I have reviewed the Expert Report DNV-GL prepared under the supervision of Dr. David M. Norfleet, and provide this supplemental testimony in response to the following characterizations, opinions, and conclusions DNV-GL provided:

**1. "The condition of the concrete is facilitating transport of this corrosive environment to the external surface of the steel liner allowing for unmitigated backside corrosion to occur on all of the RHBFSF USTs."** Executive Summary at iv.

There is no evidence of a "corrosive environment" in the concrete or that the concrete is deteriorated. Navy has a study underway to further assess the condition of the concrete, but no deteriorated concrete has been found.

**2. "If the RHBFSF is to remain at its current location, upgrading the USTs to tank-within-a-tank secondary containment, something the Navy acknowledges can be accomplished, is the best and most protective way to address these recognized tank integrity issues."** Executive Summary at iv.

Navy has not acknowledged "tank-within-a-tank" can be built at Red Hill. The Tank Upgrade Alternatives Decision Document contains Navy analysis of this concept, and discusses a timeframe for implementing double-wall equivalency. Exhibit N-042 at 6, 67. Navy is currently studying the feasibility of installing a commercially available membrane containment system. More specifically, the Defense Innovation Unit is under contract with Gaztransport & Technigaz North

America Inc., (GTT North America) to investigate concepts to adapt an existing commercial membrane technology for upgrading storage tanks at Red Hill.[1] If the feasibility study is favorable, the next step would be to initiate design work.

**3. "There is evidence of groundwater on the backside of the liner, which indicates that there are pathways for water to reach the steel liner through the concrete, and, in turn, pathways for leaked fuel to reach the environment. As such, the concrete structure does not provide fluid containment, only structure for steel liner membrane."** Section 2.0 at Page 3.

Concrete can experience cracking over time. However, the tanks were constructed well above (approximately 100 feet above) the groundwater surface. Water was used to test the storage tanks for leakage during original construction, and there is no evidence either way that the corrosion product encountered on the backside of the steel was not initiated during that initial leak testing. The design of the facility provides for layers of dense material between a drop of fuel and the country rock. Those layers are carbon steel, reinforced concrete, pressure grout, gunite, and consolidation grout. Great effort was undertaken by the designers to ensure the steel liners were well-encased in dense cementious material. The consulting engineers were eminent professionals

[1] https://www.dvidshub.net/news/379710/navfac-exwc-awards-research-contract-upgrading-red-hill-bulk-fuel-facility

in the field of hydraulic structures, including individuals such as John L. Savage,[2] best known for supervising designs on the Hoover, Shasta, Parker, and Grand Coulee Dams; Dr. James P. Growdon, P.E., chief hydraulic engineer for Alcoa Corporation; and Carl R. Rankin[3], P.E., superintendent of construction for the Metropolitan Water District of Southern California and well known for involvement in the colossal California Water Project and hydraulic tunneling on the Hetch-Hetchy reservoir.

**4. "Because of their field-constructed nature, the RHBFSF USTs are a massive patchwork of concrete, metal plates and welding – over 1.3 acres of steel plate and several miles of welds per UST – and each RHBFSF UST is large enough for the Statue of Liberty or Aloha Towner to sit inside."** Section 2.0 at Page 3.

This statement mischaracterizes the care that was utilized when the storage tanks were designed and constructed in the early 1940's. Both the reinforced concrete and the steel liner materials were carefully designed and constructed to be a system to transfer the weight of stored liquid to the surrounding rock without undue stress. In the late 1930's, most steel storage tanks were constructed using overlapping plates (lap joint) fastened together by rivets. Arc welding was a

[2] https://ascelibrary.org/doi/10.1061/%28ASCE%291532-6748%282008%298%3A3%28162%29

