BOARD OF WATER SUPPLY

CITY AND COUNTY OF HONOLULU
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March 29, 2019

Dr. Bruce Anderson
Director of Health
State of Hawaii
Department of Health
P.O. Box 3378
Honolulu, Hawaii 96801-3378

And

Mr. Jeff Scott
Land Division Director
United States Environmental Protection Agency
Region 9
75 Hawthorne Street
San Francisco, California 94105

Dear Dr. Anderson and Mr. Scott:

Subject: Navy testimony regarding Senate Concurrent Resolution 35, March 20, 2019, by Captain M.K. Delao and the Navy's Destructive Testing Report

The Honolulu Board of Water Supply (BWS) offers the following comments regarding the Navy's recent testimony (copy enclosed for reference) regarding Senate Concurrent Resolution 35, March 20, 2019 [Navy, 2019, March 20] and a Navy press release [Navy, 2019 February 25] as well as comments regarding the Navy's destructive testing report [Navy, 2018, December 17].

The Navy has expressed concern that there have been non-Navy reports that "offered a premature and incorrect assessment of tank-wall thinning based on subjective observations and imprecise measurements" and that "...earlier media reports indicated that the ten steel samples, called coupons, removed from tank No. 14 demonstrated that the corrosion was far worse than the Navy expected." [Navy 2019 March 20]. This letter is to address these statements and provide our comments on what the destructive testing report indicates regarding the reliability and accuracy of the Navy's Nondestructive Evaluation (NDE) methods that underpin their inspection and repair methodology.

Navy's testing, inspection and repair procedure

- The Navy uses two NDE technologies to determine the depth of backside corrosion: The first (LFET) is used to scan the entire inside surface of the tank ("screening"). The second (PAUT) is used to spot-check the screening ("prove-up").
- The Navy has set the action limit for corrosion repair at 0.09-inch pit depth, corresponding to 0.16 inches of remaining steel liner thickness of the original (nominal) 0.25-inch thickness. This is based on a presumed corrosion rate of 0.06 inches in 20 years or a corrosion rate of 0.003 inch/year. BWS has seen no analysis from the Navy to justify this rate, nor whether it represents an averaged corrosion rate or some bound. We note that Table 6.1 – Tank Safeguard of American Petroleum Institute (API) 653 "Tank Inspection, Repair, Alteration, and Reconstruction" recommends, in lieu of analysis, that a corrosion rate of 0.015 inch/year should be used which is five times as high as what the Navy is using. It also mentions that the corrosion rate can be determined as described in "Appendix H" but we are unaware that the Navy has provided any rationalization for the corrosion rate they are using and the current safety factor regarding this corrosion rate. Furthermore, as BWS has previously commented, the Navy found through wall pitting in Tank 16 in 2006 that also gives a higher corrosion rate (0.25/65 years or 0.0038 inch/year) [Lau, 2016 May 27].
- A pit depth of 0.15 inches leaves 0.10 inches of intact steel of the original 0.25-inch thick barrel liner wall. For scale, this is less than the thickness of two stacked dimes (a dime is 0.053 inch thick).

Twice as thick as the petroleum Industry's closest minimum standard for tank walls

The Navy continues to propagate the notion that they use twice the industry standard for minimum remaining wall. For instance, in the Fuel Tank Advisory Committee (FTAC) meeting held on November 1, 2018 Rear Admiral Fort stated: "The Navy doubles the American Petroleum Institute approved industry standard for steel liners on the tanks at Red Hill. Those tanks as designed are quarter-inch steel; that's 0.25-inches." BWS stated in a letter to Dr. Bruce Anderson, Chair of FTAC, in December 2018 [Lau, 2018, December 24] that the API standard referenced by the Rear Admiral is for aboveground tanks and does not apply to the underground tanks at the RHBFSF and that the Navy appears to have misinterpreted an API standard that does not apply to the RHBFSF. Namely, the standard prescribes a minimum thickness (0.05 inches) for the floor of an aboveground tank with secondary containment whereas there is no secondary containment for the RHBFSF tanks (as demonstrated in the 2014 release). There is, therefore no additional factor of safety on the Navy's provision for remaining wall thickness.

