# S1740-AK-RPT-010

**0910–LP–118–8301**

# U.S. NAVY SALVAGE REPORT
# EX-USS *PRINZ EUGEN*
# OIL REMOVAL OPERATIONS

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**PUBLISHED BY DIRECTION OF COMMANDER, NAVAL SEA SYSTEMS COMMAND**

**APRIL 2019**

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## FOREWORD

This report on the ex-USS *PRINZ EUGEN* (IX-300) oil removal operation documents the equipment, procedures, and teamwork used by U.S. Navy salvors to remove nearly 229,000 gallons of oil from this submerged World War II – era German heavy cruiser. The whole *PRINZ EUGEN* story is a fascinating one historically. This report provides glimpses of the early history, but focuses on more recent events following the increasingly persistent reports of oil being released by the wreck into the pristine waters of Kwajalein Atoll, Republic of the Marshall Islands. I'd like to highlight below a few of the elements of this offloading operation that I find particularly noteworthy for the Navy salvage community.

This successful salvage operation was a true team effort requiring years of collaboration from multiple agencies including the U.S. Embassy Majuro, U.S. Army Headquarters and Space and Missile Defense Command/Army Forces Strategic Command (USASMDC/ARSTRAT), U.S. Army Garrison – Kwajalein Atoll, Naval Sea Systems Command Supervisor of Salvage (SUPSALV), U.S. Navy Pacific Fleet (PACFLT), Mobile Diving and Salvage Unit, Company 1-8, and Military Sealift Command (MSC). Mobilized to Kwajalein for the long 45-day operation were individuals from SUPSALV and our Emergency Ship Salvage Material (ESSM) Pollution Response contractor, Global PCCI (GPC), along with Navy divers from PACFLT's Mobile Diving and Salvage Unit One (MDSU-1) and the USNS *SALVOR*, as the diving support platform. ESSM/GPC also subcontracted an oil receiving/transport vessel and crew, the MT *HUMBER*. The project was led and planned by SUPSALV's Pollution Program Engineer, Stephanie Bocek, and ESSM/GPC Project Manager, Craig Moffatt. The designated Salvage Officer-In-Charge of the Navy Fleet team on-scene was LCDR Tim Emge, CTF-73. These delegated leaders did an outstanding job integrating the diverse, cross-organizational forces into an effective and efficient team.

The location in Kwajalein presented unique logistical challenges, requiring personnel and equipment virtually from around the world to converge on the tiny island in the middle of the South Pacific and be nearly self-sufficient on the two support vessels for 45 days. However, what was most ground-breaking about this operation was the 173 separate tanks that potentially contained oil requiring investigation - more tanks than have ever been undertaken by any one team during a single-phase operation in the world to date. Extensive research, training, equipment design, and digital modeling enabled the divers to be able to accurately locate and successfully probe the contents of each individual tank. Careful planning, equipment redundancy, and salvor ingenuity were critical.

I congratulate all members of the ex-USS *PRINZ EUGEN* oil removal team for a job well done. I would like to especially recognize ESSM/GPC for their outstanding operational planning, massive mobilization, and for designing and building an innovative hot tap extension tool for reaching internal tanks as well as the Navy divers for their hard work and dedication during the extended operation. This job represented an important step forward for our nation in the field of sunken vessel oil removal. Lest we rest too comfortably on our laurels however, I would point out that the ex-USS *PRINZ EUGEN* could not have offered more benign operating conditions (warm, clear, relatively shallow water in a protected atoll). We must focus on the lessons detailed in this report and strive to improve our capabilities within the Navy Salvage Triad and the pollution response community.

Captain Keith Lehnhardt, USN
Supervisor of Salvage and Diving
Director of Ocean Engineering

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## EXECUTIVE SUMMARY

In October of 2018, a joint U.S. Navy-led team successfully completed a historic oil removal operation on the sunken World War II vessel ex-USS *PRINZ EUGEN* located in Kwajalein Atoll. This team, under the direction of Command Task Force 73 with technical leadership from the Naval Sea Systems Command's Office of the Supervisor of Salvage and Diving (SUPSALV) and sponsored by the U.S. Army Space and Missile Defense Command/Army Forces Strategic Command (USASMDC/ARSTRAT), spent two years researching, planning, and preparing for this unprecedented undertaking: removing oil from up to 173 tanks of a sunken German warship. Due to the wreck's inverted orientation and shallow depth profile, together with nearly ideal diving conditions at the location, this vessel was uniquely situated to make a complex underwater oil removal operation feasible.

With the approval of project funding in April of 2018, the final planning details for removing the oil from the ex-USS *PRINZ EUGEN* were put in place. SUPSALV, and their specialized contractor who manages the Navy's Emergency Ship Salvage Material (ESSM) bases, Global PCCI (GPC), leveraged the experience and technology gained from previous sunken vessel oil removal projects to tool up quickly and identify the remaining logistical requirements. With support from the Military Sealift Command (MSC) vessel USNS *SALVOR* and the deployed Mobile Diving and Salvage Unit (MDSU), Company 1-8 from Pearl Harbor, Hawaii, the joint team conducted over 100 hot taps through the hull of the ship to recover 228,830 gallons of oil. The operation took place from August through October 2018, during which the joint team removed all of the accessible oil entrapped in the sunken vessel's 173 fuel tanks. The main objective of this operation was to eliminate the potential for a major release of oil from the deteriorating wreck since such an event could adversely impact the marine environment, as well as the surrounding human population and U.S. Army property. This objective was successfully accomplished.

The ex-USS *PRINZ EUGEN* is a 697-foot long former German Kriegsmarine heavy cruiser that was taken as a war prize by the allies after WWII and allotted to the U.S. It was shortly enlisted in the U.S.'s Operation Crossroads for use in atomic bomb testing in Bikini Atoll of the Marshall Islands. The ex-USS *PRINZ EUGEN* sank in Kwajalein Atoll in 1946 and is laying bow down in 134 feet of water, while the stern rises up a coral slope with the top of the rudder and part of the propellers extending out of the water. The ship sank with a significant load of ordnance and bunker fuel. The worst-case estimates for the amount of oil onboard when the ship sank ranged from 250,000 to 750,000 gallons.

The first MDSU Company dive team members arrived on 20 August to conduct bottom surveys around the wreck. The SUPSALV and ESSM/GPC team, along with the U.S. Navy 7$^{th}$ Fleet Diving and Salvage Component (CTF-73) who provided the Officer-in-Charge, commenced operations upon arrival in Kwajalein on 28 August 2018. The next several days were spent preparing the wreck for oil removal. This included loading equipment, provisioning, and laying the anchor legs for the two primary support vessels, the tanker vessel MT *HUMBER* and the USNS *SALVOR*. There were no easy tasks in the project; all aspects of the operation demanded the utmost of skills and experience from all team members. With the support of SUPSALV ESSM equipment and personnel, the USNS *SALVOR*, and the MT *HUMBER*, the dive team from the MDSU Company utilized the Tug *MYSTIC* to complete the mooring installations and the rafting of the two primary

recovery vessels by 5 September. The first hot taps and petroleum offloads were completed on 8 September. The last tank to be pumped on the wreck was secured on 13 October. Demobilization was completed by 21 October. The interim period of activity between the first boots on the ground and the last ship's lines to be cast off is a story unto itself that includes thousands of man-hours of grueling, oily work in high tropical heat and humidity, working and living in confined quarters with limited supplies, and a shipwreck full of problems to solve.

Upon completion of the project, it is estimated that the total quantity of oil remaining onboard the ex-USS *PRINZ EUGEN* is approximately 13,300 gallons. All of the original mission objectives for the ex-USS *PRINZ EUGEN* oil recovery project were met or exceeded, and were completed on time and within budget.

There were many lessons learned from the project, and these are covered in this report in Chapter 5. The most poignant of lessons, however, is that shipwreck oil recovery is by nature a messy, potentially dangerous and always challenging endeavor. One of the most alluring and yet difficult aspects of these types of operations is that sunken vessels are always shrouded in mystery. This leads to common questions being raised. How did the vessel sink and what was onboard at the moment it went down? How much of the oil/cargo has subsequently been released to the environment and what remains on the day of salvage/offload? How will the remaining cargo react and how stable is it? Is there live ordnance onboard, and if so, what type and how much? Lastly, for vessels such as the ex-USS *PRINZ EUGEN*, which were used in atomic bomb testing, is there any remaining radioactivity on the hull or associated with any of the cargo?

It is most difficult to prepare for all of the potential variables that one may encounter when poking and prodding into a 72-year-old wreck with as much rich history as the ex-USS *PRINZ EUGEN*. The lesson-learned here is, despite diligent front end research and preparation, operators need to go into these types of operations with the mindset that there will be at least some unknowns and unanticipated discoveries. Therefore, flexibility and innovation are of paramount importance. The ex-USS *PRINZ EUGEN* recovery team certainly had their share of surprises and challenges which are described in detail herein.

Table ES.1 provides some statistical summaries for this complex oil removal operation, including the various quantities of oil collected and the product types that were removed.

Table ES.1. Summary of Findings

| DESCRIPTION | AMOUNT | NOTE |
|---|---|---|
| TOTAL QUANTITY OF OIL RECOVERED FROM EX-USS *PRINZ EUGEN* | 228,830 GAL (820 MT) | OFFICIAL QUANTITY OF OIL AFTER ADJUSTING FOR DENSITY AND TEMPERATURE ON MT *HUMBER* LOADING REPORT. |
| TURBINE OILS | 7900 GAL | TURBINE OILS ARE A HIGHLY REFINED LUBRICATING OIL |
| DIESEL FUEL | 3500 GAL | DIESEL WITH A HIGH PERCENTAGE OF CONTAMINANTS |
| NAVY SPECIAL FUEL OIL | 217,500 GAL | A HEAVY NUMBER 4 RESIDUAL OIL OR A LIGHT NUMBER 5 RESIDUAL FUEL OIL OF WWII VINTAGE. NO LONGER USED BY THE US MILITARY |
| OILY WATER SLOPS RECOVERED | 280,000 GAL | OILY WATER REMOVED FROM WRECK DURING STRIP AND FLUSH OPERATIONS (1060 MT) |
| WATER SLOPS DECANTED | 237,000 GAL | CLEAN WATER FILTERED AND DECANTED OVERBOARD (1003 MT) |
| SOLID OILY WASTE DISPOSED | 4900 LB | CONTAMINATED SORBENT BOOM & OTHER OILY WASTE INCINERATED BY USAG-KA |
| **EXTERNAL CENTERLINE TANKS:** AMOUNT RECOVERED AS % OF TOTAL | 89% | THE TOTAL PERCENTAGE OF OIL RECOVERED FROM ALL CENTERLINE TANKS |
| **WING TANKS:** AMOUNT RECOVERED AS % OF TOTAL | 6% | THE TOTAL OIL RECOVERED FROM WING TANKS AS A PERCENTAGE OF ALL OIL RECOVERED. |
| **INTERNAL TANKS:** AMOUNT RECOVERED AS % OF TOTAL | 5% | THE TOTAL OIL RECOVERED FROM INTERNAL TANKS AS A PERCENTAGE OF ALL OIL RECOVERED. |
| NUMBER OF TANKS TESTED FOR OIL | 159 | NUMBER OF TANKS PRE-DRILLED TO DETERMINE IF OIL WAS PRESENT |
| NUMBER OF INACCESSIBLE TANKS | 14 | NUMBER OF TANKS THAT COULD NOT BE DRILLED OR OTHERWISE TESTED |
| NUMBER OF TANKS HOT TAPPED | 92 | TOTAL NUMBER OF TANKS THAT HAD A FULL SIZE HOT TAP HOLE DRILLED FOR PUMPING |
| TOTAL NUMBER OF HOT TAPS | >100 | SOME TANKS HAD MULTIPLE HOT TAPS FOR INTERNAL TANKS OR DUE TO OBSTRUCTIONS |
| ALL TANKS ACCESSED WITH RECOVERABLE OIL | 95 | SOME TANKS WERE ACCESSED BY MEANS OTHER THAN HOT TAPPING, SUCH AS BY DRILL OR PUNCTURE TOOL WHERE METAL WAS THIN |
| TOTAL QUANTITY OF OIL RECOVERED BY STRIPPING | 43,420 GAL | THIS QUANTITY IS PART OF THE TOTALS LISTED ABOVE AND ACCOUNTED FOR 19% OF ALL OIL RECOVERED |

The remainder of this report provides an enormous amount of information that includes the detailed descriptions of every aspect of the recovery operation, including the planning, the actual tools and methods used on the wreck, the diving issues, mooring systems, weather and environment, and summaries of all products and materials removed. The intent of this report goes well beyond providing a historical record for the archives. The goal is to provide a description of all the facets of the project, with enough detail so that this report is valuable as a guide for future wreck oil removal projects.

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## ACKNOWLEDGMENTS

The ex-USS *PRINZ EUGEN* oil recovery operation couldn't have been possible without the hard work, tenacity, dedication, and innovativeness of the men and women who partook in the planning and execution of the project. We would like to acknowledge the following individuals and organizations for their contribution or participation.

Bob Hiser, U.S. Strategic Command (J4)

Global Energy Overseas, Pte Ltd, especially Mr. Loh Hong Leong, Mr. Victor Wee, Captain Rudy Allen and the brave crew of the Mighty Humber

Global PCCI (GPC) "The Team" for making it happen, on-site and post-project, you guys rock!

Lieutenant Colonel Bradley Van Slyke, U.S. Pacific Command

Lieutenant Commander Timothy Emge, U.S. Navy CTF-73 Salvage Officer and Officer-in-Charge of operations on-site.

Lisa Smith, U.S. Army Headquarters

Military Sealift Command (MSC) and the crew of the USNS *SALVOR*

Republic of the Marshall Islands Ronald Regan Ballistic Missile Test Site on Kwajalein

Senior Chief Charles Kevin Parsons Jr., U.S. Navy Master Diver, "Go Eugen!"

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U.S. Embassy in the Republic of Marshall Islands, especially Ambassador Karen Stewart for her support of the project from the very beginning.

U.S. Navy's Military Sealift Command (MSC) and the crew of the USNS *SALVOR*

U.S. Navy's Office of the Supervisor of Salvage & Diving, with special thanks to Captain Keith Lehnhardt and Mark Helmkamp for their phenomenal support of the team and Kemp Skudin, for his assistance during planning as well as his leadership during the operation.

USN MDSU Company 1-8, for their skill, dedication, tenacity and unwillingness to concede to defeat.

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## CHAPTER 1

# 1. INTRODUCTION AND BACKGROUND

## 1.1. Introduction

The U.S. Navy's Office of the Supervisor of Salvage and Diving (SUPSALV) was tasked and funded by the U.S. Army Space and Missile Defense Command/Army Forces Strategic Command (USASMDC/ARSTRAT) in April 2018 to coordinate an oil removal operation on the leaking ex-USS *PRINZ EUGEN* (PE) vessel sunk in Kwajalein Atoll, Republic of the Marshall Islands. USASMDC, who operates the Ronald Reagan Ballistic Missile Test Facility on the island of Kwajalein near the wreck site, sought to protect both the health and safety of the local people and the environment of the Marshall Islands while also ensuring continued safe and uninterrupted operations of the range.

This tasking came subsequent to a detailed diving survey performed by SUPSALV in May 2017 at the request of the U.S. Indo-Pacific Command (USINDOPACOM). The purpose of the preliminary survey was to analyze the current hull condition and obtain actionable data regarding the location and quantity of any remaining oil in the vessel's tanks due to increased evidence of oil leaking from the wreck. The data collected during the 2017 survey was used to estimate the probability and magnitude of a potential oil release and to provide potential courses of action and cost estimates for offloading the oil to USINDOPACOM. As a result of the findings and recommendations, actions were taken across multiple agencies and organizations to plan and enable this wreck oil removal undertaking for the summer of 2018.

## 1.2. Mission Purpose and Objectives

The primary objective of this mission was to remove all recoverable oil from accessible tanks on the ex-USS *PRINZ EUGEN* and thus eliminate the risk of catastrophic release of any significant volume of oil contained in the wreck in order to protect the surrounding marine environment and population from potential contamination and ensure uninterrupted operation of the Reagan Test Facility. This objective included ensuring that oil was removed from all actively leaking tanks and that each tank where oil was removed was permanently capped and sealed to prevent tampering or leaking of any residual oil that may be left. Lastly, it was important that the wreck was left in a manner safe for continued recreational diving.

## 1.3. Ship History

Beginning in 2016, in preparation for this undertaking, SUPSALV engineers conducted extensive research by gathering ship's drawings, examining historical documents associated with the sinking and the last known loading of the vessel and ultimately building a 3D digital hull model of the sunken vessel to aide in planning. The ex-USS *PRINZ EUGEN* may be one of the most unusual ships to serve in the United States Navy.

The German heavy-cruiser, *PRINZ EUGEN*, was commissioned on 1 August 1940 in Kiel, Germany and had an active career during World War II, responsible for many casualties. One of the more famous battles the ship participated in was the Battle of Denmark Straights, where *PRINZ EUGEN* accompanied the battleship *BISMARK* in sinking the HMS *HOOD* resulting in a tragic, heavy loss of life for the British sea forces. At the conclusion of the war, *PRINZ EUGEN* was one of Germany's largest, most modern, and most famous remaining warships. In 1945, under the Tripartite Naval Commission, the vessel was included in the list of German ships to be divided amongst the three Allied powers and by drawing lots, the famous cruiser along with 7 destroyers were allocated to the United States. The *PRINZ EUGEN* entered U.S. service on 5 January 1946 as IX-300. After studying a number of the innovations onboard, including the boiler configuration which allowed the ship to go from cold to seaworthy in only 45 minutes, it was ultimately assigned to be used as a target vessel in Operation Crossroads near Bikini Atoll in the summer of 1946 (see Figure 1.1).

Figure 1.1. Historical Photo of *PRINZ EUGEN* Prior to Operation Crossroads

The ex-USS *PRINZ EUGEN* was involved in only two of the 22 nuclear tests at Bikini Atoll. The first of these was Test ABLE (1 July 1946) in which a fission-type bomb exploded a few hundred feet above an array of approximately 70 ships. The ex-USS *PRINZ EUGEN* was approximately 1600 yards from surface zero and did not sustain any major damage. The second test (BAKER, 25 July 1946) involved an underwater burst using the same array of 70 ships with the ex-USS *PRINZ EUGEN* 1550 yards from surface zero. A short time later, the cloud of radioactive water and residue from the lagoon bottom reached a diameter of three miles, engulfing most of the ships and then drifted downwind. For about 1 hour, intermittent rainfall brought down more radioactive particles on the ship. Radioactive contamination on exposed surfaces was high, and the ships were left in a condition "hazardous to human life". The only physical effects on ex-USS *PRINZ EUGEN* from Test BAKER were minor flooding of compartments caused by sea valve and rudder post packing damage, resulting in a list to starboard. The ex-USS *PRINZ EUGEN* was towed from Bikini on 20 August 1946, and capsized in a storm in Kwajalein Atoll on 29 August 1946, according to Operations Crossroads reports.

However, another account in other historical documents cite the ex-USS *PRINZ EUGEN* sinking on 22 December 1946 during an attempt to tow her out of the lagoon for inevitable sinking. The tugs lost control in the heavy winds causing the ship to founder and run aground the east reef of Enubuj (Carlson) Island. Despite which account is accurate, the vessel sank and settled in a capsized position near the Enubuj shore where it still rests today.

### 1.4. Ship Characteristics

The structural design of the ex-USS *PRINZ EUGEN* is a welded ship with a combination of longitudinal and heavy web frames divided by 29 watertight bulkheads. The ship's three propellers were driven by three-stage geared turbine sets powered by 12 boilers, designed for a maximum horsepower of 136,000 HP at 32.5 knots.

Full Load Displacement: 19,553 tons with liquid load of tanks at 85% full
Draft at Full Load: 24.5 feet
Length Overall: 692 feet
Depth at Side: 41 feet
Beam: 71.2 feet

There are a total of 173 tanks designed to contain petroleum products. The vast majority of these tanks are easily accessible from the external shell of the hull as the wreck currently lies. However, 30 of these tanks are more internal to the ship requiring advanced tools and more invasive measures to gain access. The exact fuel load on the ex-USS *PRINZ EUGEN* at the time of sinking could not be conclusively determined from the collected historical documentation, but it was estimated prior to this mission to be between 733,896 gallons (least likely) and 215,000 gallons (most likely).

### 1.5. Mission Background

In 1973, Germany requested the U.S. Navy to recover a propeller from the ex-USS *PRINZ EUGEN* in order to be placed in a German memorial museum in Kiel. Almost simultaneously, the Trust Territory of the Pacific Islands requested title to the ex-USS *PRINZ EUGEN* so the ship could be used as a diver/salvage training project with the expectation of a profit from the venture. The Chief of Naval Operations (CNO) requested a survey to be conducted in order to determine salvage value of the vessel, salvage costs, and radiological status of the vessel in order to facilitate definitive Navy replies to these requests. NAVSEA 00C/SUPSALV was tasked and funded to put together a team to conduct this survey in 1974, which is detailed in the paragraph below.

Subsequent to the 1974 salvage and radiological survey, the CNO directed approximately $1M of funds to be included in the FY76 and FY77 budgets to plan and remove the oil from the ex-USS *PRINZ EUGEN*. Preliminary estimates indicated that $140K would be required in FY76 OMN funds to develop a detailed oil offloading plan, procure long lead material, resolve the ammunition hazard, and establish operating technique issues associated with the employment of the new "Hot Tap" equipment. $876K in FY77 OMN funds would be required for execution of the task, mostly for contractor costs under SUPSALV's WESTPAC salvage contract for a 120-

day operation. This estimate did not take into account any Fleet assets that might be used to accomplish portions of the task, and it was budgeted on a purely commercial basis. However, due to competing Navy priorities, the CNO was convinced to reverse his decision to fund an oil removal and the money was reallocated to other programs and the problem remained.

In 1978, one of the propellers was finally retrieved and sent to Germany, and in 1986 the title of the wreck was passed to the Republic of the Marshall Islands at their request. Though the wreck remained of interest to many for the four decades following, it wasn't until 2016 that the Department of Defense took action again, funding an updated survey to be performed in order to assess the current hull condition and obtain actionable data regarding the location and quantity of any remaining oil in the vessel's tanks due to increased evidence of oil leaking from the wreck. The results of this survey are detailed in the paragraph below.

Subsequent to the 2017 survey report and SUSPALV's recommendation to remove the oil as soon as time, weather, and budget permitted, multiple Department of Defense (DoD) agencies, State Department and the U.S. Embassy began obtaining necessary permissions and securing resources, while SUSPALV began the engineering, technical planning and equipment preparation for the eventual oil removal mission.

**Salvage and Radiological Survey – 1974**

The CNO requested a survey be conducted in order to facilitate definitive Navy replies to a request from the Department of the Interior for release of salvage rights to the natives of the Trust Territory of the Pacific Islands and a request from USDAO Bonn for Germany to retrieve a propeller from the ex-USS *PRINZ EUGEN* for a German memorial museum. The tasking was to estimate the salvage costs and value of ex-USS *PRINZ EUGEN*; provide a description of hazards that should be considered in disposing of the ship via salvage, and determine radiological condition of the vessel in sufficient depth to determine hazards to salvage personnel and degree to which metals in the vessel exhibit radiation which may affect materials sold into the scrap market.

Therefore, from 5–19 April 1974, a team comprised of the Pacific Fleet Salvage Officer, nine divers from Harbor Clearance Unit One, one physicist and one technician from the Naval Nuclear Power Unit, and one independent civilian Salvage Master visited Kwajalein and conducted an extensive salvage and radiological survey of the wreck. The results from the salvage survey were that salvage/breaking in place, while technically feasible, was not economically feasible. It was estimated that salvage operations would cost just under $7.5 million (in 1974) and that the scrapping value of the ship was estimated at $1.5 million if delivered at Kwajalein in towable condition. The most significant hazards identified were the large quantities of ammunition (335 tons) including 38.5 tons of torpedoes, that would greatly impede breaking the wreck in place as well as the then estimated 700,000 gallons of oil needing to be removed. The report stated that the potential for oil contamination of the Kwajalein Lagoon was serious and noted two persistent light oil slicks emanating from the wreck at the time of the survey. It was recommended that action be initiated to remove oil from the wreck at an early date to prevent future contamination of the lagoon.

The Radiological Affairs Support Office (RASO) conducted the radiological part of the survey of the ex-USS *PRINZ EUGEN*. Underwater radiation surveys, ship sample field monitoring, laboratory radioactivity analyses, and underwater personnel dosimetry were utilized to determine the radiological conditions of the ship in terms of potential hazards to salvage personnel and suitability of metal for introduction into the world scrap market. No detectable radiation levels, radioactive contamination, or neutron activation attributable to the nuclear weapons tests were found. It was concluded that no radiological hazards would be encountered during future dives and oil removal operations on the hull and outer superstructure area; the radioactivity contents of the metals analyzed were less than 30 percent of the proposed scrap steel radioactivity standard, and less than 0.2 percent of the activity concentration defined as radioactive material for purposes of transportation.

**Oil Sampling Survey – 2017**

As previously mentioned, USINDOPACOM tasked and funded SUPSALV in 2016 to assess the current hull condition on the ex-USS *PRINZ EUGEN* and obtain actionable data regarding the location and quantity of any remaining oil in the vessel's tanks due to increased evidence of oil leaking from the wreck. In the regular course of planning for the detailed survey that was originally scheduled for January 2017, a planning team from SUPSALV and from the U.S. Navy Mobile Diving and Salvage Unit One (MDSU-1) conducted an initial site visit to Kwajalein Atoll from 11–16 December 2016. The purpose of this site visit was to finalize logistic support arrangements, identify local emergency services, reconnoiter the scope of the project, and to identify any local assets that could be used to support a potential oil offload mission on the ex-USS *PRINZ EUGEN*. The site visit included meetings with local support services through the U.S. Army Garrison – Kwajalein Atoll (USAG-KA) and familiarization dives on the ex-USS *PRINZ EUGEN* wreck to assess the overall condition and to validate the hull configuration compared to the original "as-built" drawings and the developed 3D engineering model for accuracy to ensure success of the tank sampling strategy prepared for January's operation. The familiarization dives during this site visit revealed what was thought to be a significantly degraded hull in many areas, necessitating further analysis on how and when to proceed with any further action. Due to the high wind speeds and prevailing direction during the winter months, any escaping product would be driven ashore onto Enubuj Island within minutes should the hull plate give way during further exploration. Therefore, it was recommended to USINDOPACOM in December 2016 that SUPSALV should not proceed with the then-scheduled January survey and that it should be re-scheduled during a better weather window.

As a result, USINDOPACOM directed SUPSALV to plan and execute a detailed diving survey as soon as weather permitted, in order to test underwater drilling tools and methodologies to determine if the ex-USS *PRINZ EUGEN* hull structure could safely support conventional hot tapping approaches. SUPSALV planned and executed this survey from 1–8 May 2017 with a team of nine SUPSALV divers and three Emergency Ship Salvage Material (ESSM) technicians supported logistically by USAG-KA personnel. The primary objectives of the survey were to: 1) determine the structural integrity of the ex-USS *PRINZ EUGEN* hull plating, specifically its ability to hold threaded fasteners used for testing and hot tapping; 2) determine if oil was present in any tanks using a drilling-sampling-plugging method; and 3) if oil was present, collect enough samples to perform a complete laboratory analysis for chemical composition in order to classify the product for disposal options. The team spent 5 days diving on the ex-USS *PRINZ EUGEN*, conducting 17 total dives and accumulating 24 hours of total bottom time during which divers successfully accomplished all mission objectives. This included determining that the hull structure could safely support oil offload equipment and activities and sampling 14 of the vessel's 173 fuel tanks, five of which proved to contain oil of which sufficient samples were collected. However, due to the active and ever-increasing leaking of oil, SUSPALV recommended immediate removal of the pumpable oil from the wreck when the permissions could be obtained and the budget and weather permitted such activities.

## 1.6. Permissions

U.S. Strategic Command (USSTRATCOM) through U.S. Army Space and Missile Defense Command/Army Forces Strategic Command (USASMDC/ARSTRAT), Air Force Space Command (AFSPC), and Air Force Global Strike Command (AFGSC) has critical space missions and Minuteman III stockpile reliability tests that depend on the limited U.S. Army Garrison Kwajalein Atoll (USAG-KA) and Ronald Reagan Test Site resources and infrastructure and hence had a strategic interest in protecting these resources by eliminating the risk of an oil spill from the ex-USS *PRINZ EUGEN*. However, because the Republic of the Marshall Islands government owns the wrecked vessel per the 1986 agreement, but officially stated they would not fund the offload operation, the U.S. government needed to secure both Republic of the Marshall Islands permission to proceed with an offload and Congressional authorization to expend U.S. funds on a foreign owned vessel. On 20 February 2018, the Republic of the Marshall Islands Ministry of Foreign Affairs Office accepted the U.S. Embassy Note 18-018 reaching a nonbinding understanding for the U.S. Government to remove the oil. Furthermore, the FY18 National Defense Authorization Act was passed by Congress with language included authorizing the U.S. Army to fund the removal and cleanup of petroleum, oil, and lubricants (POL) from the wreck. USASMDC/ARSTRAT, working within Army channels, successfully secured FY18 funding and transferred $4M to U.S. Navy SUPSALV and $1.3M to U.S. Navy Military Sealift Command (MSC) for use of the military salvage vessel to support the operation.

## 1.7. Operational Considerations

### 1.7.1. Geographical Location

In a remote part of the South Pacific, Kwajalein Atoll is part of the Republic of the Marshall Islands and the southernmost and largest island in the atoll is named Kwajalein. This is where the U.S. Army Garrison, which operates the Reagan Test Facility previously mentioned, is located, just 3.6 miles from the wreck site. Due to the remote location and limited access to resources, extensive logistical planning was required to ensure that all necessary equipment and supplies were shipped to Kwajalein on time and in sufficient quantities to support the duration of the oil removal operation.

The ex-USS *PRINZ EUGEN* wreck lies completely inverted at an angle of approximately 40 degrees to the shoreline of Enubuj (Carlson) Island within Kwajalein Atoll (see Figure 1.2 below and Appendix A), with the bow resting in approximately 134 feet of seawater and the stern in just 26 feet of seawater with the propellers awash. The wreck is stable in its current condition and rests on a slightly inclined bottom propped up by its own superstructure at an angle of approximately 5–10 degrees list toward shore and 8–10 degrees incline down by the bow. Exact GPS coordinates are as follows:

Bow at approximately 08°45.219' N Latitude - 167°40.954' E Longitude
Stern at approximately 08°45.119' N Latitude - 167°40.999' E Longitude

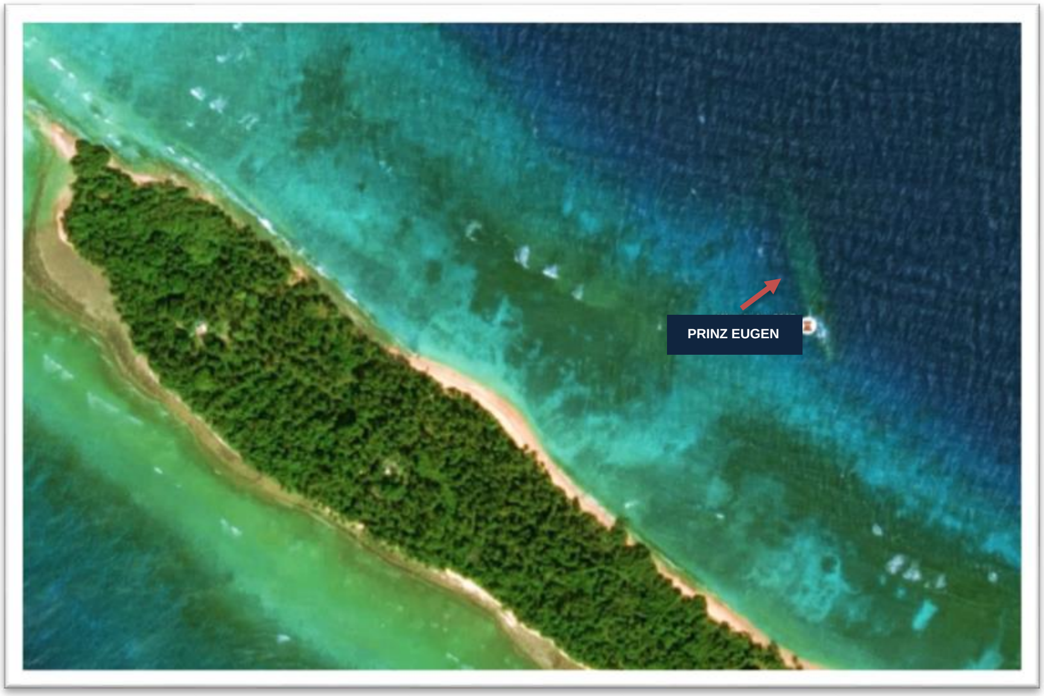


Figure 1.2. Aerial View of the Wreck Site Relative to Enubuj Island

### 1.7.2. Climatology

In order to maximize diving time on station, ensure vessel safety in a moor so near to shore, and ensure effective spill response should a spill occur during the operation, the Atoll's weather patterns were taken into great consideration when determining the best operational window for scheduling this mission. One of the primary factors was the average strength and direction prevailing winds which can be seen in Figure 1.3 below. Based on this information, and the timing of receipt of funding, the operation was scheduled for 1 September through 15 October 2018, not including mobilization and demobilization days.

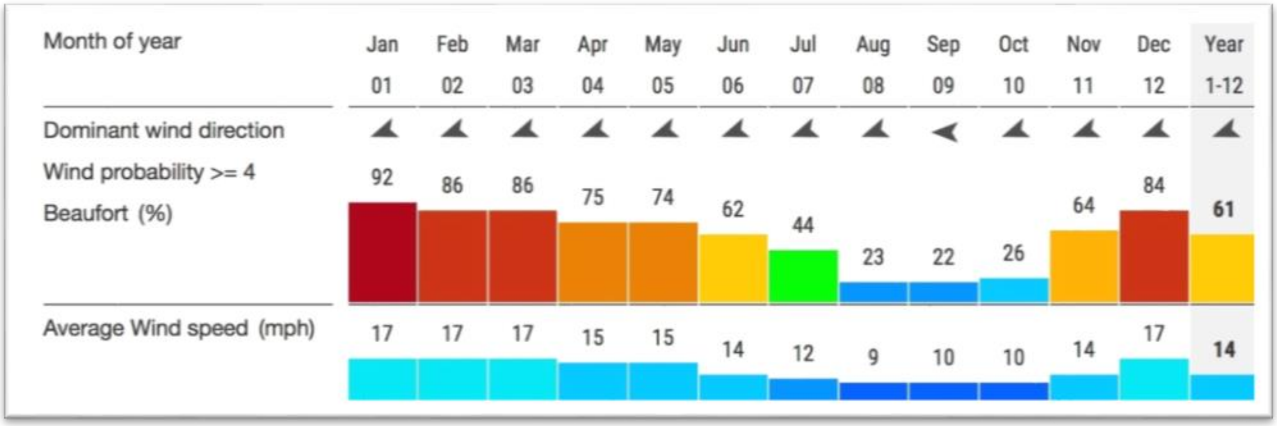


Figure 1.3. Average Annual Wind Conditions for Kwajalein
(Provided by Defense Threat Reduction Agency (DTRA))

### 1.7.3. Ammunition

One of the other important operational considerations taken into account for this mission was the large quantities of ammunition (approximately 335 tons) including 38.5 tons of torpedoes identified in the 1974 survey. However, it was determined that because all diving and operations would take place on the hull of the vessel and not underneath the body of the wreck on the seafloor (where the ammunition is located) that salvage divers and support crew were safe from hazards posed by this remaining ammunition. Strict rules were set and enforced not to disturb the sea floor area surrounding the wreck nor the underside of the wreck itself as a precaution.

# CHAPTER 2

## 2. COMMAND AND CONTROL

As discussed in Chapter 1, multiple U.S. DoD and other agencies were involved in making it possible to remove the oil from ex-USS *PRINZ EUGEN*. The coordination and collaboration took years of work and dedication from both the U.S. and the Republic of the Marshall Islands.

The U.S. Army Space and Missile Defense Command/Army Forces Strategic Command (USASMDC/ARSTRAT), who ultimately funded the oil removal mission, maintained ultimate decision-making authority over the mission goals and objectives. The responsibility to this customer and all coordination with them was maintained by Navy SUPSALV as described in section 2.2 below.

### 2.1. Organizations Involved

The U.S. Army Garrison Kwajalein Atoll (USAG-KA) provided all on-site logistics support services and also maintained command and control over their assets directly involved in the mission. U.S. Navy SUPSALV provided all logistics planning, engineering, support equipment, and the chartered tanker vessel for receiving and transporting the recovered oil for disposal. The Military Sealift Command provided the salvage vessel, USNS *SALVOR*, as the primary diver support platform and the Navy Mobile Diving and Salvage Unit One (MDSU-1), Company 1-8 supplied the divers, diving equipment, mooring planning and execution, and ultimately performance of SUPSALV's oil removal plan. A supplement of six additional divers was also provided by MDSU-1, bringing the total dive team to 20 people. The U.S. Navy Seventh Fleet, Command Task Force 73 (CTF-73) maintained operational control over all U.S. Navy assets while in theatre for the duration of the operation.

### 2.2. Command Structure and Military Tasking

On 27 July 2018, Commander, U.S. Pacific Fleet (COMPACFLT) tasked Commander, Seventh Fleet (COMSEVENTHFLT) in coordination with NAVSEA 00C/SUPSALV to provide sufficient assets to assist in the execution of the planned oil removal operation from the sunken vessel ex-USS *PRINZ EUGEN*. Given the unique technical nature of this mission and as holders of the Technical Warrant for salvage and spill response operations, SUPSALV maintained technical authority over the mission and ultimately determined when each tank was satisfactorily clean, reporting directly to the funding customer (USASMDC) as well as other important stakeholders on mission progress. SUPSALV also maintained operational control of all ESSM equipment, ESSM/GPC personnel, the chartered MT *HUMBER* and crew, as well as all spill prevention and response operations. The on-site SUPSALV Representative released daily situational reports to the stakeholders during operations.

CTF-73 maintained operational control for COMSEVENTHFLT for the overall operation and provided an on-site active duty Salvage Officer-in-Charge (OIC) (see Figure 2.1). The OIC released a daily situational report to the COMSEVENTHFLT and COMPACFLT chains of command. The U.S. Army Garrison Commander maintained operational control of all Army

Garrison vessels, lifting and handling assets, and personnel involved in any of the Garrison's logistical support services. Furthermore, the Garrison Commander was designated to act as the On-Scene Coordinator for any oil spill response should a significant incident occur, as prescribed in the Kwajalein Environmental Emergency Plan (KEEP).