[3] http://www.mwdh2o.com/WhoWeAre/Board/Board-Meeting/Board%20Archives/1953/11-Nov/Letter/064722818.pdf#search=carl%20r%2E%20rankin
http://www.mwdh2o.com/WhoWeAre/Board/Board-Meeting/Board%20Archives/1947/09Sep/Letter/064734162.pdf
https://tile.loc.gov/storage-services/master/pnp/habshaer/ca/ca4100/ca4114/data/ca4114data.pdf

new technology at the time, and many welded tanks of that era also used a lap-welded type of joint. The design at Red Hill, in contrast, used steel liner plates which were carefully fitted and butt-welded together pursuant to a detailed engineered design. The butt weld type of joint is widely in use today and requires attention to detail during preparation. Likewise, the concrete placed at Red Hill was carefully prepared using an onsite plant and classified aggregate, mixed in small batches, mechanically consolidated, tested for slump and compressive strength by a full time crew of inspectors, and prestressed using pressure grouting. The technical expertise of the engineers associated with the design and construction details of Red Hill, whom I identified above, were some of the finest in the United States. See HAER No. HI-123, cited by DNV-GL as [13].

**5. "Apparently [15], however, pressurized grout may have also been injected into crevices that formed between the steel plates and the reinforce concrete that shrank during hardening causing the concrete to pull away from the tank walls:**

> **'-Finally, you had the vault compete – a steel shell as tall as a twenty-five-story building, as large around as a house lot – backed by many feet of solid concrete butting tight against the rock. As the concrete hardened, it shrank slightly away from steel. Into this space grout under heavy pressure was forced through pipes welded into the plate. This filled in every remaining crevice and pushed inward against the steel with a pressure equal to the outward thrust expected from oil.'**
>
> **[15]** Section 2.0 Page 7.

The citation from the 1946 Builders for Battle relies on a technical detail published in in a non-technical publication that is known to be inaccurate. Tank construction drawing details clearly depict prestress grout tubes terminated at the joint between the concrete and the gunite as described in Red Hill Facility Tank Inspection, Repair, and Maintenance Procedure Decision Document. Navy Exhibit N- 076; HAER No. HI-123 Page 11.

**6. “Therefore, the Navy has, since the removal, eliminated its ability to detect leaks and to drain/manage any water intrusion between the steel liner and the concrete shell of the UST. ”** Section 2.0 at Page 8.

“The telltale leak detection system was problematic and found to be not reliable for denoting leakage”. Exhibit B-12 at 12. During development of the TIRM report, Navy recommended re-installation of telltale leak detection systems, but the regulatory agencies and the BWS opposed this recommendation. The BWS, in its 21 November 2016 correspondence, disagreed with Navy position to re-install telltale systems. BWS stated “Section 15-3 calls for the reinstallation of tell-tales. The BWS disagrees with this effort and expense, and recommends that the focus of work going forward be towards preventive technologies in the form of secondary containment with interstitial monitoring. The tell-tales have had limited effectiveness through the years, were removed in the early 1980s, and are an outdated technology for single-wall systems.” Exhibit B-45. Subsequently, the Navy deferred the decision on re-installing telltale leak detection systems pending findings from a study being undertaken under AOC Section 4 regarding a new leak detection system. As noted in the TIRM Procedure Decision Document: “During the development of the TIRM Report, it was decided to defer the recommendation of reinstalling the telltale leak detection and collection system to AOC SOW Section 3 Tank Upgrade Alternatives (TUA) and AOC SOW Section 4 Release Detection/Tank Tightness Testing." Exhibit N-76 at 12-1.

**7. "The effort involved in designing and installing the tell-tale system makes it apparent that the designers and builders of these USTs recognized the need to both detect leaks and have the ability to drain water and/or fuel from the backside of the steel liner. This is consistent with contemporaneous records from the construction period that document water intrusion during the construction of the RHBFSF. [B-12, B-313]"** Section 2.0 at P. 5.

Reference B-12, the Bechtel report, is not a contemporaneous construction record. It was prepared after construction and Bechtel was not one of the contractors chosen to construct Red Hill. One of the primary purposes of installing the telltale system was to leak test the tanks during original construction. The telltale system was used to inject air into a tank partially filled with water and visually inspect for leaks. This process was also used by Bechtel in 1949. Exhibit B-12.

**8. "The fact that water was observed during construction of the USTs makes it apparent that the designers were aware of the real possibility of water intrusion, collection and subsequent corrosion of the backside of the steel liner as a result of contact with water."** Section 2.0 at Page 6.