Examples of where the Navy continues to maintain "the twice as thick" notion is the Navy's recent testimony on March 20, 2019 to the Senate Committee regarding Concurrent Resolution 35 were they stated that "Laboratory measurements found no area on any of the coupons to be less than twice the industry minimum standard." While the Navy has not provided specific references for their claim, the BWS believes the Navy is referring to Table 4.4 from API 653 (reproduced below). If so, this is misleading since the 0.05-inch minimum thickness clearly is intended to apply only to above ground storage tanks (ASTs) whereas the Red Hill tanks are underground storage tanks (USTs). Moreover, the provision is intended to apply only to the bottom plates of ASTs with "... means to provide detection and **containment of a bottom leak**."

Table 4.4—Bottom Plate Minimum Thickness

Minimum Bottom Plate Thickness at Next Inspection (in.)	Tank Bottom/ Foundation Design
0.10	Tank bottom/foundation design with no means for detection and containment of a bottom leak.
0.05	Tank bottom/foundation design with means to provide detection and containment of a bottom leak.
0.05	Applied tank bottom reinforced lining, > 0.05 in. thick, in accordance with API 652.

Red Hill tank liners clearly are not tank bottom plates and do not have secondary containment. Therefore Table 4.4 and the allowance for walls thinned by corrosion to 0.05-inch should not be applied to the Red Hill steel liners.

Given the unique construction, volume of fuel stored, and the potentially devastating consequences of a release, the BWS believes the tolerance for corrosion should be a determination informed by careful engineering analysis, rather than simply force fitting an inapplicable provision.

Furthermore, there are other provisions in API 653 that require a minimum remaining wall to be 0.100-inch. For instance, in Section 4.3.3 "Minimum Thickness Calculation for Welded Tank Shell." API 653 states that "t_{min} is the minimum acceptable thickness, in inches for each course as calculated from the above equation; however, t_{min} shall not be less than 0.1 in. for any tank course".

This indicates that both the following statements made by the Navy's testimony and press releases are not true or misleading:

- "The Navy doubles an American Petroleum Institute's minimum thickness standard for above ground storage tanks as best practice." Quote from Navy Public Affairs Office [Navy, 2019, February 25]. The actual minimum thickness specified for ASTs without containment of a bottom leak is 0.100-inch, not 0.05-inch, therefore doubling the minimum thickness would require a minimum thickness after 20 more year of service 0.200-inch be repaired. This is half, not "... twice as thick as the petroleum industry's closest comparable minimum standard for tank walls ..." as stated in the Navy press release.
- "Laboratory measurements found no area on any of the coupons to be less than twice the industry minimum standard." Quote from Navy testimony regarding Senate Concurrent Resolution 35 [Navy, 2019, March 20]. This is incorrect since the minimum thickness as determined by the Navy's destructive testing laboratory report showed **that half of the specimens were thinner than 0.200-inchs**, twice the minimum thickness of 0.100-inch specified by other provisions of API 653. For instance, the minimum thickness measured in the Navy's destructive testing laboratory report was: coupons 2, 3, 6, 7 and A1 were found to have minimum remaining thickness of 0.152, 0.132, 0.158, 0.164, and 0.122 inches respectively [see Table 23 from Navy/IMR, 2018, December 18].

What the Navy's Destructive Testing Report shows

The Navy has expressed concern that there have been non-Navy reports that "offered a premature and incorrect assessment of tank-wall thinning based on subjective observations and imprecise measurements" [Navy, 2019 Feb 25] and that "...earlier media reports indicated that the ten steel samples, called coupons, removed from tank No. 14 demonstrated that the corrosion was far worse than the Navy expected." [Navy 2019 March 20].