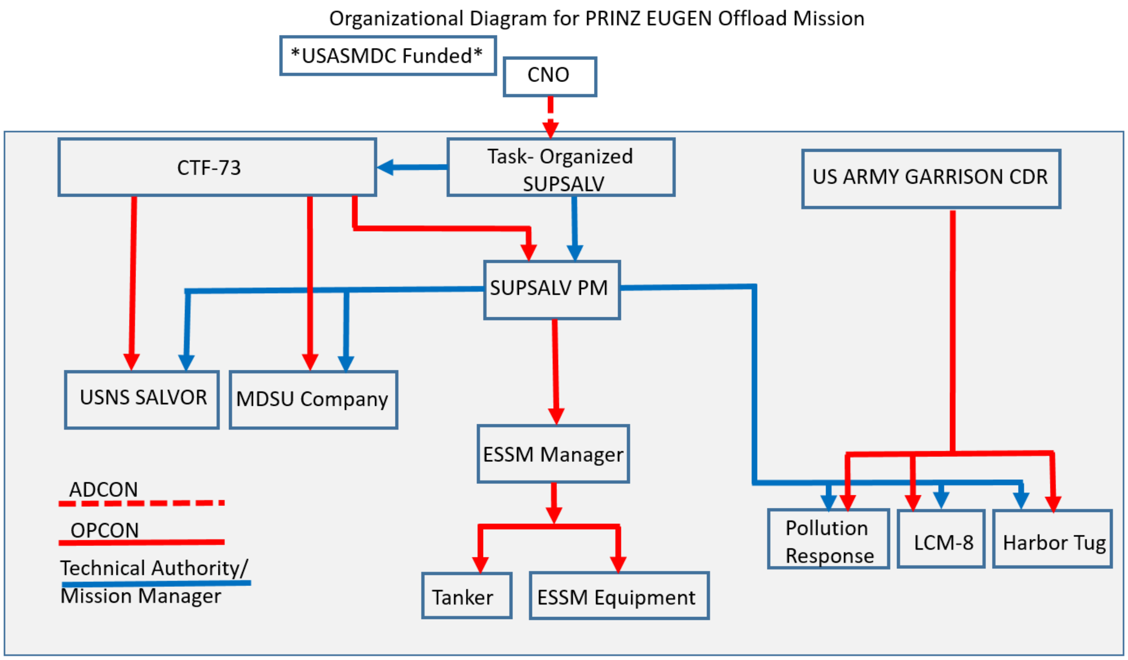


Figure 2.1. Organizational Diagram for ex-USS *PRINZ EUGEN* Oil Offload Mission

### 2.3. SUPSALV and ESSM/GPC Personnel

The core team for SUPSALV and ESSM/GPC was comprised of the personnel listed in the following diagram (see Figure 2.2). Other personnel involved in the project from Navy SUPSALV were Mark Helmkamp, Director of Salvage, Kemp Skudin, Pollution Program Manager, CDR Daniel Neverosky and LT Michael Beautyman, Salvage Officers.

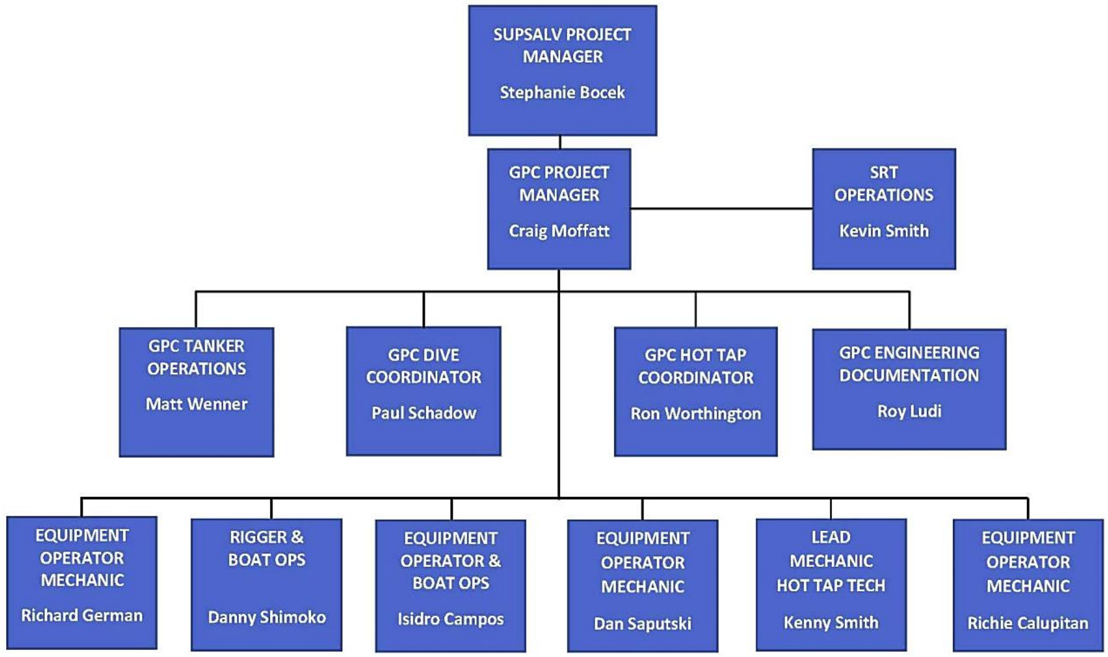


Figure 2.2. SUPSALV and ESSM/GPC Team Personnel

The C7F Salvage Officer-In-Charge (OIC) was LCDR Timothy Emge.

The MDSU Company 1-8 and six supplemental divers consisted of the following personnel:

LT Jibilian (Company Officer)
NDCS Parsons (MDV)
NDC McComas
NDC Jessup
ND1 Slayden
ND1 Johnsonerickson
ND1 Fox
ND1 Mostek
ND1 Pendlton
ND2 Reese
ND2 Penner
ND2 Orbegoso
ND3 Montes
ND3 Dattoli
ND3 Doherty
HM1 Maughan
ND3 Goldberg
ND1 Dalziel
NDCS Howe
ND2 Peters

Several other visitors from various Navy and Army activities also came to observe the operation for short periods of time.

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# CHAPTER 3

# 3. PLANNING AND PREPARATIONS

## 3.1. Scope and Overview

The purpose of this chapter is to outline, with details, the methodologies, procedures, and resources used to plan the oil removal mission on the ex-USS *PRINZ EUGEN* (IX-300). Planning for this project started in 2016 with research into old reports, a review of drawing archives, preliminary planning for surveys, and the initial development of an operations plan. Initial 3D models were developed from copies of original drawings obtained from the National Archives.

A planning team from SUPSALV and from the U.S. Navy Mobile Diving and Salvage Unit One (MDSU-1) conducted an initial site visit to Kwajalein Atoll 11–16 December 2016. The purpose of this site visit was to finalize logistic support arrangements, identify local emergency services, review the scope of the project, and to identify any local assets that could be used to support a potential oil offload mission on the ex-USS *PRINZ EUGEN*. The site visit included meetings with local support services through the U.S. Army Garrison – Kwajalein Atoll (USAG-KA) and familiarization dives on the ex-USS *PRINZ EUGEN* wreck. The familiarization dives were conducted to assess the overall condition of the wreck and to validate the hull configuration compared to the original drawings and the developed 3D engineering models for accuracy to augment success of the sampling strategy prepared for an envisioned January operation. The familiarization dives during this site visit revealed what was thought to be a significantly degraded hull, necessitating further analysis on how and when to proceed with any further action. Due to the high wind speeds and prevailing direction during the winter months, any escaping product would be driven ashore onto Enubuj Island within minutes should the hull plate give way during exploration. Therefore, it was recommended to USINDOPACOM in December 2016 that SUPSALV should not proceed with the then-scheduled January survey and that it should be rescheduled with a different scope and during a better weather window.

As a result, USINDOPACOM directed SUPSALV to plan and execute a detailed diving survey as soon as weather permitted, in order to test underwater drilling tools and methodologies to determine if the ex-USS *PRINZ EUGEN* hull structure could safely support conventional offload approaches. SUPSALV planned and executed this survey from 1–8 May 2017 with a team of nine divers and three technicians supported by USAG-KA personnel. The primary objectives of the survey were to: determine the structural integrity of the ex-USS *PRINZ EUGEN* hull plating, specifically its ability to hold threaded fasteners used for plugging and hot tapping; determine if oil was present in any tanks using the drilling, tapping, plugging and sealing method detailed in this report; and if oil was present, collect enough samples to perform a complete laboratory analysis for chemical composition to classify the product for disposal options. The team spent 5 days diving on the ex-USS *PRINZ EUGEN* wreck site, conducting 17 total dives and accumulating 24 hours of total bottom time during which divers successfully accomplished all mission objectives. This included determining that the hull structure could safely support oil offloading equipment and test drilling of 14 of the vessel’s fuel tanks, five of which proved to contain oil from samples collected.

In April of 2018, SUPSALV received confirmation that funding was forthcoming and the project should move forward. Detailed planning for the operation began and a firm operational date to have personnel and ships on-site by 30 August was distributed.

The following sections of Chapter 3, in most cases, show the original plan and intent prior to actual operations, as well as provide a brief synopsis of what was completed or how operations differed from the original plans. The detailed oil recovery and subsea operational phases are described in Chapter 4 of this report.

### 3.2. Budget

The budget for this project was $4 million for the SUPSALV and ESSM/GPC team to provide contractor labor, all materials, equipment, and subcontracted services (including tanker vessel charter and oil disposal fees), travel and per diem costs, shipping, and USAG-KA support services. The estimated breakdown is detailed below (see Table 3.1). Military Sealift Command also requested reimbursement from the Army for use of their vessel, USNS *SALVOR*, in the amount of $1.3 million. Therefore, the total budget requested by the U.S. Navy from the Army to execute this operation was $5.3 million.

Table 3.1. SUPSALV's Budgetary Cost Estimate for Emergency Ship Salvage Material (ESSM) Contracted Services

| ITEM | DESCRIPTION | BUDGETED COSTS |
|---|---|---|
| ESSM CONTRACTOR LABOR | PLANNING, EQUIPMENT PREPARATION, ENGINEERING, ON-SITE OPERATIONS, AND FINAL REPORT | $850,000 |
| CONSUMABLE MATERIALS | MISSION-SPECIFIC CONSUMABLE HARDWARE, POL TRANSFER EQUIPMENT, HOT TAP SUPPORT FABRCIATION, INTERNAL TANK TOOLS, SORBENT BOOM/PADS, AND OTHER SPECIALIZED TOOLS | $95,000 |
| ESSM EQUIPMENT REFURBISHMENT | LABOR AND PARTS TO RETURN SUPSALV'S GOVERNMENT FURNISHED SYSTEMS AND EQUIPMENT TO "READY-FOR-ISSUE" STATUS POST-OPERATION | $450,000 |

Table 3.1. SUPSALV's Budgetary Cost Estimate for Emergency Ship Salvage Material (ESSM) Contracted Services (Cont'd)

| ITEM | DESCRIPTION | BUDGETED COSTS |
|---|---|---|
| CONTRACTOR TRAVEL AND PER DIEM | COST OF 12 ESSM CONTRACTOR PERSONNEL TO TRAVEL ROUND TRIP AND STAY IN KWAJALEIN FOR 45 PLUS DAYS | $130,000 |
| EQUIPMENT, PROCUREMENT, AND TRANSPORTATION | PROCUREMENT AND SHIPMENT OF EQUIPMENT FROM ESSM BASES IN THE U.S. AND SINGAPORE TO KWAJALEIN, AND RETURN TRIP OF SAME SYSTEMS | $300,000 |
| SUBCONTRACTED SERVICES | COMMERCIAL VESSEL CHARTER FOR RECEIVING AND TRANSPORTING RECOVERED OIL INCLUDING DISPOSAL | $2,100,000 |
| USAG-KA LOGISTICS SUPPORT SERVICES | RENTAL OF THE LCM-8 FOR TRASH COLLECTION, TUG SERVICES, FORKLIFT AND CRANE USAGE, PORT SERVICES, FUEL, PILOT, SYNCROLIFT AND MATERIAL DISPOSAL | $75,000 |
| | TOTAL: | $4,000,000 |

## 3.3. Environmental Planning

### 3.3.1. Diplomatic Note

A Diplomatic (DIP) Note was signed reaching an agreement between the Government of the Republic of the Marshall Islands (GRMI) and the U.S. Government (USG) to waive the environmental requirements for extensive assessments, consultations and permitting under the UES/Compact agreement, to hold the USG harmless from the ex-USS *PRINZ EUGEN*, and allow the USG to take and dispose of the oil from the wreck despite the Republic of the Marshall Islands (RMI) ownership. RMI EPA approved SUPSALV's oil spill response plan for the operation and GRMI concurred with these three stipulations in the DIP Note.

### 3.3.2. Pollution Mitigation Plan and Resources

The overall pollution mitigation plan approved by the GRMI EPA was written to ensure that all spill prevention and recovery equipment was in place prior to any operation that could potentially cause an oil spill. In addition, all operational on-site personnel were to be trained in the basics of spill prevention, containment, recovery and safe handling of oil. The plan included all hull penetration operations (drilling or hot tapping) and subsequent pumping operations to be subject to a strict communications protocol. These procedures were to verify operational readiness of all components of the systems before conducting hull penetrations or pumping operations. Also, during all hull penetrating and pumping operations, an observer was to be placed in an over-watch location where the entire area could be viewed for signs of oil/sheen on the surface of the water.

Due to the nature of the oil recovery from wrecks that have active leaks, having oil on the water is typically a daily occurrence. Once operations were up and running at the recovery site, a primary Spill Response Team (SRT) would be selected from personnel whose duties were not critically involved in the actual process of recovering oil from the wreck. At least one SRT response boat would be in use recovering oil using sorbent boom every day. A second SRT boat would be sent out during larger leaks that required greater response. Both boats would be equipped with sweeping sorbent boom as the primary spill response measure. See Figure 3.1 for SRT boats sweeping oil on-site during the actual oil recovery operation.

Figure 3.1. Both Primary and Secondary SRTs Out Sweeping Oil with Sorbent Boom

The USNS *SALVOR* and MT *HUMBER* support vessels would be equipped with sorbent boom, sorbent pads, debris/trash containers, and heavy-duty trash bags suitable for collecting contaminated oily sorbents readily available on deck and in support boats in order to quickly deploy in response to small sheens that were anticipated during subsea hull penetration operations. It was to be emphasized to divers that prevention was the primary means of pollution mitigation during drilling and hot tapping into the hull and pumping product from the tanks of the wreck. Damage control plugs and epoxies were to be made readily available at each hull penetration site in the diver's tool box for stopping a leak should a hull penetration screw, flange, valve, or hose be broken or otherwise compromised.

All hydraulic and diesel equipment as well as pumping manifolds on deck would be operated within individual oil containment pools. All hose connections on decks also required sorbent material secured around them. Emergency hose shutoff valves, caps, and plugs would be available for controlling flow or plugging deck connections in the event of a failure. All hoses, manifolds, and system components of the fuel transfer system were required to have up-to-date pressure tests conducted. In the event of a hose or pump system leak, all pumps would be immediately shut down, hot tap valves closed, and valves on manifolds closed. There was also an emergency procedure for implementing a safe separation of all hoses from the ships if a weather emergency arose and the vessels had to separate from the rafted position. Isolation valves were to be placed where the hoses could be separated on the deck of the tanker. The lines that tied off the hose to the "hose saddle" were to be cut and the entire hose assembly dropped over the side and allowed to sink to the bottom for retrieval at a later date.

Mechanical recovery equipment was to be pre-staged onshore Kwajalein, ready for rapid deployment in the event of a significant release. This included one Salvage Support Skimmer System which consists of a 20-foot ISO (International Organization for Standardization) container with 1000 feet of 26″ heavy-duty rubber inflatable oil containment boom, 100 feet of 26″ shore-seal boom, boom anchors and light markers, two Skim-PAK suction skimmers, one Oil Mop oleophilic skimmer, one Desmi Mini-max weir skimmer, two peristaltic pumps, one diaphragm pump, two small 15′ inflatable Zodiac boats with outboard motors, two 500-gallon temporary oil storage bladders, and one air compressor. In addition, two 24′ Boom Handling Boats and 4000 feet of 42″ heavy-duty rubber inflatable oil containment boom donated by SUPSALV to USAG-KA were also to be pre-staged on shore. In the unanticipated event that mechanical recovery beyond sorbents was required, the skimmers and oil containment boom from the SUPSALV Salvage Support Skimmer System were to be deployed and operated from the 24′ Boom Handling Boats, the small 15′ inflatable Zodiac boats or from the shoreline of Enubuj Island depending on the situation. Recovered oil would be stored in the 500-gallon temporary oil storage bladders and eventually transferred to MT *HUMBER*. The 1000 feet of 26″ inflatable oil containment boom was to be staged ready for inflation and deployment by response personnel to the spill site should the need arise. This plan was all to be performed in accordance with the Kwajalein Environmental Emergency Plan (KEEP) standards and protocols.

### 3.3.3. NOAA Oil Spill Trajectory Analysis

As part of the planning and preparation for and prior to the start of the fuel offloading operation, the National Oceanic and Atmospheric Administration (NOAA) Emergency Response Division, Hawaii, conducted an oil spill trajectory analysis in the event of a significant oil release from ex-USS *PRINZ EUGEN* in Kwajalein Atoll. This analysis is presented in Appendix B. It was anticipated that the operation would proceed smoothly, but in the event of an actual release NOAA would be contacted for a specific trajectory using actual environmental conditions at the time.

## 3.4. Vessel Selection and Chartering

### 3.4.1. Requirements

It was determined early in the planning to use two vessels, a USN Salvage vessel (see paragraph 3.4.3.2) to be the anchor handling and dive platform, and a commercial vessel to act as the tanker and work platform (see Appendix C for the commercial vessel selection chart). Finding a vessel that met all of the requirements (see below) was not a simple task. Adding to the requirements was the fact that space was needed for the ESSM/GPC portion of the recovery team to live on the vessel. This ruled out many of the tug and barge charter options that were solicited. There were also some critical changes in the industry with regards to double hull tanker and barge requirements. Recovering oil using U.S. Flagged vessels and returning a product back to the U.S. had several problems involved, and it was determined that chartering a foreign flagged vessel that would also be returning to the country of origin for disposal of the oil was the best option.

The task of developing the plans for the ex-USS *PRINZ EUGEN* wreck oil recovery included locating and chartering a vessel that could provide both the required tankage for all of the oil that the team would potentially recover from the wreck, but also to provide the logistics of a work platform and other integrally important logistic functions. SUPSALV and ESSM/GPC decided that the PE recovery team needed to be berthed and messed on-site due to the nature of long hours of the work and the difficulty of finding continuous lodging for people in Kwajalein. The logistics of moving the entire team to and from Kwajalein twice a day would have required more lodging than was available on the island and also would have required more vessels or larger support vessels. The key search items for a charter vessel are shown below.

The basic requirements for the chartered tanker/work vessel were as follows:

- **Capacity**: The vessel must have enough tank capacity to carry 500,000 or more gallons of recovered fuel oil. However, after initial feedback and review of the project, the preference was to have a capacity of no less than 750,000 gallons up to 1,000,000 gallons to allow for water/oil mixtures and slops. The vessel size had to be limited to vessels with no greater than 25 feet of draft as the vessel had to be moored over the wreck and the depth of the keel over the wreck was a critical issue. The overall length of the vessels was also a consideration and vessels over 350 feet in length were not given high priority.
- **Berthing**: The vessel must be able to accommodate berthing and messing for up to 13 people for the duration of the on-site contract.
- **Mooring**: The vessel must have the capability of being placed into a multipoint mooring, preferably with the ability to self-moor.

- **Cost**: The overall contract cost was capped, so potential charters costing more than $1.5 million were put into a lower priority in the selection process.
- **Oil Disposal**: Companies that had the ability to offer recovered oil disposal as part of their contract were giving higher priority in the selection process.
- **Seaworthy**: The vessel must have the seaworthiness to travel to the Republic of the Marshall Islands and back from their port of origin.
- **Deck Crane and Space**: The vessel must have the capability and deck space to allow for equipment and personnel to work on the deck. It was also considered imperative that the vessel have a deck crane capable of reaching anywhere on the main deck with a minimum capacity of 6000 pounds and be able to handle basic deck cargo handling tasks.

### 3.4.2. Market Search

Over 30 companies were solicited to obtain proposals for charter. Ultimately, the 30 proposals were narrowed down to 15 vessels. These vessels were recorded and summarized in Appendix C. The average proposal based on all 15 proposals was 2.12 million dollars. The proposal selected was approximately 1.2 million dollars. Most proposals did not have oil disposal costs included. Some of the proposals did not have a berthing option included on the support vessel. There were several vessels that operate in the global oil drilling market that would have been excellent candidates, but the charter costs were significantly higher than average and the companies were reluctant to let their ships go on charters for a short duration (three month charter) when they would be losing out on the potential for 6 month to 2 year charters with some of the big oil companies.

### 3.4.3. Selected Vessels

#### 3.4.3.1. MT *HUMBER*

Global Energy International Ltd (GEI) (Contracted as Global Energy Overseas Pte Ltd (GEO)) provided a proposal that was cost efficient (50% of the cost of the average proposals) and technically viable. The MT *HUMBER* (see Figure 3.2) was selected as the most technically competent selection that came in with a proposal that was within budget, included berthing, had sufficient cargo space to be able to store the worst-case oil recovery quantity, and had operational space onboard the vessel. The selection also incorporated the cost to dispose of the recovered oil in the charter price.

General Characteristics:

| | |
|---|---|
| Company: | Global Energy Overseas Pte Ltd<br>(Original Parent Company Global Energy International Ltd)<br>438 Alexandra Road<br># 13-01 Alexandra Point<br>Singapore 119958 |
| Flag: | Singapore |
| Type: | Double hulled tanker |
| Propulsion: | Diesel, two, 1282 horsepower each |
| Generators: | Diesel Generator, three sets, 375 horsepower each |
| Bow thrusters: | Tunnel type, 470 horsepower diesel driven |
| Length overall: | 294 feet |
| Beam: | 52.5 feet |
| Displacement: | 3,283 tons (2,978.2 metric tons) full load. Dwt 4633 Tonnes |
| Draft: | 13 feet |
| Berthing: | 16 crew and up to 12 personnel |
| Cargo capability: | 1,078,000 gallons in eight tanks |


Figure 3.2. MT *HUMBER* as seen from USNS *SALVOR* before vessels was rafted together over the wreck in Kwajalein Atoll.

### 3.4.3.2. USNS *SALVOR*

The USNS *SALV*OR (see Figure 3.3) is a Safeguard class rescue and salvage ship operated by Military Sealift Command to render assistance to disabled ships, provide towing, salvage, diving, firefighting, and heavy lift capabilities to the U.S. Navy Fleet.

General Characteristics:

| | |
|---|---|
| Propulsion: | Four diesels, two shafts, 4,200 total horsepower |
| Length: | 255 feet (77.7 meters) |
| Beam: | 51 feet (15.5 meters) |
| Displacement: | 3,283 tons (2,978.2 metric tons) full load |
| Draft: | 16 feet 9 inches (5.11 meters) |
| Speed: | 14 knots (16.1 miles, 25.8 km, per hour) |
| Range: | 8,000 miles (12,872 km) at 8 knots (14.8 km/hr.; 9.2 mph) |
| Depth: | Diving depth: 190 feet (57.9 meters), using air |
| Crew: | 28 civilians, up to 35 mobile diving and salvage unit members |
| Salvage capability: | 7.5-ton capacity boom forward; 40-ton capacity boom aft. |
| Heavy lift: | Hauling force capable of 150 tons |

Figure 3.3. USNS *SALVOR* (Stock Photo)

### 3.4.4. Ship Checks in Singapore

A SUPSALV and ESSM/GPC team consisting of USN SUPSALV representative Kemp Skudin Pollution Program Manager, and ESSM/GPC Contractors Craig Moffatt and Ron Worthington traveled to Singapore in June 2018 to coordinate the assimilation of assets for the project. There were several high priority purposes accomplished during the trip including:

- Met with key personnel on Singaporean Military Base Sembawang to solidify the mooring plan for the ex-USS *PRINZ EUGEN*. Key personnel included were USN CTF-73 Salvage Officer, USN MDSU Detachment Master Diver, SUPSALV Salvage Representative Richard Thiel, Captain Matt Hoag of the USNS *SALVOR*, and MSC Salvage Master Diver representative. The visit included several meetings with the Navy and commercial assets that were going to be used in the project.
- Conducted a ship check of the USNS *SALVOR* including verifying the electrical connections, deck space, salvage gear, hydraulic power units, and the mooring jewelry onboard.
- Conducted equipment staging and inspection at ESSM Base Singapore. ESSM/GPC personnel were at the base the same week conducting Salvage and Pollution scheduled maintenance work. ESSM/GPC personnel were given the list of equipment and instructions on what to stage for the PE project. It was determined that all equipment coming out of Singapore would be loaded onto the USNS *SALVOR*. All transport and loading would be performed under the purchase order by Golden Oversea Engineering Co. (the ESSM Base subcontractor in Singapore). The first meeting was with ESSM Base Singapore Contractor Alfred Ong of Golden Oversea Engineering Co. and a visit to ESSM Base Singapore to pull and stage ESSM anchors, fenders, and mooring equipment for the project.
- Met with the owners of the tanker company Global Energy International Ltd (ESSM/GPC later contracted with Global Energy Overseas Pte Ltd which was a subsidiary of GEI for the purpose of the tanker charter). Three separate meetings were held to discuss the details of the project and the potential charter of the tanker MT *HUMBER*.

### 3.4.5. Electrical Power Planning and Preparation

Planning and preparation for the operation included determination of electrical power requirements and the available shipboard power and power outlet/receptacle locations on the USNS *SALVOR* necessary to provide electrical support. A ship check of the sister ship USNS *GRASP* was conducted at her homeport of Norfolk, Virginia to obtain a hands-on assessment of the electrical layout of the ship class.

Subsequently, the ESSM/GPC electrical team contacted and worked with the current Chief Engineer of USNS *SALVOR*, David W. Scarberry Jr., to identify similarities and differences between the vessels. With pictures provided by Chief Engineer Scarberry, electrical material was ordered to match and reach shipboard receptacles (see Figure 3.4, Figure 3.5, and Figure 3.6 below). A longer power supply cable was assembled with a 40-A plug for the transformer to ship receptacle connection. Also, a special 60-A Hubbell plug was obtained for alteration of the existing HPU power cable for connection to the ships 60-A receptacle.

The 480-V, 60-A connection was used to supply power to the Electric Hydraulic Power Unit. The 480-V, three-phase 25-A connection was used to supply power to the ESSM/GPC fabricated 480/220 step-down transformer. The ESSM transformer provided the power to the ESSM Shop Van and the ESSM Hot Tap Van that was located on the stern of the USNS *SALVOR*. The ESSM containers on the tanker MT *HUMBER* were not powered with electricity due to tanker safety regulations.

Additionally, four spare Navy Standard 450-V boxes and some spare 25-A breakers on the Tow Deck and in the Machine Shop were available onboard USNS *SALVOR.* Enough cable was provided by ESSM/GPC to install one in a more suitable location and closer to the after end of the Tow Machinery Room.

Lastly, all electronic support equipment, radios, chargers, and rangefinder, as well as underwater drills, grinders, thickness gauges, and other electrical tools and equipment were prepared for the operation by the ESSM/GPC Electric Shop.

Figure 3.4. 60-Amp Outlet for the HPU Located Above the Tow Winch Control Booth


Figure 3.5. 25-Amp Navy Standard Connection Just Below the Tow Winch Control Booth

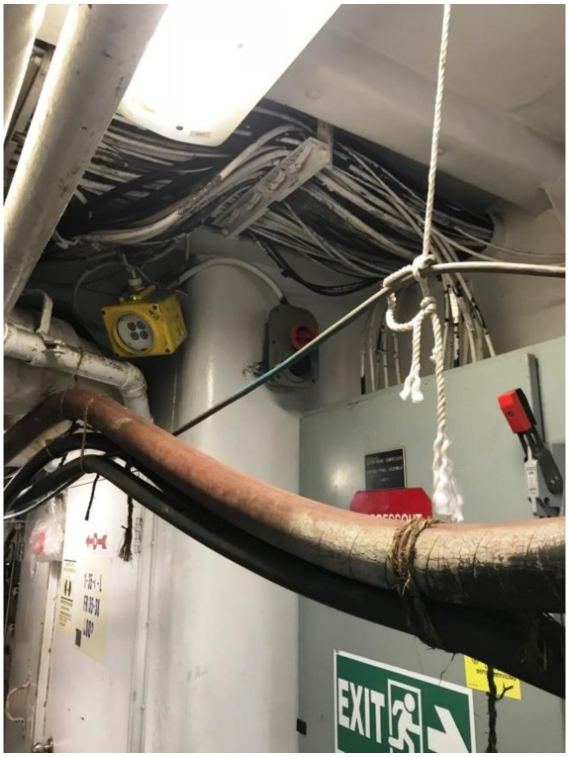


Figure 3.6. Second 25-Amp Navy Standard Connection Located Farther Inside by the Entrance Doors to the Machine Shop

### 3.4.6. Berthing and Messing

ESSM/GPC paid (as a sub-component line item in the charter contract) to have berthing on the tanker for up to 13 personnel and also paid to have food provisions and a cook provided specifically to handle the ESSM/GPC recovery team's meals.

### 3.4.7. Provisions and Resupply

Due to the unique and remote location of the project, the U.S. Army Garrison on Kwajalein was the entity who took care of incoming provisions to the island. Provisions had to be ordered 90 days in advance and there was no place on the island to receive or order food provisions other than the long lead provision request. The USNS *SALVOR* required a regular resupply of potable water due to the concern that the ship's water maker would become clogged if used in the environment where there was constant oil leakage from the wreck. A special cofferdam and hose was installed on the suction water inlet of the USNS *SALVOR* by the MDSU divers for the purpose of placing the inlet in a deeper position for freshwater intake. The USNS *SALVOR*'s provisions included no less than two pallets of bottled water per week delivered to the ship on the regular provision, and trash run by the U.S. Army's LCM. The MT *HUMBER* ordered one pallet of water during week 5 of operations, but all other water and food stocks, with the exception of fresh vegetables and milk, were pre-provisioned. However, supplies did run very low and many luxury and perishable items ran out near the last 2 weeks of the operation.

### 3.4.8. Structural Modifications

A temporary modification was made by GEO to reinforce the deck plating on the MT *HUMBER* for the support of the two 20-foot ISO containers that were put on onboard by ESSM/GPC in Kwajalein. The structural supports consisted of a heavy steel plate and chain tiedowns pre-staged on the decks.

### 3.4.9. Recovered Product Disposal

Recovered product disposal and tank cleaning costs were provided under an augmented list of agreements that went with the charter agreement as negotiated in Singapore between ESSM/GPC and GEO. In other words, the Charter portion of the contracts was specifically for the use of the vessel. All other agreements were line itemed separately and a PO was issued for each set of items that were invoiced by GEO. The agreement was that GEO would dispose of all petroleum products recovered up to 300,000 gallons for a fixed cost. Treatment of any oil water slops would have to be paid for separately. Cleaning of tanks on the tanker would be paid for as an additional fixed cost determined in the line items of the agreements.

## 3.5. Waste Disposal

Waste disposal was in accordance with federal and local regulations as well as the requirements set forth in the permit agreement. Trash and other solid waste from the "hotel" functions of both vessels were picked up three times a week on a scheduled run made by one of the USAG-KA LCM 8 "Mike Boats" chartered from USAG-KA by SUPSALV (see Figure 3.7).

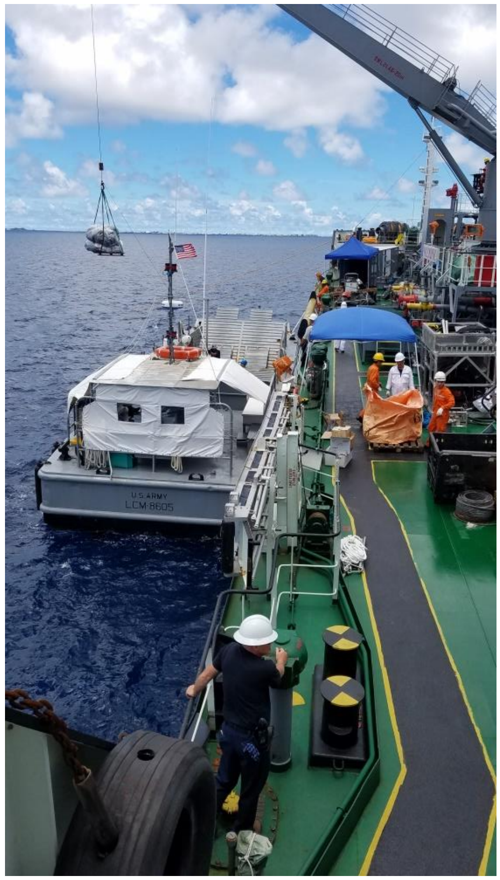

Figure 3.7. Waste Disposal Pick-up by One of the "Mike Boats"

### 3.5.1. Oily Water

All oily water collected over the course of the mission was stored in the onboard number 4 starboard "slop" tank on the MT *HUMBER*. The "water bottoms" of this tank were pumped out (decanted) every night at the end of operations after the contents had a chance to settle and separate. The water that was offloaded was pumped through a series of oleophilic sorbent filters to ensure that no oil was returned to the Atoll. The oil remaining in the slop tank was measured daily and accounted for periodically in the totals for oil onboard.

### 3.5.2. Solid Oily Debris

Solid waste such as sorbent boom and sorbent pads was collected and bagged in large heavy-duty bags onboard the MT *HUMBER* by ESSM/GPC personnel and were picked up regularly on the U.S. Army “Mike Boat” trash run. The oily debris was delivered to the USAG-KA for later incineration by USAG-KA. All oily waste debris was bagged, labeled, and separated so that no oily waste was mixed with any other refuse. Figure 3.8 shows ESSM/GPC personnel removing oily boom from the water.

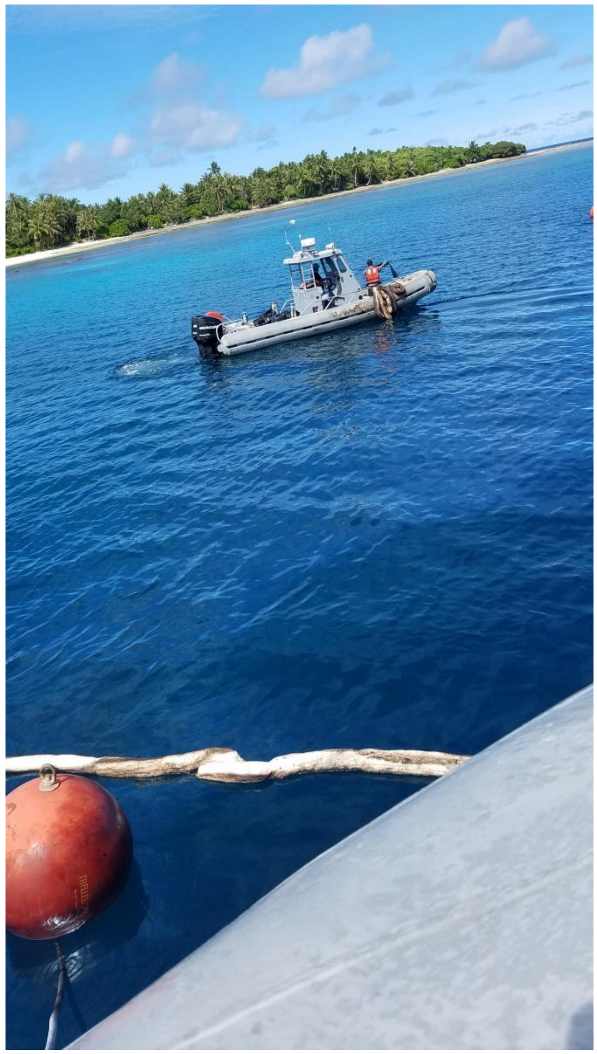

Figure 3.8. Oiled Sorbent Boom Being Recovered Onboard the ESSM 25′ Rigid Hull Inflatable Boat (RHIB)

### 3.5.3. Human Refuse

Disposal of accumulated food waste generated onboard each vessel at the wreck site was coordinated through the USAG-KA and picked up via the same “Mike Boat” run as the oily waste. Garbage or food waste was not disposed of overboard in the Atoll under any circumstances. All garbage was packed into clear, heavy wall, industrial size plastic bags and picked up every 3 days by the “Mike 8” boat for disposal at the U.S. Government approved facility on Kwajalein.

#### 3.5.4. Vessel Waste Water

Both support vessels (USNS *SALVOR* and MT *HUMBER)* processed sewage and waste water in the onboard respective treatment plants and discharged overboard (under a special provision by the Army) in the evenings when the onboard storage units were full.

### 3.6. Drawings and Modeling

Due to the sheer number of fuel oil and other petroleum tanks on the wreck, and the difficulty in obtaining complete drawings, it was determined early in the planning phase to develop 3 dimensional models from the drawings that were available. Some of these models are shown in Appendix D and other locations in this report including section 4.7. The effort and detail required to develop 3D models (see Figure 3.9) was exhausting, but the rewards payed back in aces because the development of these models enabled engineers and planners to develop the grid system (see Appendix E) and the internal tank tools (see paragraph 3.8.8) that were critical to the wreck project. Once a hull model is developed correctly, many more models can be derived from the base model. The models have become a vital tool for shipwreck planning due to the incredible amount of very accurate information that can be obtained and turned into real world tools and plans. Figure 3.9, Figure 3.10, and Figure 3.11 below show a few of the areas that can be exploited from hull models.

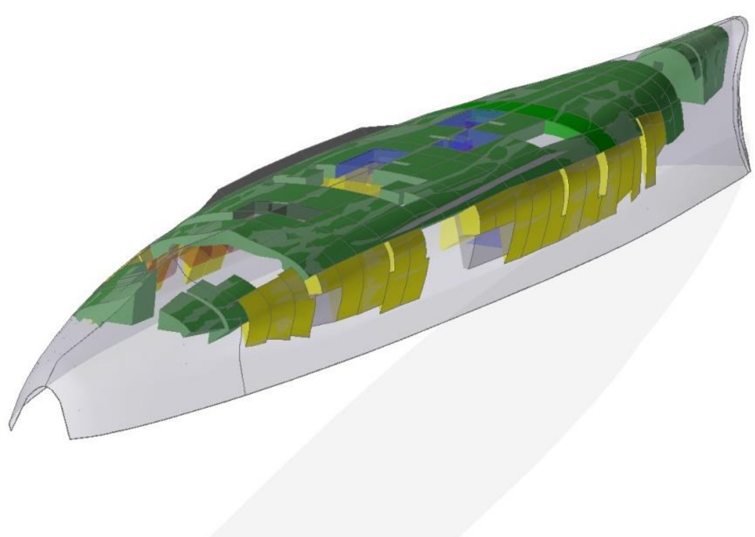

Figure 3.9. Isometric 3D Model Showing Ship Hull Looking Forward
The entire tank drill hole locating grid systems was developed using the ship model.

