# *Data Report on Corrosion Testing of Stainless Steel SNF Storage Canisters*

## Fuel Cycle Research & Development

***Prepared for***
***U.S. Department of Energy***
***Used Fuel Disposition Campaign***

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# APPENDIX E
# FCT DOCUMENT COVER SHEET [1]

| | |
|---|---|
| Name/Title of Deliverable/Milestone/Revision No. | Data Report on Corrosion Testing of Stainless Steel SNF Storage Canisters |
| Work Package Title and Number | ST Storage and Transportation Experiments - SNL FT-13SN080506 |
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|---|---|---|---|---|

This deliverable was prepared in accordance with Sandia National Laboratories
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QA program which meets the requirements of

☒ DOE Order 414.1 ☐ NQA-1-2000 ☒ Other: FCT QAPD

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# SUMMARY

This progress report describes work done at Sandia national Laboratories (SNL) to assess the localized corrosion performance of container/cask materials used in the interim storage of used nuclear fuel. A detailed evaluation of the environment to which these storage systems are exposed is included to provide context for the experimental evaluation of the effect of deliquesced salts on storage relevant steels. The results of dust deliquescence testing on 304SS obtained to date are presented and evaluated regarding feasibility of stifled localized corrosive attack.

Salt deliquescence can occur on interim storage containers only over a small part of the temperature and RH range that the storage containers will experience. A reasonable maximum possible absolute humidity is 40-45 $g/m^3$; for sea salts, this corresponds to a maximum temperature of deliquescence of ~85ºC. Existing experimental work investigating stress corrosion cracking (SCC) of stainless steel in marine environments indicates that SCC is likely to occur under storage conditions. However, test conditions may not be representative of field conditions for several reasons; sea salt may not be representative of what is on the container surfaces; exchange with atmospheric gases is limited in the experiments, and other components in the dust may either reduce or increase the corrosivity of deliquesced brines in the dust.

To address the uncertainty in the environment, the Electrical Power Research Institute and the U.S. Department of Energy have initiated a sampling program for in situ dust deposits on current storage containers. Sandia is collaborating with EPRI on the dust sampling, analyzing the dusts and aiding in data interpretation. Two samples of dust that were collected from the surface of interim storage containers at the Calvert Cliffs ISFSI were delivered to Sandia characterized using several different methods, including chemical analysis of the soluble and insoluble fractions, mineralogical analysis by scanning electron microscopy and X-ray diffraction, and others. Important results are that the soluble components in the dust are largely calcium sulfate; chlorides are present only in trace amounts. The low Na and Cl concentrations indicate that, despite the location of the Calvert Cliffs ISFSI adjacent to Chesapeake Bay, the salts deposited on the storage containers appear to be dominantly continental in origin as opposed to being marine. The analyzed soluble salts may not represent a corrosive environment, as the chloride load may be too light to support SCC, or the deliquesced brine composition may be insufficiently aggressive.

In an effort to determine if there is indeed a potential for deliquescent brines to result in extensive localized corrosion, or if any localized corrosion will stifle due to limitations as described above, a series of experiments has been (and continues to be) performed. Materials of interest have been decorated with thin layers of salt in the presence of an occluded geometry in an effort to establish if localized corrosion (i.e., crevice corrosion) could initiate and propagate under such conditions. In these experiments, no inert species were added, so potential physical sequestration of the brine by the dust layer due to capillary forces have been eliminated, allowing all of the material deposited on the metal surface to participate in the corrosion reaction.

Experiments performed on 304 stainless steel, a material used to manufacture interim storage containers for a number of manufacturers, demonstrated that

localized corrosion was able to initiate and propagate into the material. Assessment of stifling requires characterization of the extent of corrosion as a function of exposure time. While characterization of the test samples continues at this time, results to date from specimens with mass loadings from 50 to 200 $\mu g/cm^2$ of chloride bearing salt exposed to an elevated temperature and dewpoint for time intervals from 7 to 100 days suggest that stifling has not yet taken place. Additional tests and more detailed analyses are planned, as discussed below.