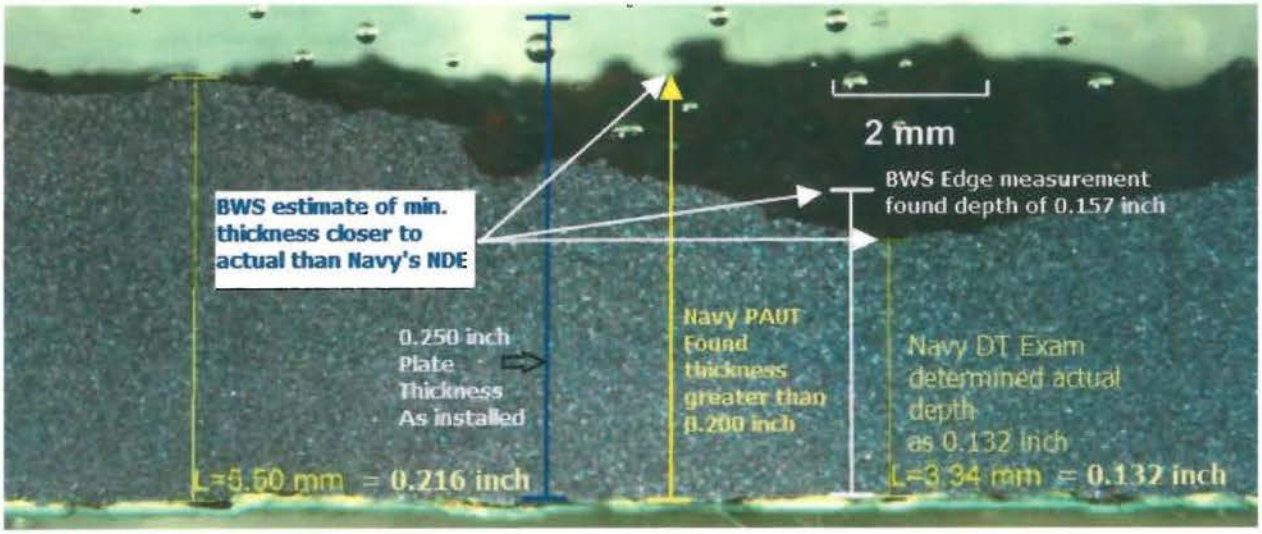
The BWS is disturbed by the Navy's characterization of events and previous reports. The Navy has not allowed the BWS to directly measure or even touch the coupons. We were allowed a brief time to photograph the coupons, and we estimated pit depths from photographs of the edges. When the BWS presented these results, we always made this limitation clear and stated the results were as preliminary, and that laboratory analysis is required to accurately characterize the corrosion. Now the Navy is showing photos of a cleaned edge of one of the coupons and claiming the preliminary estimate to be inaccurate (while not allowing the BWS access to the coupons or underlying measurements to verify that claim), and claiming that as proof our initial assessment of the NDE to be incorrect. In fact, and as shown below, despite the inherent imprecision of our earlier measurements due to limitations placed by the Navy, our overall

assessment of the inability of the NDE methods to reliably find thinned wall areas was demonstrated by the third-party laboratory report.

The destructive testing report actually shows that the corrosion found on this small number of coupons was, worse than what the Navy expected from their NDE inspection on some coupons. This rather large variation in what NDE found versus what was actually found by destructive examination supports and raises concerns about the accuracy and reliability of the NDE methods used and the Navy's inspection and repair methodology.

The Navy stated in their March 20, 2019 testimony regarding the Senate Concurrent Resolution 35 that "Laboratory measurement found no area on any of the coupons to be less than the industry minimum standard. As previously stated, (1) the standard stated is not for USTs and (2) even if it were applicable, the minimum standard would be 0.100-inch not 0.05-inch which means half the coupons were less than twice the minimum wall i.e. 0.200-inch.

