5.64
RP-4	46.6	78.06	44.76	44.53	44.03	43.54	41.93	41.71	41.58		4.89
RU-10	46.1	78.37	48.27	45.77	45.46	41.86	39.97	38.86	38.36	38.19	7.91
RU-11	45.7	81.69	49.70	48.43	48.09	46.13	40.21	38.04	37.58	37.39	8.12
SP-3	20.6	31.71	19.69	19.64	19.27	18.77	18.13	18.09	18.04		2.51
SP-4	20.4	26.20	20.19	19.42	19.09	18.83	18.41	18.30	18.26		2.10
SU-10	19.9	49.87	19.21	18.99	18.08	15.85	13.88	11.67	11.33	11.28	8.58
SU-11	19.9	53.16	29.18	19.66	19.17	17.48	13.91	12.63	12.24	12.21	7.66

[1]Gray shaded areas represent mass loss due to removal of corrosion products using ASTM G1-03, 2011.

Table 3. Corrosion Coupon Mass Loss and Average Corrosion Rates Based on ASTM G1-03.

Coupon ID	Coupon Type	Total Mass Loss (g)	Percent Mass Loss (%)	Average Corrosion Rate (mm/y)	Average Corrosion Rate (mpy[1])
BP-2C	B-25, Painted	3.68	14.0	$1.01x10^{-2}$	0.40
BP-3	B-25, Painted	3.51	13.6	$9.60 x10^{-3}$	0.38
BP-3C	B-25, Painted	4.46	17.2	$1.22 x10^{-2}$	0.48
BP-4	B-25, Painted	3.10	12.0	$8.48 x10^{-3}$	0.33
BU-10	B-25, Unpainted	5.93	23.9	$1.62 x10^{-2}$	0.64
BU-11	B-25, Unpainted	7.25	29.1	$1.98 x10^{-2}$	0.78
BU-11C	B-25, Unpainted	8.27	32.9	$2.26 x10^{-2}$	0.89
BU-12C	B-25, Unpainted	5.83	23.3	$1.59 x10^{-2}$	0.63
RP-3	SeaLand Reinforcing, Painted	5.64	12.1	$1.54 x10^{-2}$	0.61
RP-4	SeaLand Reinforcing, Painted	4.89	10.5	$1.34 x10^{-2}$	0.53
RU-10	SeaLand Reinforcing, Unpainted	7.91	17.2	$2.16 x10^{-2}$	0.85
RU-11	SeaLand Reinforcing, Unpainted	8.12	17.8	$2.22 x10^{-2}$	0.87
SP-3	SeaLand, Painted	2.51	12.2	$6.86 x10^{-3}$	0.27
SP-4	SeaLand, Painted	2.10	10.3	$5.74 x10^{-3}$	0.23
SU-10	SeaLand, Unpainted	8.58	43.1	$2.34 x10^{-2}$	0.92
SU-11	SeaLand, Unpainted	7.66	38.5	$2.09 x10^{-2}$	0.82

[1]mils per year.
[2]The suffix C denotes a coupon from a covered trench.

References:

ASTM Method G1-03. 2011. Standard Practice for Preparing, Cleaning, and Evaluating Corrosion Test Specimens, American Society for Testing Materials, ASTM International, West Conshohocken, PA.

ASTM Method G31-12. Standard Guide for Laboratory Immersion Corrosion Testing of Metals. American Society for Testing Materials, ASTM International, West Conshohocken, PA.

Dunn, K. A. 2001. B-25 Corrosion Evaluation Summary Report. WSRC-TR-2001-00587. Savannah River Technology Center, Westinghouse Savannah River Company, Aiken SC.

Jenkins, C. F. 2004. Corrosion Rates, Metal in Soil (U). SRNL-MTS-2004-40074. Savannah River National Laboratory, Aiken, SC, 29808.

Jones, W. E. 2005. E-Area B-25 and SeaLand Container Corrosion Monitoring Program (U). WSRC-TR-2005-00404, Rev. 0. Savannah River National Laboratory, Aiken, SC, 29808.