The original construction mitigated effects of vertically migrating subsurface water by surrounding the mined excavation with gunite and extensive consolidation grouting. An average of 74,000 $ft^3$ of cement was used to grout around the perimeter of the reinforced concrete on each tank, consuming a project total of cement (only for grouting) of almost 1.5 million sacks of cement. This means the volume of mixed grout used to surround the concrete on each tank is the same volume that would almost completely fill two tanks. The design intent was for the country rock to support the weight of fuel by being consolidated by pressure grouting. Exhibit B-12. Grouting was performed non-stop for weeks to ensure a dense region of cementious material surrounded each reinforced concrete structure. The designers took efforts to ensure the storage tanks were constructed in a manner which kept them well above the height of groundwater and surrounded them with a dense layer of grout and concrete to prevent lateral intrusion by water migrating vertically towards the groundwater surface.

**9. This second EEI report likewise acknowledges significant concerns regarding backside corrosion and the potential for releases due to through-wall pitting.** Section 2.1 at Page 10.

Mr. Stephen Brooks, P.E., is the same professional engineer (who is also a tank inspector) at EEI who authored the 1998 and 2008 reports and was involved in the 2020 determination that the inspection and repairs performed on Tank 5 rendered it suitable for service for 20 years. Mr. Brooks is a principal at EEI which is the inspection firm of record for inspections performed or in progress on Tanks 2, 5, 13, 14, 17, 18, and 20. The same professional engineer cited in the 1998 and 2008 reports is, in 2020, involved in certifying Red Hill tanks to be suitable for another interval of service.

**10. The Navy's inspection techniques are inherently unreliable at the RHBFSF given the scale of the USTs and the conditions under which the inspections occur.** Section 3.1.1 at Page 13.

The conclusion that inspections are unreliable due to the scale of the surfaces and conditions is not supported by evidence and contradicts API 653. Similar means and methods are used to assess the condition of large storage tank bottoms around the world pursuant to API 653, and the DNV-GL report does not cite any authoritative source that finds a relationship between the inspection technique and the area, which diminished the reliability. API Standard 653 states NDE data is dependent on personnel, equipment, and procedures – not the area being inspected.

**11. Further underscoring the difference, the top side of the bottom of an AST is typically sand blasted and can be visually inspected.** Section 3.1.1 at Page 16.

Navy does not "typically" remove coating on storage tanks for inspection. This is a practice that has been found to have detrimental effects and is atypical. Most modern NDE technologies easily scan for metal loss through coating. In addition, the product side of the metal is inspectable for evidence of metal loss using visual methods which can then be measured with a pit gauge or ultrasonic means.

**12. Table 2 at Page 19.**

Table 2. Summary of the number of anomalies identified from the API 653 inspections performed on Tanks 2, 5 (2010), 6, 15, 16, and 20.

| Feature Type | Tank 2 | Tank 5 (2010) | Tank 6 | Tank 15 | Tank 16 | Tank 20 | Total |
|---|---|---|---|---|---|---|---|
| Underside Corrosion | 48 | 249 | 181 | 94 | 138 | 71 | 781 |
| Through Holes | 2 | 2 | 0 | 11 | 6 | 1 | 22 |
| Topside (pits, gouges, tack welds, dents, bulges) | 52 | 56 | 99 | 4 | 55 | 35 | 301 |
| Weld Cracking | 12 | 1 | 0 | 2 | 0 | 1 | 16 |
| Weld (IP, LOF, LOP, porosity, undercutting, etc.) | 59 | 40 | 398 | 65 | 310 | 137 | 1009 |

Table 2 identifies and lists “anomalies” encountered during inspections. However, these are raw data and no contextualization is made to clarify the significance of the anomalies. For example, the report for Tank 2 identifies that of the weld cracks found, half (six) of them were on tank plates. Other cracks were identified on external appurtenances such as sample line penetration closures on the casing in the lower tunnel – a situation which is not related to tank integrity. Another example is anomalies of dents, bulges, and weld undercutting. These conditions are noted as inspection findings but are not related to corrosion, and often do not require repair. Another example is the listing of six “Through Holes” for Tank 16 that does not make the distinction that four of the six, or 67% of the count, are located above the maximum fill height. Likewise the list of holes on Tank 15 does not note that they were all located in the upper dome, which is a height above the maximum fill.