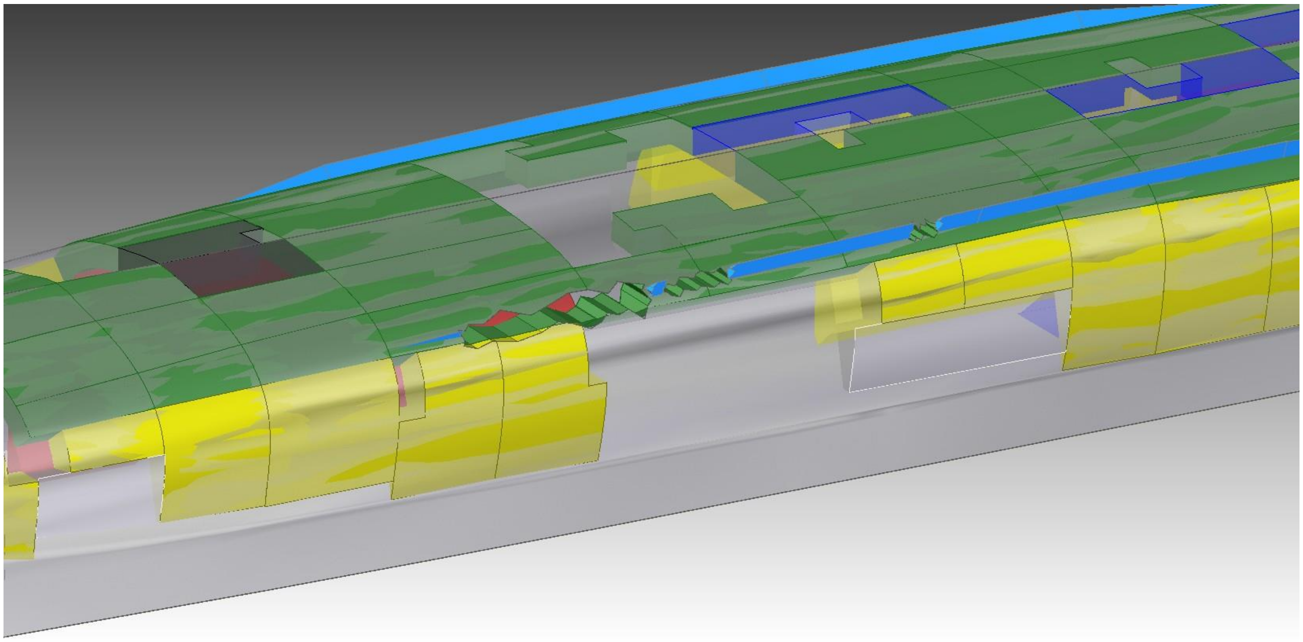

Figure 3.10. 3D Model Showing the Location of Damaged Hull Sections
Port Side Aft along Bilge Keel
Damaged ship areas (though not details of the actual damage) and internal tank locations were drawn in 3D models to assist with planning tool design as well as to determine oil estimates.

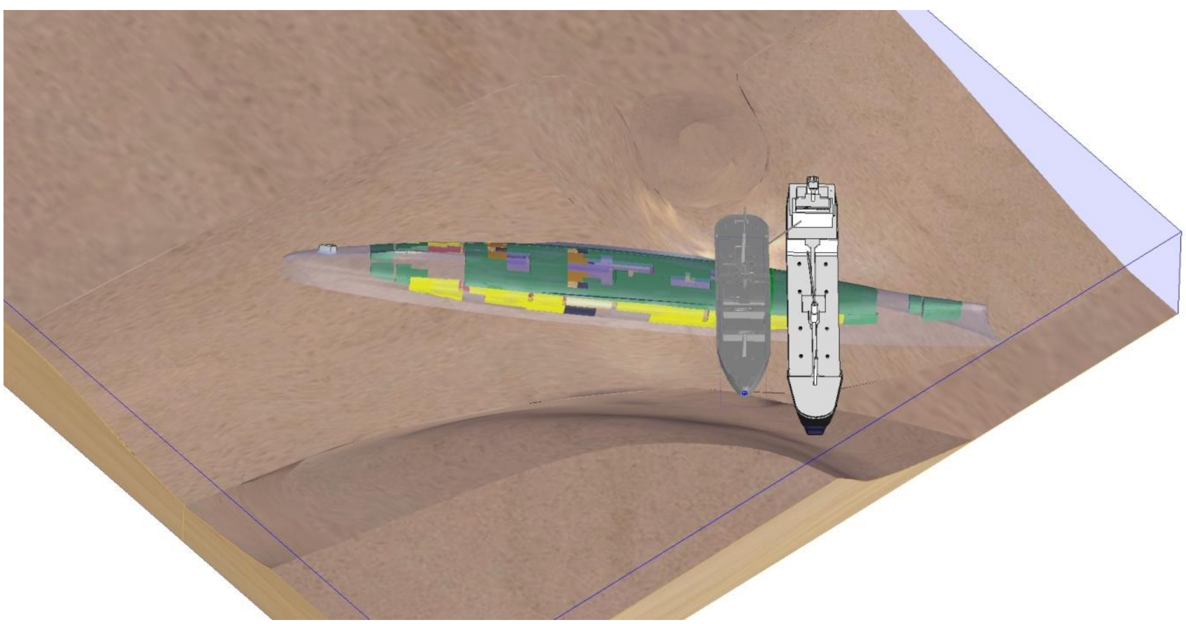

Figure 3.11. 3D Model of Bathymetry around the Wreck
The image was developed from bottom depth estimates and used in early planning.

## 3.7. Planning for Oil Removal

### 3.7.1. Locating, Testing, and Hot Tapping

#### 3.7.1.1. Vessel Marking and Navigation Grid System

The original operations plan called for a bolt-on padeye type clamp to be used to fasten the backbone of a flexible wire grid system along the bilge keels, the centerline keel, and athwartships at the thirteen major tank divisions (I–XIII) as shown on the original vessel drawings. In addition, to avoid confusion, the intent was to primarily hot tap in one section of the hull at a time, beginning with the centerline tanks in Section IV and moving forward to Section XIII, and then move back aft to the centerline tanks in Section I, II, and III completing wing tanks along the way. The original plan was to complete the more difficult internal tanks last and as time permitted. However, to reiterate the famous quote by Heluth von Molkte, "no plan survives the first contact with the enemy" proved no less true here, but the plan was not far off. It was thought that Sections I, II, and III were so significantly compromised and wasted that they were unlikely to contain much if any oil, which was partially true as many of the tanks were empty on the port side, but the three sections combined still held more than 10% of the recovered oil.

For the grid system to be accurate, large protruding concretions and coral heads had to be removed in order for the grid to lay true on the hull and assist divers in locating the high points on the tanks to drill and remove the oil. It was originally planned that removal would be accomplished upon the start of the formal project in September, but hull cleaning actually began in August, and divers started clearing Section IV and the bilge keel per direction from SUPSALV. Removal and relocation of species was performed in accordance with environmental best practices and as time allowed.

Prior to diving, the intention was to have a re-orientation with the divers regarding installation of the grid system including how to identify hot tap locations. In practice, ESSM/GPC met first thing in the morning usually between 0630 and 0700 on the tanker and then met with CTF-73 and MDSU on the USNS *SALVOR* to go over the plan of the day. The Master Diver conducted a morning brief for the divers going to work on the bottom each day, which included a layout of the day's plans and review of tools needed for that day.

The pre-made grid of flexible wire and braided line was laid and attached on the wreck's hull surface in order to partition the hull sections corresponding to the original German tank segmentation scheme. This portion of the operation went generally as planned. The initial starting point of the grid system (the baseline) was the readily identified aft end of both bilge keels and the centerline of the main keel. Problems did arise during the early flange mounting and tapping operations when it was realized that the grid system was laid 10 inches too far forward because the beginning of the bilge keel was actually not physically located at the same frame as that shown on the German Hull Expansion Plans.

Grid lines for the tanks in Sections V–XIII were established using the forward grid line or point of the previous section as the base point (e.g., the forward end of the grid for Section IV became the aft end of Section V) as the grid and hot tapping process moved forward “downhill” on the hull.

#### 3.7.1.2. Hot Tapping Plan

Once the highest point on a tank was located using the grid, the original plan was to clean a 3 foot x 3 foot area thoroughly using the hydraulic chisel, a chipping or brick hammer, hydraulic grinder, battery operated grinder, hand scraper, or combination of these tools to remove the dense marine growth. By the end of the project, most of the cleaning was performed with the hydraulic grinder and a hammer to remove growth and crustaceans. It was difficult to achieve “shiny metal” level clean surfaces and even when the surfaces were cleaned well, there was severe pitting that caused holding problems for the magnets. Early in the operation, the cleaning area was reduced from 3 foot square to approximately 27 to 30 inches in diameter with the “test hole” in the center. It was found that this was large enough for the flange and magnets (refer to section 3.8, Subsea Tools, for more discussion about tools used).

After initial cleaning, the area was to be sounded with a hammer to ensure that the hot tap final location was not located on a frame member or a weld seam. In actuality, divers were not able to consistently sound the tanks for frames successfully and many flanges ended up on frames.

The 4-inch hot tap flange was designed to attach to the hull using self-tapping screws on the hull plate. The hot tap attachment consisted of the 4-inch valve assembly threaded onto the attached flange and was tightened using a large pipe wrench. The hot tap assembly was then attached to the valve using the camlock fitting with the integral Teflon hard gasket. The hot tap pilot/cutter was manually fed until it was flush against the hull surface. The hydraulic drill was fitted to the drive spindle and the pilot hole then drilled by the dive team. Hot tap drilling continued with the 3.5-inch cutter head. On the surface and in practice, the drilling was completed when noted by the sound and feel, resistance of the spindle, and back pressure feed, as well as the dramatically decreased hydraulic pressure, at which time the hot tap cutter was fully retracted, the valve closed, and the hot tap machine removed from the valve. For the divers on the bottom, it was all about feel, vibration, and resistance on the feed handle to know when the hole saw was through the hull completely.

### 3.7.2. Pumping

In order to reduce the possibility of an accidental petroleum discharge, deck spill, or dangerous scenario with combustible products on the tanker or subsurface, all fuel transfer operations protocols were designed to adhere to a strict procedure that was adapted from standard industry petroleum transfer practices set forth by the Oil Companies International Marine Forum (OCIMF) and published in the International Safety Guide for Oil Tankers & Terminals.

The OIC on the tanker was technically the First Officer of the ship, but ESSM/GPC took over this role. As the receiving vessel for all fuels and fluids being transferred, it was the OIC's responsibility to ensure that the vessel tanks were prepared by confirming that the hoses and piping on the vessel were intact, receiving tanks had vents open and had adequate volume available, and conditions were safe and secure prior to every pumping sequence. All pumping operations followed the same procedure. It was anticipated that ESSM/GPC personnel would run all equipment and defer to the chief mate of the tanker for the final check, but pumping operations were run entirely by ESSM/GPC and coordinated with the ESSM/GPC Hot Tap Supervisor and the MDSU Master Diver at the dive station to guarantee safety of the divers on the bottom. No pumping was initiated without the approval of the MDSU Master Diver or Dive Supervisor. No pumping operations could begin until the Pump Receiving Station OIC was ready to receive the product and had recorded pertinent location information for the shipwreck tank that was being transferred from, and the tanker tank that oil was being pumped to.

All hoses and camlock connections were to be checked prior to pressurizing the system for integrity. Figure 3.12 shows a hot tap flange with valve, suction hose, and pump assembly. The receiving station OIC was responsible for ensuring that the hose transition was secure and not kinked. One of the inlet deck valves ended up with a crack that was leaking oil into the receiving station cofferdam, and one hose camlock connection became disconnected on the wreck causing a leak which had to be responded to by the SRT, but other than that, all piping remained relatively leak-free for the duration of the project.

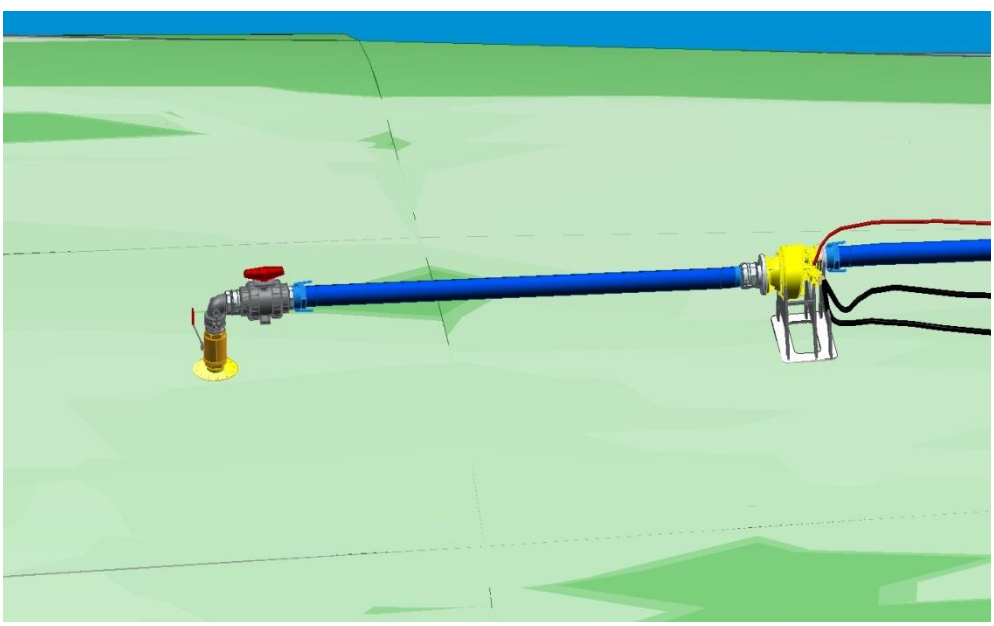

Figure 3.12. Hot Tapped Hole, Suction Hose, Pump and Discharge Connection on the Bottom

The tanker OIC was also responsible for ensuring that the tank top hose and stingers were in place and secure in all over-the-top tank covers. The OIC, in conjunction with the tanker's Chief Officer, was responsible for sounding the receiving tanks on a regular interval (this became a daily operation) using an electronic meter that measured the oil level and water level in the tank.

The ESSM/GPC Tanker Operations Supervisor was to verify that the OIC put up the Bravo flag (red fueling flag) and or red fueling lights. In practice, the Bravo flag was flown all day, every day, because pumping operations were ongoing most of the day every day.

Any person could stop the pumping (tankers call this loading) operation at any time. If any person on either vessel observed a leak, an active oil sheen/spill appearing on the surface of the water around the wreck, or a hose kink or any other potential hazard that could interfere with the fuel loading operation, they were to locate the nearest VHF radio and call "ALL STOP, STOP PUMPING", at which time the pump operator must secure the HPU and verify the HPU is off. A secondary emergency communication signal was the horns provided at each station. Any blast of a horn or a whistle could stop the pumping operation. Then the leak had to be identified, secured, isolated, or treated prior to resuming normal loading operations. The pumping operations were stopped many times for many different reasons including leaks on the bottom, ship issues, weather, random vessels approaching the dive operations and several other incidents.

All loading operations were initiated at the dive station with the Hot Tap Supervisor and Master Diver calling the tanker to let them know that divers had installed and set up equipment, and were ready to pump. The tanker OIC (ESSM/GPC Supervisor) would prepare systems and call back on the radio that they were ready to receive and valves would be opened. The Hot Tap Supervisor would then verify with the Master Diver that the divers were ready and the Hot Tap Supervisor would call the hydraulic power unit operator who was in view to start the hydraulic flow to the pump on the bottom. The receiving station on the tanker would call out on the VHF radio when the station started to receive flow at the tanker and would continue to call out on the VHF every few minutes to let the Hot Tap Supervisor know when and how much oil was in the hose at the tanker. The loading rate was generally turned up to between 40 to 80 gallons per minute (gpm) to clear the previous contents of the hose and until oil was sampled at the receiving station, at which point flow rate was "dialed in" to a level that could be sustained in stable form. It was usually turned down when nearing the bottom of tank with some exceptions. When pure oil was being received it was directed to one of two product tanks. When oil with large percentages of water was being received it was diverted to a slop tank on the tanker.

## 3.8. Subsea Tools

### 3.8.1. Overview

Due to the design of the ex-USS *PRINZ EUGEN*'s ship structure, there were 30 internal tanks in addition to the 143 external tanks that potentially contained oil. Therefore, a means to access the internal tanks to determine if oil was present and recoverable was necessary to develop in order to accomplish the full objective for this project. Conventional hot tapping is performed through the exterior hull shell plate and the normal procedure for addressing internal tanks is to cut away the exterior tank wall in order to expose the interior tank wall for access. However, if oil had been previously pumped from the exterior tank, there would be no easy way to sufficiently clean the tank side walls of residual oil clinging to the walls before cutting. Therefore, use of the conventional procedure would have had the potential to be dangerous for both divers and the environment. Furthermore, the normal procedure of cutting away the tank structure would be highly destructive to the wreck itself which is enjoyed by many recreational divers. Lastly, there was also the added danger of cutting the tank structure with unknown contents and the hazard of munitions still present on the wreck that influenced the need for viable alternatives. As a result, a less invasive means for accessing the internal tanks was developed as an alternative to the normal cutting procedure, which was to be used only as a last resort and as time permitted. The tools developed and used to access the internal tanks on the project are discussed in paragraph 3.8.8. Paragraphs 3.8.2 through 3.8.7 detail the development and use of all the major tools used subsurface on the ex-USS *PRINZ EUGEN* project including some of the tools that had to be developed on-site. The only known variable in any shipwreck oil recovery project is that there is going to be a large amount of unknown problems to resolve on the fly. The very nature of working with a vessel that had a catastrophic incident causing it to sink, and then laid on the bottom of the ocean for 72 years, ensures that crews will have to be ready to improvise on-site. This section on subsea tools discusses not only tools developed and tested in advance, but also tools that were made on location from materials on hand.

The following paragraphs provide a summary of the tools and hardware used subsea during the ex-USS *PRINZ EUGEN* oil recovery operation. The section is divided into the following subparagraphs: Electric Battery Powered Tools, Hydraulic Tools, Hand Tools, Fasteners, Grid System and Fixed Hardware, Tools Developed On-Site, and Hot Tap Extension Tools (Internal Tank Tools). Each section will list the tools and/or hardware used, give a brief description, explain the intended use of each tool, and then discuss the pros/cons of each.

### 3.8.2. Electric Battery Powered Tools

#### 3.8.2.1. Battery Powered Grinder

This tool consists of a 4 1/2″ angle grinder made by Nemo Power Tools and a 22-V lithium-ion (Li-ion) rechargeable battery rated for 50m depth. The grinder was intended to be used for light to medium cleaning/polishing of the hull plating for placing magnets and the hot tap flange gaskets. The grinder could also be fitted with cutting wheels for an extra light-duty cutting application. The grinder worked well as a lightweight substitute for the hydraulic grinder (see paragraph 3.8.3) for hull cleaning/polishing. It was easily recoverable to the surface for a battery change-out and disk replacement. It was not efficient for heavy cutting or grinding; the battery life does not support constant use that was required for cutting. The trigger system for starting the grinder was less than ideal for use underwater as the hand trigger must be pulled and a rotary three-position selector needs to be cycled from left to right, the center being low speed and right being high speed. Improper starting sequence can be easily mistaken for a dead battery.

#### 3.8.2.2. Battery Powered Drill

This tool consists of a 13mm drill made by Nemo Power Tools and an 18-V Li-ion rechargeable battery rated for 50m depth. The drill was intended to be used for light to medium drilling applications, drilling test holes with drill bits, and installing the hull grid attachment foundations with one to two fasteners at a time. There were multiple configurations of the electric drill; hand-held, mounted to a geared drill press with an on/off magnet, and mounted to a lever operated drill press with a rare earth magnet. The drill worked well as a lightweight substitute to the hydraulic drill, and allowed divers to move forward along the vessel sampling tanks and installing the grid system. The drills did not handle continuous installation of fasteners well. When using the drill to install the hot tap flange fasteners on consecutive hot tap flanges, two of the drill motors overheated and ruined the drills.

The hand-held drill could easily be used to get into tight spaces and to quickly identify the exact drilling locations. It could only be used when the diver had additional reaction points to pull from (hold on to) and provide opposing force to apply pressure to the drill. Hand-held drilling was limited to drill bits only. Using a hole saw style cutter produces too much torque at the handle, making it hard to hold the drill and cut effectively.

There were two magnetic drill presses used on the operation. The first one (see Figure 3.13) is an ESSM modified fixed drill press from Miko that was designed to be used with the battery operated drill. The second one is referred to as the “geared” drill press with a single cam to remove the magnet (see Figure 3.14). The geared drill press provided a stiffened support structure for using larger drill bits and the use of hole saws. The weight of the drill press made it more cumbersome to move around and the magnet required a very clean, steel surface with limited pitting for good holding power. The larger fixed magnet, with only the “single-side removal cam”, was more difficult to position over the flange bolting holes, but had more holding power on the pitted steel surfaces. The drill removal/replacement required the front bolted plate on the drill housing to be unbolted (on the surface only), which was not ideal for the sealed drill housing and was time consuming. The remaining drills all experienced leakage and corrosion issues which turned out to be fatal to the drill mechanisms during post operational repair and refurbishment. However, there was considerable time and manpower effort saved on-site by using the portable drills without having to drag cumbersome hydraulic umbilical hose assemblies around for every drilling effort.

Figure 3.13.  Miko Fixed Magnetic Drill Press with Attachment for Miko Battery Powered Submersible Drill

Figure 3.14.  Hydraulic Drill Press with Single Cam Lever and Two Different Sized Magnets

The lever operated drill press with the fixed magnet was more lightweight, and provided sufficient holding power for securing the drill.  It was easy to locate with the duel cam operated magnet release, and could easily be operated by one person.  The height of the press had to be modified to be used with the extra-long fasteners.  The lever press was also modified from the off-the-shelf configuration.  Drill removal/replacement required the front bolted plate on the drill housing to be unbolted, which was not ideal for the sealed drill housing and was time consuming.

### 3.8.3. Hydraulic Tools

The hydraulic tools in the diver tool kit are the primary tool set when it comes to heavy underwater applications such as mounting flanges and drilling large holes. A hydraulic drill must be used during the lengthy hot tapping evolutions. The hydraulic grinder was very effective at cleaning large areas in the way for mounting hot tap flanges. A hydraulic jack hammer was employed for coral head removal in the way of grid line installation. The circular saw was not used. However, the circular saw would have been a good tool to use to remove hull plating in damaged areas to gain access. One downside of hydraulic tool use is that when multiple tools are in use, the work area can quickly start looking like a highway overpass clover leaf due to the amount of hydraulic hose needed to support the tools. A submersible hydraulic splitter was utilized to support multiple tools off of one supply line. Recovery of the hydraulic tools to the surface was difficult and time consuming. After recovering tools the first day of operations, it was decided to leave the tools on the bottom in the essence of time. Hydraulic tooling currently cannot be switched underwater, making it time consuming to switch configurations. The tools need to be fitted with zinc anodes to reduce corrosive effects due to being in saltwater for an extended period of time.

### 3.8.4. Hand Tools

The following is a list of hand tools that were used subsea: chipping or brick hammer, torque wrench, Cygnus underwater ultrasonic thickness gauge, locating angles, centerline locating bar, and a standard ratchet and sockets. Most of these tools were sent down in the diver’s tool box; however, the locating angles were too big for the tool box. These hand tools were what the diver used on a daily basis to accomplish the installation of the hot tap flanges.

The chipping hammer worked well for cleaning off coral and the layer of marine growth over the hull plating. However, it was not ideal for areas where the hull plating was known to be thin. The diver could easily punch through thin hull plating using the spade end of the chipping hammer (and actually did this on more than one occasion).

Two different style torque wrenches were used for two different style fasteners. First, the 1/4″ fasteners used a beam style torque wrench (0–80 in-lb). The torque for these fasteners was set at the maximum torque 80 in-lb. With the beam style torque wrenches, it was easy to push the red indicator past the mark on the scale and over torque the fastener. This style torque wrench was also comparatively delicate for subsea tasks and broke easily. The second torque wrench was an adjustable click torque wrench, 10–80 ft-lb, which was used with 5/16″ and larger fasteners. However, the scale only started at 20 ft-lb and was confusing to set. After a short period of use underwater, the ratchet lever broke as well. Towards the end of the project, a dial style torque wrench supplied by the divers out of their tool box was used.

The Cygnus underwater ultrasonic thickness gauge is a hand-held underwater ultrasonic thickness gauge. The standard procedure was to send it down in the diver’s tool box to be used on every tank to measure the hull thickness in the proposed drilling area. This was done to obtain data on hull wastage as well as to ensure that the hull plate was strong enough for hot tapping. The measuring probe required a clean, shiny metal, with minimal to no pitting for an accurate reading. The most prevalent issues presented were when the hull surface was too pitted for accurate readings and the meter would flash or repeat erroneous readings. The thickness gauge worked very well when used on flat, clean hull plates. The screen provides a bright, readable display, even in cloudy, silty water.

A set of tools, designed and fabricated by ESSM, called "Locating Angles" (see Figure 3.15) were provided to the divers as a reference tool to locate the ideal spots for hot tapping tanks. There were three different size square angles, 20 1/2″, 24″, and 27″. Starting from a baseline grid reference point, these locating tools were sized to identify a spot in between the structural frame member. They were fitted with handles for easy positioning and removal from the hull surface and were labeled with the corresponding length. They functioned as designed; however, if the grid reference point was off then the measured offset was off as well. The locating angles were meant to be a reference tool and divers were still required to "sound" the area around the proposed hole to ensure that they were in a hollow spot. Sounding for internal frames did not always work well as it is very subjective and more of an art than a science. For future reference, the locating angles could have more graduations indicated on the edges which would help to adjust for variations in the grid line.

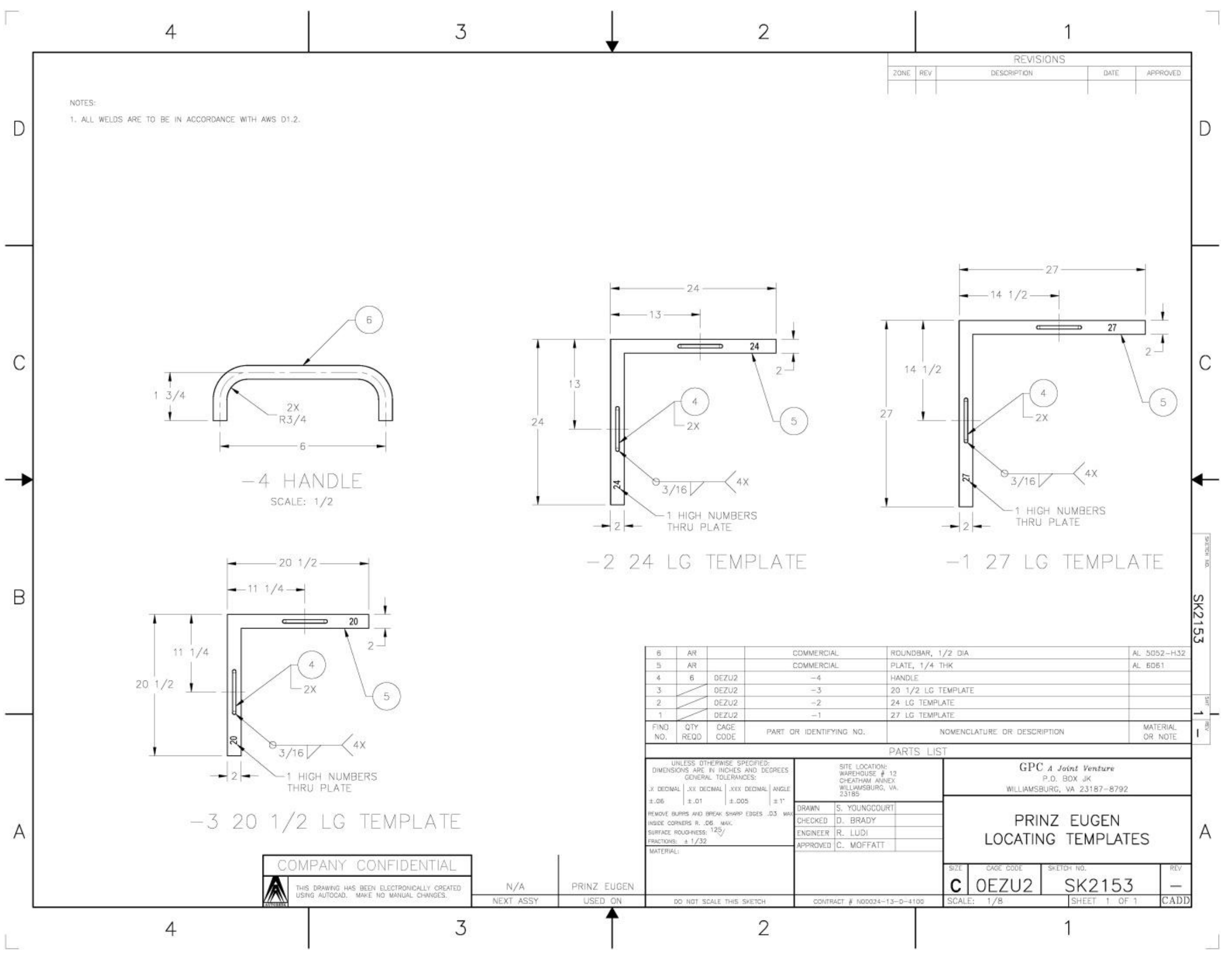


Figure 3.15. Locating Angle Templates

A centerline locating bar was used to locate the approximate center location of the vessel. The bar was approximately 4′ long, notched at both ends, and had a hole located in the center. The notches were used to locate the weld at the outer edge of the keel plate. When properly centered, this would locate the centerline of the vessel for the diver. This was a great reference tool used for installing the centerline fixed hard point hardware required for the grid installation.

There were usually more than one standard ratchet and sockets supplied in the diver's tool box. They were used for installing and removing test plugs, and tightening hot tap flange bolts. They were perfect for working in and around the hot tap flange. Test plugs were being located inside and just off dead center of the hot tap flange, which required a deep socket to reach the test plug bolt through the opening of the 4-inch male pipe nipple. The cheaper quality ratchets did not last long when repeatedly used in underwater applications. It is recommended for future operations that the more expensive ratchets that can be rebuilt in the shops are to be used, which would allow them to be cleaned and serviced on-site with spare parts.

### 3.8.5. Fasteners

There were two main type of fasteners used on the job: hot tap flange securing fasteners and test-hole plugs. All fasteners were the thread cutting type. However, hot tap flange fasteners where both self-drilling and thread cutting. There were varying sizes of each fastener. For the hot tap flange fasteners, there were 1/4″ and 5/16″ fasteners. The test-hole plugs sizes used were 1/2″ and 3/8″ self-tapping fasteners.

Since the hot tap flange fasteners are both self-drilling and self-tapping, there are some limitations. The 5/16″ fasteners cannot drill and tap themselves into a material greater than 1/2″ thick without having a blind hole drilled first. Drilling a blind hole first is an option. The longer 1/4″ fasteners can drill into material up to 7/8–1″ thick. However, the 1/4″ fasteners are much longer than the 5/16″ fastener and are therefore more difficult to install due to the lack of stability. The 1/4″ fasteners were used up until hull Section III was being hot tapped. At some time during the Section III flange installation, the recovery team switched to the shorter 5/16″ fasteners. Overall, a combination of the two fasteners may have to be used as well as blind drilling some holes to expand the use of the shorter 5/16″ fasteners.

For the test-hole plugs, the 1/2-13 UNC x 1 1/2″ long fasteners were only self-tapping and required a specific drill bit for each size to start and cut the proper threads. Since there were three different fastener sizes, it required three different drill bit sizes. Using the correct drill bit size with the correct plug caused some confusion. There were a couple of occasions that the wrong hole size was drilled compared to the test plugs that the divers had on hand. In the end, there were some broken test hole plugs and/or ones that would not fully thread down to the sealing washer. For future operations, testing will be required to determine a standard size that can be used with a specific drill bit.

### 3.8.6. Grid System and Fixed Hardware

The grid system was made up of fixed hardware attached at a designated location, with wire rope or ropes strung between the hard points to section off the hull, and once it was placed on the wreck it became, in essence, a full scale road map. The grid system had major lines across transverse bulkheads and tank section boundaries. The transverse lines consisted of bi-color ropes made with two color ropes attached together at the center. The yellow lines were used for the starboard side and white lines were used for the port side. The longitudinal tank boundaries were marked with tags. Tanks in between the transverse boundaries and outside the turn of the bilge were located using triangulation lines from known hard points at the tank boundaries.

The entire grid system was referenced off of the port and starboard bilge keels. Each bilge keel was fitted with a wire rope, yellow for starboard and white for port, labeled with frame references starting at the aft end of the bilge keel frame 65.75. These wire ropes were secured with hardware brackets at each end and along the length at each specific frame measurement. A transverse braided line was also secured at these reference frame locations and in the center of the ship.

The hardware used to secure the grid system to the hull was a bent plate or angle iron drilled with holes for fasteners and clips for securing the line. They were easily installed, the hull mounted hardware required two or more fasteners, and the bilge keel mounted hardware only required one fastener. The lesson learned on-site was that any hardware attaching to the hull surface external to a fuel tank requires a gasket to seal the fastener holes and all grid lines should be made of wire rope and not line to prevent stretching.

### 3.8.7. Tools Developed On-site

The following is a list of tools that were developed on-site to support increased productivity and reduce the time required to close-out tanks, as well as new techniques for capturing oil from within a tank. The description includes a non-technical given name, a technical name, the intended use, and recommended further tool development. Tools included in this list are: tank venting equipment, obstruction finding device, drill leverage device, oil pumping wand, and additional tool designs that were not built on-site.

#### 3.8.7.1. Tank Venting

The Tank Vent tool, aka the “Schadow Device” (see Appendix F), or more technically referred to as a pump through vent tube was created using a 4″ tee fitting, with the pump hose attached at the junction port, and a long PVC tube through a 4″ packing gland attached at one of the through connections. The other end, straight through from the packing gland, would attach to the valve on the tank. The tank valve could be opened and the vent tube inserted into the tank to provide a quick vent directly through the hot tap flange, all while pumping. Issues found were the alignment of the vent tube with the hole in the tank surface or obstruction in the tank that would prevent the vent tube from going farther into the tank to create a proper vent into the tank. The device was altered to allow for fire main water to be pumped into the tank to help displace oil. This was performed using an adaptor and the ship's fire hose and then pressurizing the ship's firefighting piping system. There were concerns that at times the fire main water was the only product getting pulled from the tank (e.g., the fuel oil was pushed away) due to the depth at which the vent tube would have been inserted. Further development would include: a tighter packing gland more suited to the tube size to help with the centering of the vent tube, aluminum tubing versus PVC, possible attachments for the tube ends to support pumping water in, and tank cleaning.

#### 3.8.7.2. Obstruction Finding Device

The Obstruction Finding Device is more technically an obstruction check or go/no-go device. The tool was created using 1/4″ SST rod, bent into a Z shape that could be fished into a test hole of the hot tap flange and spun around to check for obstructions in the local area. It was fitted with foam rubber to prevent the leaking of oil product from the test hole. Further development could include a flange with stuffing tube and magnets for the secure attachment and positive gasket compression.

#### 3.8.7.3. Drill Leverage Device

Also known as the "Bubba Bar" is a lever arm and fulcrum device with a magnet attached as the securing end and a sliding receiver piece that could be attached to the drill. The device was used to put downward pressure onto the top of the manual drill without causing a reaction force against the diver. The new bubba bar, aka "Inverse Bubba Bar", was more technically diver friendly or a pull-up bubba bar. It was similar to the original bubba bar, but reverses the pivot location of the attachment point compared to the drill such that a lifting force imparts a downward force on the top of the drill. On-site, two bubba bars were bolted back-to-back with one magnet to secure the bars. The drill cup on the bar opposite from the magnet was used to apply the drill load, like a see-saw. This allowed the diver to pull up on the bar (versus push down) and apply a downward force on the drill. This configuration still required two divers to operate. A shortened version compared to what was on-site, should be considered.

#### 3.8.7.4. Oil Pumping Wand (Mosquito Tool)

The Oil Pumping Wand, aka the "Mosquito Tool" (see Appendix F), which was also referred to as the diver hand-held oil pumping wand, was another tool that was constructed on-site. The pump wand was a "Stinger" that was pulled from the 2″ to 6″ pumping kit. The "Stinger" is a section of 2″ aluminum pipe with one male and one female camlock fitting welded to each end and attached to the end of a 2″ hose which was connected to the suction side of the pump. It was fitted on-site with a common orange plastic traffic cone to act as a catch for any oil that escaped the wand. The tip was fitted with stainless steel locking wire to create a screen to prevent any large trash and/or debris from being pulled in. It was utilized in tight spaces where the hull plate was very brittle and easily punctured. The device was effective and used several times in the operation. In retrospect, it would have been beneficial to have a hole inside the cone to pump off any collected oil and the tip be tapered to fit into the damaged hull area to prevent oil leaking. It is recommended that the angled fitting and various lengths of attachment pipe allow for versatility in areas of overhangs and the damaged hull plate.

### 3.8.8. Hot Tap Extension Tools (Internal Tank Tools)

Development of a hot tap tool that could address internal tanks began in April of 2018, when funding arrived from USASMDC to SUPSALV. A prototype tool was designed, built, and tested by May 2018. The design was then refined by the end of May 2018 and submitted for final production. Fabrication of the innovative hot tap extension tools was completed by the end of July 2018. Tools were shipped via FedEx Freight to Hawaii where they were combined with other equipment and then put on a military flight to Kwajalein to arrive in mid-August.

#### 3.8.8.1. Prototype Internal Tank Tool Concept

The internal tank tool concept developed for this project leveraged the existing ESSM Lightweight Hot Tap (LWHT) equipment as the feed and driving component of the tool. However, the tool was designed to extend the reach of the standard LWHT and allow for the hole saw to extend through the external (original) hole to cut another, deeper hole in a tank wall at a pre-set distance. The distance of the extension was predetermined and set by the length of the drill extension bar used. The concept of the device was that it used a rigid support tube fitted with a drill bushing to support a drilling extension bar. The conventional LWHT attached to the drill extension bar and acted as the main support at the top of the bar. The drill extension bar was supported at the other end with the drill bushing. The concept tool utilized a 1 1/2″ diameter support tube with a steel drill bushing. The extension bar was 1 1/4″ diameter, solid aluminum (see Figure 3.16, Figure 3.17, Figure 3.18, and Figure 3.19). The tool was designed to cut a hole through the inner tank boundary at the bottom of an external tank, which is the highest accessible point on the internal tank. The concept tool was not designed to be removed as in conventional hot tapping procedures prior to pumping the contents of the tank. The product from the inner tank is pumped directly through the support.

During concept testing at ESSM Base Cheatham Annex (CAX), the aluminum drill bars were galling due to heat buildup at the steel bushing. The aluminum extension bar required longitudinal grooves cut into the surface to allow for water flow/cooling. Also, the hole saw pilot bit had to be modified to a 90-degree drill point to help drilling on a plate that is not perpendicular to the axis of drilling. This was a known issue for drilling internally due to the external and internal tank wall surfaces not having the same curvature.