APPENDIX A

Cumulative Mass Loss Plots

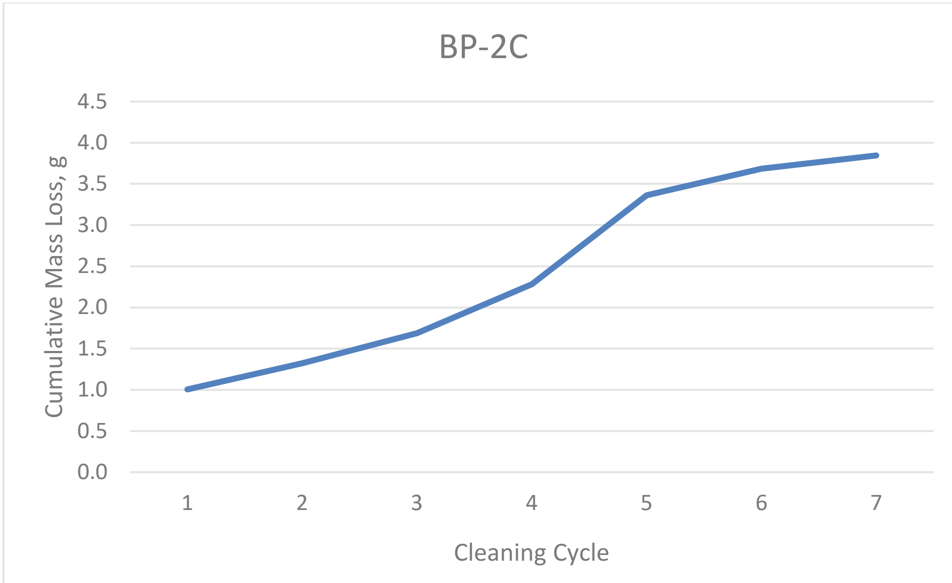


Figure A.1. Cumulative mass loss as a function of cleaning cycle for corrosion coupon BP-2C.

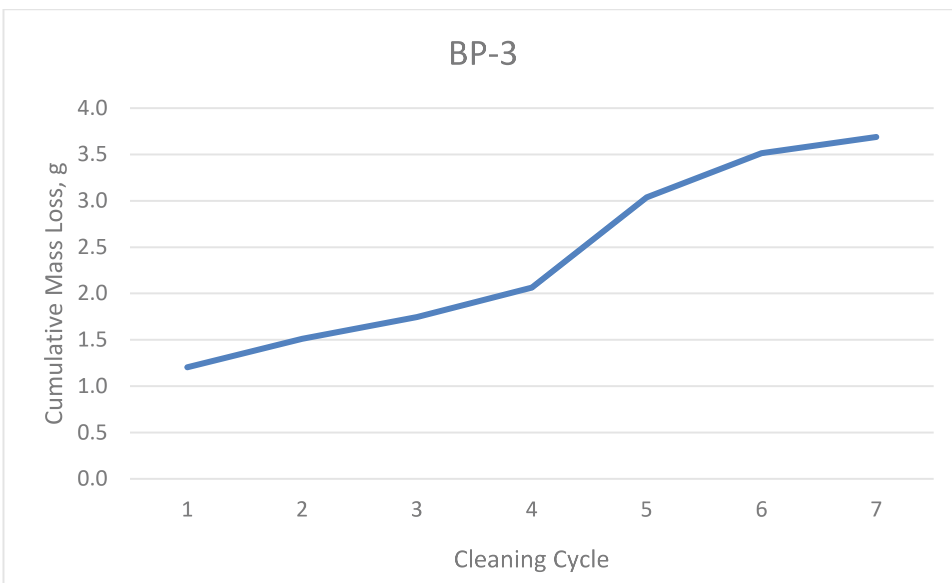


Figure A.2. Cumulative mass loss as a function of cleaning cycle for corrosion coupon BP-3.

