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August 20, 2018

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and

Ms. Roxanne Kwan
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Department of Health
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2827 Waimano Home Road
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Dear Mr. Shalev and Ms. Kwan:

Subject: Honolulu Board of Water Supply (BWS) Comments on the Red Hill Bulk Fuel Storage Facility (RHBFSF), Scope of Work for Destructive Testing Supplement – Destructive Testing Plan, Supplement to Administrative Order on Consent (AOC) and Statement of Work (SOW) Section 5.3.2, dated June 1, 2018 and Our Inspection on June 25, 2018 of Coupons Removed from Tank 14.

The BWS appreciates the opportunity to review the Navy's Destructive Testing (DT) Plan (NAVFAC, 2018) and to view and photograph the steel plate samples (coupons) removed from the steel liner of RHBFSF Tank 14. This letter summarizes our observations and comments.

Coupon Observations

1. Presence of substantial backside corrosion — There were areas of substantial corrosion on the backside (non-fuel wetted side) of the ¼-inch thick steel plate lining the tank (Figure 1, for example).

2. Staining on Backside of Steel — Deposits on the backside of some coupons suggest hydrocarbon-staining and should be tested for presence of released product (Figure 2, for example).
3. Non-Destructive Evaluation (NDE) Technique Underestimates Remaining Wall Thickness — Corrosion pit depths measured on the cut specimen edges suggest that NDE techniques were not able to locate and measure the thinnest wall of the coupon. For instance, the scale shown in Figure 1 indicates the wall along the edge of Coupon No. 2 has thinned to about 0.079-inches (reduced from 0.25-inches thick when new). However, the two NDE techniques (screening and Prove-up) predicted the thinnest area of this coupon to be 0.187-inches and 0.135-inches, respectively, underestimating the measured thickness by 51%.

Again, these are our observations, and we await the results of the independent testing laboratory for confirmation. Overall, it appears that the corrosion exhibited by the 10 coupons removed from Tank 14 justify our concerns regarding the risks of through-wall pitting associated with corrosion of the steel liners. In addition, NDE test results raise serious concerns regarding the ability of the tank inspection and repair methodology to find and repair all critical defects.

Destructive Testing Plan

1. Scope does not include piping — We first note that the DT plan pertains only to the liner of Tank 14, and the BWS would like to reiterate our previously expressed concerns regarding how piping, from the tank to the tunnel, is inspected and repaired as being insufficient to assure leak free operation for the currently set 20-year re-inspection interval.
2. Scope of Testing Reduced to a Single Tank — It is our understanding that the Navy now intends to remove coupons from only one tank. This is a reduction in scope from the three tanks initially discussed as being examined with NDE (Tank 14, 17 and Tank 18) (Navy/DLA, 2017) and the initial destructive evaluation plan that proposed destructive testing on both Tank 14 and 17 (NAVFAC, 2017). With a sample size of ten coupons from only one of twenty tanks, generalization of the condition of the steel to other tank steel liners and the reliability of the NDE technique to other tanks is not possible.
3. Tank 14 may not be Representative of Others — It has not been shown that the nature of the backside corrosion in Tank 14 is representative of other tanks. If other tanks exhibit conditions (e.g., pitting, thinning, cement paste adhesion, weld flaws) outside the range found in the Tank 14 coupons, the accuracy of the NDE method calculated for Tank 14 coupons may not apply. In this respect, we disagree with the Navy's position, expressed in the conditionally approved scope

of work that any destructively tested tank does not necessarily need to be representative in condition.

4. Navy Stated Goals for DT Cannot be Achieved — As stated in NAVFAC's Supplement to the DT Plan (NAVFAC, 2018), the Navy's goals (Goal A and Goal D) include:

"A. Validate the results of NDE inspection technologies, specifically the NDE process used at Red Hill." This is also mentioned in Section 3 "Destructive Testing Discussion" of the DT Section 5 plan where it reiterates: "The intent of this section is to validate the results of NDE technologies and processes used to scan the Red Hill storage tanks."