The Navy then states that "...the non-Navy photo (with the ruler, Figure 1) which was used to allege that corrosion of this coupon was worse than the Navy anticipated. Also included are two laboratory photos (Figures 2 and 3) of the same coupon which show, after proper preparation and precise measurements, significant metal thickness remains in this area." The figures refer to Coupon #7. First, BWS was not allowed to handle or otherwise participate in the NDE or destructive testing or to otherwise properly prepare or make more precise measurements, and secondly, this is just one of the 10 coupons examined. For instance, if the Navy had selected Coupon #3 to discuss; the results would be dramatically different. The Navy's NDE indicated that the expected minimum thickness on this coupon would be greater than 0.200 inches as PAUT found no indication (Appendix B). BWSs edge measurements estimated that the edge thickness was 0.157 inch. The destructive testing report showed that the actual minimum thickness on the specimen was 0.132-inch. The figure below shows the cross-section through Coupon #3 at the thinnest location. For reference, 5.5 mm is 0.217 inches, 3.34 mm is 0.1315 inch and a ¼-inch is 6.35 mm. As can clearly be seen the smallest defect is significantly smaller that the Navy expectation from PAUT of the thickness being greater than 0.200 inch.



In this specific instance, the BWS edge estimate, based only on the crude measurements allowed by the Navy, were significantly closer to the actual plate minimum thickness. For Coupon #7 it is true that "the corrosion was far worse than the Navy expected."

Finally, with respect to Coupon #7, BWS is not convinced that the minimum thickness of the edge is what is stated and will remain unconvinced until the Navy provides the CT scans and allows an independent inspection of the cut plates and metallographic samples. BWS has made this request in our March letter [Lau, 2019, March 6].

The Navy in their March 20th testimony also indicated that "The Navy continues working with industry experts to evaluate cutting-edge technologies and procedures to improve the ability to "see" the backside of the steel to further protect the environment and drinking water. For example, on March 14, the Navy hosted a leading robotics firm to conduct a live demonstration at Red Hill of their company's capabilities to scan tank walls using robotic techniques. The demonstration looked promising and the Navy will be pursuing this concept in greater detail." Clearly the destructive testing of the coupons indicated that the current NDE methodology is not very accurate and reliable. BWS remains unconvinced that unproven NDE robotics will have the sufficiently improved reliability and accuracy to assure 20 years of leak free service. This is why BWS believes the only way forward it to either close the tanks or make them double wall.

The Navy's testimony of March 20th also indicates that "Each Red Hill tank is made of several feet of reinforced concrete with a steel liner. The tanks also have been secured into basalt rock with Gunite, a type of cement that is pressure injected to fill the space between the outer tank wall and the basalt rock. Effectively, the liner, cement walls, gunite and the basalt rock become the tank that holds the fuel." As BWS has previously

stated on several occasions, the reinforced concrete, pressure injected gunite, and basalt rock provide no reliable fuel confinement. This fact was clearly demonstrated when at least 28,000 gallons of fuel was lost when the steel liner repair welds cracks allowed fuel to escape from Tank 5 in 2014. The reinforced concrete, gunite, and basalt did nothing to prevent the release. It is only the 0.25-inch thick carbon steel liner that prevents the release of fuel.

The NDE results from the Navy's LFET and PAUT NDE inspections (Navy, 2018 June 1 – Table 1 and Appendix B), where thickness values are given for both the screening (LFET) and prove-up (PAUT), we used the prove-up value as presumably it is more accurate. Since PAUT cannot detect plate thickness greater than 0.200-inch plate thickness, the actual plate thickness could be anywhere between 0.200 and 0.250 inches. We therefore assume 0.250 inches where no indications or no corrosion is suspected. Where PAUT is only reported as being above or below the repair threshold (i.e., 0.160) we use the LFET value if available, if consistent with PAUT, and is not unrealistically small (i.e. Coupon 5).

We also provide the values for the minimum wall we observed on the cut edges. BWS notes that we were not allowed to handle or otherwise participate in the handling or destructive examination. However, BWS notes that these edge measurements appear to be nearly as accurate as the Navy's NDE measurements when all the test coupons are considered. The comparison of the Navy's NDE values with the minimum thickness found on the coupons clearly demonstrates that the Navy did not achieve their qualitative validation goal of pit depth within 20 mils (0.020-inch) or wall thinning of within 5% of actual.

"After nearly 75 years in service, no more than 1 to 2 percent of each tank's surface area requires repair."