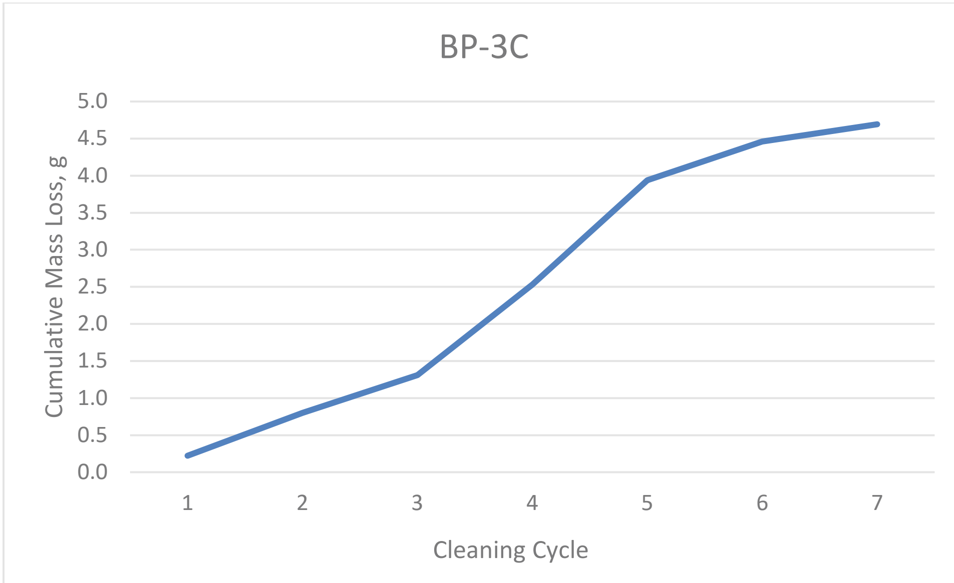


Figure A.3. Cumulative mass loss as a function of cleaning cycle for corrosion coupon BP-3C.

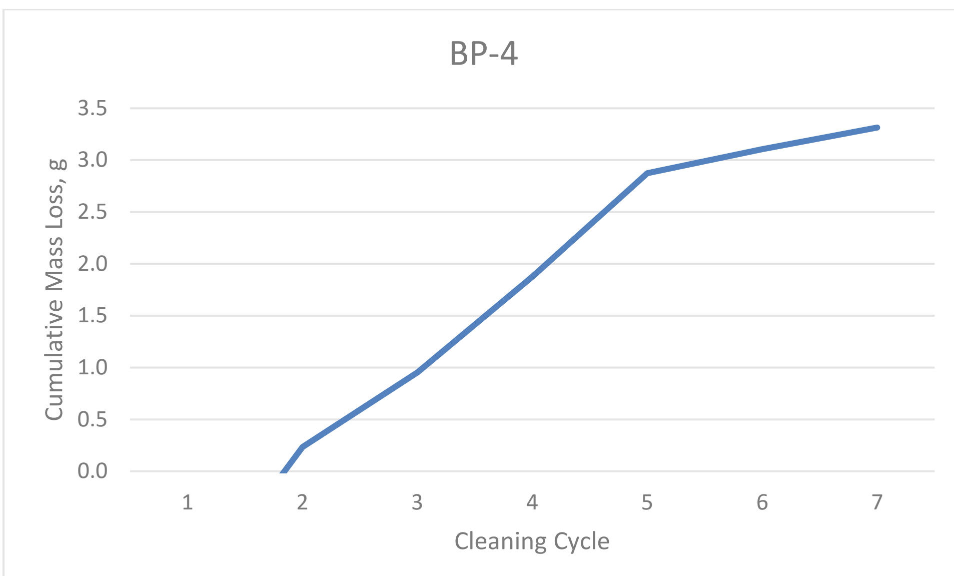


Figure A.4. Cumulative mass loss as a function of cleaning cycle for corrosion coupon BP-4.

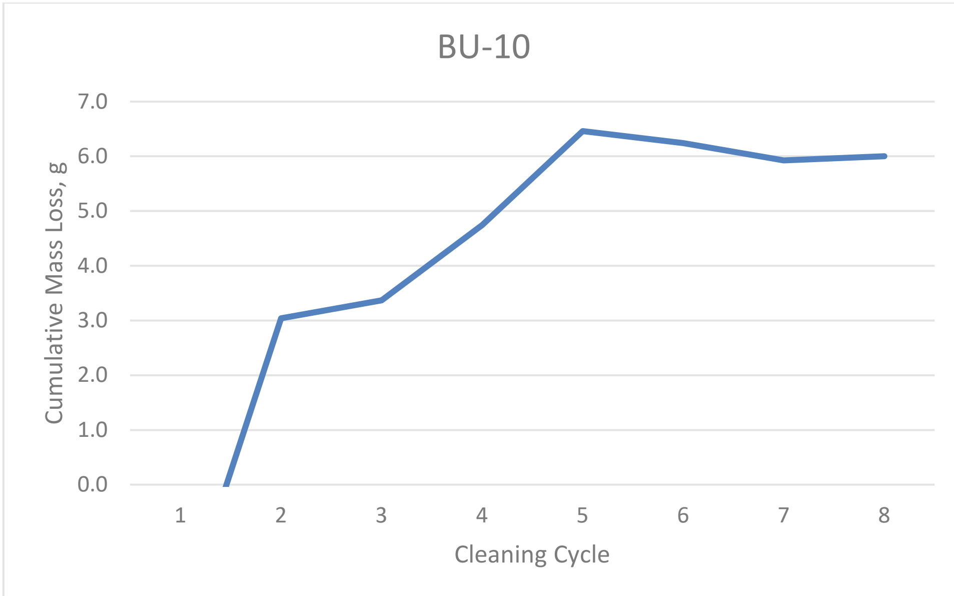


Figure A.5. Cumulative mass loss as a function of cleaning cycle for corrosion coupon BU-10.

