Section 5.0 – Project Scope of Work and Inspection Methodology

5. 1 Introduction and background

The project objectives under this contract are to provide mechanical isolation, cleaning, waste disposal, NDE, inspection and integrity analysis for Tanks 5 & 17. Repairs are to be performed under a contract modification as selected and approved by NAFVAC ESC. The scope of work (SOW) includes the tank, components and to the first flange connection on the tank to the first isolation valve. The project scope of work is defined in the NAVFAC SOW document and described in the Willbros work plan and this report.

The project site is located on the Pearl Harbor Naval Base, Redhill Complex on Oahu, HI. The Redhill Tank Complex provides strategic fuel supply to the USN Pacific Fleet. The Redhill Complex contains twenty (20) UST tanks, 100 ft. dia. X 250 ft. high and ancillary equipment. The complex was originally built beginning in December 1940 and construction was completed in September 1943.

5. 2 Project Implementation

All site activities were performed in accordance with the Willbros WP, policies and procedures, applicable federal and local standards, and specified NAVFAC EXWC requirements. In the event that the aforementioned regulations conflict, the most stringent standards will be met. The project WP, SSHEP, HASP, EPP and WDP, submitted under separate cover. All Willbros and subcontractor personnel involved in this project shall review and understand these documents prior to the start of work.

5. 3 Project Specifications

The project specifications listed in Section 3.0 are compiled from the NAVFAC SOW and related contract documents. These project specifications were implemented in the development, design and execution of the project work plan. The project monitored activities to insure compliance with all local, state and federal regulations and Willbros standard policies and procedures.

5. 4 Project Permits and Environmental Responsibilities

Willbros obtained the required gas free certificates after completing the cleaning and gas freeing the tank. Willbros contracted Pacific Commercial Services (PCS) to transport the unusable fuel and wash rinsate to the disposal facility and coordinate the disposal in accordance with regulation requirements.

Willbros obtained the required hot work permits for any hot work task on the storage tank and confined space permits were obtained as needed. A Marine Chemist certified the site condition was gas free and ready for hot work. Willbros coordinated with Federal Fire to obtain hot work permits. No environmental or other permits were required.

5. 5 Tank Inspections and Methodologies

The inspection of Tank 17 at the Red Hill Complex was performed in accordance with the requirements of API Standard 653, *Tank Inspection, Repair, Alteration and Reconstruction*; and as supplemented by the NAVFAC EXWC Statement of Work. The inspections were performed in a safe and professional manner. The inspection, preliminary and final field reports; tank evaluation and integrity analysis are completed in accordance with API 653, applicable general industry practices, codes, standards; federal and local regulations.

Willbros inspected and evaluated the tank's structural tower and catwalk structures after gas freeing the tank. Minor repairs were made tank's structural tower and catwalk structures to replace missing bolts and inadequate structural sections. After all of the structural repairs were completed and checked, Willbros installed two (2) boom systems on the tower structure with man baskets. The man baskets were utilized to access all the internal surfaces areas of the tank for NDE testing and inspection.

Testex performed all of the (NDE) non-destructive examination and testing for the tank shell, upper and lower domes, welds and appurtenances. Testex provided two (2) non-destructive examination and testing (NDE) crews which examined the walls and components for remaining wall thickness readings. Testex utilized three different (NDE) methods as previously performed on the last (5) tank inspections at the Red Hill Storage Tanks. The (NDE) evaluation and testing methods utilized the (LFET) Low Frequency Electromagnetic Technique – Falcon 2000 Mark II and (BFET) Balanced Field Electromagnetic Technique – Hawkeye 2000; and traditional ultrasonic longitudinal and shearwave inspection for proofing areas. Testex developed site specific equipment for the inspection and testing of the Redhill Tanks, along with site specific testing procedures.

The NDE testing and evaluation was performed in accordance with the project SOW which included 100% scanning of courses A, B, C, D, E and F of the upper dome; the extension (including the manway); the tank's shell / barrel (including under Cat Walk); courses 1, 2, 3, 4 of the lower dome; and the floor. The LFET Falcon 2000 Mark II system was used for component scanning for wall thickness and back side corrosion, with UT prove up as needed for actual wall condition or weld quality. The BFET - Hawkeye system was used to evaluate the accessible tank welds for surface and toe cracks. Ultrasonic (UT) shearwave and magnetic particle (MT) color contrast dry particle testing was used for prove up as needed.

The API653 inspector was assisted by Willbros on-site personnel as needed to perform the visual inspection of all accessible tank surfaces. Testex and the Willbros API653 inspector are qualified to ASNT NDE Level II in performing all NDE inspections. The API653 inspector monitored the NDE testing and reviewed the test data acquired for potential areas of concern and to identify areas for follow-up proof UT or NDE inspections.