The Navy has stated publicly several times that "... Historically, about 1-2% of the tank linings require repair." (Navy, 2018 Nov 28) and "... Historically, about 1-2% of the tank linings require repair." [Navy, 2019 Feb 25]

Apparently, the Navy is quoting this area fraction of liner repaired to illustrate that the repaired area is small. Although 1% to 2% sounds like a small number, the tank surface area is very large (80,000 square feet or 1.8 acres) (Navy, 2017 May 30). Two percent (2%) of 80,000 square feet is 1,600 square feet that needs repair since these areas are so thin that they may corrode to minimum allowable wall thickness of 0.100-inch prior to the next inspection in 20 years. To put this in perspective, 1,600 square feet is about the area of a volleyball court. This combined with the fact that a very small diameter hole can leak an enormous amount of fuel (a ¼-inch diameter through-wall pit could release up to 12,000 gallons per day) provides us little comfort. This is why both secondary containment and very reliable and accurate NDE methods are so important.

Thank you for your prompt attention to this matter. 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

Enclosure

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Ms. Roxanne Kwan
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Department of Health
Solid and Hazardous Waste Branch
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References

[API 653, 2014] "Tank Inspection, Repair, Alteration, and Reconstruction", API Standard 653, Fifth Edition, November 2014.

[Lau, 2018, December 24] Ernest Y.W. Lau, Letter to Dr. Bruce Anderson, Chair FTAC, "Subject: Honolulu Board of Water Supply (BWS) Comments on draft "Report to the Thirtieth Legislature, State of Hawaii, 2019, Pursuant to Section 342L-62 Hawaii Revised Statutes, The Third Annual Fuel Tank Advisory Committee Meeting to Study the Issues Related to Leaks of Field-Constructed Underground Storage Tanks at Red Hill Bulk Fuel Storage Facility and Four Other DOD Facilities", Prepared By: State of Hawaii, Department of Health (DOH),

Underground Storage Tank Section, dated December 2018", Board of Water Supply, City and County of Honolulu, December 24, 2018

[Lau, 2019, March 6] Ernest Y.W. Lau, Letter to Mr. Omer Shalev, EPA and Ms. Roxanne Kwan, Hawaii Department of Health, "IMR Test Labs Destructive Analysis of ten (10) Steel Coupons Removed from Red Hill Fuel Storage Tank #14, Report No. 201801967, dated December 17, 2018 pursuant to Section 5.3 of the Red Hill Bulk Fuel Storage Facility", Board of Water Supply, City and County of Honolulu, March 6, 2019

(RHBFSF) Administrative Order on Consent (AOC) Statement of Work (SOW)

[Navy, 2018 June 1] "Scope of Work for Destructive Testing Supplement – Destructive Testing Plan", AOC/SOW Section 5.3.2, Navy Facilities Engineering Command, June 1, 2018

[Navy, 2018 Nov. 28] "Testimony on behalf of Navy Region Hawaii by Captain Marc Delao" regarding Resolution 18-266, Related to Underground Storage Tanks, presented to Honolulu City Council Committee on Public Works, Infrastructure, and Sustainability, November 28, 2018

[Navy/IMR, 2018, December 17] "Destructive Analysis of 10 Steel Coupons Removed from Red Hill Storage Tanks #14", Report by Thomas N. Ackerson and Jennifer Breetz, IMR Test Labs, Report No. 20181967, Louisville, KY

[Navy, 2019 February 25]. "Statement: Navy releases test results on Red Hill Bulk Fuel Facility tanks," Commander, Navy Region Hawaii, Public Affairs Office, JBPHH, Hawaii

[Navy, 2019, March 20]. Department of the Navy (Navy). 2019. Navy testimony regarding Senate Concurrent Resolution 35, March 20, 2019, by Captain Marc Delao

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SENATE COMMITTEE ON AGRICULTURE AND THE ENVIRONMENT
SENATE COMMITTEE ON PUBLIC SAFETY, INTERGOVERNMENTAL, AND MILITARY AFFAIRS
Testimony on Senate Concurrent Resolution 35, Urging the United States Environmental Protection Agency and the Hawai'i State Department of Health to reject the approval of a single wall tank upgrade alternative option for the Red Hill Bulk Fuel Storage Facility and to reject the conclusions presented in the Groundwater Protection and Evaluation Considerations for the Red Hill Bulk Fuel Storage Facility Report dated July 27, 2018.