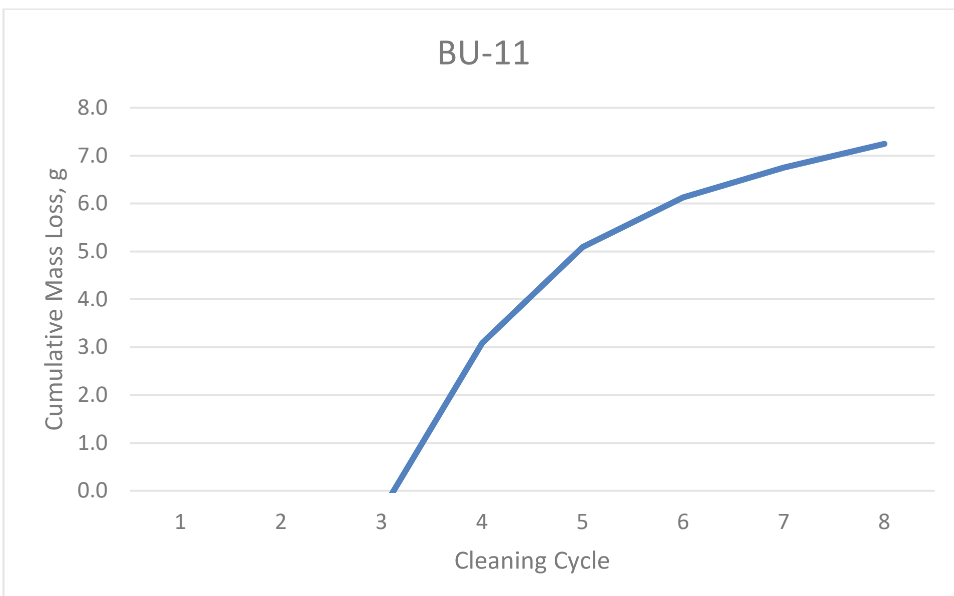


Figure A.6. Cumulative mass loss as a function of cleaning cycle for corrosion coupon BU-11.

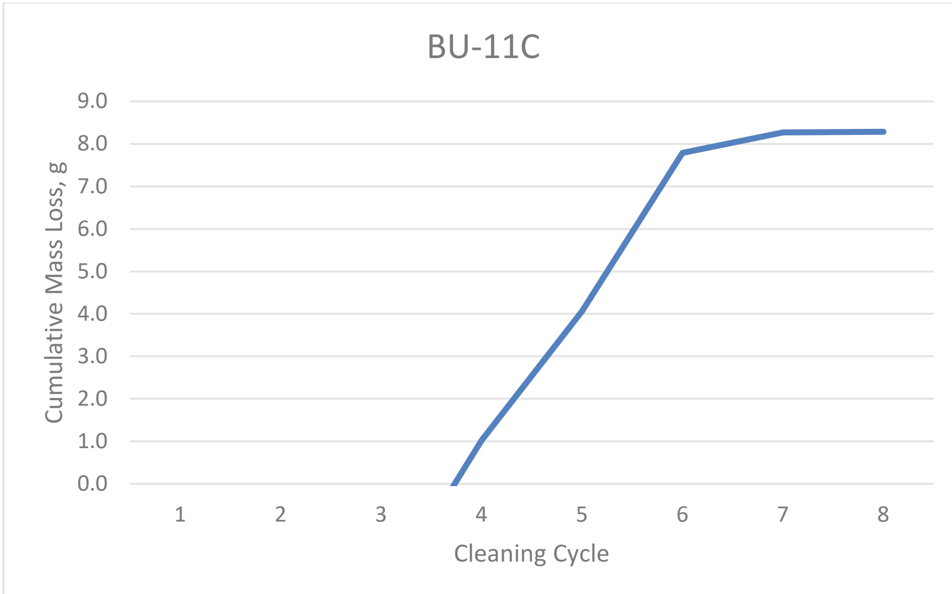


Figure A.7. Cumulative mass loss as a function of cleaning cycle for corrosion coupon BU-11C.