And

"D. Analyze corrosion rate calculation procedures and recommend improvements as warranted."

Goal A cannot be achieved: There are too few specimens to validate whether the NDE technology employed by the Navy can reliably find severe corrosion. The Navy acknowledges this in Section 5 of their Destructive Testing Plan: "Due to the huge surface area presented by the steel tank liner, acquiring sufficient number of samples for worthwhile statistical analysis of a particular tank's status and behavior with respect to corrosion would be an inordinate task."

While the sample size is insufficient to validate NDE results to any reasonable confidence level, the converse is not true. Initial results indicate the NDE techniques are not sufficiently accurate to provide confidence that all defects that could grow to through wall failure prior to the next inspection interval will be found and repaired.

For instance, comparison of the results from the two independent NDE techniques applied at the same locations (the screening and prove-up measurements) suggests the two techniques produce inconsistent results. This is illustrated in the Navy's Table 1 for coupon #1 where the "screening measurement" NDE method predicts a remaining thickness of 0.147-inches whereas the "Prove-up Measurement" estimates the remaining wall as 0.112-inches. This difference between the measurement methods indicates that there is a high probability that not all damaged areas that need to be repaired (i.e. areas where the remaining wall less than 0.160-inch) will be repaired.

Furthermore, our visual observations of some coupons suggest that the actual defect depth was greater than measured by either NDE technique. For example, Coupon #7 measurements indicated a remaining wall of either 0.157-inches or 0.135-inches whereas the cut edge of this coupon appears to show a minimum

remaining wall of 0.079-inches (see Figure 1). These are our observations, and we look forward to reviewing the results of the independent testing laboratory for confirmation.

In summary, the current NDE/DT testing reinforces BWS's previously stated concerns about the accuracy of the NDE and the reliability of the API inspection and repair methodology. The BWS informed the AOC parties of this in several letters (BWS 2016a, BWS 2016b, BWS 2017a, BWS 2017b, BWS 2017c, BWS 2017d, and BWS 2017e). In particular, the current NDE/DT results further indicate the need to develop probability of detection (POD). The POD for the NDE techniques can be done using plates manufactured with various flaw types of various depths as we have previously described. This information will help ascertain the reliability of the API inspection and repair procedures used to assure leak free tank operation for the next 20-years until the next inspection.

Goal D cannot be achieved: Since the Navy does not have any prior API inspection reports regarding Tank 14, accurate estimates of the corrosion rate from the current NDE/DT testing are not possible. Corrosion rates are not necessarily constant over long time-intervals. The observed corrosion may have occurred over 76 years, or it may have only occurred since the last inspection and repair cycle. In addition, it will not be known if the corrosion found was from a previously non-corroded area, from a prior defect that was of a size that did not need repairing, or from a previously non-detected defect. Some of this uncertainty could have been avoided if the Navy selected a tank that had a complete API report showing the location of previously found defects and repairs.

5. Selected Locations of Tank 14 Coupons — The sample location selection process was not transparent, and the BWS cannot comment on how well the Tank 14 coupons represent the general condition of the steel liner elsewhere in Tank 14.
6. Lack of Integration with Quantitative Risk and Vulnerability Assessment (QRVA) — The Navy acknowledges that the number of samples generated in the DT plan will be insufficient to support “worthwhile statistical analysis (page 4). The test plan contains no mention of supplemental testing with manufactured coupons to address this limitation, which implies the ongoing QRVA will be unable to account for the contribution of NDE inspection failures in estimating the frequency of future tank leaks and ruptures at Red Hill.

Laboratory Testing of the Coupons

The BWS understands that the coupons removed from Tank 14 will now be tested by an independent laboratory. Although some of the testing procedures are outlined in the DT plan, detailed protocols are not included. Given the importance of these specimens and the nature of the DT being planned, the BWS requests that we be allowed to attend and

observe the laboratory examination of the steel coupons. In the interim, we offer the following suggestions to add to the DT protocols.