Hearing Date and Time: Wednesday, March 20, 2019 at 1:15 p.m.

Testimony on behalf of Navy Region Hawaii by CAPT Marc Delao,
Commander, Naval Facilities Engineering Command Hawaii

Aloha Chair Gabbard, Chair Nishihara, and Committee Members,

Thank you for the opportunity to submit testimony on Senate Concurrent Resolution 35. The Navy fully recognizes and respects the public and legislative concern in protecting the fresh water aquifer at Red Hill. We not only share that concern, but work every day to ensure this important facility is monitored, operated and upgraded to protect against any release of fuel. We all want to protect our aquifer and we are working under the oversight of the State Dept. of Health (DOH) and Environmental Protection Agency (EPA) in an Administrative Order on Consent (AOC) to do just that.

The AOC process is working. The Navy and Defense Logistics Agency (DLA) have invested significantly and faithfully in the carefully negotiated AOC, expending over $45 million complying with the AOC and over $260 million in Red Hill since 2006. We again extend an invitation to all of the members of the legislature to tour our facility and meet the individuals who are responsible for keeping our storage facility environmentally safe and ready for any emergency. The Navy believes we fill an important role in the protection of our country and Hawaii. To help ensure you have all the facts and see for yourselves, rather than take our word for it, we ask legislators again to tour the Red Hill facility before your final decision on this resolution.

We are concerned that there have been non-Navy reports that offered a premature and incorrect assessment of tank-wall thinning based on subjective observations and imprecise measurements, derived outside of the AOC process. For example, earlier media reports indicated that the ten steel samples, called coupons, removed from tank No. 14 demonstrated that the corrosion was far worse than the Navy expected.

Laboratory measurements found no area on any of the coupons to be less than twice the industry minimum standard. Last week the Navy met with the Regulators where the laboratory results of these coupons were thoroughly scrutinized. For the coupon questioned in the media, the Regulators probed the laboratory in detail. The laboratory confirmed that the area of the coupon depicted in the newspaper was inaccurate. Included below is a copy of the non-Navy photo (with the ruler, Figure 1) which was used to allege that corrosion of this coupon was worse than the Navy anticipated. Also included are two laboratory photos (Figures 2 and 3) of the same coupon which show, after proper preparation and precise measurements, significant metal thickness remains in this area.

The laboratory report is an interim product that will be further evaluated and used to form the content of a larger report expected to be submitted in July as part of the Administrative Order on Consent between Navy, EPA and DOH.

The Navy continues working with industry experts to evaluate cutting-edge technologies and procedures to improve the ability to "see" the backside of the steel to further protect the environment and drinking water. For example, on March 14, the Navy hosted a leading robotics firm to conduct a live demonstration at Red Hill of their company's capabilities to scan tank walls using robotic techniques. The demonstration looked promising and the Navy will be pursuing this concept in greater detail.

The drinking water is safe. The Board of Water Supply and other independent tests confirm drinking water meets all applicable standards. Tests performed every six months confirm the tanks are "tight" and not leaking. Each Red Hill tank is made of several feet of reinforced concrete with a steel liner. The tanks also have been secured into basalt rock with Gunite, a type of cement that is pressure injected to fill the space between the outer tank wall and the basalt rock. Effectively, the liner, cement walls, Gunite and the basalt rock become the tank that holds the fuel.

Many people understand what a vital strategic asset Red Hill is for the military's mission, just as Pearl Harbor Naval Shipyard and the Pacific Missile Range Facility on Kauai are. But not many realize how fully committed the Navy is to serving as the safety net for Hawaii's energy needs under the Defense Support for Civil Authorities. We are capable of delivering fuel from Red Hill to Honolulu Harbor, the Daniel K. Inouye International Airport, Barbers Point and Hawaiian Electric Company for commercial ships, airplanes and generating electricity, all via existing fuel lines. The delivery system is through gravity feed and does not require any additional energy, which is important in any emergency when the power goes out.

Thank you for the opportunity to submit this testimony today.