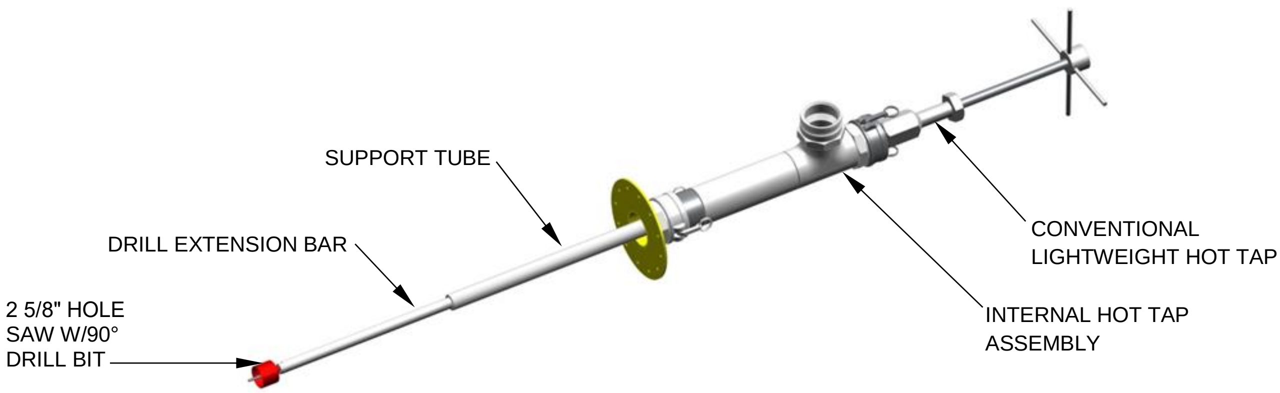


Figure 3.16. Prototype Concept for the Hot Tap Extension Tool

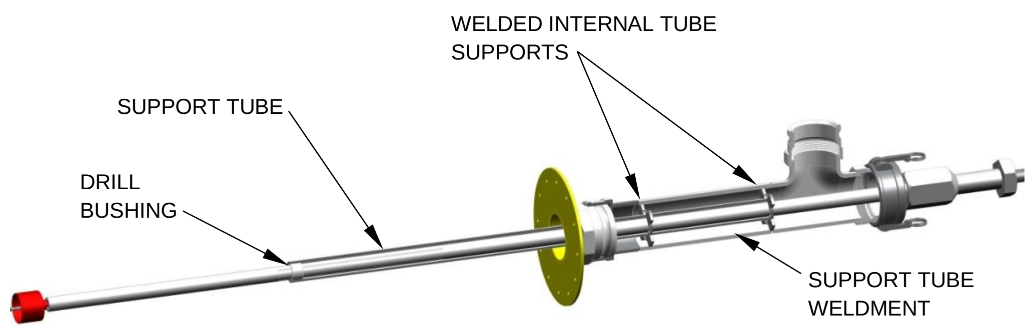


Figure 3.17. Cross Section of the Prototype Hot Tap Extension Tool

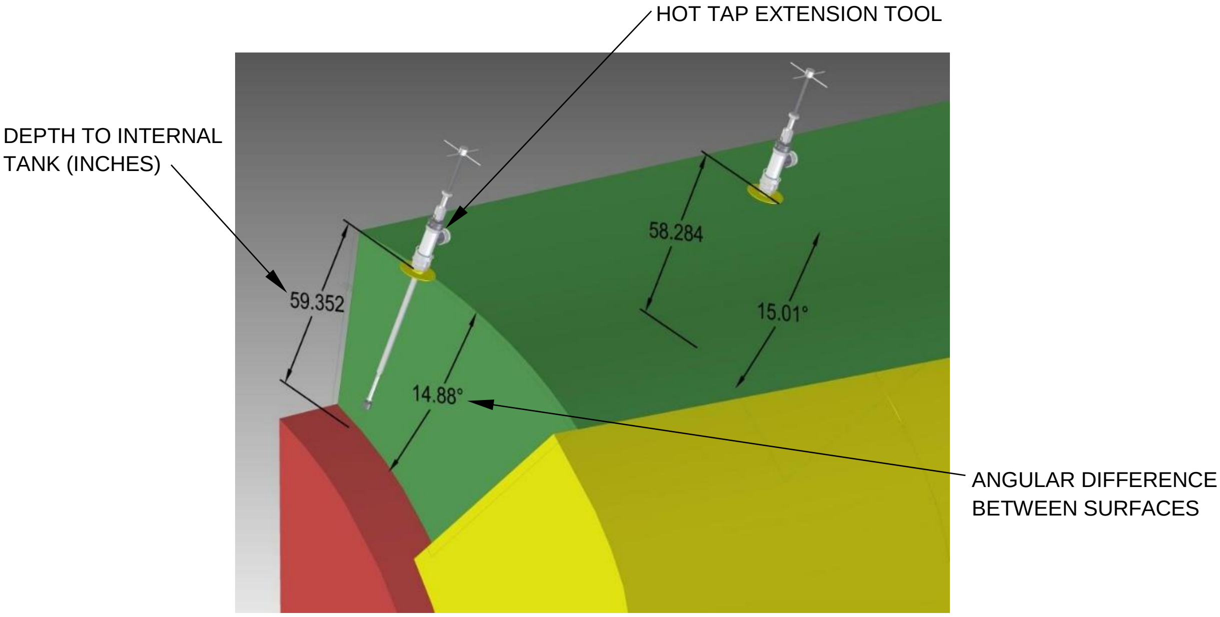


Figure 3.18. Representation of Hot Tap Extension Tool Installed on the Ship Hull Model (Section IV)

### 3.8.8.2. Final Tool Design

The final set of hot tap extension tools were designed to have all of the support tube structure extend beyond the exterior tank's surface. This effectively shortened the distance that the tool protrudes off of the hull surface, thus making it easier for the diver to drive the hot tap with the drill. An additional larger diameter support tube was added to stiffen the overall structure as there was concern about fatigue over time, stress cracking, and possible failure due to the vibrations associated with cutting. The drilling bars were cut with a helix groove to aid with moving water across the bearing area to prevent the heating and galling of the aluminum.

The final tool had three configurations: short, medium, and long drill extension bars with two different length support tube structures (see Figure 3.19). The short configuration required its own short support tube structure, while the medium and long configurations used the original length support tube structure. The variations in length were required to suit the varying depths between the external hull surface and the internal tank surface. The shorter tool was designed to fit the tanks that were approximately 35 to 39 inches in depth. The medium length tool was designed to fit tanks that were approximately 47 to 52 inches in depth, and the long tool was designed to fit tanks that were approximately 54 to 59 inches in depth. The conventional lightweight hot tap has approximately 10 inches of travel and therefore, limits the range of length any of the tools could achieve. Also, the further away the hole saw is to the support tube structure, the more vibration and movement occurs in the hole saw itself while cutting.

An additional tool was created in anticipation of the internal structure that would be directly in line with the hole in the external tank surface (see Figure 3.20). This tool was similar to the original concept design. It had a 1 1/2″ diameter support structure tube that was supported externally. The tube connected to the cam and groove fitting was angled, which created a cam effect and would allow for the application of an off center final hole saw location at the internal hull surface.

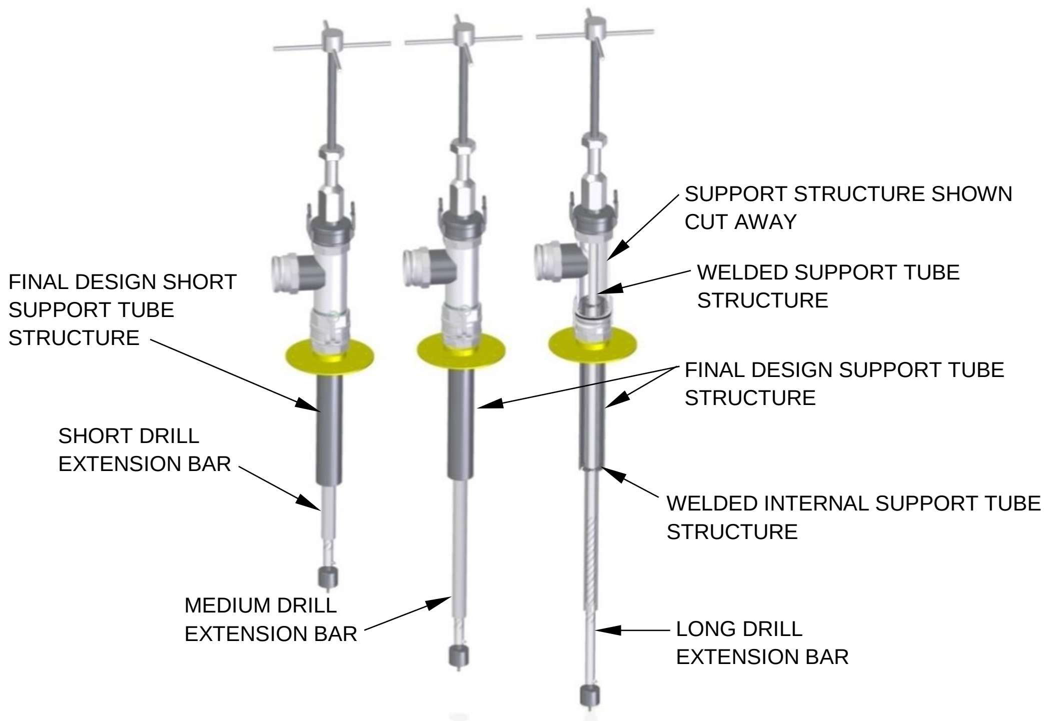


Figure 3.19. Three Different Lengths of the Final Design Hot Tap Extension Tools

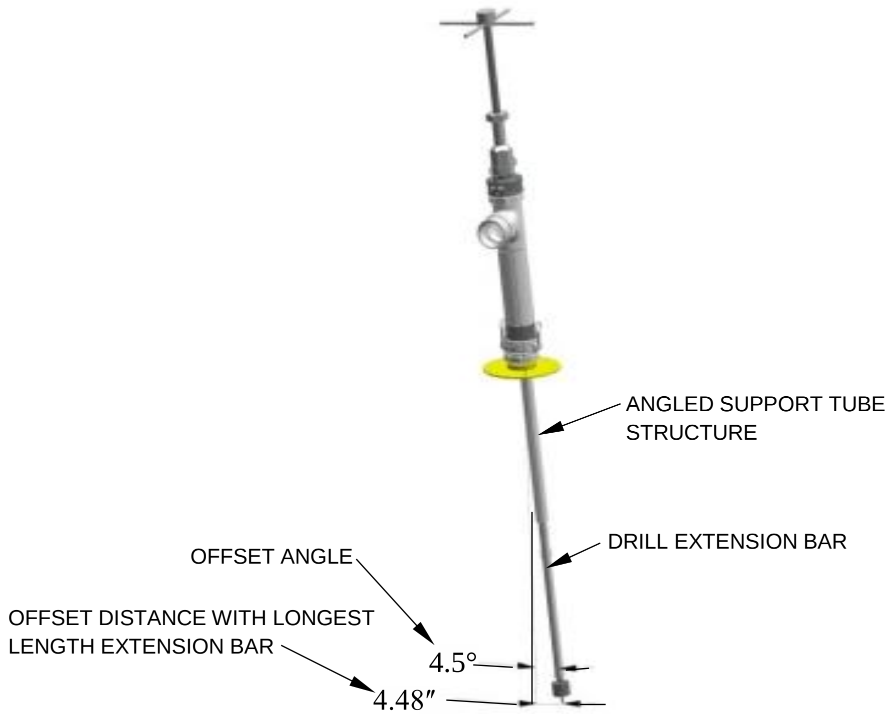


Figure 3.20. Angled Hot Tap Extension Tool for Structure Avoidance

#### 3.8.8.3. Tool Usage

The prototype tool was utilized on the following tanks:

- Section II, Tanks 5.1 and 5.3 – the tool was modified with a ball valve to compensate for the length of the prototype tool. The medium length drill extension bar was used.
- Section IV, Tanks 5.1 and 5.3
- Section VIII, Tank 5.1

The short final design tool was utilized on the following tank:

- Section II, Tank 5.1 – The short tool was first attempted, however, due to concentricity and the misalignment of the flange and hot tap hole, the internal support tube prevented proper mating of the camlock fitting to the flange. Therefore, a modification of the prototype tool ended up being used for this tank.

The medium length final design tool was not attempted nor used on any tanks. Most of the tanks that would have required the medium length tool were deemed inaccessible due to piping or other tank structure blocking access to the internal tank wall or due to damaged exterior hull plate altering the alignment of the two walls causing any variation of the extension tools to be unusable.

The long final design tool was utilized on the following tank:

- Section III, Tank 5.5 – This was the first internal hot tap completed. The inner support tube was a challenge to get through the original hot tap hole on the exterior tank, but once through, the camlock fitting properly mated with the external hull flange.

The angled design tool (see Figure 3.20) was utilized on the following tanks:

- Section III, Tank 5.3 – Internal piping was noted in the video inspection in the direct path to the internal tank wall, therefore, the angled tool was selected to attempt avoidance.
- Section V, Tank 5.1 – An internal frame member was noted in the video inspection in the direct path to the internal tank wall, therefore, the angled tool was selected to attempt avoidance.
- Section VIII, Tank 5.2 – An internal frame member was noted in the video inspection in the direct path to the internal tank wall, therefore, the angled tool was selected to attempt avoidance.

#### 3.8.8.4. Hot Tap Extension Tool Evaluation

The most successful of the hot tap extension tools was the angled tool design. The offset angle allowed the tool to miss the internal structure that would have otherwise blocked the straight path to the internal tank wall and prevented the hot tapping of the internal tank. The angled tool allowed for the internal hot tapping of three additional tanks than if only the straight tool was developed.

One problem that was encountered was a clearance issue between the final design tool's support tube and the original hot tap hole on the exterior tank wall. The holes at the external hull surface were not concentric with the flange camlock fitting and because the support tube had tight tolerance compared to the hot tap hole, it required the two points to be concentric. This prevented the tool from being secured to the external tank surface. Therefore, with the exception of the first internal hot tap, there were issues getting the final design tools properly mated to the external tank surface flanges.

For the next generation internal tank tool, development of internal tube support structure that is not restricted to the concentricity of the external hot tap hole and flange should be considered. Also, development of a tool with an adjustable extension and angle would be ideal. Lastly, investigation of a concept that would allow for pumping oil at the internal tank wall surface, rather than requiring the oil to fill the exterior tank before pumping would be an advantage.

## 3.9. Equipment Identification and Loadout

During the planning and preparation stage of the operation, equipment and materials needed to support the effort were identified, collected, assembled, sorted, and stowed in 20-foot ISO container vans or military flight compatible sealable cargo boxes. The 20-foot ISO container loadouts included the majority of the bulk items needed for the transcontinental and Pacific Ocean shipments to Kwajalein. This equipment, along with other items, included the entire contingent of hydraulic and product hoses, hydraulic pumps, work station equipment, hot tap tools, diver tools, sorbent boom, an inflatable boat, outboard motors, and hydraulic power units to name a few. All this equipment as well as a 25′ RHIB boat, shipped separately, was required for the project. The transit time from Williamsburg, Virginia and Port Hueneme, California to Kwajalein was expected to be 30 to 45 days, but 8 weeks was allotted to ensure that there was no change or postponement in the project timeline due to equipment shipment delays. The equipment container vans and cargo boxes and their major equipment content are summarized in Appendix G. The remaining shipments from ESSM sources were all completed by shipping the equipment to ESSM Base Hawaii and from there the equipment was flown via military flights to Kwajalein.

## 3.10. Logistics Support

### 3.10.1. Shipping

Special consideration was given during the planning of shipments due to the transit time of 45 days for surface shipments originating from the East Coast of the U.S. to Kwajalein Atoll. In addition, shipments by commercial air are extremely costly and very limited in size due to commercial aircraft cargo configurations available. Larger air shipments via the Military Airlift Command’s C-17 require a TAC code and are very limited due to other high priority cargos and the flight schedules into Kwajalein. Therefore, the majority of ESSM equipment was shipped from the ESSM Base Cheatham Annex in Williamsburg, Virginia to Kwajalein by commercial vessel transportation via regularly scheduled routes. Departure of the major shipment from Virginia was scheduled for 15 June 2018. One ESSM container and some of the ESSM mooring equipment located at ESSM Base Singapore was slated to travel onboard the USNS *SALVOR* from Singapore to Kwajalein to minimize transportation costs, however, the container was not shipped on the USNS *SALVOR*.

The staging area(s) for all ESSM equipment arriving in Kwajalein was identified by the U.S. Army Garrison-Kwajalein Atoll (USAG-KA) to be near the LCM Boat ramp. The port or origin of both support vessels was Singapore.

### 3.10.2. USAG-KA Support Services

All services provided by the U.S. Army Garrison on Kwajalein had to be solicited for and planned for using U.S.A. format of either a WOR (Facilities Engineering Work Order Request form 4283) or a TMR (Transportation Movement Request) for assets such as tugs and Mike boats. These requests had to be submitted in advance for each movement or operation.

### 3.10.3. Lifting and Handling

Included in the logistics support planning, crane and forklift support was to be provided by USAG-KA. The following material handling equipment was determined to be required to offload and load equipment at the staging areas:

a. One 20- to 50-ton commercial mobile crane (with operator) for containers and vessel loading operations.
b. One 6000-pound forklift and one 30,000-pound forklift.

### 3.10.4. Personnel Travel and Transportation

Personnel not transiting on the military vessel USNS *SALVOR*, were to transit to Kwajalein on a combination of commercial and military aircraft. It is important to note that commercial flights into Kwajalein are scheduled to arrive on Tuesdays, Thursdays, and Saturdays and depart on Mondays, Wednesdays, and Fridays only. SUPSALV and ESSM/GPC personnel were scheduled to arrive in Kwajalein on 26 August 2018 and after. Personnel transportation shore-side included provisions for a military motor pool truck(s) and bicycles.

## 3.11. Diver Training

Job-specific training for the dive team assigned to the oil removal operation has proven helpful during historical operations such as the USS *MISSISSINEWA* (AO 59) and ex-USS *CHEHALIS* offloads. Therefore, prior to deployment of MDSU Company 1-8 divers to the 7$^{th}$ Fleet AOR, the SUPSALV and ESSM/GPC team traveled to ESSM Base Hawaii and MDSU-1 on Hickam Air Force Base in order to brief and train the divers on tactics specific to the ex-USS *PRINZ EUGEN* operation. The training was conducted over the course of 5 days from 11–15 June 2018.

On the first day, SUPSALV and ESSM/GPC personnel set up and prepared visual training aids in the ESSM Hawaii conference room. Introductions were made between team members and an overview of the ex-USS *PRINZ EUGEN* oil removal plan was briefed. Wreck orientation was performed using a scale hull model with tank boundary overlays as the primary visual aid. The diver navigation grid system was explained in great detail, including the concept overview and installation instructions. A classroom review of the lightweight hot tap equipment and hydraulic tool operations was given, followed by an introduction to the new underwater battery-powered tools and techniques. Explanation on use of the Cygnus underwater ultrasonic thickness gauge was also provided. The day concluded with hands-on training with Section IV of the full-scale tank navigation grid system laid out in the parking lot simulating the wreck.

On Tuesday, 12 June, a refresher was given on overall concept of operations and hands-on training for the grid system and flange installation continued. Hands-on lightweight hot tap drilling operations began in the test tank at the ESSM Base. Topside operations in the test tank continued into the afternoon including rehearsing tank close-out procedures.

On the third, fourth, and fifth days, diving operations were conducted performing test drilling, in-water flange attachment, hot tapping and capping/close-out operations using the MDSU "Mud Monster". This joint training provided an excellent opportunity for SUPSALV and ESSM/GPC experts to review proper hot tapping techniques and equipment care with the divers. The training reiterated the need for trained ESSM/GPC personnel to be present during hot tap training conducted by the MDSU units in order to ensure proper employment of the highly specialized tools and prevent damage to the equipment.

### 3.12. Mooring Plan

Note: The actual final mooring array and details concerning the final position of the USNS *SALVOR* and MT *HUMBER* over the wreck of the ex-USS *PRINZ EUGEN* is presented in Chapter 4 of this report.

The anchoring/mooring of the USNS *SALVOR* and MT *HUMBER* was planned to occur during phase III of the operations plan sequence of events. The mooring was scheduled to take place 1–3 September 2018 and called for the following actions to occur:

a. Monitor the weather using a combination of the USAG-KA/RTS Weather Station, Kwajalein and if available, the U.S. Navy provided OTS weather supplemented by commercially available HF weather transmissions and VHF notifications from the USAG-KA Harbor Control Tower. Use daily forecasts and adverse weather notifications to determine the anticipated arrival and impact of severe weather. If required, use the forecasts determine the appropriate time to conduct or secure operations and subsequent securing and/or evacuation of the site.
b. Size and configure the anchoring/mooring equipment that was shipped to the Kwajalein to support the designated vessels for the historical weather conditions in the Atoll during the selected operational window of 1 September through 15 October. Anchoring systems were to utilize both the organic onboard vessel systems as well as the ESSM systems being shipped to the project. The final mooring plan was dependent on the actual vessel master's decisions once on-site.
c. Launch the small boats with a dive team upon arrival at the operational site to mark the ex-USS *PRINZ EUGEN*'s bow, forward and aft ends of the bilge keels, and the anchoring/mooring locations, as needed, with small inflatable buoys.
d. Place the twin four-point anchor/moorings around the ex-USS *PRINZ EUGEN* to withstand the anticipated sea and weather conditions as well as to facilitate operations. The primary notional mooring strategy was the "rafted" position, which included both vessels secured together with the ship's lines and only the pneumatic ESSM ship fenders separating them. This plan would have the MT *HUMBER*'s brow connected forward of amidships for personnel to transfer back and forth between the vessels which was critical to the efficiency of the operation. However, due to concerns from one of the ships captains over weather and rafting together, the primary plan reverted to an option that had the vessels being moored independently and each with their own separate four-point moor. It was not necessary to implement the secondary (less than optimal plan) and the rafted configuration, which is shown below in Figure 3.21 and in section 4.5, was utilized for the entire operation without major incident.

The original notional mooring plans were based on predominate wind/wave conditions, E and ENE, expected in the Atoll throughout the anticipated operational window of September–October. The anchoring/mooring configurations were designed to provide a working lee where feasible, direct access for dive operations, and hose runs to the surface to facilitate operations and reduce strains on the subsurface fittings and hoses. They would also allow operational personnel to readily transit between the diving support vessel and the oil storage vessel with minimal risk.

Figure 3.21. MT *HUMBER* and USNS *SALVOR* Rafted Together Over ex-USS *PRINZ EUGEN*

The proposed mooring sequence and proposed unmoor/anchor recovery procedures extracted from the operations plan are shown below in Figure 3.22.

PROPOSED MOORING SEQUENCE:

1. Divers deploy small inflatable buoys to mark the 25′ water depth from the wreck on each bilge keel and designated mooring locations for anchors 1 through 4.
2. Using USAG-KA tug, barge or other means, lay shallow water anchors 1 through 4.
3. Using USNS *SALVOR*, lay anchors 6 and 7.
4. MT *HUMBER* maneuvers into place and drops port bower.
5. With USAG-KA tug standing by or made up as conditions warrant, MT *HUMBER* runs lines by boat to anchors 6, 3, and 4.
6. MT *HUMBER* positions herself above the wreck using lines and, as necessary, her propulsion and/or tug.
7. Once MT *HUMBER* is in place, deploy two 10′ x 50′ inflatable fenders on her starboard side
8. USNS *SALVOR* drops starboard bower.
9. With USAG-KA tug standing by or made up as conditions warrant, USNS *SALVOR* runs lines by boat to anchors 7, 1, and 2.
10. USNS *SALVOR* positions herself using lines and, as necessary, her propulsion and/or tug.
11. Depending on conditions, ships stay separate or come together with lines separated by the fenders. Deploy brow across two vessels using the crane onboard the MT *HUMBER*.

PROPOSED UNMOOR/ANCHOR RECOVERY:

1. MT *HUMBER* winches forward in her moor until her swing circle is clear of USNS *SALVOR*. Use USAG-KA tug assist, if needed, for safety.
2. MT *HUMBER* disconnects from anchors 3, 4 and 6 by boat and remains on port bower (5).
3. MT *HUMBER* weighs port bower anchor (5) and departs.
4. USNS *SALVOR* runs lines by boat and connects into spud buoys on anchors 3 and 4. When secure and tight to 3 and 4, transfer line from 1 spud buoy to 1 crown buoy by boat. Recover 1 anchor. If necessary, use divers and lift bags to assist recovery of anchor.
5. When 1 is recovered, repeat with 2.
6. When 2 is complete, repeat with 3. If necessary, use divers/lift bags to assist. This will leave USNS *SALVOR* in a 3-point moor.
7. USNS *SALVOR* winches forward in her moor until her swing circle clears the wreck.
8. USNS *SALVOR* disconnects from anchors 4 and 7.
9. While at short stay on her starboard bower (8) or after recovery of it as conditions warrant, USNS *SALVOR* recovers anchors 6 and 7.
10. USNS *SALVOR* repositions and recovers anchor 4. If necessary, use divers/lift bags to assist.

Figure 3.22. Proposed Mooring Sequence and Proposed Unmoor/Anchor Recovery Procedures

**CHAPTER 4**

# 4. ON-SITE OPERATIONS

## 4.1. Overview

The on-site operations that took place in Kwajalein Atoll ran from 20 August to 21 October, 2018. On-site operations included numerous evolutions which included mobilization of equipment to Kwajalein, preparation, and laying of anchors and jewelry for the moor, putting vessels in the moor, the preparation and setup of the oil recovery equipment on the moored vessels, and the setup and operation of the dive equipment and stations. A large contingent of personnel and equipment was required to complete the daily operations involved in the project. There were countless shipboard functions being consistently carried out on the respective vessels each day. Some of the shipboard tasks included direct oil recovery operations such as divers conducting hull cleaning, tank testing, hot tapping and/or oil pumping. There was also constant equipment positioning, equipment preparation, small boat operations, ship mooring/position maintenance, dive station and diver preparation, oil spill response, and the "hotel" functions on each vessel including provisioning and solid waste disposal. Section 4.7 of the report specifically describes the oil recovery in detail.

The mooring operations took place immediately upon arrival of the dive team and are described in section 4.5. The two ships supporting the operation needed to be positioned over the bow of the wreck between hull sections VII and XI. It was determined that this location was critical in order to effectively put divers as close to the work as possible, and not have the vessels too close to the shallow part of the wreck or the reef behind it. This task was more challenging because of the close proximity of the wreck to the neighboring coral reef, which would not allow the ships to drop the shoreward anchors due to the shallow depth. Therefore, SUPSALV arranged for use of the U.S. Army Garrison – Kwajalein Atoll's harbor tug *MYSTIC* to collect the anchors at the pier and drop them in place. This process was completed on 4 September by the U.S. Navy MDSU Company and the Tug *MYSTIC* when the ships successfully finalized their combined nine-point moor over the ex-USS *PRINZ EUGEN*.

The oil recovery operation (see section 4.7) performed on the ex-USS *PRINZ EUGEN* project can be broken down into seven basic components: tank location, hull cleaning, tank testing, hot-tapping, pumping/stripping, tank closing, and recording. Each step had to be completed as efficiently as possible before the next step could take place with the exception of recording. Recording of all events of the project took place on a continuous basis throughout the operation.

## 4.2. Chronology of Events

The overall ex-USS *PRINZ EUGEN* oil recovery operation spanned almost 3 years, from 2016 through 2018, and consisted of several major phases: initial research, wreck surveys, pre-planning, planning, mobilization, oil recovery operations, demobilization, refurbishment, and reporting. Planning for the oil recovery operation started early in 2016 and continued through the spring of 2018. During this time, there were two mini-surveys conducted, one in 2016 and one in 2017. In addition, there was a substantial amount of development completed between the 2017 survey and the arrival of the project funds from the Army in May of 2018. Most of this development time was spent on hot tap tool development, cordless underwater drill development, grid system, and 3D model development. The detailed planning and the majority of the logistics for the project were initiated and put together starting in April and May of 2018. The basic chronology shown in Figure 4.1 below outlines the major phases and events of the project. A detailed chronology of events is presented in Appendix H.

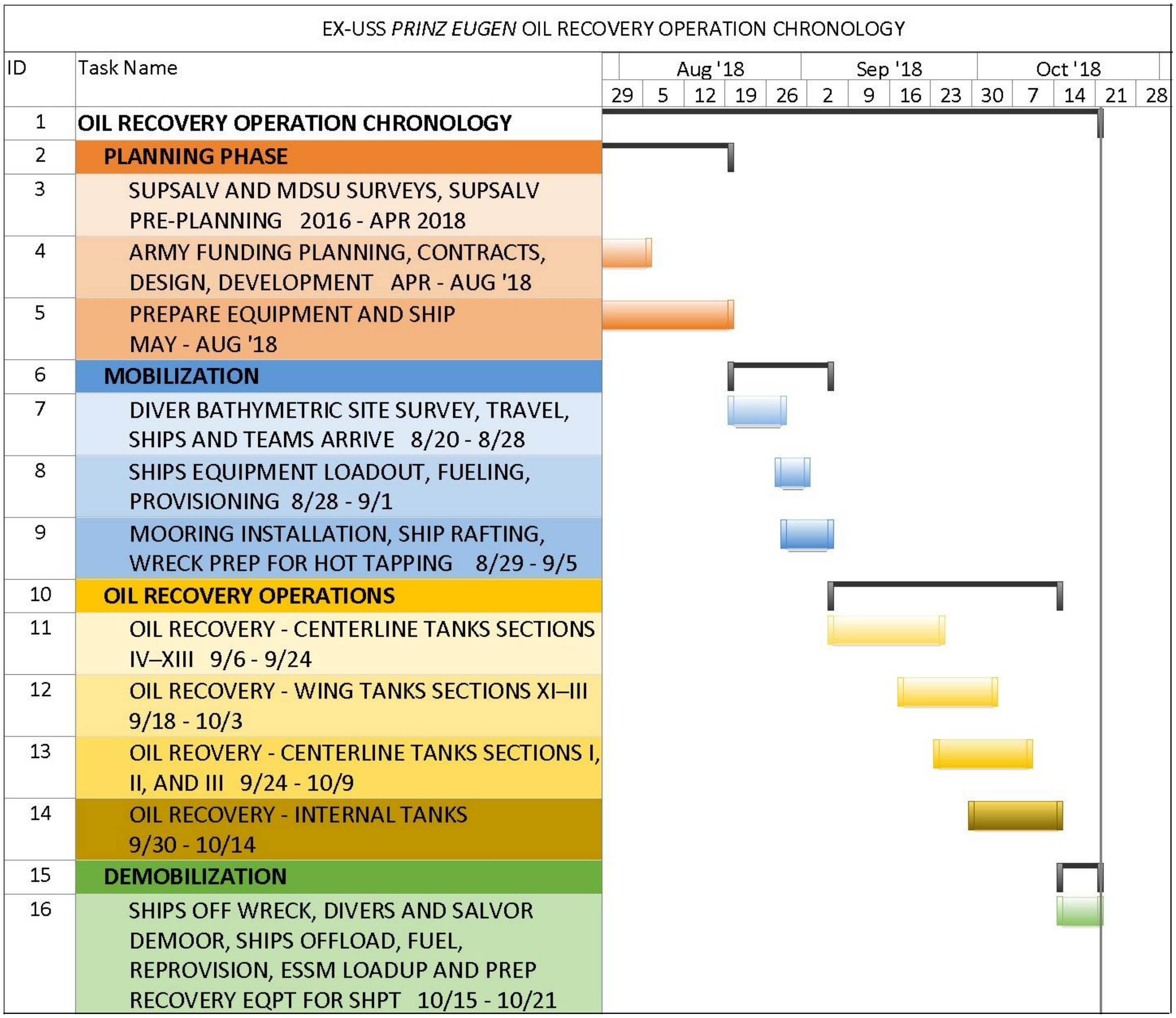


Figure 4.1. Ex-USS *PRINZ EUGEN* Oil Recovery Operation Chronology

### 4.3. Bathymetric Survey

On 23 August 2018, the dive team from MDSU-1 employed small boats and conducted a bottom bathymetric survey of the proposed anchoring/mooring locations (see Figure 4.2).

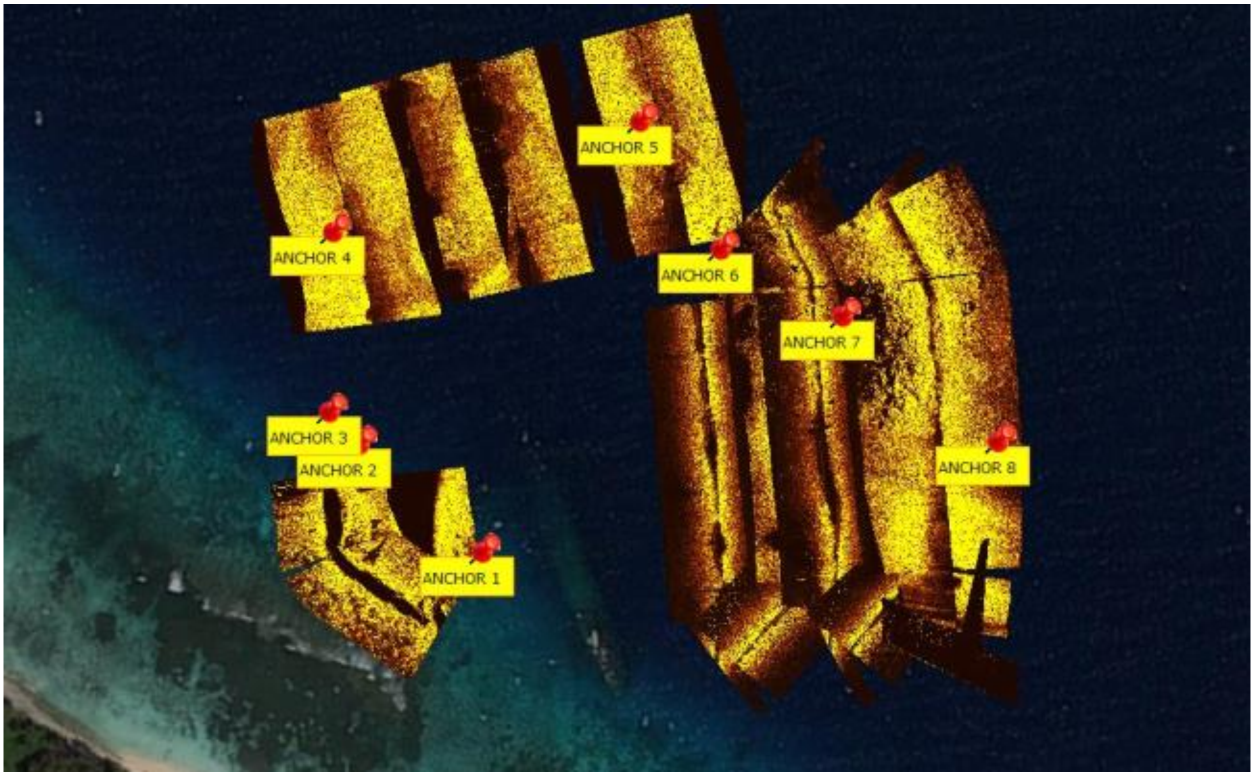


Figure 4.2. Bathymetric Survey of the Proposed Anchoring/Mooring Locations

#### 4.3.1. Ex-USS *PRINZ EUGEN* Coordinates

The following are the latitudinal and longitudinal coordinates of the ex-USS *PRINZ EUGEN* wreck:

Bow: (approximately)
Latitude: 08°45.219' N
Longitude: 167°40.954' E

Stern: (approximately)
Latitude: 08°45.119' N
Longitude: 167°40.999' E

#### 4.3.2. USNS *SALVOR* Location over the Wreck

The following is the approximate position of USNS *SALVOR* stern over the ex-USS *PRINZ EUGEN* wreck:

Latitude: 08°45.184' N
Longitude: 167°40.976' E

### 4.4. Mobilization

Mobilization refers to the period devoted to unpacking gear, removing equipment shipped in holds and ISO containers, staging and reloading equipment onto the salvage and support ships, and preparing equipment and provisions required for an efficient operation. The more than 100 tons of equipment and provisions that were required for the ex-USS *PRINZ EUGEN* oil recovery operation were made ready for use during the mobilization phase of the task.

The mobilization phase of the ex-USS *PRINZ EUGEN* oil recovery operation arbitrarily began on 20 August with the arrival of part of the MDSU Company to conduct bottom and bathymetric surveys. By 28 August the remaining MDSU Company, ESSM/GPC personnel, the ships, and the final members of the ex-USS *PRINZ EUGEN* recovery team arrived. Mobilization continued into the end of the first week of September. Laying the moorings was an integral component of mobilization and was difficult to execute due to the topography of the bottom, the close proximity to the reefs, and shallow depth.

Multiple support vessels were used throughout the operation. All vessels, boats, and craft were set up, staged, and put to use on-site during the initial mobilization period. ESSM/GPC provided a 25′ Rigid Hull Inflatable Boat (RHIB) and a 23′ inflatable Zodiac. The 25′ RHIB was used as a crew boat, shore taxi, Spill Response Team (SRT) oil recovery platform, and a support boat for divers, as well as an equipment transfer boat for gear needing to be placed or retrieved from the bottom. The Zodiac was used specifically for diver support and the SRT function. The USNS *SALVOR* provided a RHIB and a 36′ workboat which were used for transiting back and forth to shore and for mooring evolutions. The workboat was also used for anchor recovery operations. MDSU provided a Combat Rubber Raiding Craft (CRRC) which was used for diver support. Additionally, prior to starting the oil offload, MDSU utilized USAG-KA provided boom handling boats (BHBs) (former USN SUPSALV vessels) to conduct diving surveys of the wreck. The BHBs were maintained and repaired by ESSM/GPC personnel on-site in Kwajalein.

### 4.5. Mooring Installation

#### 4.5.1. Overview

The USNS *SALVO*R and USNS MDSU Company 1-8 was tasked with deploying the mooring systems. ESSM/GPC provided extra Stato anchors, chain, and jewelry out of ESSM Base Singapore, which were loaded onto the USNS *SALVOR* while the ship was outfitting in Singapore in early August.

The final mooring system anchor array utilized six Stato anchors, one Bruce anchor, and one of each ship's bow anchors (USNS *SALVOR* port bower and MT *HUMBER* starboard bower). While USN MDSU Company 1-8 provided the leadership and manpower, the U.S. Army Tug *MYSTIC* that was provided to SUPSALV for the project and paid for under contract funds, provided the primary deployment and recovery platform. The USNS *SALVOR* was also used for some of the mooring deployment and recovery.

The original system plans were modified on-site to adjust for bottom topography and on-site wind profiles. The bottom profiles were obtained by MDSU. Using the modified plan with the equipment shipped to Kwajalein allowed the two ships to be "rafted" together and have the capability of being separated if weather conditions exceeded a predetermined ceiling level of 35 knots or higher sustained winds for more than 1 hour. When the two vessels de-coupled, they would each have their own four-point moor albeit in effect temporarily. The double four-point mooring systems allowed both ships to nest together for operations or un-nest should the weather become unsuitable to continue operations. Weather did come up, approach, and temporarily exceed the ceiling and the ships had to shut down operations for weather on more than one occasion, but at no point did the two vessels have to de-couple until the completion of the operation.

Because of the sheltered location of the mooring system, wave action was not a factor; the main force it would have to resist was wind. Calculations showed that the system would hold in continuous 40 knot winds with a small safety factor.

The anchors were placed by a combination of USNS *SALVOR* and USAG-KA Tug *MYSTIC*. *MYSTIC* placed four Stato anchors and one Bruce anchor into their respective locations and the USNS *SALVOR* placed two Statos. The *MYSTIC* was required to place the anchors located in the shallower water or near coral shoals due to having better maneuverability and a more shallow draft than the USNS *SALVOR*. These locations included anchor positions 1, 2, and 3 (refer to Figure 4.3).

There was no crane available to place the anchors onboard the *MYSTIC*, so a USAG-KA contractor operated synchrolift was utilized. The anchors and chain were loaded on the synchrolift and the lift was lowered to the bottom. Then *MYSTIC* was backed into the lift and pulled the anchor chain onboard using its tow drum. The anchor was left on the hip for transit to the drop site. Two anchors were picked up at a time in this way and then were dropped at the appropriate waypoints in vicinity of the wreck (see Figure 4.2).

The anchoring/mooring system consisted of nine separate mooring legs. This was originally going to be eight legs, but it became apparent after the initial system was set and the ships rode out the first few tidal cycles that there were issues with the arrangement because of winds, bottom topography, and especially with the lack of holding power of the MT *HUMBER* bow anchor. The tug was brought back out and with USN MDSU leading the deployment, another 6000-lb Stato anchor was dropped in position 9 shown in Figure 4.3.