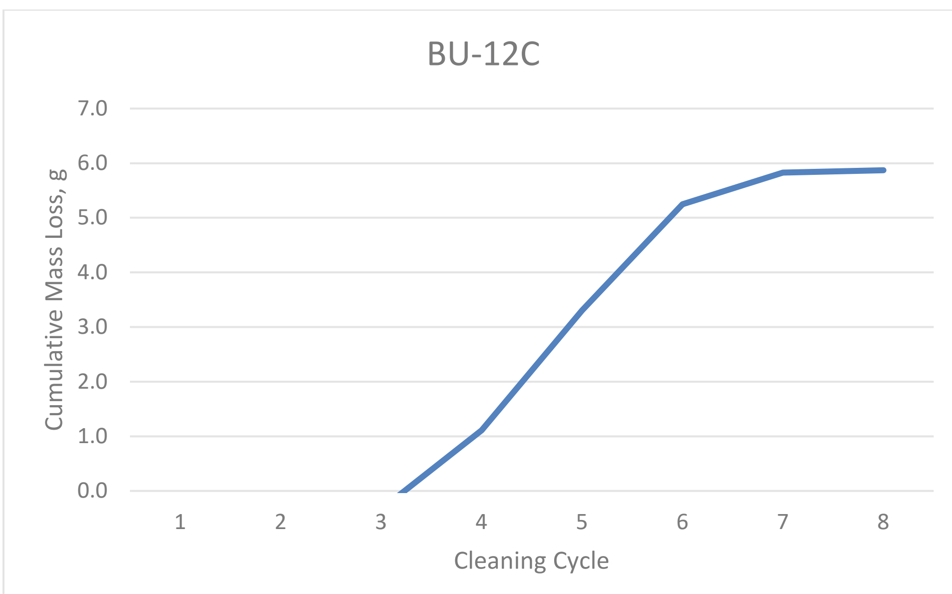


Figure A.8. Cumulative mass loss as a function of cleaning cycle for corrosion coupon BU-12C.

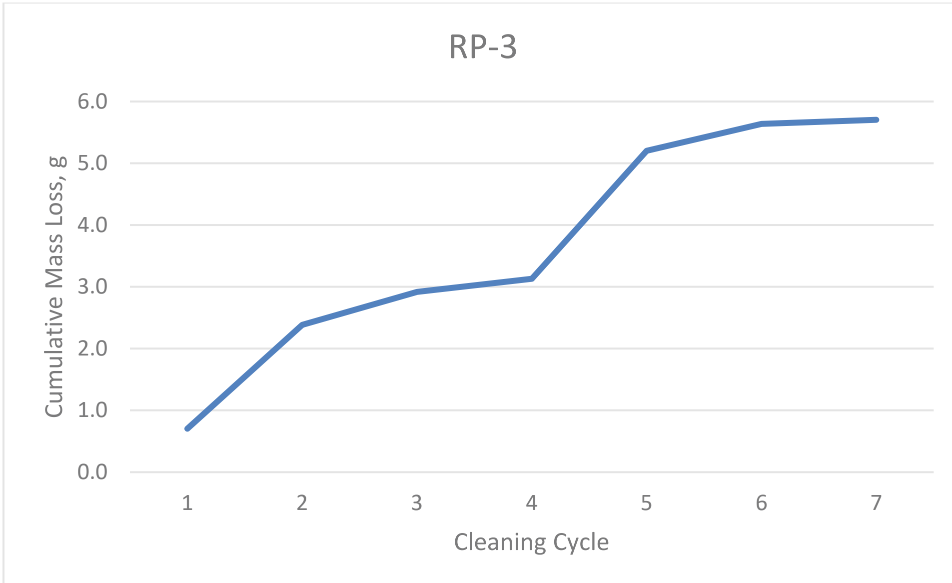


Figure A.9. Cumulative mass loss as a function of cleaning cycle for corrosion coupon RP-3.