5.5.1 Historical Record Review

The API653 inspector reviewed the available historical records for the entire tank detailing as much information as possible, including the information as accessible:

- Nameplate Information - tank dimensions, capacity, operating and design pressure.
- Tank Data- original manufacturer, construction contractor, and year of construction.
- All applicable construction standards used.
- A general plan drawing, showing the general arrangement of the major components, and the location and size of all penetrations. Product presently stored.
- Design specific gravity, maximum permissible liquid level and maximum operating temperature.
- Shell material and allowable stress of each shell course to be used in calculations.
- Previous inspection reports, as available.
- List and description of any significant environmental (earthquake, hurricane, etc.) Or operational (over-pressure, vacuum, foundation settlement, etc.) events.
- Description of any repairs or alterations completed (drawings, material test reports/certifications, radiographs attached, etc.)
- All other pertinent information and details.

5.5.2 General Tank Overview

The API653 inspector performed a general overview of the tank for compliance with latest editions of API650, *Welded Steel Tanks for Oil Storage*, API653, *Tank inspection, repair, alteration and reconstruction*, API651, *Cathodic protection of aboveground petroleum storage tanks*; applicable codes and standards; good tank construction, industry standards and operating practices. This includes as applicable, but is not limited to:

- General assessment of the tank site, soil structures, berm, dike and dike drainage, soil conditions and surrounding areas.
- Description of nearby tanks that could possibly affect the tank that is undergoing inspection.
- Description of any signs of over-pressure or vacuum such as shell buckling, distortions, dimpling not accounted for in the historical review.
- Description of any signs of significant natural attack or event not accounted for in the historical review.

5.5.3 Bottom & Lower Dome Inspection

The NDE technicians and API653 inspector conducted examinations and inspections according to the SOW listed in Section 5.0 of this report and API-653. The API653 inspector performed a comprehensive visual inspection on all tank components and recorded all relevant observations.

5.5.3.1 LFET or UT readings and Visual inspection as follows:

- Rectangular plates: 100% Per the NDT section SOW.
- Sketch plates: 100% Per the NDT section SOW.
- Circumferential readings: 100% Per the NDT section SOW.
- Any relevant indications or defects were mapped in the Tank Inspection Report and marked on the tank surface.
- Any relevant corrosion areas were mapped in the Tank Inspection Report and marked on the tank surface.
- In areas where LFET examination indicates loss of material, UT measurement back up is completed to verify extent of underside corrosion.

5.5.3.2 BFET / UT or MT inspection as follows:

- Rectangular plates: 100% Per the NDT section SOW.
- Sketch plates: 100% Per the NDT section SOW.
- Circumferential readings: 100% Per the NDT section SOW.
- Any relevant indications or defects were mapped in the Tank Inspection Report and marked on the tank surface.
- In areas where FFET examination indicated a discontinuity, UT shearwave or MT examination was performed to verify extent of the discontinuity and limits for acceptability.

5.5.4 Shell and Extension Inspection

The NDE technicians and API653 inspector conducted examinations and inspections according to the SOW listed in Section 5.0 of this report and API-653. The API653 inspector performed a comprehensive visual inspection on all tank components and recorded all relevant observations.

5.5.4.1 LFET or UT readings and Visual inspection as follows:

- Rectangular plates: 100% Per the NDT section SOW.
- Sketch plates: 100% Per the NDT section SOW.
- Circumferential readings: 100% Per the NDT section SOW.
- Any relevant indications or defects were mapped in the Tank Inspection Report and marked on the tank surface.
- Any relevant corrosion areas were mapped in the Tank Inspection Report and marked on the tank surface.

- In areas where LFET examination indicates loss of material, UT measurement back up is completed to verify extent of underside corrosion.

5.5.4.2 BFET / UT or MT inspection as follows:
- Rectangular plates: 100% Per the NDT section SOW.
- Sketch plates: 100% Per the NDT section SOW.
- Circumferential readings: 100% Per the NDT section SOW.
- Any relevant indications or defects were mapped in the Tank Inspection Report and marked on the tank surface.
- In areas where FFET examination indicated a discontinuity, UT shearwave or MT examination was performed to verify extent of the discontinuity and limits for acceptability.

5.5.4.2 Tank Shell Measurements
The tank shell was measured in accordance with API-653 for dimensional tolerances. All measurements, including peaking, banding, plumbness and roundness, were performed in accordance to API-653 and recorded in the inspection report and engineering data.

5.5.5 Upper Dome / Roof Inspection

The NDE technicians and API653 inspector conducted examinations and inspections according to the SOW listed in Section 5.0 of this report and API-653. The API653 inspector performed a comprehensive visual inspection on all tank components and recorded all relevant observations.