**13. Figures 5 and 6 from Page 22.**

Figure 5. Photographs extracted from the API Tank 16 Inspection Report (Photograph 8) showing "holes at the top of course F of the upper dome".

Flaw 347 through hole in strap

Figure 6. Photograph extracted from the API Tank 20 Inspection Report showing a through-wall hole.

The DNV-GL report identifies inspection report findings termed “holes.” However the term “hole” has been inconsistently used over the years and does not always represent a passage from the interior to the exterior of the tank. For example, DNV –GL Figure 6 depicts a photograph from the Tank 20 report captioned “through-wall hole.” However a review of the Tank 20 report reveals the finding is located in the upper dome on a backer strip. Thus behind the backer strip sits ¼-inch liner plate material. The hole in the backer strip is a noted inspection finding but it is not a breach in the hydraulic boundary of the tank because of the liner plate. This means that while it will be repaired, it is not a “hole” through the tank liner. Figure 5 depicts a photograph from the Tank 16 report captioned "holes at the top of course F of the upper dome.” The Tank 16 report notes 4 holes in Course F which was reachable from the gauger’s gallery. Course F is a very small region at the extreme top of the tank. The upper tower connections are evident in the photograph and the plate boundary meridians are very close together. The holes are located approximately 50 feet above the maximum fill height of the tank. This means that while they were repaired, they do not represent a release risk because fuel does not reach them.

**14. "The locations of these coupons were identified following LFET inspection and prove-up inspection, as necessary, per the normal tank inspection procedures discussed in Section 3.1.1."** Section 3.1.3.1 at Page 27.

The third step of the TIRM process was not conducted for purposes of the coupon experiment. Navy agreed to halt its repair layout at or near the coupons in order to avoid the appearance of bias in the test results. The layout of repairs, which involves additional PAUT in the area of a repair to identify the full metal thickness required to establish the weld boundary, had not been performed at the time coupons were selected. Navy notified the Regulatory Agencies, prior to coupon site selection that repair data were draft at the time of the coupon selection.

**15. "Although the source of the deleterious chlorides has not been determined by the Navy, there are two likely sources; the surrounding soil or chlorine-laden constituents used to fabricate the concrete (water and/or sand)."** Section 3.1.3.1 at Page 30.

This statement implies there is soil adjacent to the tank liner plates or the reinforced concrete. However it is documented in the construction records that the tank cavities were mined from country rock and the steel liner plates are surrounded by layers of cementious materials: gunite, grout, and reinforced concrete. Furthermore, Navy used an onsite batch plant to prepare the concrete, which was composed of aggregate and sand classified at an onsite classification plant.

**16. "It is clear that the technology, practices, and procedures that the Navy is currently using to assess corrosion damage are inadequate to identify and accurately size the wall loss anomalies." [CITE]**

Navy acknowledges the NDE should have found the metal loss, but there is significance in the findings that DNV-GL report does not explain. The amount of metal loss that exceeded actionable criteria on Coupon 6 was 0.002 inch, or two mils, or approximately the width of an average human hair. The rate of metal loss is approximately 1-mil per year which would take 58 years to reduce in thickness down to the Navy's minimum allowable thickness of 0.100 inch. Regarding Coupon 3, Navy was instructed by the Regulatory Agencies to not prove up the area of the adjacent repair with NDE in an attempt to eliminate the appearance of bias of NDE data on the site selected for laboratory test. The fact that the repair data were draft was identified to all parties at the time of coupon selection. The significance of this is that the metal loss identified on Coupon 3 would have been detected during the third step of the examination, which is prove up of the adjacent repair location.

The significance of the laboratory thickness measurement findings has not been presented. The DNV-GL report acknowledges, some of the data found to be outside the range of expected results would not result in a release (Page 33 "Some of the NDE measurements were conservative"). In addition Navy's position is that metal loss on Coupon 3 would have been detected during repair layout (the third step that was halted in order to perform the coupon experiment), and the metal loss in Coupon 6 was so small that it would not have resulted in a release during the next service interval.

The laboratory tests yielded valuable information about the TIRM process. The information obtained will be used to refine and improve the TIRM. The significance of the tests is not that NDE is unreliable. The regulatory agencies understood the test was performed on a tiny percentage of tank plate in areas specifically chosen (not random), and the test was never intended to be a statistically significant sample size. The significance lies in the information that was obtained and how it is being used to reduce variability.