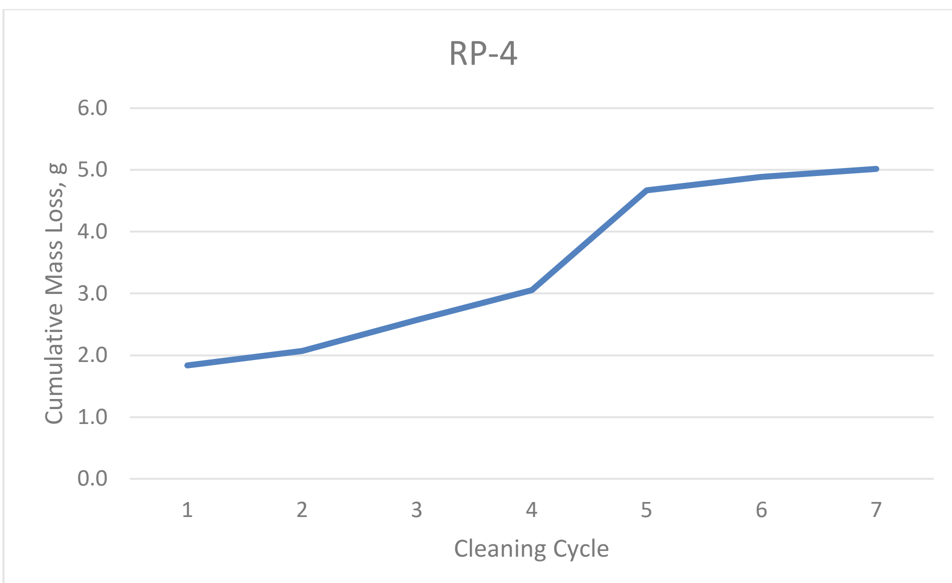


Figure A.10. Incremental mass loss as a function of cleaning cycle for corrosion coupon RP-4.

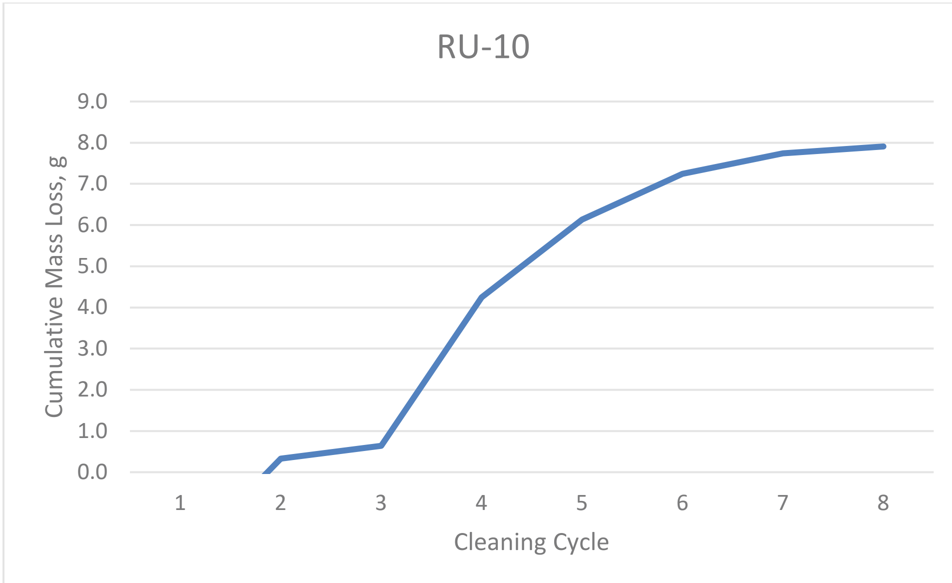


Figure A.11. Cumulative mass loss as a function of cleaning cycle for corrosion coupon RU-10.