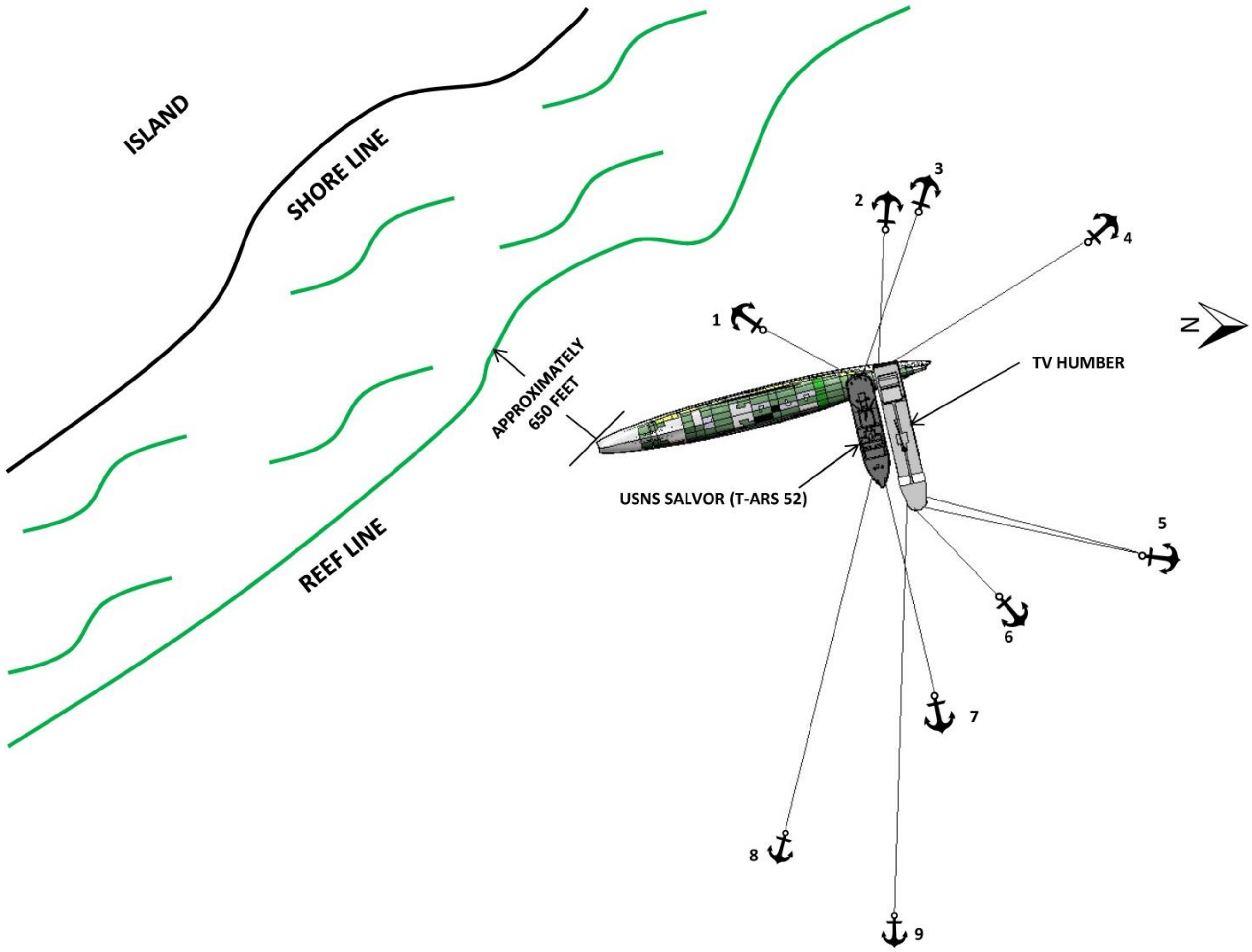


Figure 4.3. Ex-USS *PRINZ EUGEN* Oil Recovery Project Mooring Array

Anchor legs 1, 2, 3, 5, 8, and 9 were all set up with 6000-lb Stato anchors, one shot of 2 1/4″ chain, a number 5 pear shaped detachable link, two 100′ sections of 1 1/4″ wire rope connected by 2 1/4″ detachable links and recovery buoys. Then line was run from that point to the respective vessel. The MT *HUMBER* used their own 5″ circumference synthetic braid mooring line (rated breaking strength 38 MT) and the USNS *SALVOR* used a 6″ circumference Spectra mooring line. Anchor position 4 used a 3000-lb Bruce anchor with a shot of 2 1/4″ chain, the same 1 1/4″ wire rope, and a 2 1/4″ detachable link to the recovery buoy. Anchor positions 6 and 7 were the MT *HUMBER* starboard bow anchor and the USNS *SALVOR* port bow anchor respectively. The crown buoy make-up consisted of 100′–200′ of Spectra line secured to a recovery buoy at each location.

The USNS *SALVOR's* bower consisted of one standard Navy stockless anchor, five shots of anchor chain 100′–200′ of Spectra line, and one lightweight anchor buoy. The MT *HUMBER* deployed her starboard bower consisting of; one anchor, eight shots of anchor chain, and the MDSU unit attached 100′–200′ of Spectra line on a buoy as a crown wire (see Figure 4.4).


Figure 4.4. USNS *SALVOR* with the Starboard Stato Anchor Rigged for Deployment

### 4.5.2. Anchor Coordinates

The following are the longitudinal and latitudinal coordinates for each anchor:

Anchor 1:
Latitude: 8°45.165' N
Longitude: 167°40.947' E

Anchor 2:
Latitude: 8°45.201' N
Longitude: 167°40.906' E

Anchor 3:
Latitude: 8°45.212' N
Longitude: 167°40.896' E

Anchor 4:
Latitude: 8°45.272' N
Longitude: 167°40.897' E

Anchor 5:
Latitude: 8°45.309' N
Longitude: 167°41.000' E

Anchor 6:
Latitude: 8°45.266' N
Longitude: 167°41.027' E

Anchor 7:
Latitude: 8°45.244' N
Longitude: 167°41.068' E

Anchor 8:
Latitude: 8°45.202' N
Longitude: 167°41.120' E

Anchor 9:
Latitude: 8°45.244' N
Longitude: 167°41.143' E

### 4.5.3. Anchor/Mooring Leg Diagrams

The following figures refer to pertinent information and details specific to each anchor used in the operation.

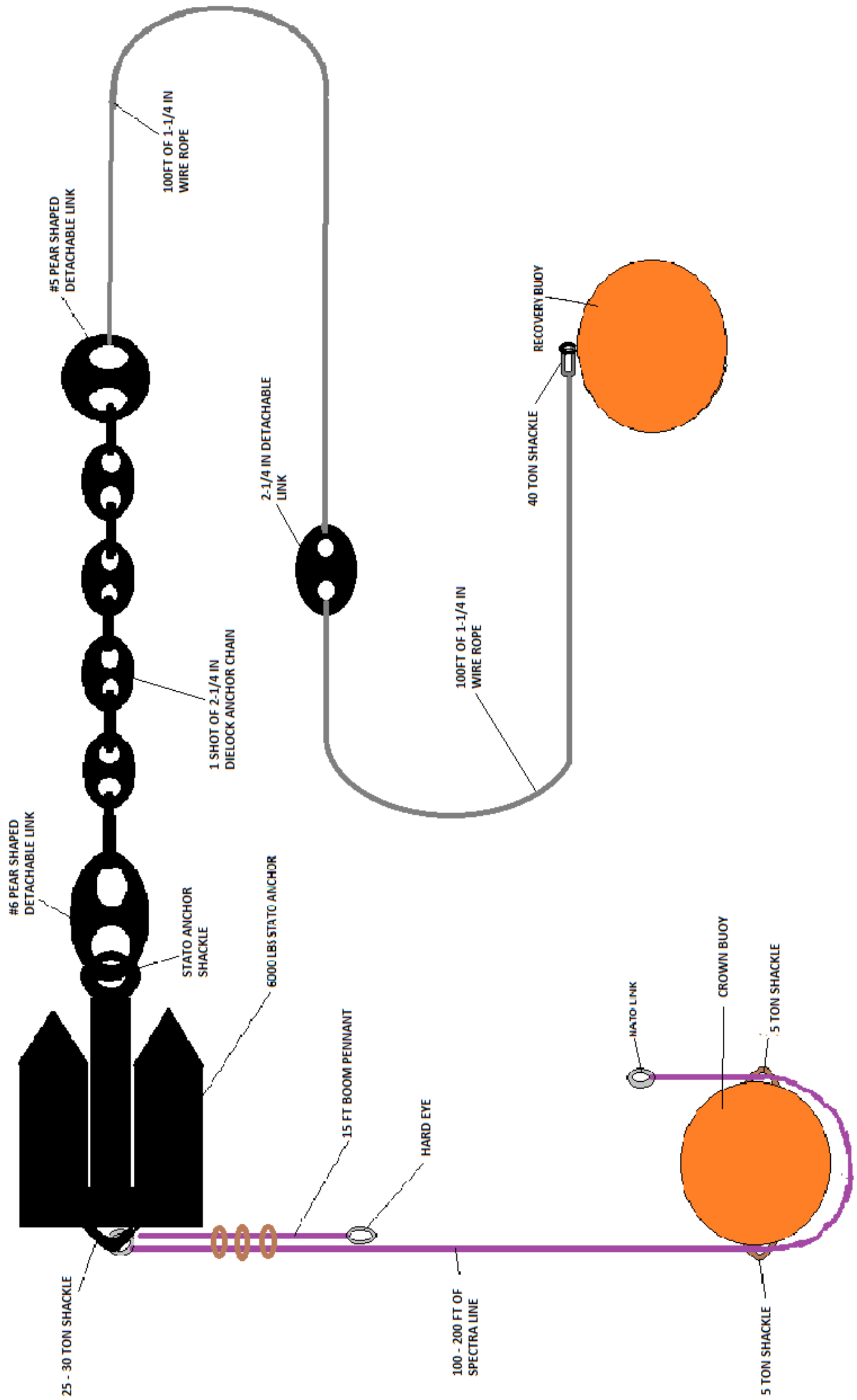


Figure 4.5.  Anchor 1

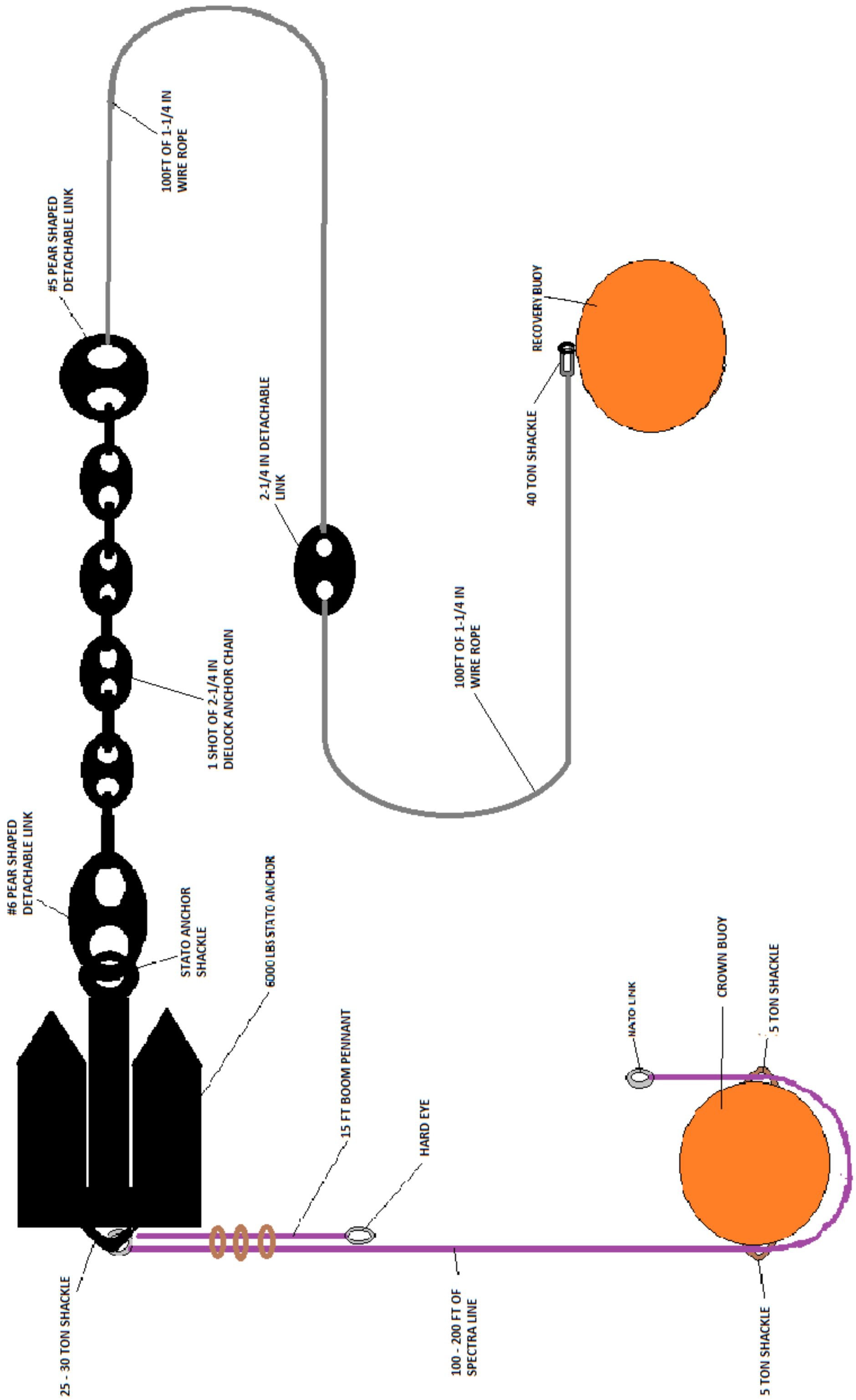


Figure 4.6. Anchor 2

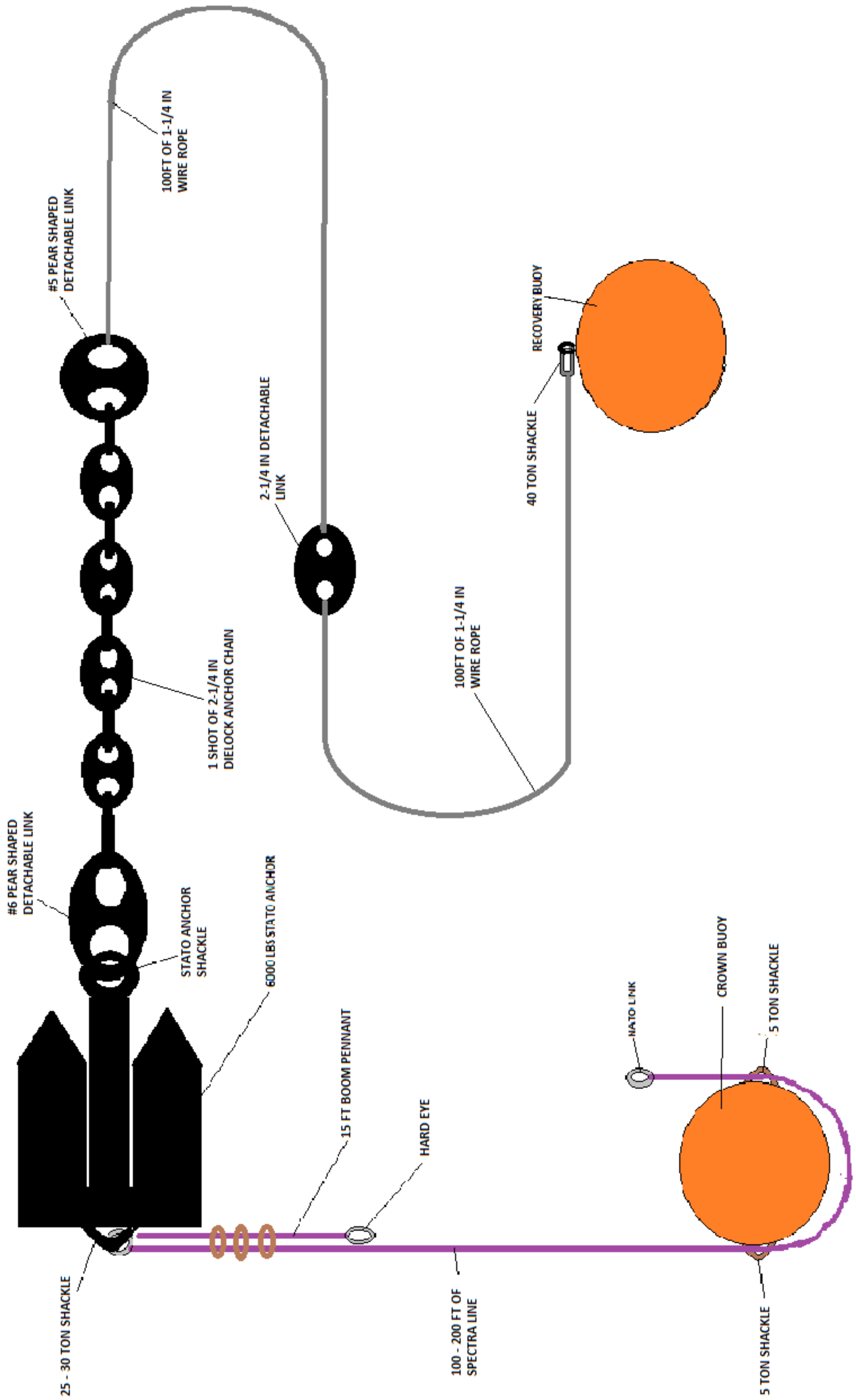


Figure 4.7. Anchor 3

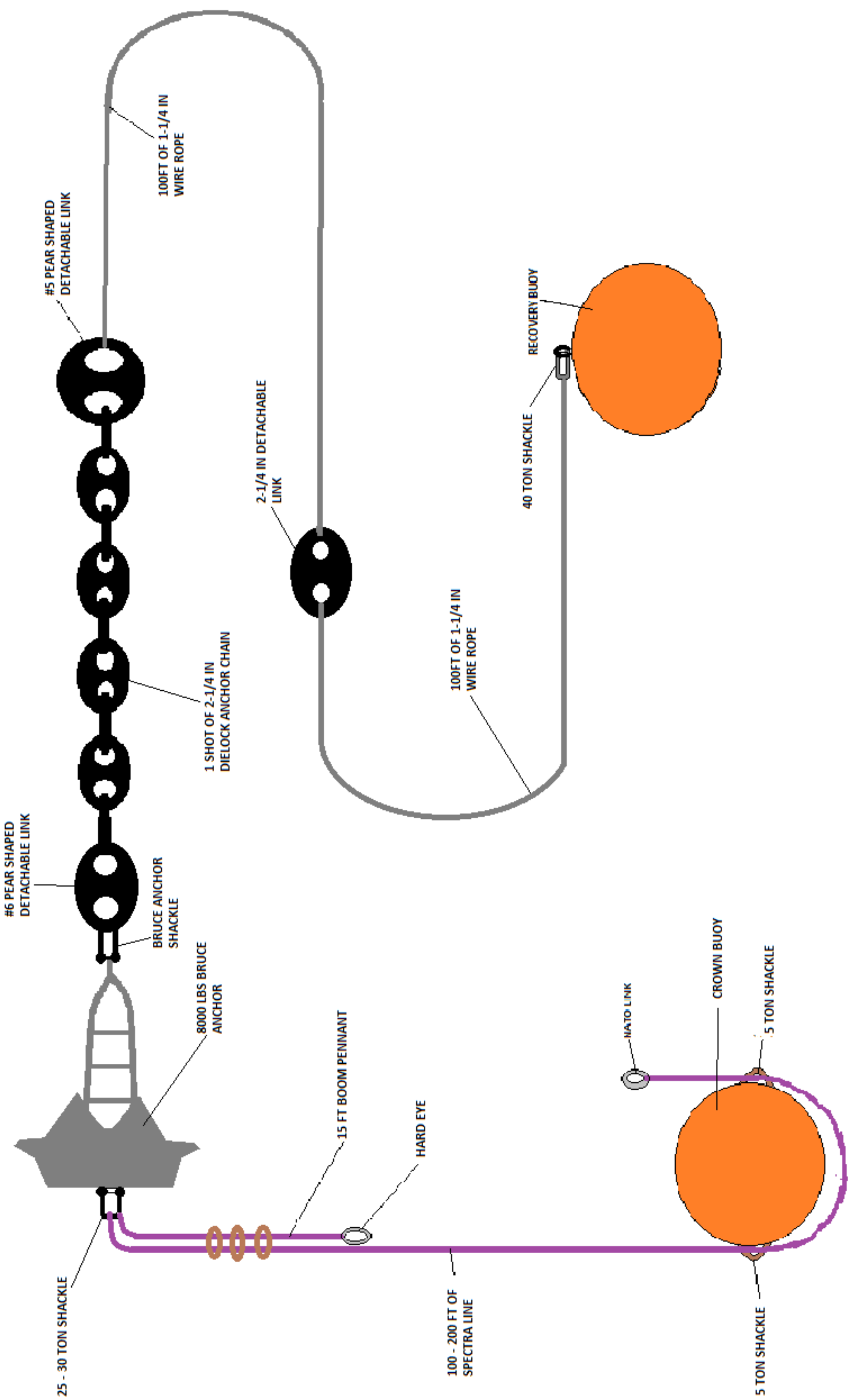


Figure 4.8. Anchor 4

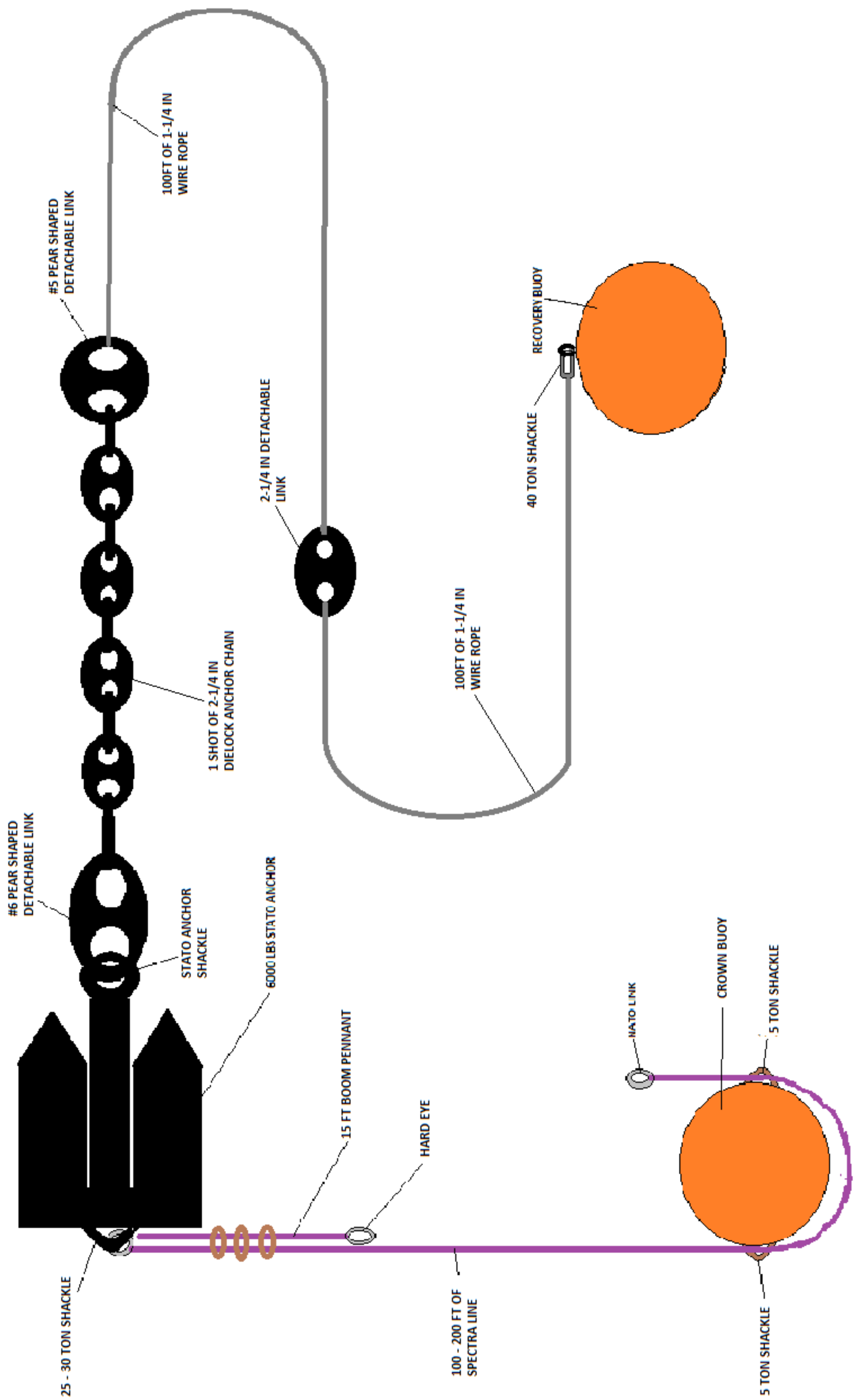


Figure 4.9. Anchor 5

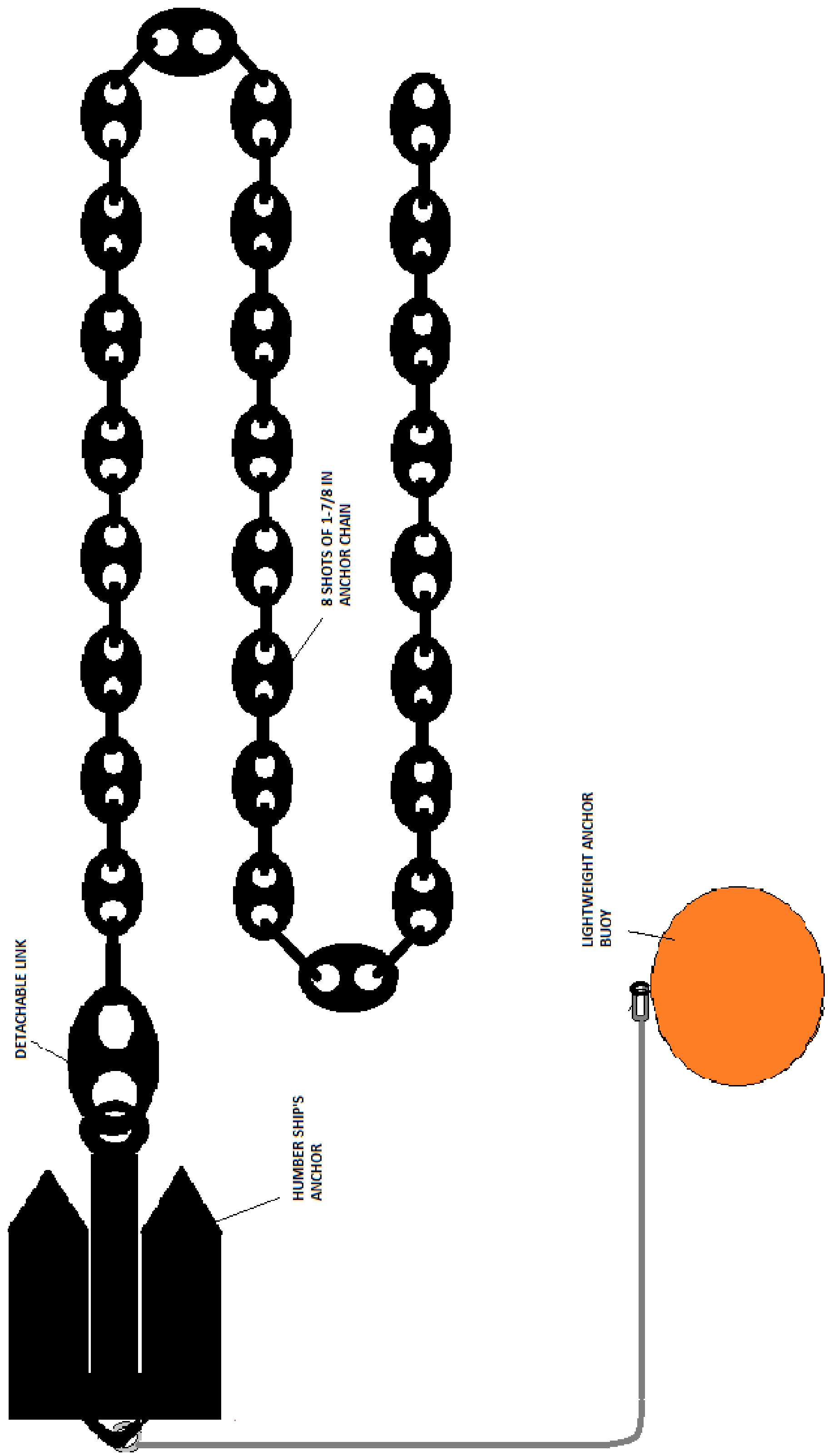


Figure 4.10. Anchor 6 (MT *HUMBER* Bower)

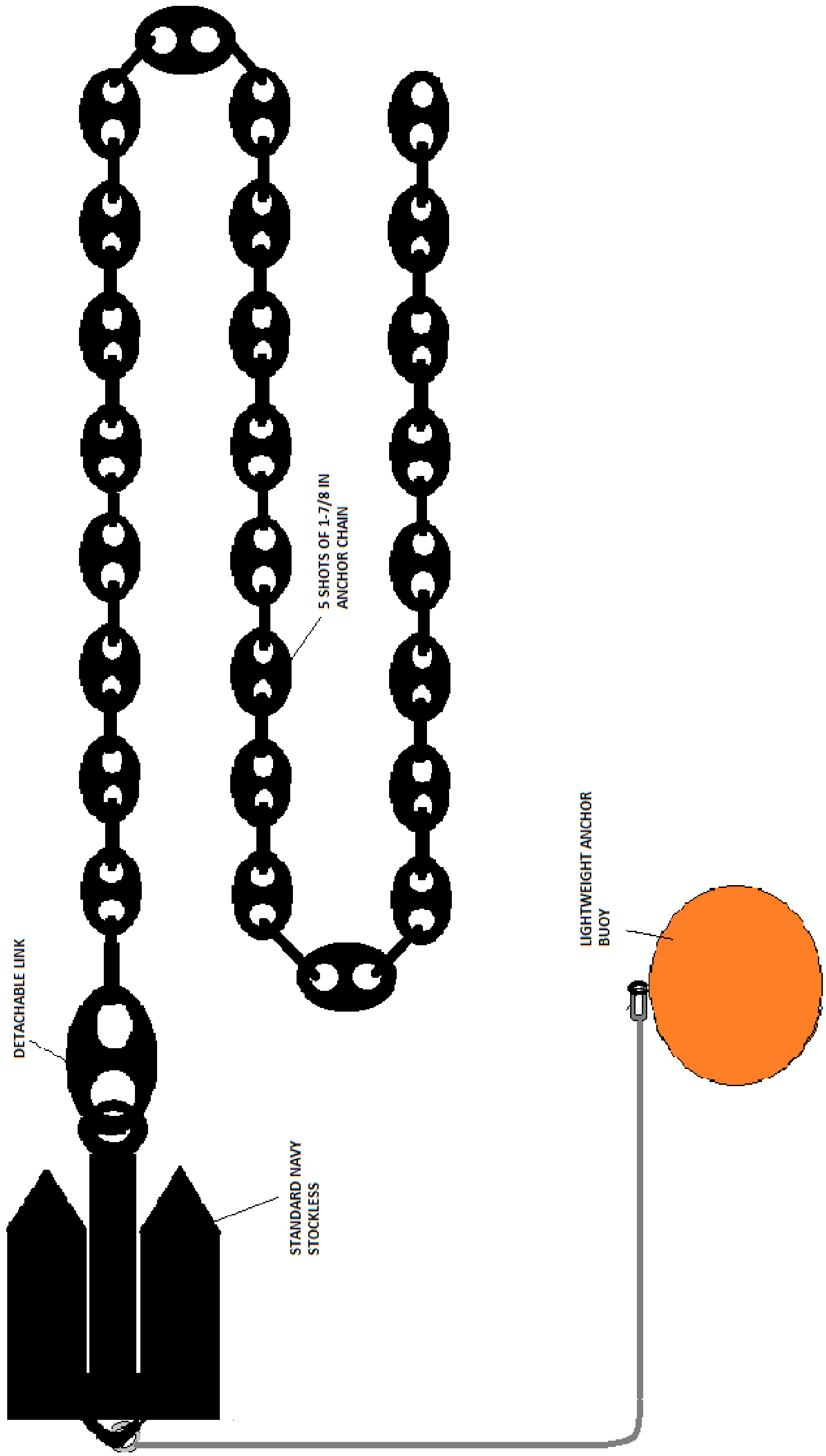


Figure 4.11. Anchor 7 (USNS *SALVOR* Bower)

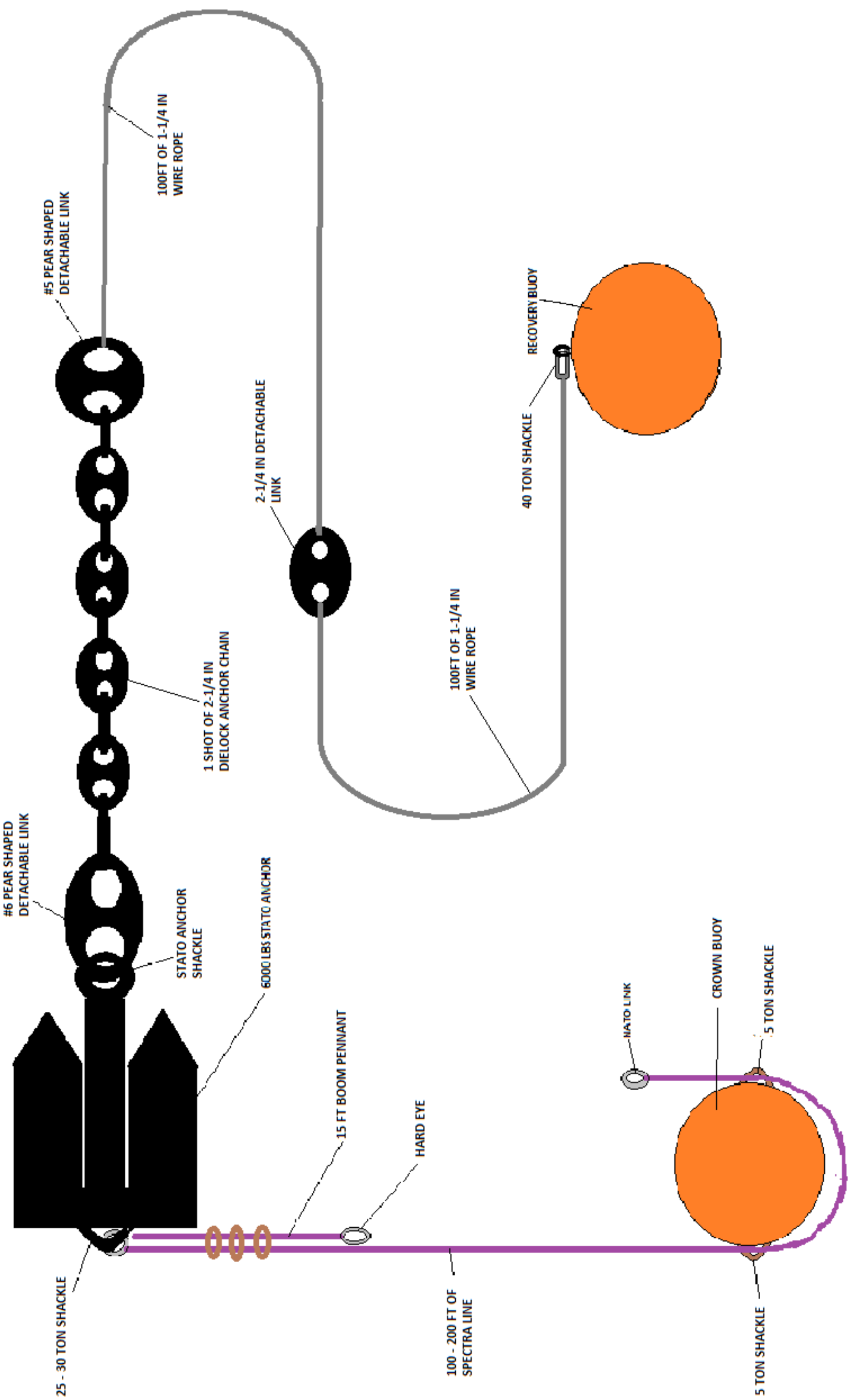


Figure 4.12. Anchor 8

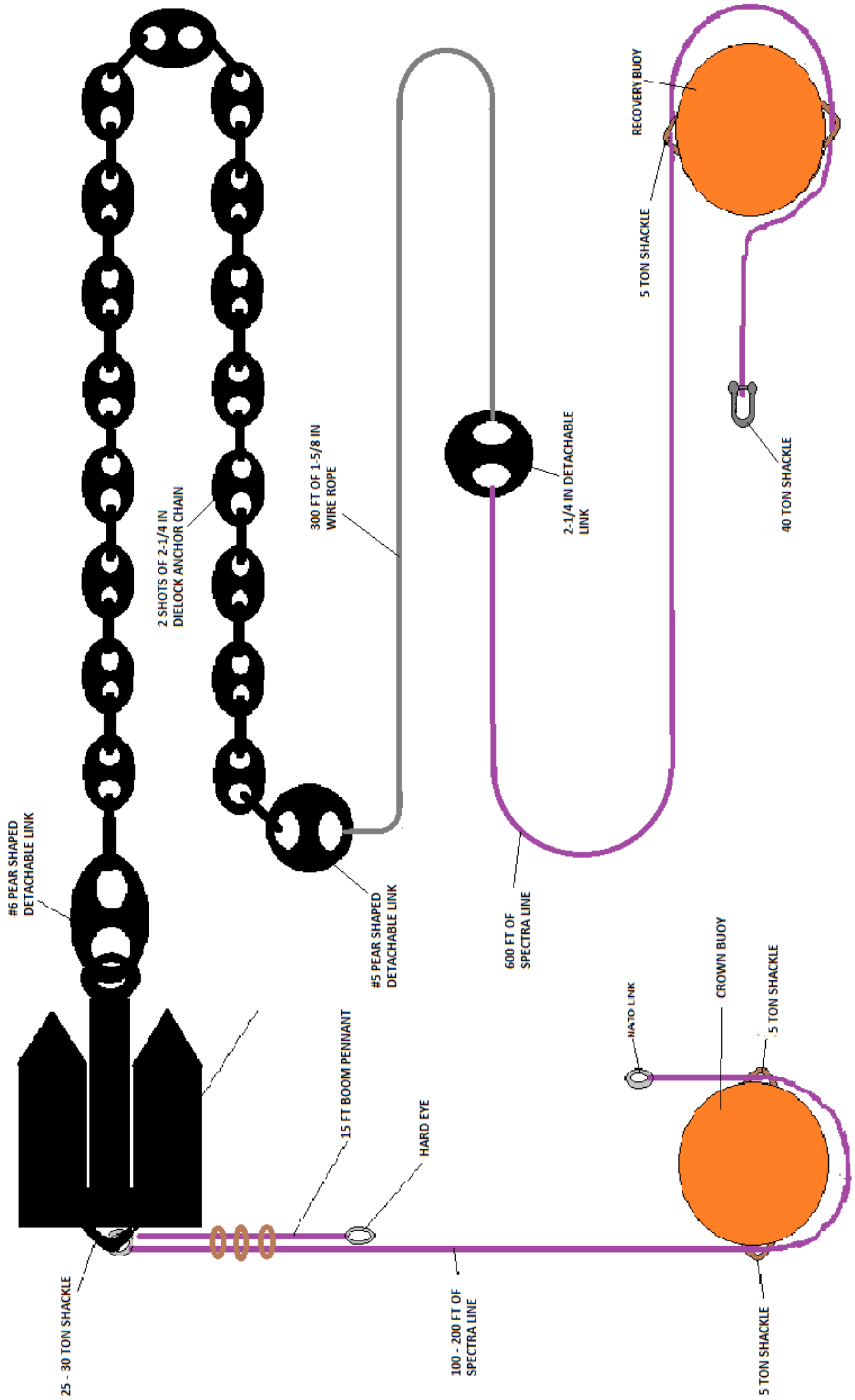


Figure 4.13. Anchor 9

## 4.6. Diving Operations

The core and backbone of any oil recovery endeavor from sunken wrecks are the dive operations. Over the course of the ex-USS *PRINZ EUGEN* oil recovery evolution, diving operations accumulated over 965 hours of bottom time during 340 dives. MDSU divers performed more hot taps and accessed more tanks on the PE project than any prior wreck oil recovery task SUPSALV has been involved in. The professionalism, persistence and tenacity of the MDSU divers were essential to the timely and successful completion of the project.