**17. "API 1163 is an important standard in the oil and gas industry that is key to quantifying NDE tool performance relative to meeting vendor specifications."** Section 3.1.3.4 at Page 40.

Statistical analysis using API Std 1163, which is an industry standard used to qualify inline inspection systems, is misplaced. Inline inspection is used to acquire condition information on inaccessible, direct-bury pipelines. During an inline inspection tools are propelled at speed and use an array of sensors to detect and measure metal loss which is information that cannot be obtained in any other manner. API Std 1163 does not apply to a Red Hill storage tank inspection, and pipeline inline inspection system qualification is not relevant. The coupon testing performed at Red Hill, during which ten square feet (out of approximately 80,000 square feet of surface) was sampled, was not designed for statistical analysis. The DNV-GL statistical analysis based on API Std 1163 using data from ten coupons removed from a Red Hill tank does not support the conclusion that NDE technology, practices, and procedures are inadequate.

A more relevant standard for determining the effectiveness of a tank bottom examination is found in API 653 Annex G, which is “Qualification of Tank Bottom Examination Procedures and Personnel”. The requirements in the Annex are intended to provide additional assurance on the reliability of an examination, but are not intended to quantify the probability of detection. Navy followed principles of Annex G in inspections of Tanks 5, 13, 14, and 17.