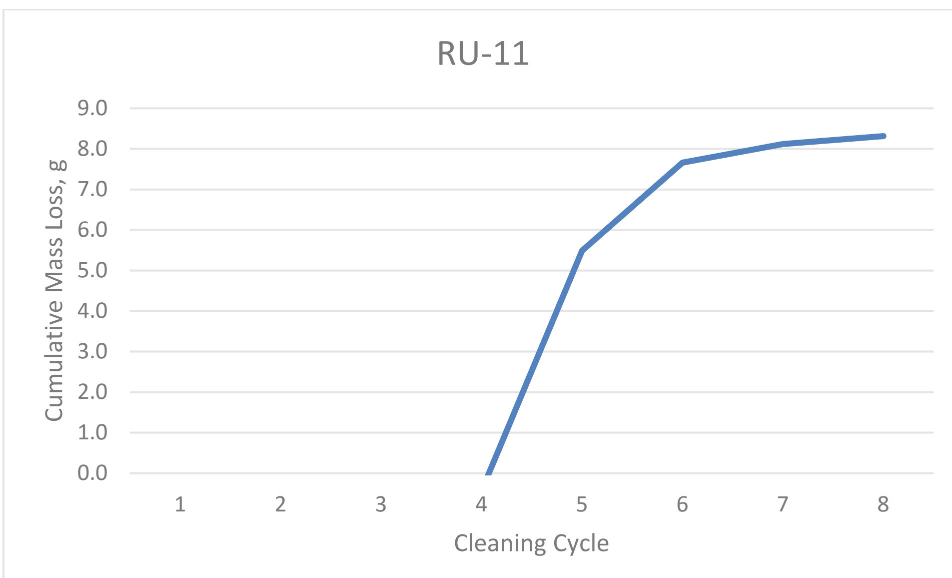


Figure A.12. Cumulative mass loss as a function of cleaning cycle for corrosion coupon RU-11.

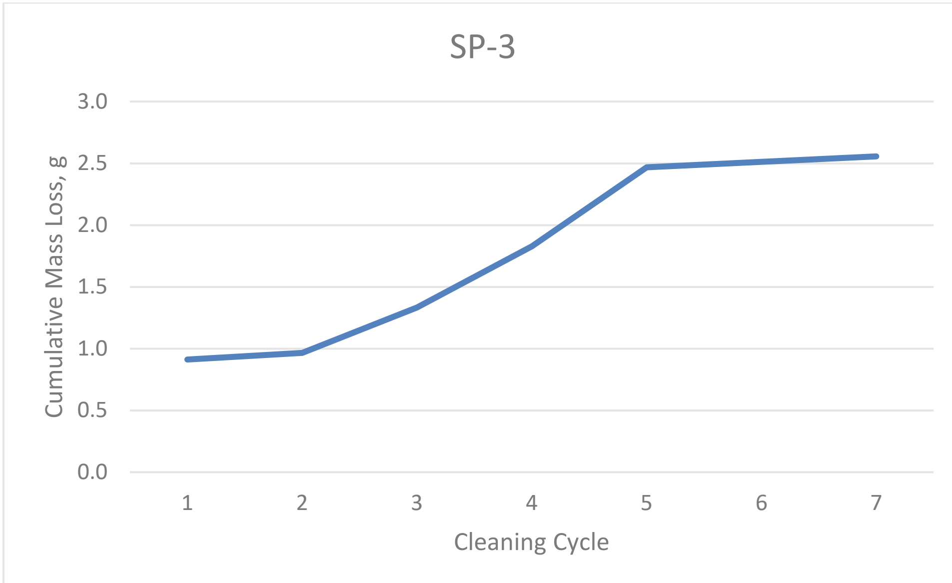


Figure A.13. Cumulative mass loss as a function of cleaning cycle for corrosion coupon SP-3.

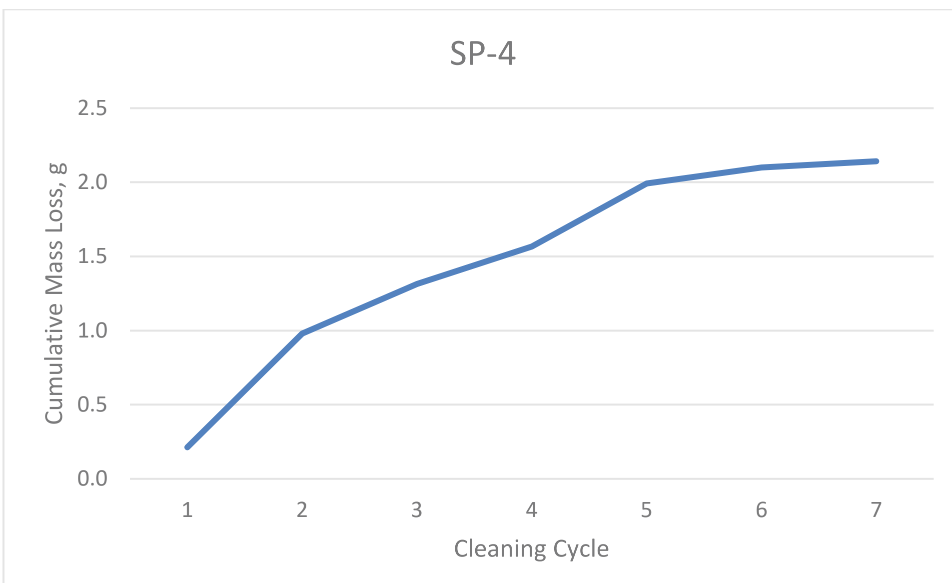


Figure A.14. Cumulative mass loss as a function of cleaning cycle for corrosion coupon SP-4.