1. Collect samples of corrosion product and stains for scanning electron microscopy (SEM/EDS) and Fourier Transform Infrared (FTIR) spectroscopy prior to any cutting or grinding.
2. X-ray radiographs on each of the coupons to locate the thinnest locations on each coupon. These areas should be marked for corrosion depth measurements by pit depth gaging as well as metallography.
3. Grind each of the four edges of the coupons flat and perpendicular to the plate faces in order to accurately document the minimum remaining wall thickness on each edge.
4. Section 4.2 of the DT Plan (NAVFAC, 2018) report states that independent laboratory analysis will include "Performing surface characterization of the exterior and interior surfaces of the steel coupon using three-dimensional profilometry after the coupon is cleaned". It is unclear from the report how this profilometry will be accomplished. The independent lab should provide the raw data that comprises the profiles of each coupon, including the raw point cloud files if laser scanning is being used. The BWS requests that the Navy provide this raw data to the BWS as soon as possible after the completion of the surface characterization analysis.

If you have any questions, please contact Mr. Erwin Kawata, Program Administrator of the Water Quality Division at (808) 748-5080.

Very truly yours,


ERNEST Y.W. LAU, P.E.
Manager and Chief Engineer

cc: Mr. Steve Linder, United States Environmental Protection Agency, Region IX
Mr. Mark Manfredi, NAVFAC Hawaii

References

BWS, 2016a. Comments to the Work Plans Being Developed Under the Red Hill Bulk Fuel Storage Facility Administrative Order on Consent (AOC) Statement of Work (SOW) Sections 2 through 5 and 8, May 27

- BWS, 2016b. Comments Discussed with the United States Environmental Protection Agency (EPA) and Hawaii Department of Health (DOH) at the October 4 and 5, 2016 meeting to discuss to Work Plans Developed under Sections 2, 3, 4, and 8 of the Red Hill Fuel Facility Administrative Order on Consent (AOC) Statement of Work (SOW), November 4
- BWS, 2017a. Comments to the Work Plan Being Developed Under the Red Hill Bulk Fuel Storage Facility Administrative Order on Consent (AOC) Statement of Work (SOW) Section 5.3, February 13
- BWS, 2017b. Comments to the Work Plan Being Developed Under the Red Hill Bulk Fuel Storage Facility Administrative Order on Consent (AOC) Statement of Work (SOW) Section 5.3, Dated May 30, 2017, June 16
- BWS, 2017c. Comments to the Underground Storage Tank System Evaluation Final Report, Red Hill Bulk Fuel Storage Facility Joint Base Pearl Harbor-Hickam, dated June 13, 2017, July 14
- BWS, 2017d. Revision to Conditional Approval of Scope of Work for Destructive Testing Dated May 30, 2017 Submitted to the Regulatory Agencies Pursuant to Section 5.3.2 of the Red Hill Administrative Order on Consent, October 16
- BWS, 2017e. Red Hill Bulk Fuel Storage Facility - Red Hill Tanks 14, 17, and 18 NonDestructive Examination Plan Document Dated October 2017, November 9
- NAVFAC, 2017. Scope of Work for Destructive Testing, Red Hill Bulk Fuel Storage Facility, Administrative Order on Consent (AOC) and Statement of Work (SOW) Section 5.3.2, May 30.
- NAVFAC, 2018. Red Hill Bulk Fuel Storage Facility Scope of Work for Destructive Testing Supplement - Destructive Testing Plan, Supplement to Administrative Order on Consent (AOC) and Statement of Work (SOW) Section 5.3.2, June 1.
- Navy/DLA, 2017. Red Hill Tanks 14, 17, and 18 Non-Destructive Examination Plan (Redacted), October https://www.epa.gov/sites/production/files/2017-10/documents/redhill_nondestructive_examination_plan_oct_2017_redacted.pdf.