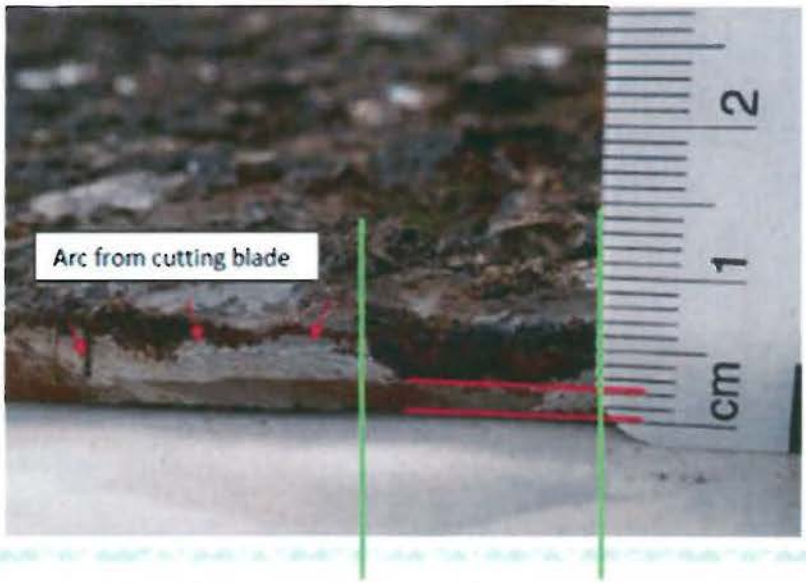

Figure 1: Edge of Coupon #7. Image from non-Navy source alleging the thickness of the remaining steel at the location shown between the two red lines was no more than 2 millimeters, less than the Navy's predictions. The label "Arc from cutting blade" was added by the laboratory to help demonstrate that all 3 photos shown are of the same location of coupon #7.

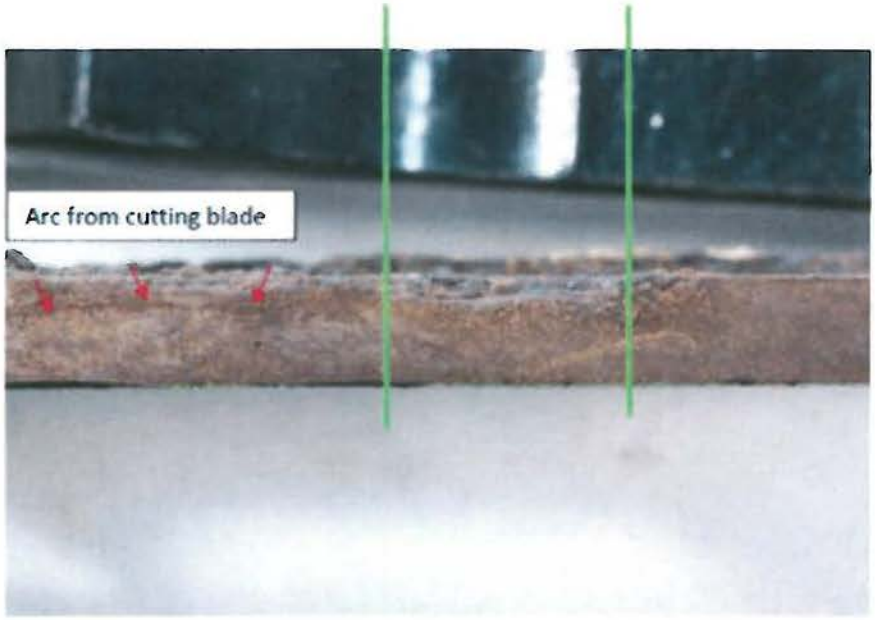

Figure 2: Edge of Coupon #7. Laboratory photo of same location on coupon #7 as depicted in Figure 1 taken after cleaning but before grit blasting. Cleaning apparently removed debris resulting from cutting the coupon out of the tank