The on-site dive operations that took place in Kwajalein Atoll ran from 20 August to 20 October 2018. Diving operations were conducted using surface supplied Kirby Morgan KM 37 helmets with 600 foot long umbilical hose assemblies. MDSU utilized their Lightweight Diving System (LWDS) along with the ship's Air Supply Rack Assembly (ASRA) to allow for three working divers and one standby diver. This configuration significantly increased the productivity of diving operations. Two divers could work on hot tapping and pumping tanks while the third diver could test tanks for oil, install grid lines, and prepare tanks for hot tap flanges.

Tag-outs were required for USNS *SALVOR* every day. And tag-outs were also required for the MT *HUMBER* but only during times when divers were working underneath that vessel which was usually only when specifically working on the bow sections. In addition, Emergency Gas Supply (EGS) equipment was worn by the divers when there was chance the divers would need to go deeper than 60 feet, for conducting enclosed space dives into breached tanks, and when umbilical assemblies were extended all the way to the stern of the vessel.

## 4.7. Oil Recovery Operations

The reason and purpose for the many months and thousands of hours of planning, the mass shipment of equipment, preparations by dive planners, ship schedule planning, offloading planners, the budgets, and travel all boil down to one thing, the oil recovery operations. This report section describes how the recovery operation took place and includes the results and some of the major problems incurred during each wreck tank section recovery. Although relatively detailed, descriptions of events, completed tasks, and problems encountered during each dive and on the tank sections are not comprehensive as there were many events omitted in the essence of time and space in this report. In general, the term "PE team" is used throughout the section and remainder of the document to refer to the personnel involved in the recovery operation and includes NAVSEA/SUPSALV, CTF-73, MDSU, USNS *SALVOR* crew, MT *HUMBER* crew, and ESSM/GPC personnel.

### 4.7.1. Tank Location

Planning efforts were made to provide tools and instructions that would direct divers to the correct hot tap locations for every tank on the wreck. These planning efforts included the development of a digital 3D scale hull model, detailed Microsoft Excel files with descriptive hot tap location instructions (for hot tap location maps see Appendix E), tank drawings, and a complete tank navigation grid system with identity (ID) tags (see paragraph 3.7.1.1and Figure 4.14). ESSM/GPC engineers also designed a complete set of target hole location tools that could be laid out in conjunction with the grid system ID tags to find the exact tap locations. Each proposed hot tap location had to be physically located by divers using the grid system and location tools. Divers used various methods for fine tuning the exact hot tap spot that included use of the grid system, a measured locating tool, unique hull features, visual inspection, and sounding with a hammer to ensure that the hot tapping location was not over a frame or other internal reinforcement or structure.

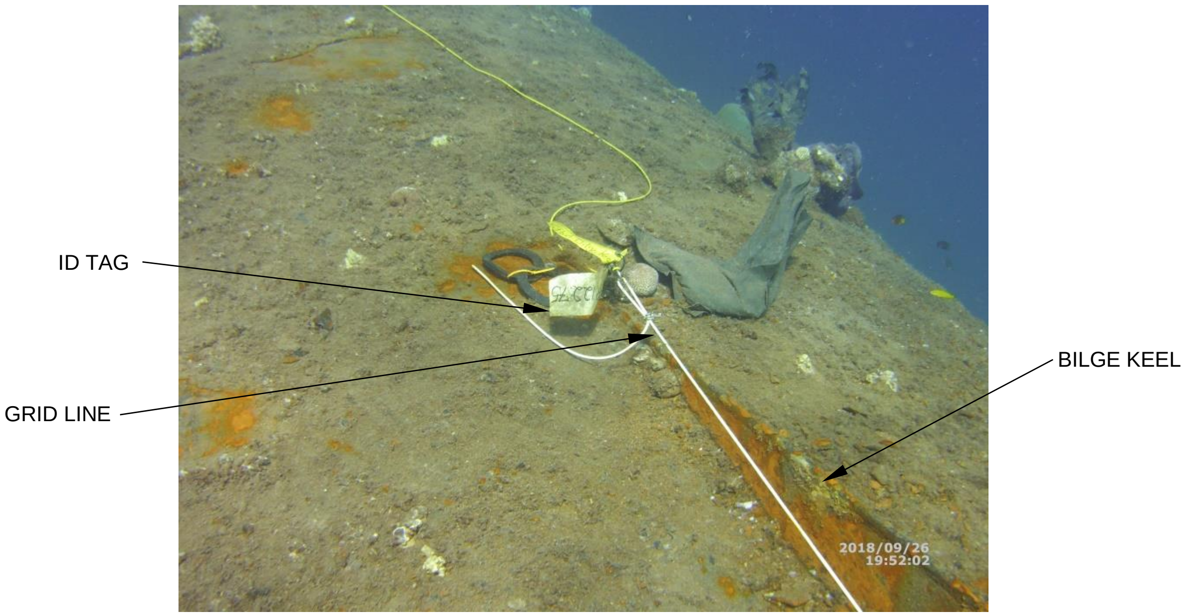


Figure 4.14. Grid Line Termination Point Shown Bolted into the Hull with White Plastic Coated Wire Running Fore and Aft Along the Bilge Keel of the Wreck

The grid system included supporting documentation and drawings, wire and rope materials, clamps, attachment brackets, fasteners, tags and markers, and location aids which were developed by ESSM/GPC engineers and planners (see paragraph 3.7.1.1 for a more detailed description of the grid system used). The basic tank locating process began with the diver on the surface attending a pre-dive planning session. Once on the bottom, the diver would go to the pertinent tank section by first following the portion of the grid line attached to the bilge keels of the wreck and transit to the correct cross-frame number tag. Transverse grid lines were located at key watertight bulkhead frames. Once at the correct transverse line, the diver would follow the transverse grid line to the tag with the correct section and tank label indicating the specific tank boundary. Using instructions and the “Right Angle Distance Tool”, divers would place the tool down along the grid and mark the spot to be cleaned.

### 4.7.2. Hull Cleaning

Using conventional hammers, chipping hammers, punches, chisels, hydraulic or battery operated grinders and/or a pick axe and a shovel, some coral and marine growth had to be cleared from the grid line areas and the flange locations in order for precise locations to be identified. A hammer was used to sound for frames in the identified hot tap flange location and then a hydraulic or battery powered wire brush tool was used to do the final cleaning of the area of approximately 27 to 30 inches in diameter to ensure that the drill tool magnets would have enough space. A second area would sometimes have to be cleaned for the drill assist leverage bar, also known as the "Bubba Bar", which provided leverage on the drill for the divers to apply while drilling. Once the area was thoroughly cleaned, a Cygnus underwater ultrasonic thickness gauge was used to measure the hull plate thickness.

### 4.7.3. Tank Testing

Once the precise tank location was identified and the area adequately cleaned, preparation for hot tapping consisted of first drilling a 15/32″ hole (nominally 1/2″) in the center of the cleaned area to test if oil was present. Originally, the test hole was drilled a few feet away from the proposed flange area so as not to interfere with the pilot bit hole, but this method changed after the first section was hot tapped (Section IV) to place the test hole directly under the cutter head location, but still offset from the center pilot bit, to prevent having to clean a separate area and needing to plug and seal an additional penetration on every tank. Upon drilling the test hole, air, oil, or water was encountered. If oil escaped, the hole was immediately plugged with either a bolt or a wooden plug. If air escaped, the hole was plugged with the thread forming bolt, and then allowed to bleed out when a diver was available to monitor it. Another method was the use of a valve threaded into the hole, but there were a limited number of valves available and this method was not frequently used. The release of air was controlled using the bleed valve (or open hole) until either oil came out or the air simply stopped indicating only water was left in the tank. The valve was immediately closed upon the release of oil. If oil was observed, the hole was temporarily plugged and the hot tap flange was installed over the hole in the center of the cleaned area. If oil was not present, the hole was plugged with a self-tapping fastener and the tank was marked "Water".

If air emerged from the test hole, it indicated that there was air in the high end of the tank and that the tank was intact enough to trap air (i.e., the hull was not cracked and otherwise open to the sea). If the tank was tight, it was more likely to have oil trapped although it is suspected that not all tanks were originally loaded with oil and some of them may have only contained a small residual amount of oil when the vessel sank. Some of these tanks would produce a positive test for oil when "drill tested", but would end up not producing any oil when the tank was pumped out. Many times air would stop bleeding from the tank and the hole would be seemingly neutral with water, only to have air release again when the tank was checked at a later date which showed that the air was seeping or migrating through the tank structure.

Another tool used after drilling the test hole was a “dipstick” device that was inserted into the hole to reach through the air pocket and check for oil and rotated around to feel for tank frames.  If the “dipstick” device detected any frames or obstructions present, the hole would have to be moved over and away from the obstruction before the hot tap hole could be drilled.

### 4.7.4. Hot Tapping

Due to excessive pitting on the hull, it was necessary to use a flange with a bead of marine sealant (specifically 3M 4200) around the periphery of the gasket.  Later in the project, a double gasket was used where the gasket closest to the hull was made of a soft closed cell material, approximately 20 or 30 duro scale hardness, and the flange side gasket was harder at 60 to 70 duro hardness.  The softer rubber gasket placed next to the rough hull plate enabled it to be compressed into the rough surface to better seal off any hull leakage.

All of the tools, hot tap equipment, one of the underwater cameras, and oil recovery equipment used by the divers were provided from ESSM inventory and were brought in for the project.  All dive equipment was part of the MDSU loadout.  Each and every day the tools and equipment that were to be used for dive operations had to be prepared for use prior to diving.  Preparations for use included cleaning the hand tools, cleaning and preparing the hot tap tools, applying grease (or other lubricant), thread tape, installing new bits and cutter heads, applying gaskets, fittings, fasteners, charging batteries,  removing metal shavings and hull rust from all magnets, fueling power units, maintaining power units, deploying hose, and in a nutshell, ensuring that every possible tool, material, or item (except dive equipment) that was going to be used by the divers for that day was prepared and ready to be sent to the bottom.  All of the tools to be staged for the day were readied and placed in a staging area near the dive station (see Figure 4.15).  The dive team always prepared, cleaned, maintained, and repaired their dive equipment (e.g., umbilical hoses, masks, regulators, cameras, helmets, dive station monitors and electronics, chambers) and the seemingly limitless amount of gear needed to carry out daily dive operations.  The dive team often worked late in the evenings performing repairs and preparing equipment.

Hot tap flanges were pre-staged on the bottom in a location near the area to be cleaned, unless it had to have sealant on the flange, in which case, the flange was sent down when it was ready for installation to ensure that the sealant was fresh and pliable.  If necessary, the flange was placed on the hull and secured with magnets.  Sometimes only one magnet was required, or when the target area was flat, the divers were able to drill the flange without using any magnets and simply holding it down.


Figure 4.15. View from Dive Station Looking Aft on USNS *SALVOR* During a Rain Squall, Arrow Points to Vent Tool (Schadow Device), Electric Drill, and Miscellaneous Tools Laying in Staging Area Ready for Divers

With regards to the hot tap flange, the self-drilling/self-tapping screws were installed in a diagonally opposing pattern. Then using a torque wrench, the diver tightened the screws first to half the final torque and then to the final torque in a diagonally opposing pattern. Torque specification was directed from topside. The ball valve was installed on the flange, and then tightened with the pipe wrench. The flange hole was checked for blockages prior to the hot tap installation.

The hot tap was then installed and the camlock dogs were tightened and secured. The valve was opened and the hot tap feed lever was rotated to the right, which rotated the bit down. The bit was driven forward until the pilot bit touched the hull plate. The hydraulic drill was attached to the hot tap drive spindle and the drill operated while the feed handle was slowly turned to drive the pilot bit through the material. The cutter head then slowly cut the hole. The feed was done manually by the diver to slowly move forward into the hull with the feed handle while the drill rotated the bit at an rpm proportional to the hydraulic flow rate of the HPU to the drill (approximately 5 to 7 gpm). Once the hot tap hole saw blade went completely through, the speed and resistance would definitely change and drilling would stop. The process of cutting the hole would take 20 to 45 minutes depending on the thickness and angle of the hull to the cutter bit.

After the cutter head penetrated the hull, it was rotated four or five turns so as to drop out the coupon and to ensure that a full penetration occurred.

After coordinating with topside, the hot tap cutter was fully retracted while closing the ball valve behind it.  Depending on the pre-determined plan with topside, the hot tap was detached and the pump inlet hose assembly camlock fitting was installed or a cap was attached if the tank was not going to be pumped immediately.  Direction from topside determined the pumping operation as this was a coordinated effort between the receiving station, the hot tap station, and dive operations.

### 4.7.5. Pumping

Pumping operations were performed using a basic plan that changed and adapted as the project progressed (see Figure 4.16 and Figure 4.17).  Many on-site challenges were addressed and resolved over the course of the month-and-a-half-long oil recovery marathon. There were several changes to the original plan starting with a modification during pumping of the very first tank.  The pumping rates estimated from the original plan were in the 170 to 300 gpm range based upon the effective feet of hose estimated, the assumed viscosity of the product, and the amount of hydraulic power available to the pump on the bottom.  The actual on-site pump rates were significantly lower than originally estimated.  There were several reasons for the reduced flow rates which combined, reduced the ability of the system to pull oil from the 3 1/2″ hot tap hole at higher flow rates than approximately 90 gpm.  One of the limiting factors was the higher than anticipated friction loss in the flow dynamics through the hot tapped hole, another addition to this was suction hose friction losses on the inlet side of the pump, higher than expected discharge hose runs which added friction losses to the system.  There were also a large amount of bends and kinks in the discharge line which added a significant pressure loss to the discharge.

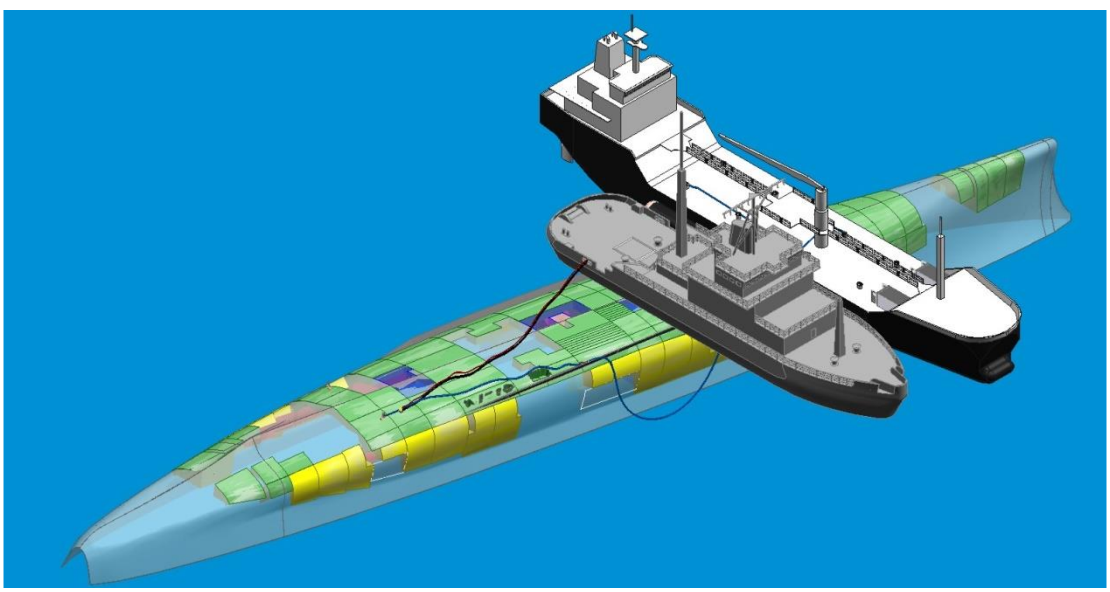

Figure 4.16.  Site overview including a view of the wreck beneath the two recovery vessels and the general recovery pump hydraulics and discharge hoses shown attached in Section III.

Figure 4.17. Divers hot tapping a centerline tank using the lightweight hot tap tool (left), and another tank inboard showing the suction hose, flange, valve, discharge hose, and pump (right).

The suction side pump dynamics were the primary limiting factor contributing to flow rates. This could be seen when pump rates exceeded the suction limit, the pump would cavitate and lose suction. Pump cavitation is the formation of bubbles or cavities in the pumped liquid, in the areas of relatively low pressure around the center of the pump impeller. The formation of bubbles in the low pressure area around the pump impeller can cause the loss of suction lift. The imploding or collapsing of these bubbles has a negative effect on the suction capability of the pump and can cause vibration and damage to the impeller. The effort of trying to pull oil at a fluid velocity that was too high would result in cavitation at the pump inlet and loss of suction lift. This problem was exacerbated by the almost constant presence of large volumes of air in the tanks on the wreck. From the first tank pumped and thereafter, pump rates were reduced to the point where pumping could be consistently sustained without cavitation issues, and usually increased only to the point where a good flow rate was achieved and held constant. Thus the optimal flow rate for removing oil became tank specific and unpredictable how fast or slow pumping would be on any given tank.

Often times the final remnants of oil being recovered from a tank on the wreck visibly indicated that it was becoming mousse like (i.e., having a thick brown consistency). The physical indicators that the oil was becoming more viscous were; the pump rate (gpm) would start dropping as the viscosity increased, and more viscous oil filled the discharge hose. The hydraulic pressure to the bottom pump would have to be increased by the HPU operator to counteract the back pressure increase to the system. The increase in system head was due to the increase in friction loss of the more viscous oil/water emulsion coming out of the tank. Post-operational lab analysis of samples from the “heavier oil” showed that the viscosity of the mousse oil was as much as 10 times the viscosity of standard Navy Special Fuel Oil

(NSFO). The act of trying to pull that mass of higher viscosity oil out of the hole and then push that mass through several hundred feet of discharge hose to the receiving station, increased the discharge pressure drastically. In some tanks, this required dialing up the hydraulic pressure to the pump to the maximum level to give the pump enough energy to continue rotating at a high speed. One of the tanks (Section VIII 4.2) had oil that became so viscous that it overcame the ability to pump it with the centrifugal pump that was on the bottom. The pump team had to inject water in the inlet to try and reduce the viscosity of the emulsion by creating a high water to oil ratio slurry. This method was successful.

When stripping tanks, the pump team usually "dialed down" the flow rate to the lowest rate that the pump could support without losing suction. The reason behind this effort was to try and pull as much of the top oil layer as possible out of the tank without breaking the surface tension of the oil and pulling water like a worm hole up from lower down in the tank. Many times only a low percentage of oil was found in the tank and the tank was usually pumped at the slowest rate that the pump could operate effectively. However, if there was only a small amount of oil in the tank, it did not seem to matter if the rate was slow or fast as the slightly higher rate pulled a lower percentage of oil, whereas the slower rate pulled a higher percentage. The end result was the same approximate amount of oil. However, if the oil was thicker in depth and more viscous, it was always better to slow the rate. Also, if the oil was believed to be coming into the target tank from another source, such as being fed with a low rate flow from a crack in an adjacent tank wall or an internal tank, then pumping slow or pumping and intermittently stopping to allow oil to slowly flood in were the more effective strategies.

The average flow rates varied considerably depending on conditions as described above. In almost all cases, the flow rates were less than 100 gpm and were generally only higher than 100 gpm during the hose flushing process. The process of pumping was complicated. The lack of visual aids or methods of determining how much air, how much oil, and how much water was in any specific tank, at any given time, often created a mystery that could only be solved by using all of the tricks in the magic bag to make it work.

Stripping: The process of stripping tanks was simply done by first pumping the contents of the tank down until the recovered oil started coming into the tanker station at lower percentages in relation to seawater that filled the bottom of the pumped tank. Stripping required shutting down the pump operation at regular intervals to wait for the oil clinging to tank walls to release, migrate, and coalesce at the high point in the tank where the tap was located. After waiting a nominal period of time such as 30 minutes to several hours, the tank was pumped again. This process was usually repeated unless the oil to water percentage in the recovered product dropped to a consistent level of less than approximately one half a percent.

Internal tank content removal was slightly different. It proved prudent to wait for oil to gravitate to the pump suction when conducting an internal hot tap. This is because the internal tank was tapped through an external tank, but suction was at the tap of the external tank meaning the oil was only pumped after it had a chance to leak up into the upper external tank and displace seawater. Thus the internal tank pumping process usually took more than twice as long as the external tank process.

There was a combination of methods used to keep track of the oil pumped and collected daily. As oil was pumped into the pump station, the pure oil was put into one set of cargo tanks and oily water was directed into another tank referred to as the slop (or slops) tank. The slop tank accumulated a lot of seawater that had to be given time to settle out as the lower density oil rose to the top of the tank. The clean “water bottoms” were removed periodically by decanting (pumping out the clean seawater). The oil that collected in the slop tank was measured daily by the use of an electronic sounding tape that gave indication of where the oil water interface level was within the tank.

Figure 4.18 and Figure 4.19 show the generic hose configuration that was set up on the tanker. The two main oil receiving tanks were located in 2 port and 2 starboard. The slop tank was located in 4 starboard.

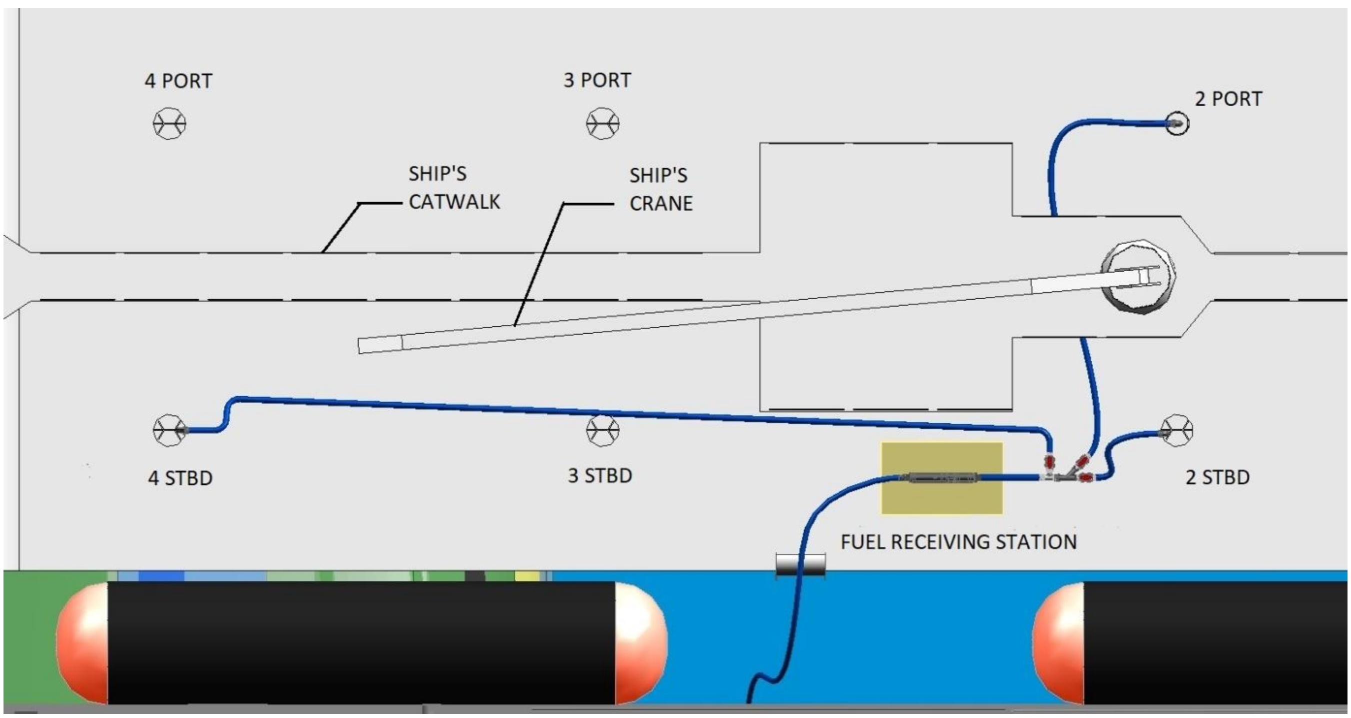


Figure 4.18. Generic Fuel Receiving Station Hose Configuration

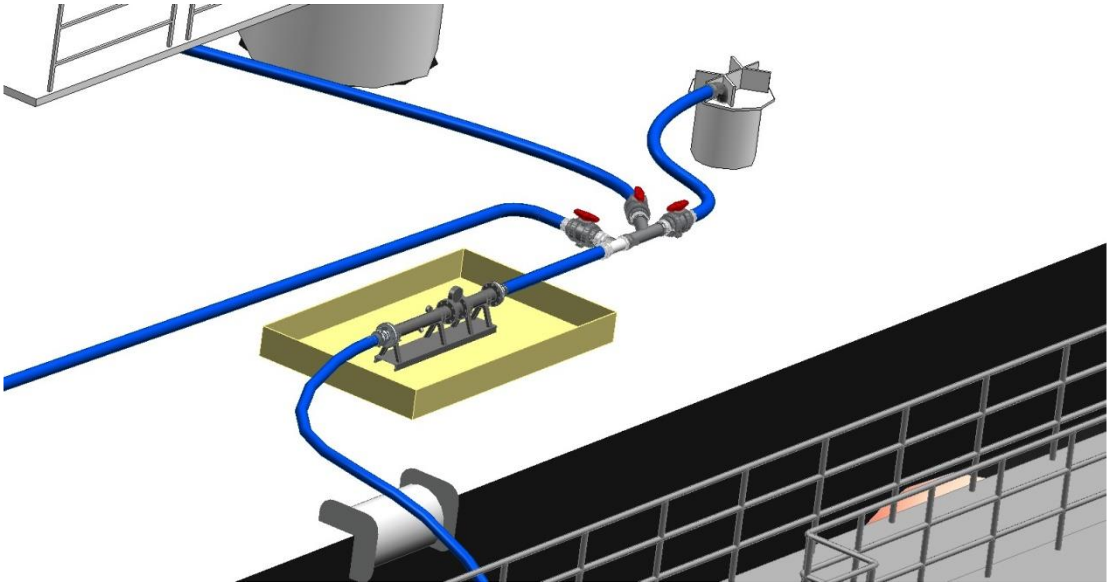

Figure 4.19. Generic Tanker Manifold and Piping Configuration as Set Up by ESSM/GPC Showing Hose, Manifold, Catch Basin, and Number 2 Starboard Receiving Tank

The process began with identification and confirmation of the tank being pumped by the ESSM/GPC dive station and hot tap coordinator, and then once the MDSU Dive Supervisor gave the all clear to pump, a request to the receiving station on the tanker would be relayed via VHF radio stating “ready to pump”. The tanker receiving station would confirm the location of the wreck tank source and start a new record, then open the pertinent valves and via radio, declare the station ready to receive. The hot tap supervisor would have the pump operator open the hydraulic power to the pump located on the wreck and slowly start pumping. Every pumping evolution had an initial quantity of water in the hose from the flushing of a previous tank and this amount would be accounted for by the receiving station. As oil appeared in the sampling port at the receiving station (see Figure 4.20 below), the flow of product was diverted to an oil receiving tank by use of a portable hose and valve system set up on the tanker by ESSM/GPC personnel at the beginning of the project. ESSM/GPC installed a calibrated flowmeter, pressure gauge, and a sample port valve in the fuel receiving station which allowed operators to record the flow rate of oil and water as well as the total amount of oil and water pumped. Each of the oil cargo tanks on the tanker was also “sounded” daily by the Chief Mate and deck crew of the MT *HUMBER*.

Figure 4.20. Fuel Receiving Station Onboard the MT *HUMBER*. ESSM/GPC personnel are taking regular periodic samples as well as recording flow rates, oil content, total volume of oil and water taken onboard.

### 4.7.6. Closing the Tank

In the life cycle of a tank oil removal process, the “close-out” was a multi-step process. When a tank was close to becoming empty, the pump station operators would see indications in the instrumentation in the form of pressure and flow fluctuations due to the changes in pump speed and energy. As oil gave way to water, or a mix of water and oil, it would change head pressure and thus the flow rate would rise.

Once oil levels in the tank were reduced to a small amount, the process of stripping was performed in which the last of the oil contents were removed by slowly pumping as previously described. Stripping continued until the percentage of oil in the sample station product tests were consistently less than 1% based on samples taken at the receiving station.

Once the tank was declared “closed” by the SUPSALV representative onboard, the pumping stopped until the divers were in a position to remove the valves, suction hose, elbows, and pump from the hot tapped hole. At this time, pumping would resume temporarily in order to flush hoses for divers to remove subsea equipment with a minimal amount of oil residue leakage during the disconnection on the bottom. When performed correctly, this method worked well.

The completed tank would then have the valve assembly removed (while holding a plug in the hole) and the hole would then have a toggle assembly and set of close-out caps installed (see Figure 4.21 below). The inner dome (not visible in this photo) was installed and a standard nut with a washer was applied and tightened enough so that the inner dome compressed the gasket at least half way. A larger second dome was then added along with another gasket and an external nut with two bolts sticking out that were used like a wing nut to tighten the nut down onto the external dome, compressing it into the edge of the flange gasket. Thus, tightening this nut would compress the dome onto the oversize gasket located under the original hot tap flange which would seal the tank. Once this was tight and the tank was ready to be permanently sealed, the bolts were removed by unthreading, and the holes and threads of the fastener joint were filled with underwater epoxy. The epoxy paste would then harden to eliminate the possibility of a sport diver being able to remove the nut and dome and re-open a tank.

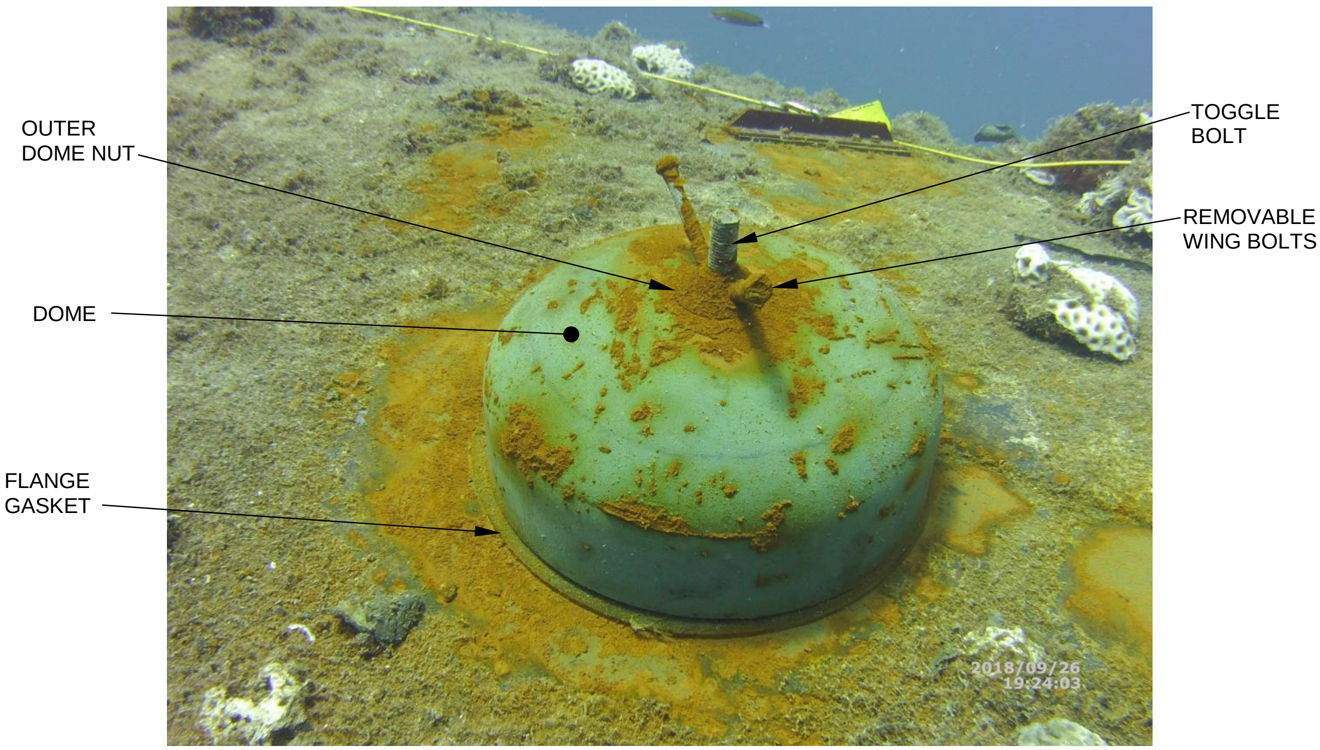


Figure 4.21. Close-Out Cap Shown as Installed.
(Note: this was an early cap installation and later was re-capped using a new set of gaskets including one under the top wing nut. The nut on top of the dome had the wings removed after tightening and a permanent underwater epoxy sealant applied to the threads and bolt holes, so that the cap could not be removed by sport divers.)

#### 4.7.7. Record Keeping

Record keeping directly related to the oil recovery operation was primarily conducted by ESSM/GPC, NAVSEA, and MDSU personnel at two locations; the dive station on the salvage vessel and the receiving station on the tanker (see Figure 4.22). The dive operations log and tanker soundings conducted by the respective parties are not included in this report unless they specifically added value to the recovery operation information. The main record taken at the diver station was a log called the Hot Tap Station Log which is presented in Appendix I of this report. The main receiving station log was called the Pump Station Log and is presented in Appendix J of this report.


Figure 4.22. Samples taken from the pumped product at the receiving dive station were used to determine the type of oil being recovered, and as a basis for determining where to send the product on the receiving tanker. This sample shows that only a few percent of NSFO is currently being stripped from the wreck.

#### 4.7.8. Preparation for Hot Tapping in Sections IV and V External Centerline Tanks

The first few days of the ex-USS *PRINZ EUGEN* oil recovery project, after the initial mobilization and once the vessels were in the moor, were spent preparing the hull for flange installation and hot tapping. Although removing coral heads and cleaning the wreck surfaces to make room for the grids and flanges started weeks prior to the first hot tap, the major work to clear the hull for the installation of the wire and rope grid system started on 2 September. The initial components of the wire grid system were installed along the bilge keels on 5 September and continued through 7 September. The first test holes were drilled on 6

September. Product hoses, the bottom pump, and supporting hydraulic hoses were lowered down and moved into respective locations on 7 September in preparation for hot tapping. The general rule for environmental safety and spill prevention was that there was to be no hot tapping without a pump nearby to pull product if a hole leaked. The first hot tap flange was installed on 8 September, and the first tank of the operation was pumped the same day. The details of the oil recovery are presented in the remaining sections of this chapter.

### 4.7.9. Oil Removal - Sections IV and V External Centerline Tanks

#### 4.7.9.1. Tank Section IV

The actual oil removal project started in Section IV and moved towards the deeper bow sections. The term "downhill" was coined at the start of the operation to mean towards the bow of the wreck. All directions on the wreck were referenced from facing towards the bow (i.e., facing downhill) and since the ship was upside down, the port side was on the right when facing downhill and the starboard was on the left. When on the hull, the bow cannot be seen and it is easy to get turned around and not know which side is which. Referring to everything as right or left when facing downhill alleviated a lot of confusion and gave all parties a quick and universal directional benchmark. The grid system that was installed on the wreck was color coded to aid in keeping track of location and direction. The white plastic coded wire rope was used on the port side of the vessel which was on the right side when the diver faced downhill towards the bow on the upside down hull. A yellow line was used on the left side (starboard side of the ship). The original plan of starting at Section IV with the centerline tanks and moving downhill was followed on-site (refer to Figure 4.23, Figure 4.24, and Figure 4.25). The premise being that once all of the "easier" centerline tanks were tapped and pumped from Section IV to Section XIII in the bow, the recovery team would return towards the stern along the side shells, alternately tapping and pumping the wings along both sides of the wreck. The reason for starting in Section IV and moving down the hull was to start in an external centerline section that was relatively shallow, flat, was known to have some oil, and did not have a lot of corrosion and wastage as in Section I through III (reference Figure 4.23 below).

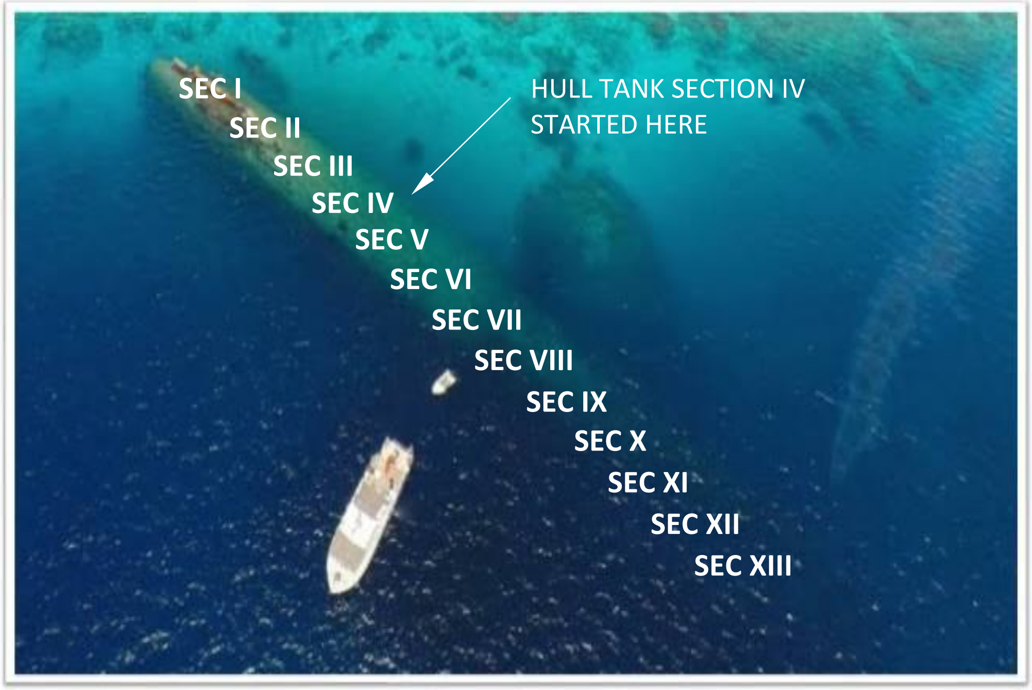


Figure 4.23. Overhead View of ex-USS *PRINZ EUGEN* Wreck with Sport Diver Boat near Amidships. Date of photo is unknown, note oil leaking from bow. The general location of Sections I through XIII is overlaid on the photo.