**18. Figure 16 at Page 48.**

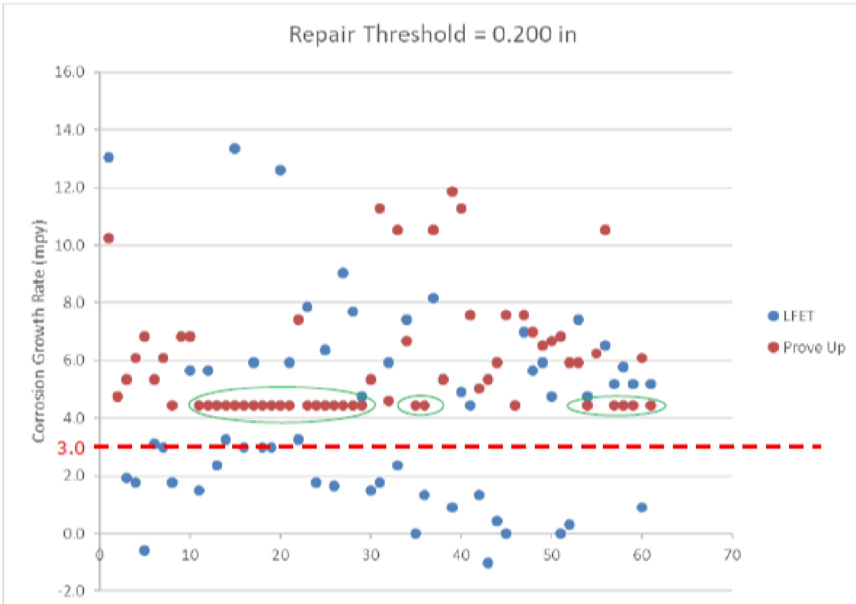


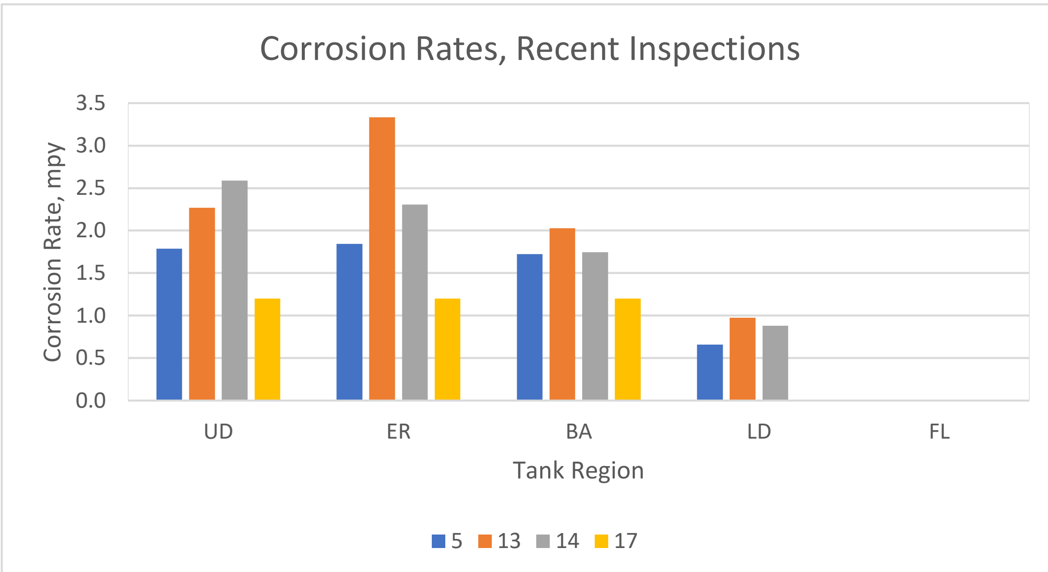

Figure 16. Plot showing the calculated corrosion growth rates for backside corrosion anomalies identified during the 2017 API 653 inspection for Tank 5. Navy's adopted corrosion growth rate tied to reinspection intervals. Note – Data circled in green correspond to measurements that were only reported as "<0.160", such that the data are lower bounds.

The corrosion rates in Tank 5 presented in the DNV-GL report are based on a calculation which used an interval of 6.74 years. During warranty repairs to Tank 5, Willbros Government Services poorly performed work by overgrinding the metal. This resulted in metal loss not due to corrosion. The metal removal performed by Willbros Government Services is depicted typically in DNV-GL Figure 17 on Page 49, which shows a large area of ground metal surrounding a patch plate. 6.74 years should not be used as the corrosion rate calculation denominator in Tank 5 because the metal loss was not caused by corrosion, it was caused by a grinder. The rates reported in Figure 16 are not valid because they calculate a rate of metal loss due to corrosion when actually the metal loss was not due to corrosion.

Navy has recent inspection data for Tanks 5, 13, 14, and 18. The inspection firm performing the work has reported actual corrosion rates. The rates were reported by the maximum metal loss per region of the tank. Maximum metal loss describes a single location on a plate and is not representative of conditions on an entire plate or an entire region. Regions are described as Upper Dome (UD); Extension Ring (ER); Barrel (BA); Lower Dome (LD); Floor (FL). Rates are reported in mils-per year (mpy) which is 0.001 inch per year. With one minor exception, the rates of metal loss were found to align with the 2.9 mpy assumption made during the inspection design. Outlier rates for anomalies such as a product-side pits or non-corrosion related defects (such as a gouge) were not considered when assigning a uniform rate by region. Regardless of rate assumptions made during design, minimum thickness assessments are performed in accordance with the modified API 653 approach that is in the TIRM procedures approved by regulators. Exhibit N-018.

The inspections on Tanks 5, 13, 14, and 17 are the most thorough ever performed at Red Hill. Processes used on these tanks reflect the three-step modified API TIRM approach described in the TIRM Procedures document. The data in the reports and depicted below are based on actual condition information acquired by independent inspectors managed by qualified expert engineers at Red Hill. The technology, processes, and personnel used in these inspections are the best available. Navy has learned information during the inspections and as a result of destructive testing, and that information is being used to improve the TIRM process during the next round of inspections. Relevant corrosion rates measured in the four inspections are consistent with assumptions.

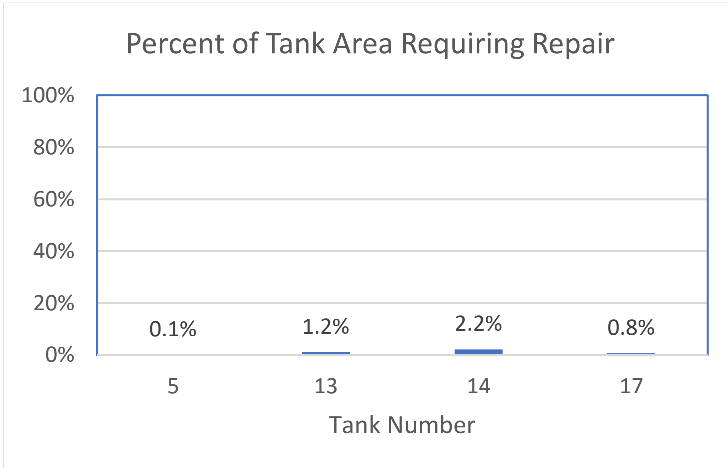
The chart below summarizes reported corrosion rates for inspections performed in 2017-2019 on Tanks 5, 13, 14, and 17. Data for all tanks region Floor, and data for Tank 17 region Lower Dome are not missing but instead were reported by the inspector to be negligible rates which is equivalent to zero.




