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Long Term Corrosion/Degradation Test Third-Year Results

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ABSTRACT

The Subsurface Disposal Area (SDA) of the Radioactive Waste Management Complex located at the Idaho National Engineering and Environmental Laboratory contains neutron-activated metals from non-fuel, nuclear reactor core components. The Long Term Corrosion/Degradation (LTCD) Test Project is designed to obtain site-specific corrosion rates to support efforts to more accurately estimate the transfer of activated elements to the environment.

The LTCD test project deploys two proven, industry-standard methods for determining corrosion rates: (1) direct corrosion testing using metal coupons and (2) monitored corrosion testing using electrical/resistance probes. Included in the test are various metal alloys generally representing the metals of interest buried at the SDA: such as Type 304L stainless steel, Type 316L stainless steel, Inconel 718, Beryllium S200F, Aluminum 6061, Zircaloy-4, low-carbon steel, and Ferralium 255. In the direct testing, metal coupons provide corrosion rate data upon retrieval and evaluation after having been buried in SDA backfill soil and exposed to natural SDA environmental conditions for times ranging from one to as many as 32 years, depending on research needs and funding availability. In the monitored testing, electrical/resistance probes buried in SDA backfill soil provide corrosion data for the duration of the project or until the probes fail.

This report provides an update describing the current status of the test project and documents results-to-date, particularly the results from corrosion evaluation of coupons retrieved after 3 years of exposure to SDA corrosion conditions. Data from the 1-year results are also included for comparison and for evaluation of trends.

In the third-year results, most metals being tested showed extremely low measurable rates of general corrosion. For Type 304L stainless steel, Type 316L stainless steel, Inconel 718, and Ferralium 255, corrosion rates fell in the range of 0.0001 to 0.0006 mils per year (MPY) (5.08×10^{-9} to 1.52×10^{-8} m/year). Corrosion rates for Zircaloy-4 ranged from no measurable corrosion to 0.0002 MPY (5.08×10^{-8} m/year). These rates are two orders of magnitude lower than those specified in the performance assessment for the SDA.

Coupons of carbon steel, beryllium, and aluminum showed more evidence of corrosion than other metal alloys. A significant factor of corrosion was the depth at which the coupons were located; more metal loss occurred on coupons buried at greater depths. Notable surface corrosion products were evident, as well as numerous pit initiation sites. Since the corrosion of the beryllium and aluminum is characterized by pitting, the geometrical character of the corrosion

becomes more significant than the general corrosion rate. Both pitting factor and weight loss data should be considered when describing the material loss from the samples. For three-year exposure, the maximum carbon steel corrosion rate was 0.4598 MPY (1.17×10^{-5} m/year) while the maximum beryllium corrosion rate was 0.3267 MPY (8.3×10^{-6} m/year) and the maximum aluminum corrosion rate was 0.0044 MPY (1.1×10^{-7} m/year).

ACKNOWLEDGMENTS

The support necessary to successfully pursue the objectives of the project has been vast, and in addition to the authors of this document, many have contributed to the success of the project. Foremost has been the programmatic support from Waste Management and Environmental Restoration, which has continued to champion funding for the project's continuation. An integrated team of engineers and scientists participated in both project and laboratory analysis support. Planners, schedulers, craft personnel, safety, and industrial hygienists supported field operations. Meeting the challenge to obtain high-quality results with impeccable technical credibility while maintaining a safe work environment has been paramount. Donovan Bramwell contributed significantly to the preparation of this report by providing technical writing/editing support. As the project continues into successive phases and as new challenges arise, we extend our appreciation to all those who have made significant contributions.

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ACRONYMS

DOE	U.S. Department of Energy
EBE	Engineered Barriers Extension
EBTF	Engineered Barriers Test Facility
E/R	electrical resistance (probes)
INEEL	Idaho National Engineering and Environmental Laboratory
INTEC	Idaho Nuclear Technology and Engineering Center
LTCD	long term corrosion/degradation
MIC	microbiologically induced corrosion
MPY	mils per year
NIM	Northern Isolation Mound
RWMC	Radioactive Waste Management Complex
SDA	Subsurface Disposal Area
SRB	sulfate-reducing bacteria
TDR	time-domain reflectrometry