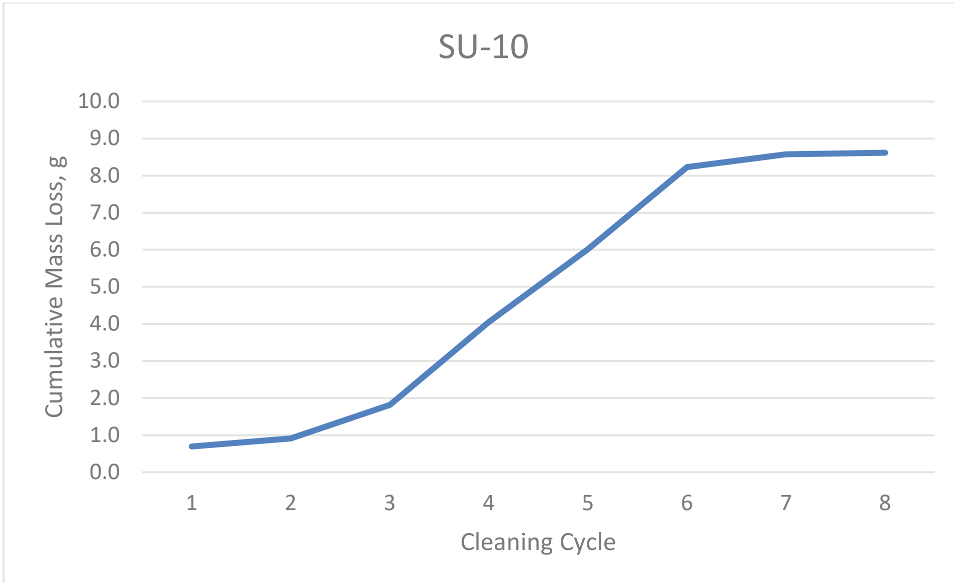


Figure A.15. Cumulative mass loss as a function of cleaning cycle for corrosion coupon SU-10.

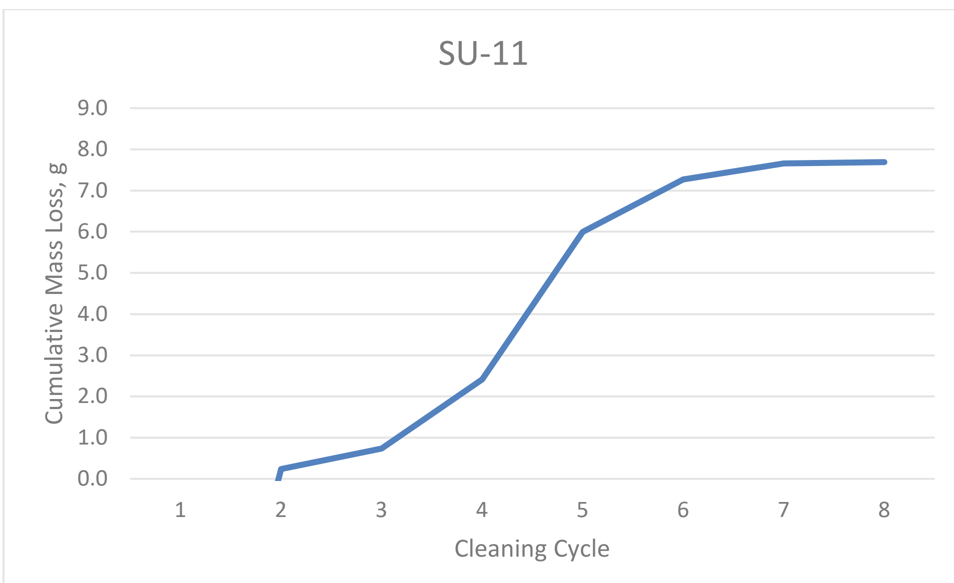


Figure A.16. Cumulative mass loss as a function of cleaning cycle for corrosion coupon SU-11.

Distribution:

sebastian.aleman@srnl.doe.gov	ira.stewart@srs.gov
john.mayer@srnl.doe.gov	jansen.simmons@srs.gov
jennifer.wohlwend@srnl.doe.gov	holly.vermeulen@srnl.doe.gov
kenneth.dixon@srnl.doe.gov	virginia.rigsby@srs.gov
james.dyer@srnl.doe.gov	
luther.hamm@srnl.doe.gov	
marion.cofer@srnl.doe.gov	