**19. "DNV GL's opinion is that the tanks are in an end-of-life phase and that a true renewal process is not occurring."** Section 3.1.6 at Page 53.

The basis for the DNV-GL opinion that tanks are at end of life condition and true renewal is not occurring, appears to be that the corrosion allowance for the steel has been exhausted. However, that opinion contradicts the principles of API Standard 653, which require a minimum bottom thickness at the end of a service interval and the use of welded-on patch plates to achieve the minimum thickness. All of the steel renewal work taking place at Red Hill is designed and approved by a licensed professional engineer with substantial experience in inspection and repair of Red Hill storage tanks, who also certifies that the tank is fit for service at the conclusion of the renewal process. So not only is Navy following a recognized industry standard for renewing the storage tank liner material, Navy is following the professional recommendations of licensed engineers with verifiable experience repairing not only Red Hill tanks, but storage tanks around the world, using a process that was approved by regulatory agencies.

The DNV-GL opinion that tanks are at end of life condition is not supported by the results of the most recent inspection, which determined that small areas of each tank required repair due to backside corrosion in Tanks 5, 13, 14, and 17. The largest area of repair was Tank 14 which was 2.2%, and the smallest area was Tank 5 which was 0.1%. The chart below depicts the percentages of the tank area that required repair. Many other repairs are programmed for each tank in an abundance of caution. However the repairs due to backside corrosion, which is the progressive-type of damage that requires repair to renew the liner steel, is taking place in relatively small areas. Thus, the opinion that renewal is not taking place and that tanks are in end-of-life condition is inconsistent with recent inspection information.




**20. Figure 17 at Page 49, Backside Corrosion around existing patch plates**


Photo 29: Backside Corrosion around existing patch plates

Figure 17. Photograph from the API inspection conducted on Tank 5 in 2017 showing backside corrosion (BC) below the repair threshold of 0.160 (requiring repair) adjacent to an area that was previously repaired with a patch plate.

DNV GL's Figure 17 is offered to depict a location of backside corrosion adjacent to a previous repair and evidence of more corrosion. However the conditions depicted warrant contextualization to understand actual conditions and clarify what actually was done.

The previous repair annotated WR69 on Figure 17 is a patch plate installed by Willbros Government Services (WGS) during Tank 5 warranty repair work in 2016. The plate was used to repair two non-corrosion related conditions which were a weld repair and a gouge. At the conclusion of WGS warranty work, Navy re-inspected Tank 5 with an independent firm in a manner consistent with the TIRM three-step process. During the re-inspection, metal surrounding patch plate WR69 was found to have been over-ground and excessive metal had been removed. The LFET technician detected the metal loss and marked the location for examination during the second step of the inspection, which is the PAUT technician. The PAUT technician circled two pits which were tool marks made during the grinding. During repair prove-up the decision was made to remove WR69 patch plate and install a larger plate covering the entire area where excessive metal had been removed. Exhibit N-080.

There was not metal loss due to corrosion at this location. Navy's re-inspection of the area detected a human error (over-grinding) made by the same contractor, and the Navy three-step process led to the identification of metal loss and subsequent repair, none of which was due to backside corrosion. Exhibit N-105.

This poor practice which led to the defects depicted in Figure 17, became evident during the WGS warranty phase. To mitigate against this type of practice from being repeated, Navy included

Paragraph 3.3.1 in Section 33 56 18.00 20, which is Attachment BE of the TIRM Procedures report. Exhibit N-008 at Page 18. The paragraph requires additional thickness measurements to be taken whenever plate grinding must occur. Should thickness be found to be reduced, repair is required.

Executed this 15th Day of January, 2021, Port Hueneme, California

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Frank Kern