After the first transverse grid lines were installed in Sections IV and V, and the tanks were tested for oil in Section IV, the first hot tap flanges were installed on 8 September. That same day the centerline Tank 1.2 in Section IV was the first tank hot tapped and pumped on the wreck. Referring to the Hot Tap Log (see Appendix I) the hot tap flange installation took 14 minutes to install 12 of the long screws and another 6 minutes to torque the screws. This tank showed that hull thickness was approximately 5/8″ thick. The hot tapping component of the operation took 29 minutes to complete. Once pumping was started, oil was pulled as soon as the hoses cleared the initial volume of water (clearing the hose refers to pumping the volume of water that is statically sitting in the hose from a previous tank flush or, in this case, from the beginning). Air appeared later in the process slowing things slightly in the second pump (first strip) on the same day. The pump rate averaged around 70 to 77 gpm and 4070 gallons was removed on the first pumping session. There were six centerline tanks located in Section IV and two of those were not hot tapped. One of the two that was not hot tapped was obviously breached and the other tested negative for oil (any tanks that did not test positive for oil and did not bleed air during the initial testing were referred to as “water tanks”, only containing water). The last tank in Section IV was finished on 9 September and 10 September and all tanks were capped (but not completely closed) the same day. 7000 gallons of NSFO was removed from this section. The statistical results of almost every tank that was tested, accessed, or pumped on the wreck can be found in Appendix I and Appendix J.

Referring to Figure 4.24, this upside down cross sectional view of Section IV Frame 71 provides a good example of a section that contained all three tank types that are on the PE. It shows the oil tanks that were targeted for tapping and also shows the differentiations by the geometric location in the hull. Tanks that were located on the bottom of the hull between the bilge keels are shown in green (now on top in the upside down wreck). Tanks that were originally located in the ship side walls, referred to as wing tanks, are shown in yellow. The tanks that were located internally (e.g., they do not share a wall with the hull of the ship) are shown in red. This color scheme is repeated throughout the report in the majority of the images.

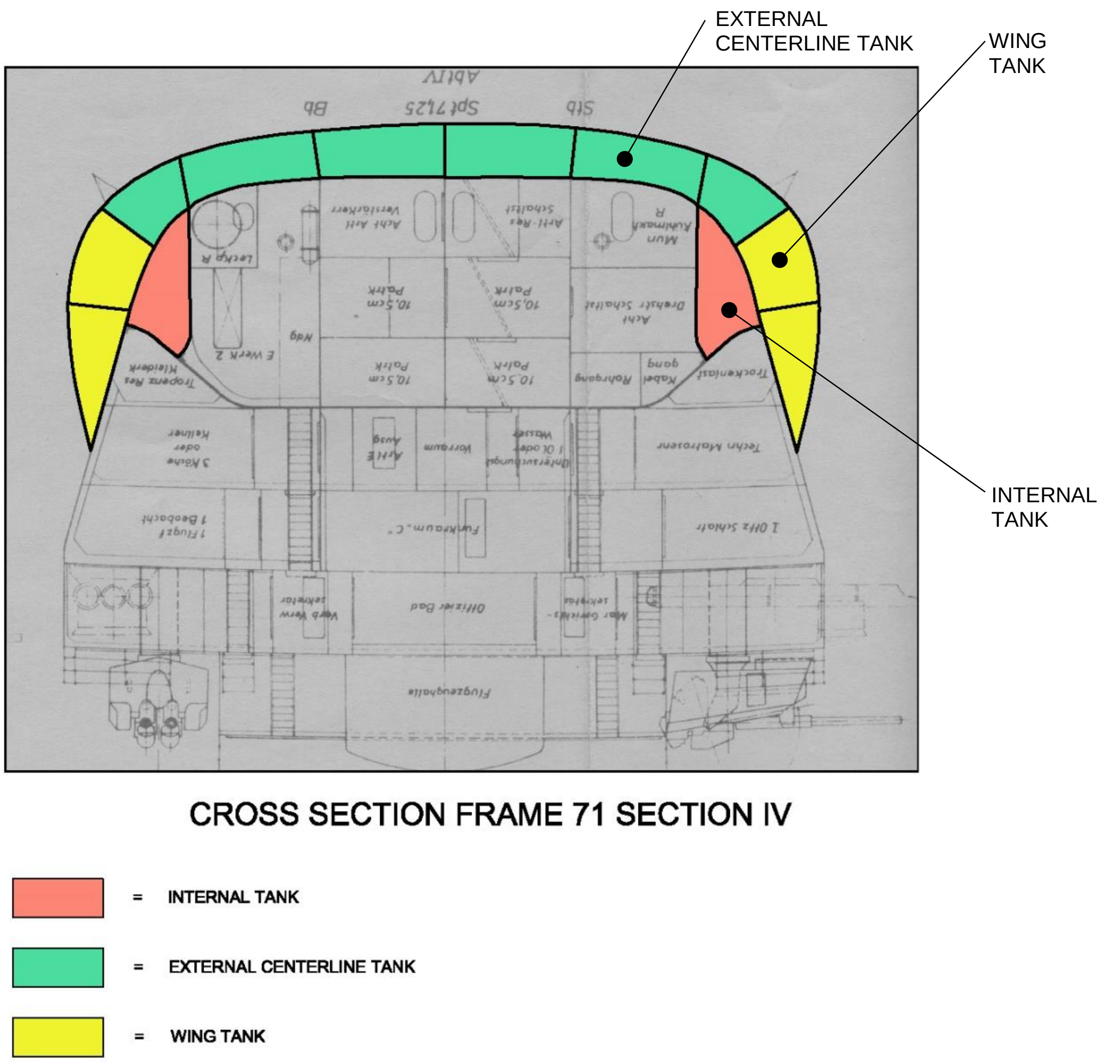


Figure 4.24. Ship Cross Section at Frame 71

The following external, internal, and wing tank figures in the remainder of this chapter section show the tank number that was pumped, the amount of oil recovered (REC OIL), hull material thickness (HMT) (in inches), if the tank was inaccessible (IA), low percentage oil (LPO), and the date that each tank pumping was completed.

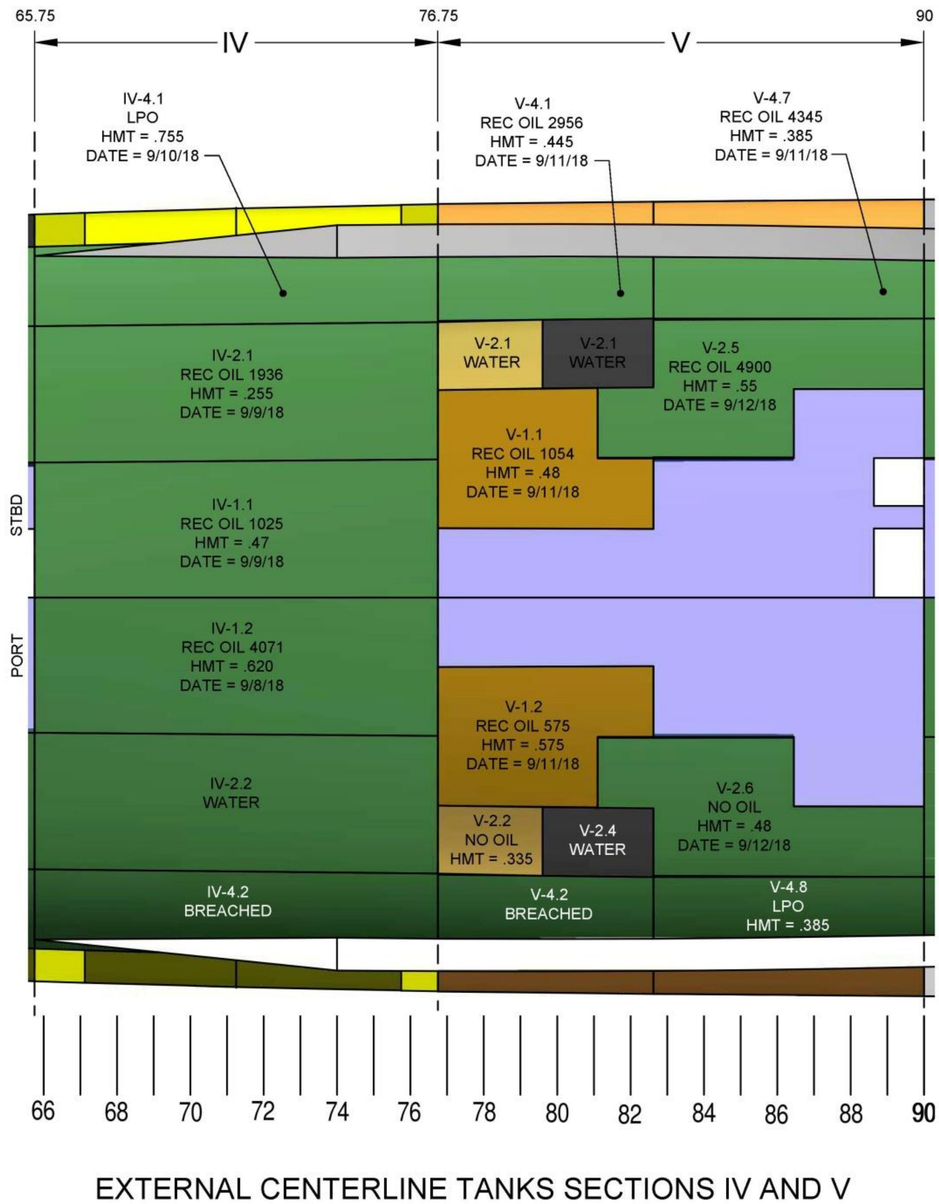


Figure 4.25. Hull Sections IV and V, The First Two Sections of the Wreck to be Hot Tapped and Pumped, are Shown Above

#### 4.7.9.2. Oil Removal - Section V External Centerline Tanks

Referencing Figure 4.25, there are 12 target oil tanks in Section V. Testing showed one of them to be breached and three of them to contain only water. All other tanks were hot tapped, but not all other tanks contained oil. Tank V 2.2 (listed as a purified turbine oil tank) was tapped, but no oil was found. Tank V 2.6 (an NSFO tank) was also tapped and contained no oil. Overall five of 12 tanks in this section contained oil, of which two of them contained turbine oil.

To summarize the previous two paragraphs, hull Sections IV and V were the first to be hot tapped and pumped. This area of the wreck provided the recovery team a sneak preview of many of the problems that would plague the dive and pump teams throughout the rest of the project. These included: hull cleaning problems, internal frame interference, tapping in the wrong location due to issues trying to define a correct and reliable grid reference point, air issues, fastener issues, and close-out issues to name a few. The time required for primary flanging and hot tapping in these first two sections, when conducted without extraneous problems, averaged 20 minutes for flanging and 31 minutes for hot tapping. Hot tapping time increased with metal thickness. The combined sections were started on 8 September and completed on 12 September. Oil recovered was approximately 7040 gallons for Section IV and 13,830 gallons for Section V, which represented 11% and 26% of the potential full tank section volumes respectively. At the completion of pumping these two sections, the tanks in Sections IV and V were closed out (capped with small and large domes), but were not completely sealed with permanent sealer.

### 4.7.10. Oil Removal - Sections VI and VII External Centerline Tanks

Sections VI and VII external centerline tanks were addressed 11–14 September. Refer to Figure 4.26 and Figure 4.27 for image summary. Close-out materials, extra product hose, and diver tools were delivered via either the ESSM RHIB boat or the small inflatable boats to the divers in the aft sections of the wreck to save time and effort by dive teams. Locating, cleaning, and test hole drilling went as per the previous sections, although at some point in these section processes, drilling test holes was moved from an outside independent test hole process to drilling a hole inside the area of the hole cutter; a change that increased the efficiency. The usual problems came up during hot tap preparations and hot tapping which were broken drill bits, broken flange bolts, leaking holes in and around the flange bolts. There was a sea chest interference in Tank VI 2.2 resulting in the original hole location being moved to the right location instead of the left location.

The Spill Response Team (SRT) operated daily during the recovery of oil in these sections as well as throughout the remainder of the project up until approximately the last couple of weeks of the operation. The sheer number of holes being drilled into the wreck on a daily basis, the number of hose connections and disconnections that had to be made, and the fact that the wreck was still actively leaking in several areas were all contributors to the almost persistent sheen and sometimes darker oil on the water around the operation. As the operation progressed and more and more leaks were patched and tanks were emptied, the PE team finally started seeing a positive reduction in leakage and surface sheen. The last week of the operation, through departure, the wreck looked pristine and as if it had never contained oil.

Section VI had five tanks, one of which tested for water and the other four all had NSFO. Approximately 8700 gallons of oil was removed from this section which amounts to 17% of the full tank capacity of the section (if loaded to 85% of total volume, which was common for loading). Section VII external centerline tanks consisted of 11 tanks, all NFSO except for Tank VII 4.2 which had tested as oil, but produced no oil when pumped. The remaining tanks collectively yielded 19,800 gallons of oil which amounted to 24% of the section's potential fully laden volume. All tanks were pumped down to less than 1% of oil and then shut down for a waiting period of at least 30 minutes, sometimes hours, or overnight to allow oil that was clinging to the internal sides of the hull to separate and rise to the surface of the tank. The tanks in Section VI were each stripped twice; once down to 1% or less and then after a period of waiting they were striped again before they were closed out.

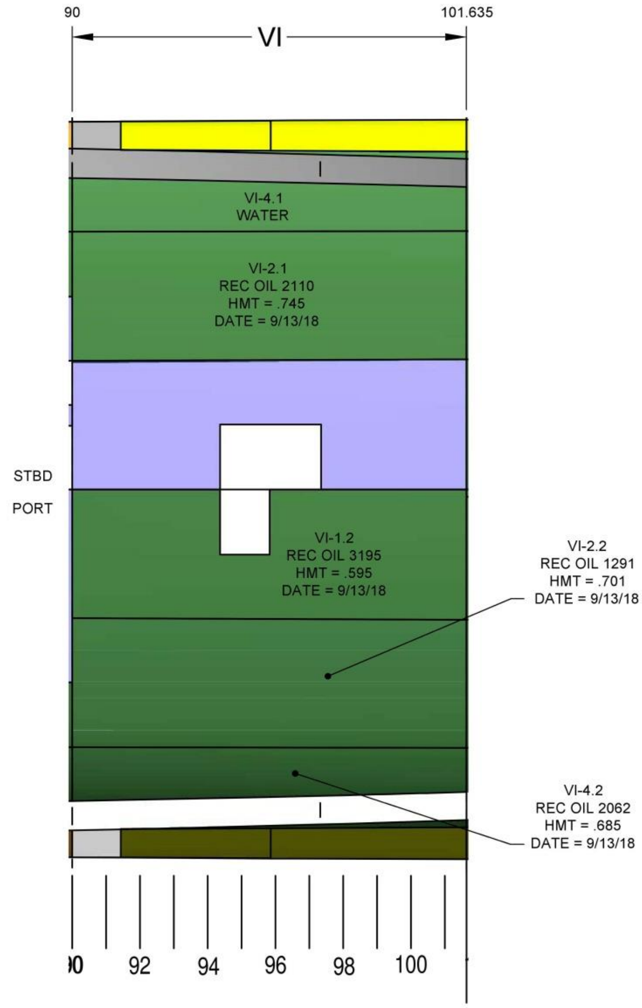


Figure 4.26. External Centerline Tanks Section VI

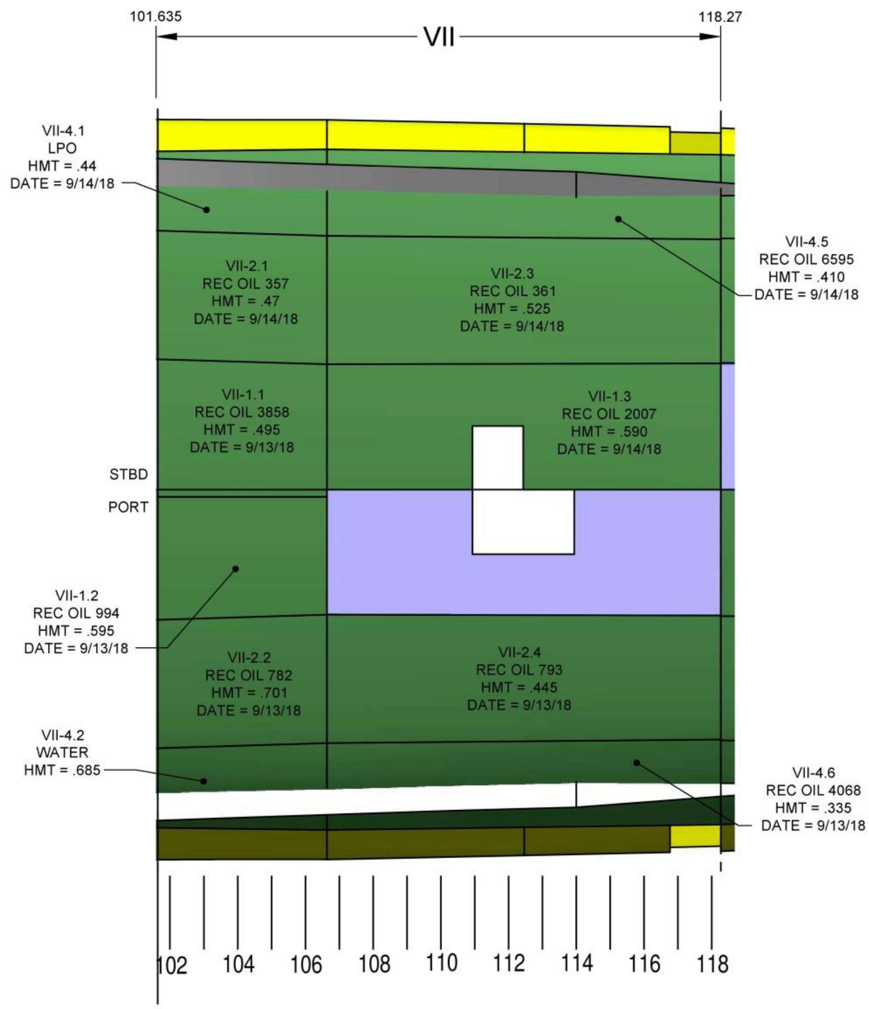


Figure 4.27. External Centerline Tanks Section VII

### 4.7.11. Oil Removal - Sections VIII and IX External Centerline Tanks

Sections VIII and IX (see Figure 4.28) contained five NSFO tanks in Section VIII and seven diesel fuel tanks in Section IX. There were several new and noteworthy problems that appeared in these two tank sections. It was noted during hot tapping that oil came out of two of the grid installation clips when installing these via screws into the hull. The divers used a two part epoxy made by Devcon to stop the leaks. The Devcon epoxy was in the form of adhesive sticks. Tank VIII 1.2 was re-bolted and re-torqued due to air issues, but had very little oil. Tank VIII 4.1 had to have a second flange put in later in the month (see internal tank section) due to obstructions, but Tank VIII 4.2 had air leaking from the flange bolts.

Starting on 15 September, the tire pump system was put into place using a 4″ centrifugal submersible hydraulic pump with a slurry impeller. This pump was placed in a modified truck tire within a cradle that floated on the surface, between the ships next to the receiving station. It had a suction hose that extended down to the wreck. The pump suction hose was connected to a hose that snaked along the wreck and terminated at the connection to the hot tap hole. This setup worked fine when there was no air in the tank and the suction hose was relatively straight up and down, but would lose suction as soon as air came up. Loss of suction was due to the suction hose having bends in it, the air would get trapped in the hose and the pump could not force the air out with the limited suction pressure the pump generated. This pump was used to pump oil from Tanks VIII 1.2, 2.1, 2.2, and 4.1 and was finally removed late in the day of 15 September.

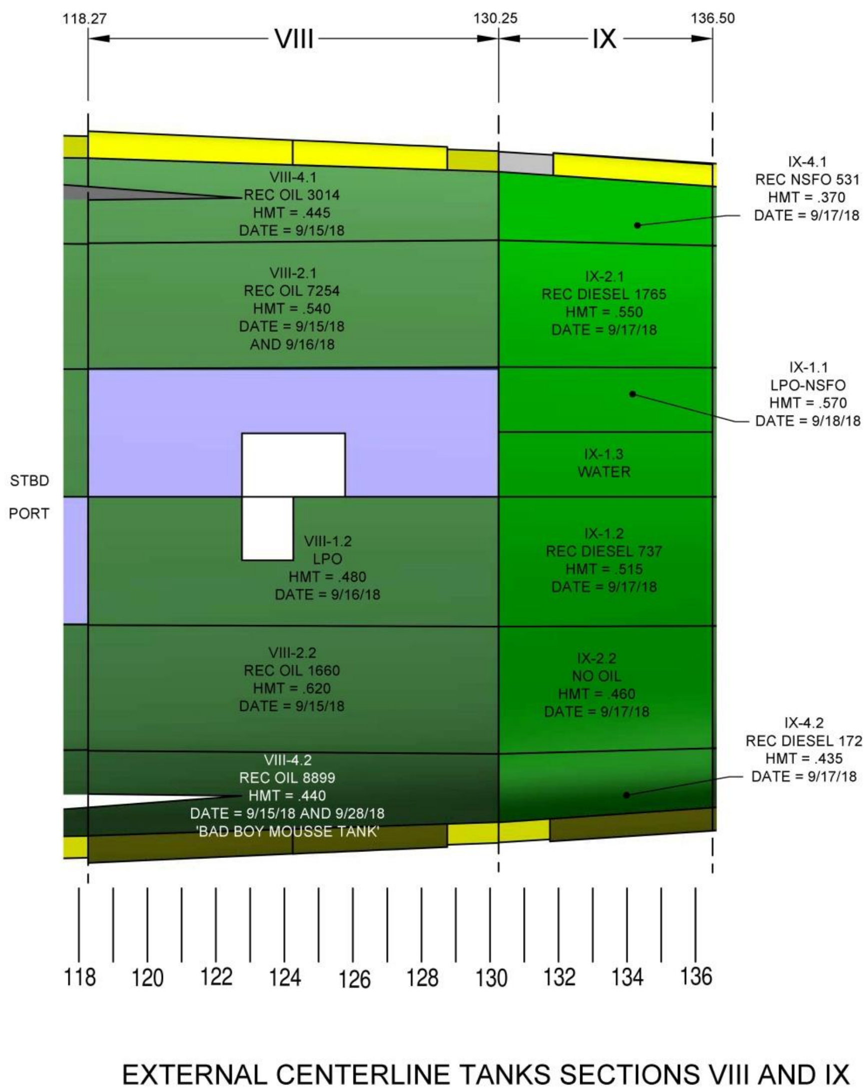


Figure 4.28. External Centerline Tanks Sections VIII and IX

One of the most noteworthy and surprising pumping evolutions in the project was Tank VIII 4.2, which was unofficially referred to as the "Bad Boy Mousse Tank". The pump team pulled 8900 gallons of oil from that single tank (which was only an 8800 gallon tank) and the oil in the bottom of the tank came up as a very heavy, viscous brown oil/water emulsion that looked similar to a dessert called chocolate mousse, hence the name. The viscosity of the oil recovered from the bottom of this tank created enough back pressure that it exceeded the ability of the pump to push the oil to flow through the long discharge hose. Water had to be injected into the hose near the pump inlet in order to decrease the viscosity at the pump impeller. It is believed this tank was common to either other oil tanks, possibly the internal tank below it, or was common to other tanks via internal piping.

When pumping resumed the second time, very little mousse oil was recovered and the product being recovered turned to water as realized at the sample station. It is very probable that most of the mousse was removed in the first run. The hose was cleared and the tank was capped for the evening. The next morning, 16 September, pumping began for a short period of time and removed another few hundred gallons of NSFO, but mousse was no longer recovered from that tank. It's possible that if it is too thin to sustain a consistent pump, the suction will pull a "worm hole" of water and not pull any more mousse. It is believed that all of the oil that could be pumped was successfully pumped out of this tank with a total take of 8500 gallons out of an 8800 gallon tank. At a later date, the tank was pumped again to ensure that it was clear and to be able to access the internal tank (Tank VIII 5.2) below it. Another 400 plus gallons of oil was removed from Tank VIII 4.2 and 535 gallons of NFSO was removed from the internal tank. Based on the fact that the upper tank yielded more than its full working capacity, it is believed that the upper tank had an opening common to the internal tank below. If two or more tanks are common to each other because of a crack in a bulkhead or holes in interconnecting piping, the oil levels will find equilibrium.

Section VIII recovered oil totaling 20,800 gallons of straight oil (not including oil stripped in low percentage to the slop tank) which accounts for a very high 39% of the original volume of the section. Section IX (the diesel tank section) did not solely contain diesel fuel. Three of the seven tanks contained water (in the case of Tank IX 1.3), and LPO (in the case of Tanks IX 2.2 and IX 1.1). Tank IX 4.1 on the starboard bilge keel contained NSFO as did Tank IX 1.1 albeit in low quantity. The remaining tanks contained gritty black diesel oil similar to the diesel fuels recovered from previous WWII wrecks. Details on the product specifications can be obtained in Appendix J. Overall, recovery for Section IX was 3200 gallons, or approximately 10% of full volume.

On 17 September, diesel fuel pumping began in Section IX. The diesel that was removed came out as black diesel; similar to what was seen on the USS *MISSISSINEWA* oil recovery project (reference S300-B6-RPT-010 U.S. Navy Salvage Report USS *MISSISSINEWA*). Diesel was recovered from four of the seven diesel tanks that were pumped and only 3200 gallons was recovered. One of the tanks contained a minimal amount of a more viscous emulsion bottom of the black diesel, and one of the tanks contained NSFO or an NSFO and diesel mix which suggested that the bulkheads were compromised. It should also be noted that some of the fuel discharge and pump suction hoses on the bottom floated off the hull of the ship and came to the surface when pumping this diesel fuel. The hoses did not rise up with NSFO or any other product that was pumped except for the unidentified fluid that was pumped from the tank (Tank IX 6.32) late in the project.

### 4.7.12. Oil Removal - Sections X and XI External Centerline Tanks

The ex-USS *PRINZ EUGEN* tank Section X is located forward of amidships, but just aft of the upper forward 8-inch turret magazine (see Figure 4.29). Section XI was located directly underneath the lower forward 8-inch gun turrets (see Figure 4.30). The tanks in Section XI produced the largest percentages of oil per section on the entire wreck, but not without problems. At 55 feet, in mid-section, Section XI was getting deep enough so bottom time for divers was an issue.

The recovery operations in Sections X and XI were performed 17–21 September. While one set of divers was working pump operations in the previous section, Section IX, one or more divers were drilling test holes and cleaning flange target areas in Section X and XI. Test hole drilling began in Section X on 17 September with five of six tanks indicating oil and/or air. The hot tapping and flanging side of the operation started in this section on 18 September and had immediate problems when the first flange landed on a frame. The frames interfered with flange installation and especially with the penetration of the 3 1/2″ hot tap hole saw bit. Tanks X 1.1 and 4.2 had interference issues, and the coupon (also referred to as a biscuit or a puck) in Tank X 4.2 did not drop out and had to be beaten out using the "Coupon Removal Tool" (see Appendix F for definition). There were four hot taps completed that day, and one of the last hot taps in Section X was completed on 19 September. Tank X 1.1 also had a "stuck coupon". Tank X 1.1 was pumped with the coupon still in the hole at a rate of 30 gpm on 18 September. It was stripped again on 27 September when the divers went back to remove the coupon and close the hole with a closure cap.

Tank X 1.2 gave up oil and air when the test hole was drilled which indicated there was oil in the tank. When the tank was tapped and all of the air bled out, no oil was recovered and the hole was immediately closed out. Tank X 4.2 was pumped with a small amount of oil recovered, but air issues plagued the entire pumping operation and continually caused the pump to lose suction. The "Pump Through Vent Tube Device" (see Appendix F) was used to help introduce seawater and allow oil to be removed from a tank that had no natural vent.

As described above, Section XI tanks were originally of some concern and thought to be double tanks instead of single tanks, which would have meant 16 hot taps would be required in that section instead of eight. After Tank XI 6.1 was tapped and tested, it was shown that they were indeed single tanks. Other issues in Section XI included the main hot tap hole was drilled outside of the flange (Tanks XI 6.6 and 6.9), and there was a nuisance air bleed problem with Tank XI 6.4. Tank XI 6.2 was another problem tank; it was dubbed the "Drunken Sailor" due to the fluctuating nature of the flow rates and hydraulic pressures as a result of persistent air problems. It was stripped four times over the span of 3 days and finally closed on 21 September. The tank had poor seawater venting and had air trapped in the upper end which was repeatedly being pulled out with the oil and is what created the wild fluctuations in the pump flow rates. There were most likely air pockets trapped behind the frames in the internal structure that slowly dribbled out as the tank was pumped. Tank XI 6.2 yielded 5100 gallons of oil.

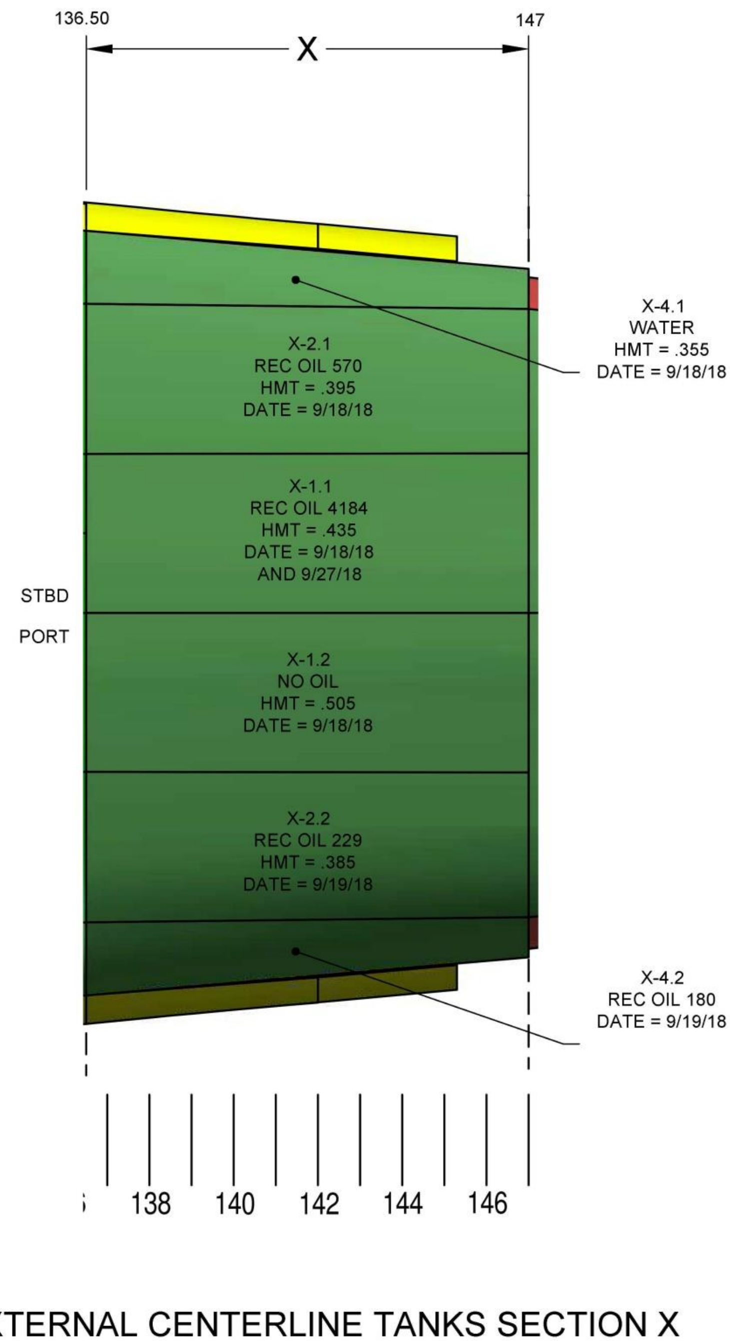


Figure 4.29. External Centerline Tanks Section X

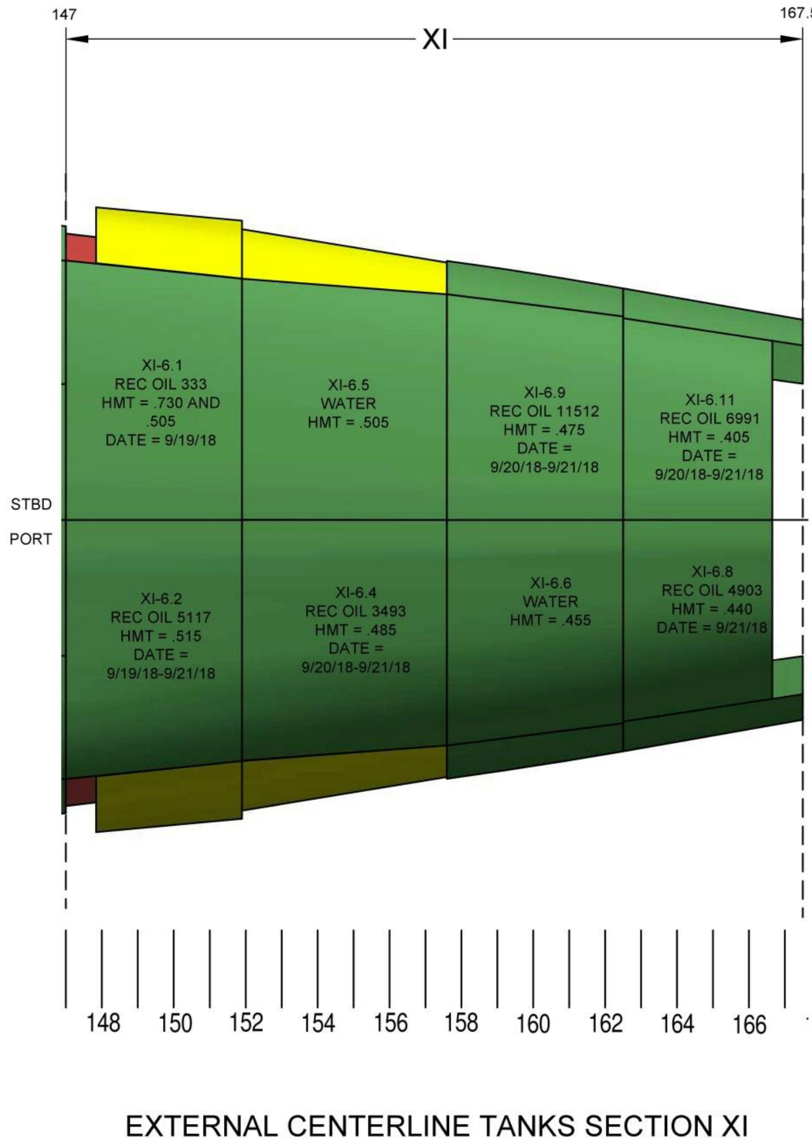


Figure 4.30. External Centerline Tanks Section XI

In summary of hull Sections X and XI, 5200 gallons (10% of full section volume) of oil was recovered from Section X and 32,350 gallons from Section XI which was 28% of the total original full volume of the section and one of the highest section yields of the entire project. Most of the tanks that had oil in Section XI were poorly vented and had air issues. The poor venting was possibly due to the structural damage on the main decks and upward angle in the ship as it now sits upside down on the bottom with vents filled with sand and marine growth or crushed and pinched off altogether. The PE recovery team used the vent device often, and sometimes with the addition of a fire hose, to forcefully inject water deeper into the tank than the tank top suction hole. Other times, a separate vent hole was drilled below the oil line.

### 4.7.13. Oil Removal - Sections XII and XIII "The Bow" External Centerline Tanks

The recovery of oil from the bow sections was not without excitement and drama as it was rich in oil, but also plagued with changing conditions and conducive to leaks and hot tap flange obstructions (see Figure 4.31). The bow was in approximately 68 feet of water, meaning bottom time was even more of an issue than with other tanks. There were constant leaks emanating from the bow and these leaks had been seeping for many years. The PE team discovered the hard way that in the process of replacing the removed air and oil with seawater, the buoyancy of the wreck was changed and this possibly induced stresses in other locations, which in turn exacerbated the leaking from tanks that were not pumped out yet.

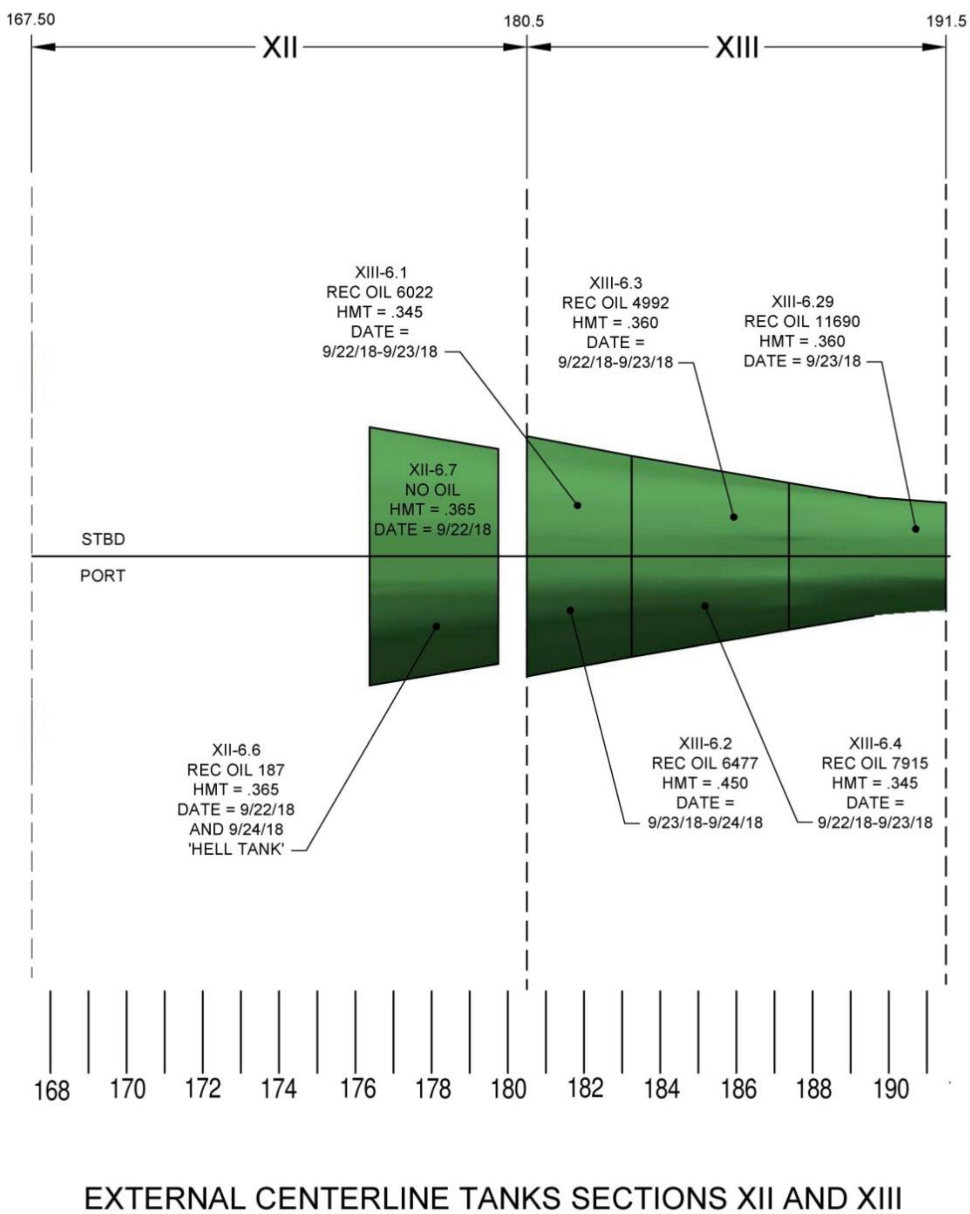


Figure 4.31. Tanks Sections XII and XIII

The recovery operations for the Sections XII and XIII in the bow were performed 21–24 September. The PE recovery team had several challenges with the bow sections. There were two hot tap flange leaks which required immediate attention and a changeup of the pump placement on the bottom from one hole to another that also had a leaking flange. This had to be repeated several times and is reminiscent of the game “whack-a-mole”, the circus game where the plastic mole pokes his head up in random holes in a board and the game player tries to whack his head before he drops back into the hole. The bottom line is, in order to relieve the pressure causing the oil to ooze from the leaks, the causes had to be investigated and eliminated, then the pump had to pull the product and displace the same quantity with water on that particular tank. When the PE recovery team started removing air and oil from the bow sections, it was speculated that the change in buoyancy may have caused the bow to settle slightly and open up an existing crack down on the side shell of the bow which allowed oil to leak out at an accelerated rate.