Figures

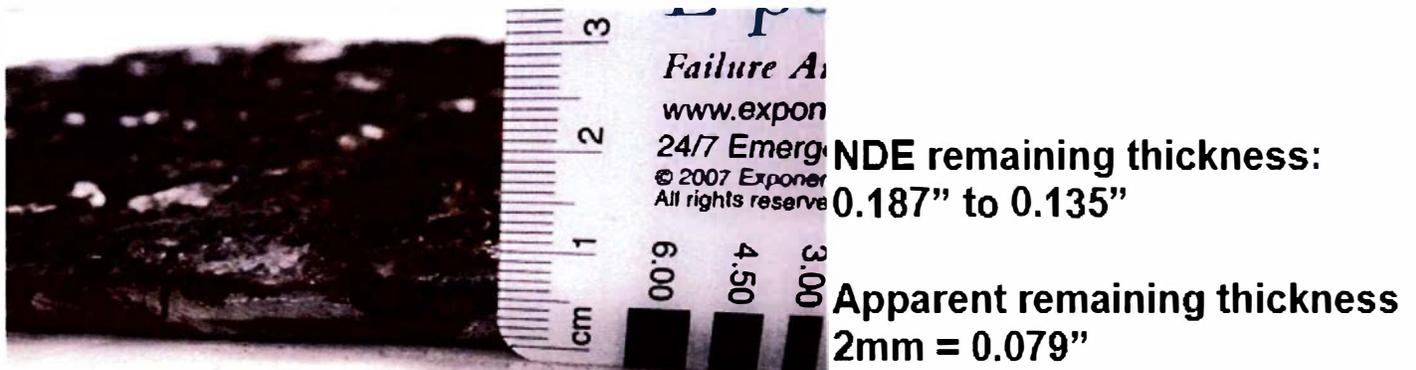


Figure 1: Coupon No. 7 viewed from the cut edge shows the corrosion and staining on the backside against the concrete. Remaining wall appears to be about 2 mm or 0.079-inches.

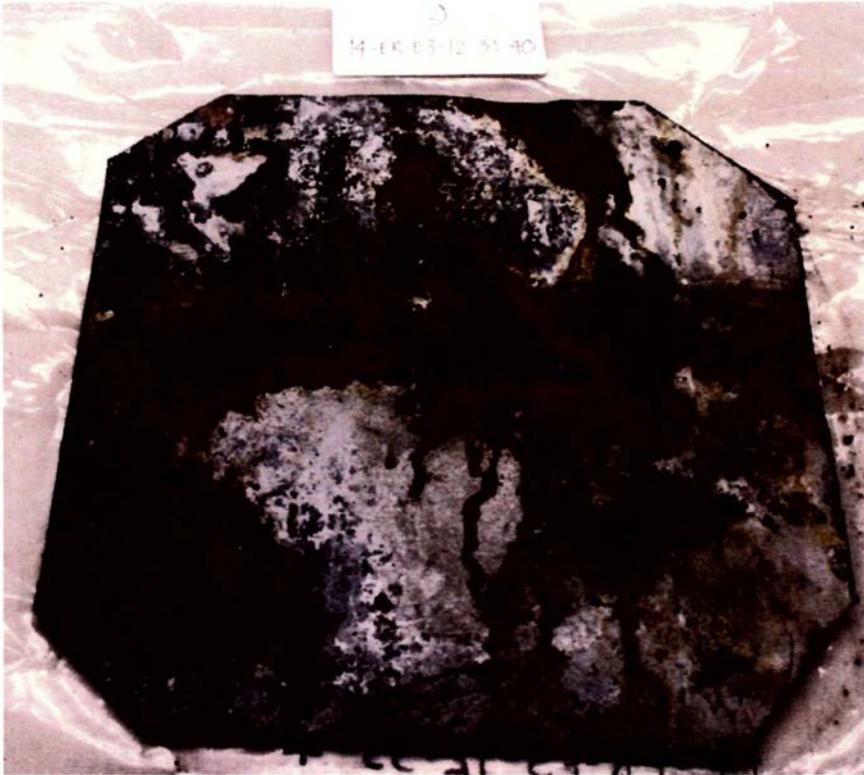


Figure 2: Backside of Coupon No. 2 - The dark horizontal stain is likely corrosion product and/or hydrocarbon stains. Drip seen running down backside.