5.5.5.1 LFET or UT readings and Visual inspection as follows:
- Rectangular plates: 100% Per the NDT section SOW.
- Sketch plates: 100% Per the NDT section SOW.
- Circumferential readings: 100% Per the NDT section SOW.
- Any relevant indications or defects were mapped in the Tank Inspection Report and marked on the tank surface.
- Any relevant corrosion areas were mapped in the Tank Inspection Report and marked on the tank surface.
- In areas where LFET examination indicates loss of material, UT measurement back up is completed to verify extent of underside corrosion.

5.5.5.2 BFET / UT or MT inspection as follows:
- Rectangular plates: 100% Per the NDT section SOW.
- Sketch plates: 100% Per the NDT section SOW.
- Circumferential readings: 100% Per the NDT section SOW.
- Any relevant indications or defects were mapped in the Tank Inspection Report and marked on the tank surface.
- In areas where FFET examination indicated a discontinuity, UT shearwave or MT examination was performed to verify extent of the discontinuity and limits for acceptability.

5.5.6 Tank Foundation Inspection

A survey of the foundation near the outside of the tank could not be performed since the tank is a UST and encased in a concrete / gunite. The condition of any anchor rods, embedment rebars or beams were not accessible for observation or recording.

5.5.7 Tank Appurtenances

The tank nozzles, man-ways, and other appurtenances were examined and inspected for adequacy of wall thickness, reinforcement, weld spacing and corrosion. Observations were made from both the outside and inside of the tank, as accessible. Nozzles were examined for structural adequacy and compliance with

applicable standard. Tank accessories, such as instruments, relief valves and level gauges were examined for functionality and general condition, if possible.

5.5.8 Inspection Checklists

Willbros utilized the API653 Inspection checklists from an Out-of-service checklist during the inspection of TK 17. But due to the fact that the configuration of the tank is a UST tank, the majority (>90%) of the items listed are not-applicable items. All items, components and accessories on the tank were inspected and observations recorded.

5.5.9 Tank Calibration

The tank will be strapped / calibrated after all repairs are completed in accordance with API's Manual of Petroleum Measurement Standards Chapter 2 – Tank Calibration utilizing the Optical Method. A three-dimensional scan of the tank internal wall will be performed utilizing a GPT-3100W Non-Prism Total Station to accomplish a high definition scan. A proprietary computer program will then be utilized to determine precise tank capacities and generate the final tank calibration charts. Gauge Point Systems will perform the strapping, dimensioning and final tank calibration charts.

Note: The tank has various plates with bulges or distortions that are scattered throughout the tank. These areas may have potential for deflections when the tank is placed back into service and filled up to various operational heights. These areas would deflect back in contact with the external concrete / gunite liner which would provide additional plate support. This is not a structural or integrity concern where the plate will deflect back in contact with the external liner. But this may have an impact on the overall accuracy of the tank strapping and calibration charts. Since the calibration charts are based on the volumetric 3D laser dimensions obtained prior to the tank being filled with product and any plates deflecting back into operational position.

5.5.10 Technologies and Equipment

Willbros in conjunction with Testex and subcontractors utilize the most modern technologies available and proven instruments to perform equipment, STI or API 653 inspection and Non-Destructive Examinations. Some of the technologies utilized, but are not limited to, are as follow:

- A TesTex - BFET Hawkeye low voltage remote eddy current scanner to detect surface cracks in metal plates or weld toes. A small handheld unit is used on hard to reach places.
- A TesTex - LFET Falcon 2000 Mark II low voltage remote eddy current scanner to detect back side corrosion or surface cracks in metal plates. A small handheld unit is used on hard to reach places.
- Krautkramer DMS 2 Ultrasonic thickness meters to determine metal thickness. These meters are of the latest technology displaying both a thickness reading for the metal but also a second reading of the coating thickness when measuring through paint. All measurements are electronically stored and down loaded into the API-653 Report Program. All minimum required thicknesses, corrosion rates, tank safe fill heights and tank life before required repairs are necessary.
- Krautkramer USN-60 Ultrasonic longitudinal and shearwave test equipment used to determine or evaluate metal thickness. These test equipment are of the latest technology longitudinal and shearwave test equipment for evaluating material flaws in metal plates and thickness testing. The equipment can be set up for displaying both a thickness reading for the metal but also a second reading of the coating thickness when measuring through paint.
- Thorpe pit gauges when measuring pitting on tank bottoms, shells and roofs. Also when evaluating pitting and corrosion on piping during an API-510/570/653 evaluation.
- Eagle Monitors / REA Systems / Industrial Scientific: Atmospheric testing equipment