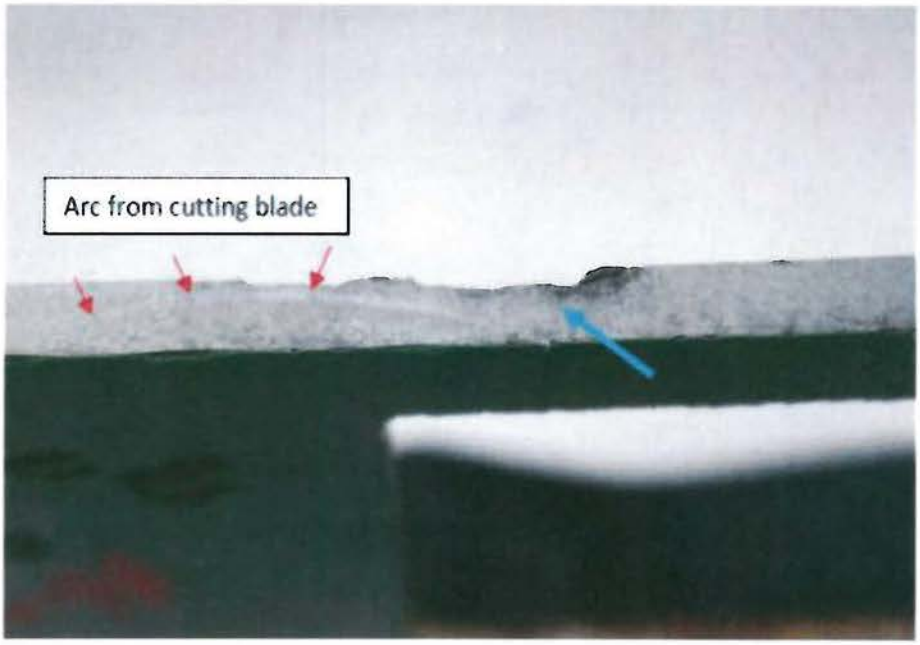

Figure 3: Edge of Coupon #7. Laboratory photo of same location on coupon #7 as depicted in Figure 1 taken after grit blasting. Note there is still significant wall thickness remaining in the area in question (blue arrow).

U.S. INDO-PACIFIC COMMAND
(USINDOPACOM)
CAMP H.M. SMITH, HAWAII 96861-4028

March 5, 2019

Testimony on the Red Hill Bulk Fuel Storage Facility

Aloha and thank you for the opportunity to submit written testimony about Red Hill.

USINDOPACOM, commanded by Admiral Phillip S. Davidson, is the highest level DoD headquarters in the Indo-Pacific region. It provides command and control of assigned forces from the Army, Navy, Air Force, and Marines operating in the Indo-Pacific. The Red Hill Fuel Storage Facility is owned and maintained by the U.S. Navy, with support by the Defense Logistics Agency (DLA).

The purpose of my testimony is to inform the Committees of the vital strategic significance of the Red Hill Fuel Storage Facility, and to communicate USINDOPACOM's resolve and commitment to conduct operations in an environmentally responsible and compliant manner.

The Red Hill facility holds a significant percentage of petroleum war reserves required to defend national security interests in the Indo-Pacific region. As our strategic reserve, it supports all U.S. military forces throughout the theater, including those stationed in and transiting through Hawaii. It also supports the Hawaii Army and Air National Guard and is available to support civil authorities, should circumstances dictate. Its hardened, underground, cyber-protected, gravity-fed system to Joint Base Pearl Harbor-Hickam is unique, and there is no comparable U.S. owned facility anywhere from India to mainland USA.

Admiral Davidson maintains Red Hill is a "vital strategic asset" to USINDOPACOM and Service components "during contingency operations" throughout the Indo-Pacific region. He also fully supports the Navy and DLA's commitment to be good stewards of the environment and protect the water we all drink on Oahu. Therefore, USINDOPACOM will continue to support the binding Administrative Order on Consent and its objectives to ensure the groundwater is protected and Red Hill is operated and maintained in an environmentally protective manner.

I am happy to provide additional information as necessary.

SUSAN A. DAVIDSON
Major General, U.S. Army
Director for Logistics, Engineering and
Security Cooperation