The first problem that came to the attention of the team was a leaking flange on hull Tank XIII 6.3. This leaking flange initiated the launching of the PE Spill Response Team (SRT). While deployed late in the afternoon, the SRT reported seeing very high concentrations of oil (i.e., more oil than what was leaking from the known flange leak). All bottom flanges and taps were checked, and checked again, and then a third time at the bequest of the Project Manager. There was very little leakage found from any of the existing taps and as darkness approached, it was assumed the oil that the SRT team was seeing was oil previously leaked via the flanges and the issue had been resolved. The ship is very narrow in Sections XII and XIII so it was easy to see that there were no leaks coming from the centerline tanks as verified by the surface team via diver helmet cams.

The bottom pump was physically connected and pumping from Tank XIII 6.1 when the leak in the hot tap flange of Tank XIII 6.3 previously mentioned was discovered. The pump operation had to be shut down and the pump, suction hose, discharge hose, and fittings had to be physically moved to Tank XIII 6.3 to take pressure off of the leaky flange, and to remove the threat by pumping the tank empty. It took some time to figure out that the test hole had been inadvertently drilled under the gasket instead of in the hot tap hole and that was where the oil was leaking. The leak was secured just in time to have another emergency rear up when it was discovered Tank XIII 6.4 also had a flange problem (oil leaking from fasteners) and developed a small leak. The pump was moved to Tank XIII 6.4 at 1626 on 22 September and was still pumping when at 1822, the pump was stopped and an emergency transfer was made back to Tank XIII 6.3. It was discovered that the tank was leaking badly down on the side shell thus, the “Crack Baby” leak had been found. The actual leak was discovered by one of the divers. It was nearing dusk and bottom visibility was low but the Red Diver working on the bow area discovered a black cloud drifting up the side of the wreck, almost out of visible range. Tank XIII 6.3 had developed a crack on the side shell that must have opened up sometime during offloading in the previous tank. The large crack was way down on the side shell, but the tank was evidently just full enough to have its bottom edge in the crack area and heavy NSFO was slowly streaming out of the crack. Once the pump was placed on the hot tap flange and pumping began, the leaking stopped, but then the team was committed to continue until the tank was emptied. Pumping continued late into the evening and the maximum rate achieved was only about 45 gpm. Tank XIII 6.3, dubbed “Crack

Baby", was pumped until no more leakage was observed (around 2200). Dive teams, SRT teams, and recovery teams had all been working for 16 to 18 hours by the time the leak was secured, the majority of the spill that could be located was recovered, and the divers were off the bottom and safely shutting down the dive station. Pumping resumed the next day and all tanks in Section XIII were stripped and closed that day, 23 September, and the following day, 24 September.

Section XII yielded only 187 gallons of oil (about 2% of the total potential volume) and LPO into the slops tanks despite the amount of work and effort that went into trying to get vents and obtain a decent pump rate. Section XIII however, was the highest yielding and highest percentage of recovered oil of the entire wreck. Section XIII produced 37,100 direct gallons of oil with a yield of over 74% of the original volume.

### 4.7.14. Oil Removal - Wing Tanks

According to the German Tank Plan (see Appendix K) the wing tanks were for reserve fuel oil. Regardless of the purpose, the fuel was the same NSFO and it was located in the side shell tanks, referred to here as wing tanks (see Figure 4.32, Figure 4.33, Figure 4.34, Figure 4.35, Figure 4.36, and Figure 4.37).

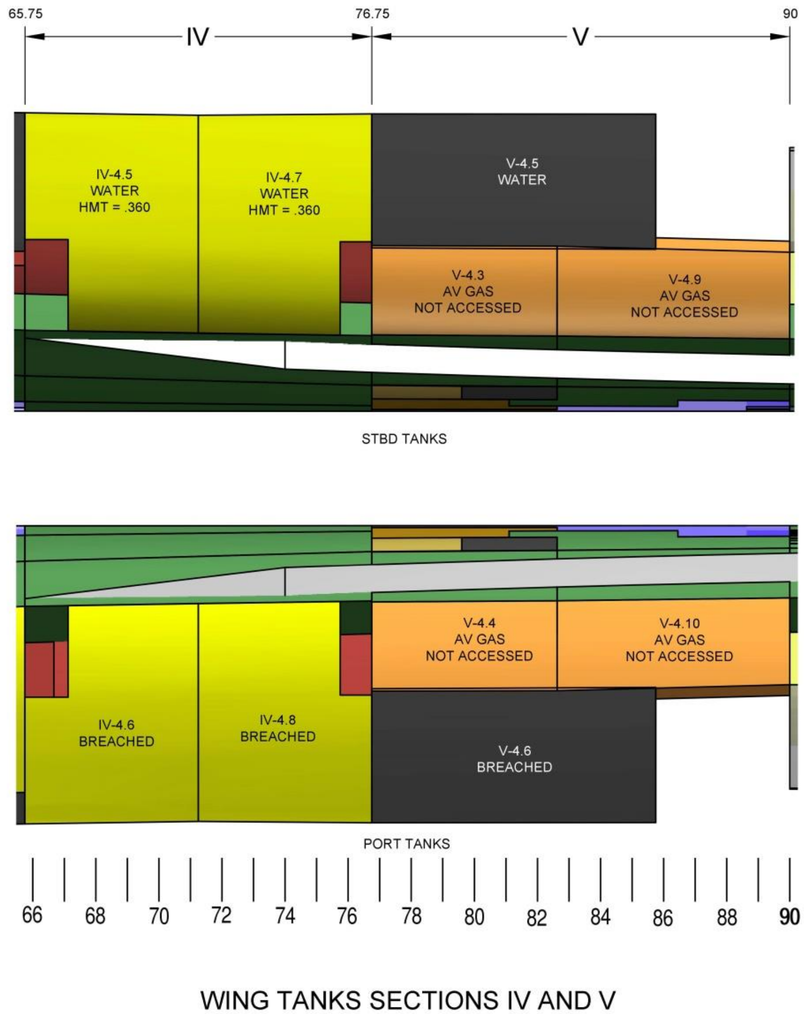


Figure 4.32. Wing Tanks Sections IV and V

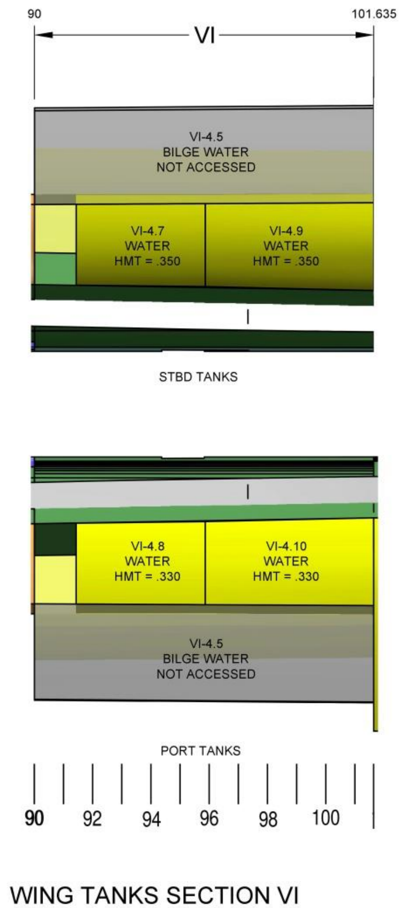


Figure 4.33. Wing Tanks Section VI

The first wing tanks to be drill tested were in Section IV on the afternoon of 18 September while the other dive team members were up forward test drilling Section XI and hot tapping Section X. The first hot tap in that section did not take place until 11 days later on 29 September when it was determined, based on testing, that only one tank in Section IV had oil. However, no oil was found after hot tapping the hole. The tank was clean and therefore closed without pumping. The other wings in Sections IV and V were tested 18–19 September and no oil was found. Sections VII and VIII wing tanks were drill tested 20–22 September and only five of ten tanks contained oil. All five of the tanks in those two sections were pumped on 24–25 September. Two other wing tanks in Section II were hot tapped 29–30 September and pumped the first week of October.

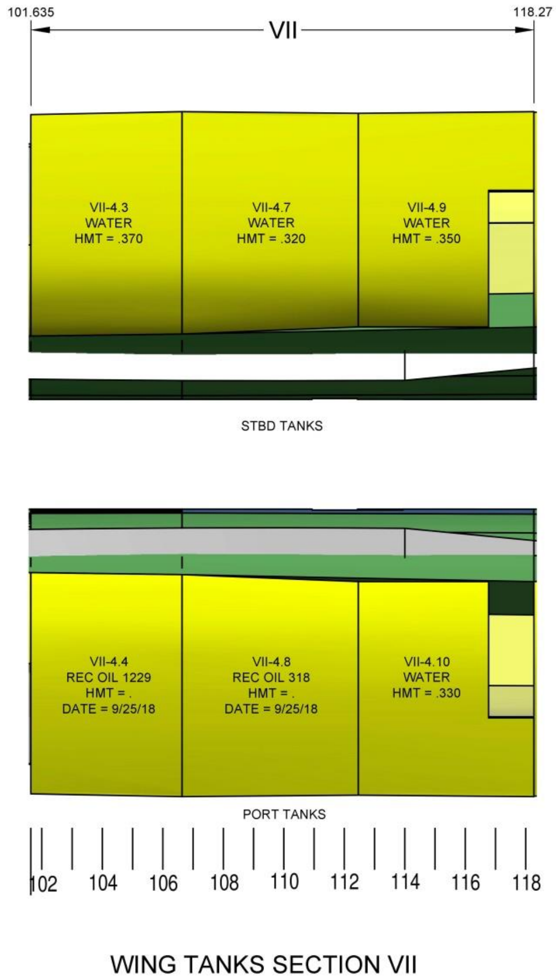


Figure 4.34. Wing Tanks Section VII

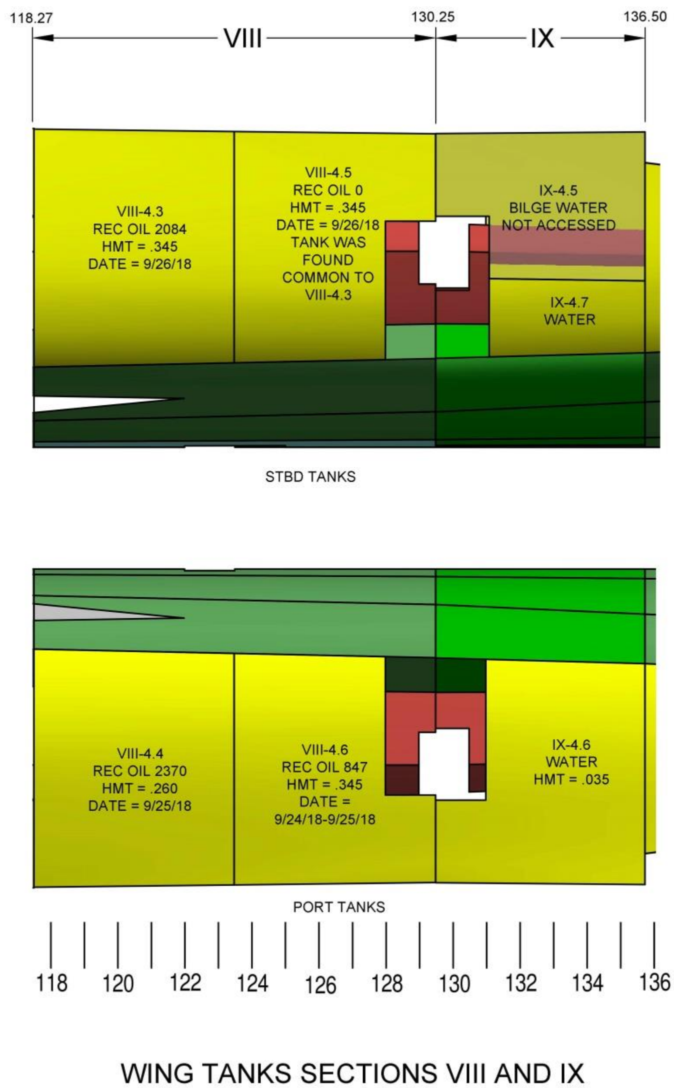


Figure 4.35. Wing Tanks in Sections VIII and IX Provided to Show Typical Location

The wing tanks were difficult tanks to hot tap and did not produce a lot of oil. The total amount of oil directly recovered from the wing tanks was approximately 10,700 gallons. Only 10 of 48 potential tanks were found to contain oil. The recovered oil amounted to approximately 5% of the total amount recovered from the entire wreck. The wing tanks were not as easy to access compared to the centerline tanks. Hot tapping had to be completed at a steep angle and the hot tap tools protruded out from the tank surface a considerable amount. When the tool is used on an angle, as was the case with the wings, the cantilever force had a tendency to cause the bit to drill offset internally and even rub on the hull or the flange. Drilling at an angle was more difficult for the divers as they had to hang on lines or platforms and operated the tools while working against gravity.

There were also issues with the curved hull plate which required the use of the tee shaped flanges. Sealing these flanges was more troublesome as they had to conform to the hull and the gaskets had to be more generous to account for less than optimal shaping. Most of the tanks that were tapped had internal obstructions in the form of frames and/or steam coil piping. Framing was closer together in the wings than in the centerline tanks and the radius of the hull outside of the bilge keels created challenges.

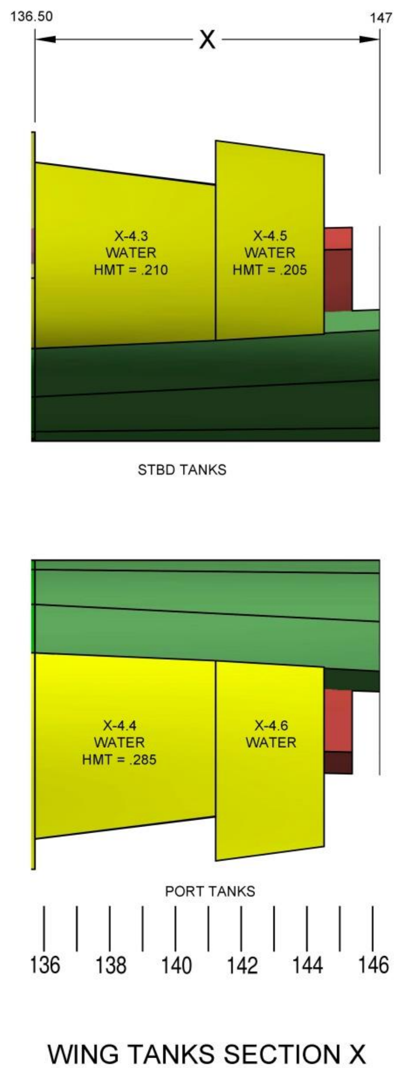


Figure 4.36. Wing Tanks Section X, No Oil Found

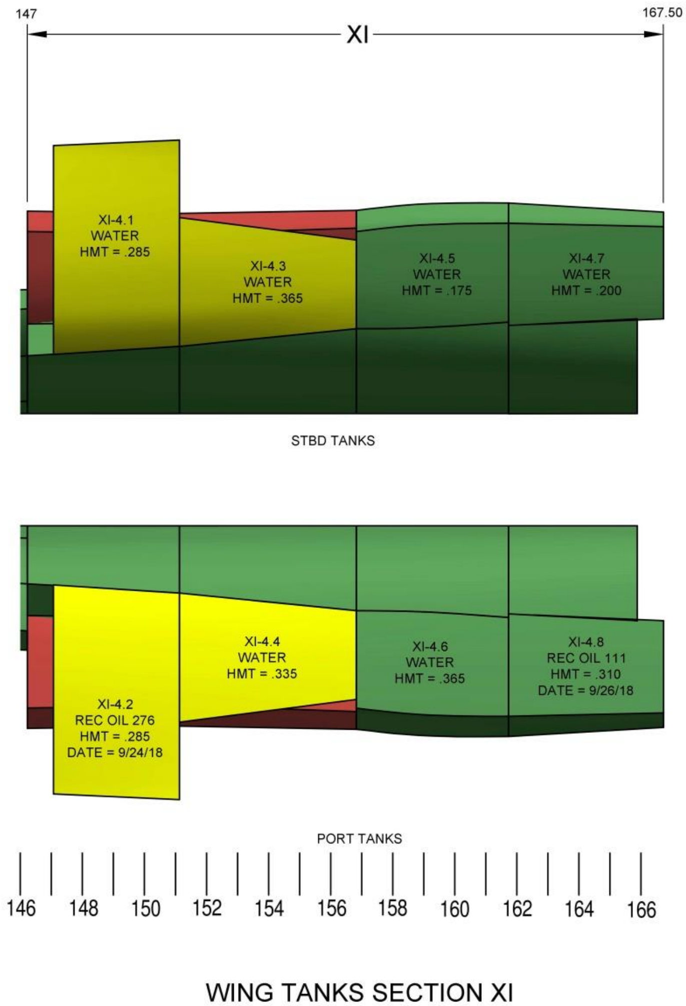


Figure 4.37. Wing Tanks Section XI Produced Less Than 400 Gallons

### 4.7.15. Oil Removal - Section I, II, and III Stern Centerline Tanks

Tanks in Section I, II, and III were visually inspected, measured, and marked with lines and tags starting on 24 August. During the planning stages of the operation, it was decided to start the cleaning, gridding, and hot tapping operations in Section IV of the wreck and move forward and deeper towards the bow before doing the shallow water Sections I, II, and III. The reasoning behind that decision was that it was assumed there was not as much oil in these sections and it was also assumed there would be problems with the thinner, hull material. The hull in the very aft sections were more shallow, much more corroded and rusted with a lot of missing sections due to the physical contact with the reef during the sinking of the ship.

The planners knew that the hull was most likely thinner in the stern sections of the wreck due to advanced rust and corrosion. However, the recovery of oil from the stern of the wreck proved to be much more problematic than anticipated in the planning stages. These three sections (Sections I, II, and III; see Figure 4.38 and Figure 4.39) contained approximately 16,800 gallons of directly recovered oil and another 3000 gallons of oil removed from the tanks during the various stripping processes. Those numbers do not include the internal tanks which are covered in paragraph 4.7.16. The stern section was completed late in the operation. The problems that introduced themselves to the PE team stemmed from the previously mentioned issue that the stern section metal was heavily corroded, rusted, and wasted away which made it difficult if not impossible to screw a flange or even clean an area enough to install a flange. Many of the tanks still had small amounts of oil and even some of the tanks that were breached and open to the sea had small amounts of oil trapped in the upper sections.

There was a much greater amount of internal framing that was closer together than in the midship sections and this also exacerbated the interference issues in trying to drill hot tap holes.

#### 4.7.15.1. Section III

Test drilling started in Section III on 25 September and continued through 27 September. The first tank to be pumped in the stern was a dirty turbine oil tank in Tank III 2.3 which had a lot of water emulsified in the oil. The water in the oil settled out fairly quickly in the samples. The turbine oil was relatively dense oil, but pumped well due to its high lubricity and low viscosity. Two other turbine oil tanks were pumped on 28 September including Tank III 2.5 and Tank III 1.3. The remaining Section III tanks were pumped on 29 and 30 September. The majority of the problems encountered in Section III were the limited hole sizes due to obstructions that prevented the removal of some of the templates. There were also some problems with air. Section III had 18 centerline tanks, 11 of which had some oil.

#### 4.7.15.2. Section II

There were only two centerline tanks in Section II that potentially contained oil, one of those was severely breached and the other was inaccessible due to its location under the propeller shaft strut.

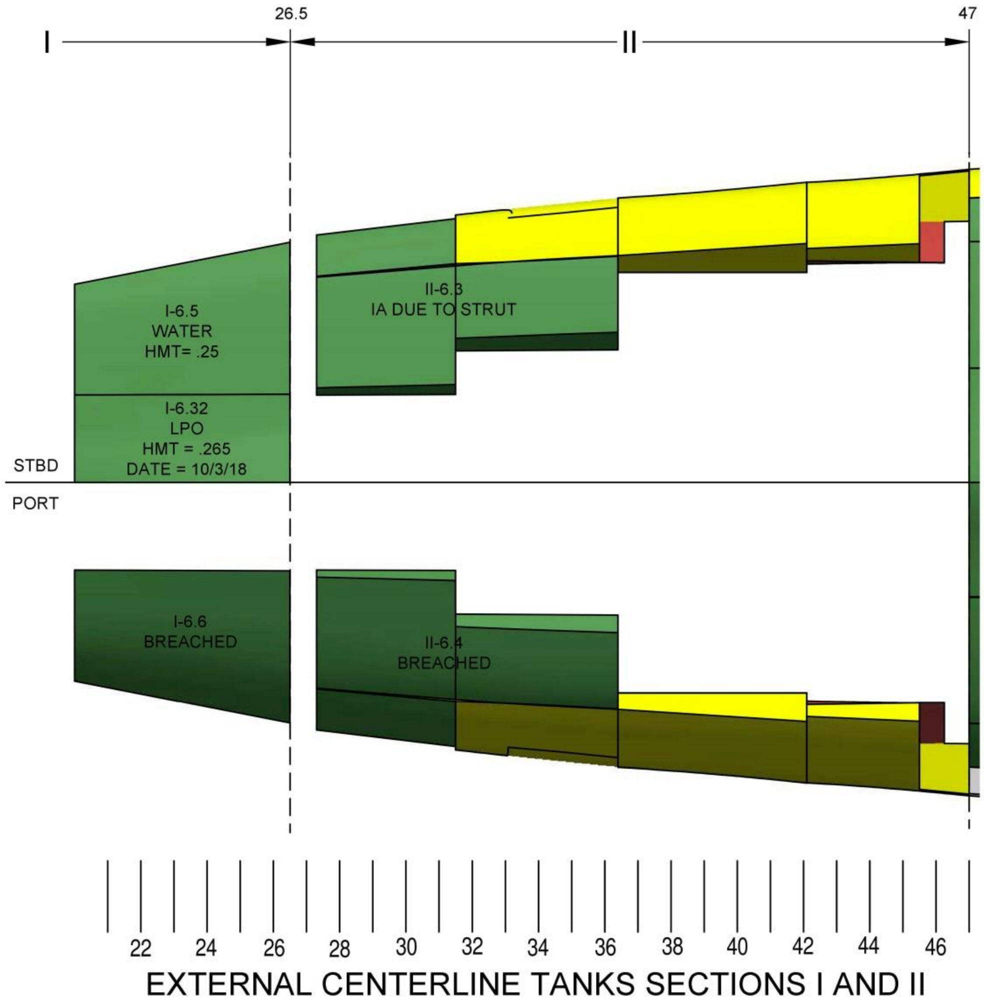


Figure 4.38. Hull Sections I and II - Tanks that were Accessed and Pumped

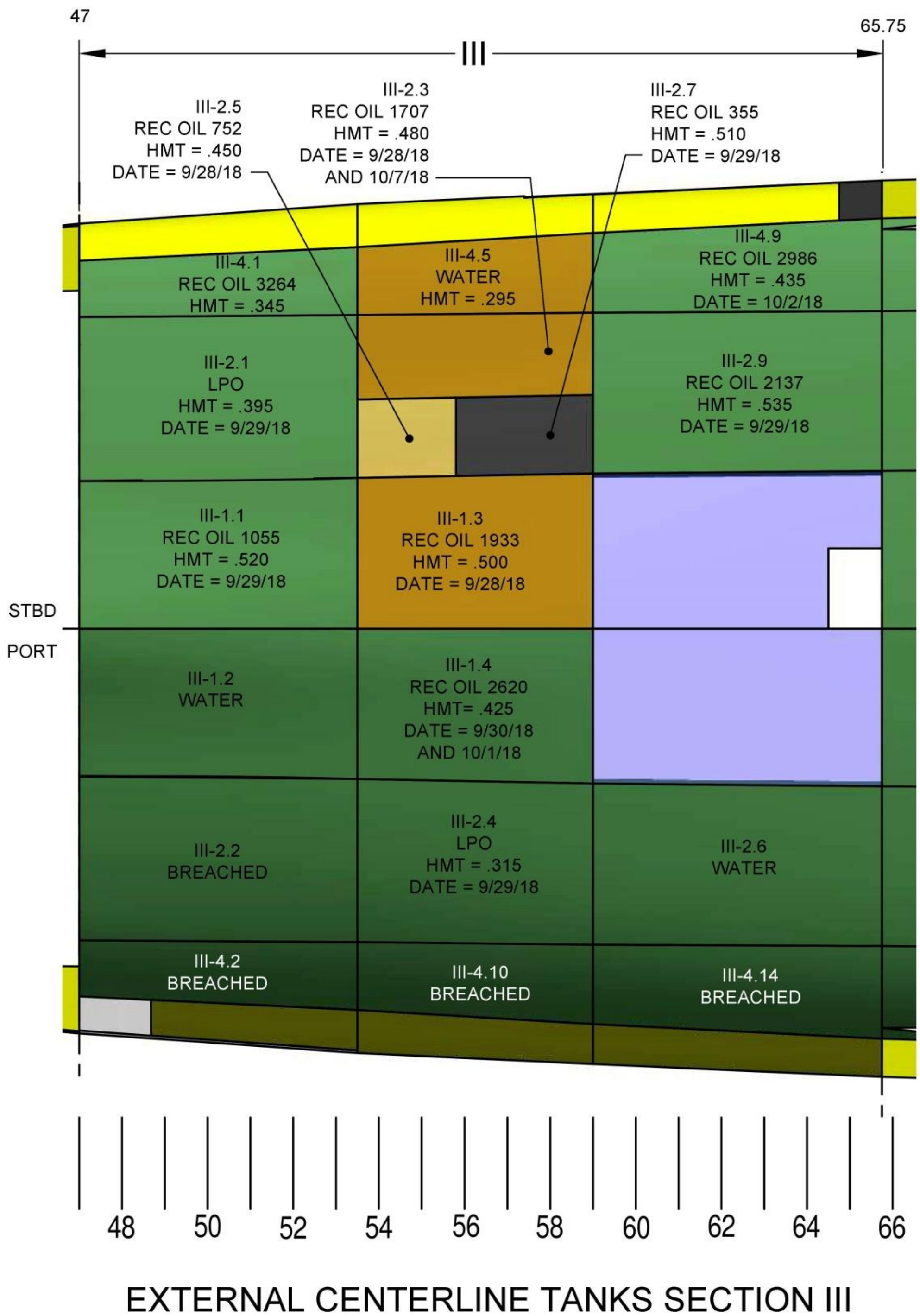


Figure 4.39. Hull Section III - Tanks that were Accessed and Pumped

### 4.7.15.3. Section I

Section I was the aft-most section that potentially contained oil on the ship and only had three potential oil tanks. Tank I 6.6 on the port side was breached and had no oil, and Tank I 6.5 on the starboard side tested negative for oil. The last bunker tank in the section, Tank I 6.32, contained a very small amount of oil that after tapping, pulled at a ratio of about 1% oil to water in the samples taken during recovery. The problem with this tank was that it contained a strong smelling, slightly off color liquid that was initially assumed to be water. As samples were continually taken, it was apparent that there was only a small amount of oil; the team was stripping the tank and only recovered a small percentage of oil in the sample. After several minutes of stripping at a low flow rate, it was noticed that the strong chemical smell was coming from the sample port and from the area around the receiving station. The color of the sample, when viewed in a clear jar, was concerning. It resembled water until it was held to the light and then appeared to be an opaque purple color. A sample jar was taken to the other members of the command team and then a review of drawings was conducted to determine what other tanks were located in the vicinity of the fuel tank (Tank I 6.32). The contents of the tank could not be determined from the drawings. It was decided to secure the tank stripping operation and seal the tank. There were only very small amounts of oil in the tank and it was not worth the risk of taking a large quantity of unknown liquid onboard that could change or contaminate the remaining oil onboard the tanker. Within a few hours of being taken, the sample of purple water had turned to an opaque brown watery color and the small percentage of oil in the top of the sample had settled into the fluid column as wispy tendrils near the bottom of the jar. This lead the team to infer that the unknown liquid had a lighter density than water, but close to that of the oil and once allowed to settle, the chemical rose to the top of the sample jar displacing the oil and water. There was no lab aboard either of the vessels on-site and no immediate means to care for samples that could have been highly flammable and/or highly toxic. Samples were not shipped back to the U.S. and were disposed of in the dirty slops that went to Singapore.

The tank immediately below the fuel tank (which would have been above the fuel tank when the ship was upright) is labeled as “FlugzeugmunK” which it is believed translates to “Plane Munitions Hold” (see Figure 4.40 below). It is speculated that the substance that was pumped from the fuel tank could have been any number of liquids including spotter dye (used by ships aircraft to mark locations where suspected submarines were spotted), de-icing fluid, or some type of antifreeze. The bottom line for this tank is that any future activities conducting salvage or recovery on this wreck should proceed with caution if reopening this tank.

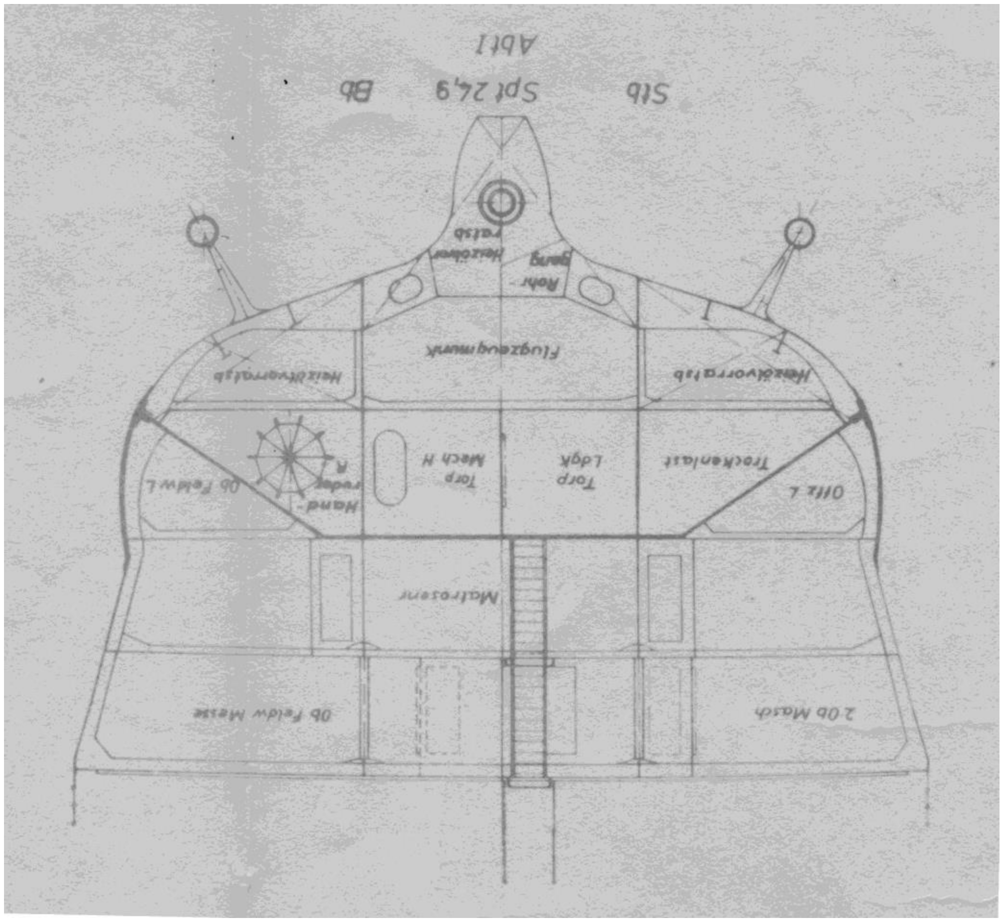

Figure 4.40. Sectional View of *PRINZ EUGEN* at Frame 24.9 Shown Upside Down as the Wreck Lies

**4.7.16. Oil Removal - Internal Tanks**

The internal tanks on the ex-USS *PRINZ EUGEN* were located both port and starboard, and longitudinally from tank Section II aft, to Section XI forward. They are located inboard of the wing tanks, and below the outboard centerline tanks. A majority of the internal tanks were accessed by using the centerline tank hot taps that were already drilled from the pumping of the centerline tanks. Sections II and XI had internal tanks that had to be accessed via the wing tanks. The methodology for pumping out an internal tank was to use the extended version of the existing hot tap tool (see paragraph 3.8.8 for the internal hot tap tool description) to reach inside and through the outer tank. The extended tool bit (which was smaller in size than the original hole saw) had to be able to make contact with the tank bottom or side wall shared with the internal tank and drill a new hot tap hole in the internal tank. The angle of approach did not have to be exactly 90 degrees, but if it was more than a little off 90 degrees a tool with an angled head had to be used. The internal tank tool is sealed in the outer hot tap and once the new hole is drilled (assuming the inner tank has a vent access to the sea), any oil in the tank will flow out of the hole, around the tool shaft, and up through the water in the outer tank (displacing it) and will collect in the upper tank. In order for this take place, there must be good communication from the lower tank to the sea as well as the outer tank. In other words, there must be a way to push seawater out of the highest level tank, while the new oil flows up and in. The process is slow, but if there is oil and there is "communication with the sea", then it is steady.

During the testing/discovery process, the PE recovery team found 13 internal tanks to be inaccessible with the tools and equipment available on-site due to several factors. These factors included the lack of direct access through an outside tank, and damage to the hull or internal tank structure located in the external hot tap (the outer tank) openings that prevented access to the internal tank wall (see Figure 4.41). Three of the internal tanks were openly breached and 14 of the tanks were accessed by either using one of the internal hot tap tools described in section 3.8, or they were accessed by drilling or punching a hole through the side wall of the tank. The oil directly recovered amounted to 9300 gallons which was only 4% of the total volume recovered from the entire wreck. Accessibility to these remaining internal tanks could still be achieved, but would require developing new tools, new methods, and/or cutting larger holes in the side shell of the ship and have divers enter in through the wing tanks. These methods would require specific planning and tooling to accomplish.

The oil recovery efforts for the internal tanks chronologically started in Tank III 5.5, but for purposes of clarity the review will start in section II (out of chronological order) and work forward. As already discussed in the previous paragraphs, the internal tank sections were difficult tanks to access and pull oil. Some of the methods used for extracting the oil (e.g., punching holes in the side shells of thin walled tanks) were rough and unorthodox, but in the end were effective. Figure 4.41 provides a good example of how a tank that was wasted away could be accessed to enter the tank next to it by physically punching through the side wall. One of the methods used to determine if an internal tank would have impediments to the internal tank tool insertion was to place a small video camera into the end of a pole that was inserted into the hole and rotated to look for obstructions. The outer tank had to be pumped very thoroughly in order for visibility to be clear enough to make out details in the tank.

Figure 4.41. This photo gives a good representation of some of the damage and wastage on the aft hull. This is most likely a view of the port side bilge keel (what is left of it) looking aft (uphill) around tank section IV frame 76.75.

Internal Tank II 5.1 was accessed via Wing Tank II 4.5 and the internal Tank II 5.3 was accessed via Wing Tank II 4.7 (see Figure 4.42). Both internal hot taps were conducted through the wing tanks using the ESSM "Concept Tool" (see paragraph 3.8.8 for internal tank tool descriptions) on 4 October. The third internal tank to be accessed and pumped was Tank II 5.6, which was accessed by punching a hole in the side shell of the internal tank after the diver was able to widen a corroded hole in the side of the wing tank wall. No significant oil was recovered from this section; only small amounts in low percentage oil volumes which went to the slops tank onboard the tanker.

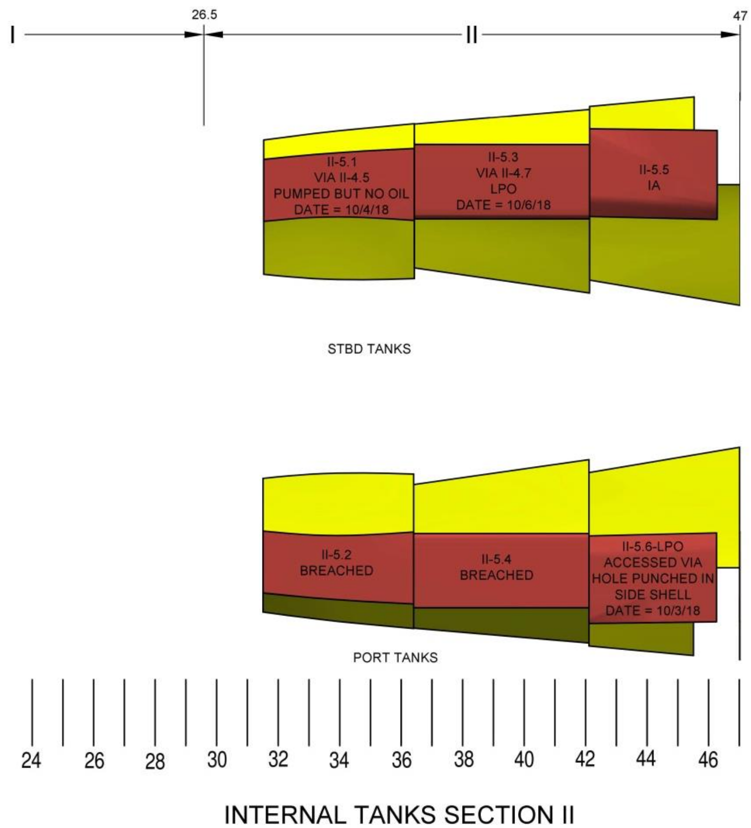


Figure 4.42. Internal Tank Sections I and II

Section III had five internal tanks, of which four were accessed and pumped (see Figure 4.43). Only one of these tanks contained any significant amount of oil and that was Tank III 5.5, the very first tank pumped. Tank III 5.5 was accessed using the ESSM "Final Long Tool" design via the centerline tank on 6 October. 1422 gallons of oil was recovered before the oil percentage dropped to a low level and the stripping phase took over. Tanks III 5.2 and III 5.6 were both accessed via side holes in the tank skin via "wasted" openings in the wing tanks. Tank II 5.3 had been hot tapped using an "Angled" internal hot tap tool, but the hole saw did not cut through and there was only a small hole in the tank. After stripping the centerline tank twice, it was determined that only a small amount of oil came out. The tank was closed on 7 October.

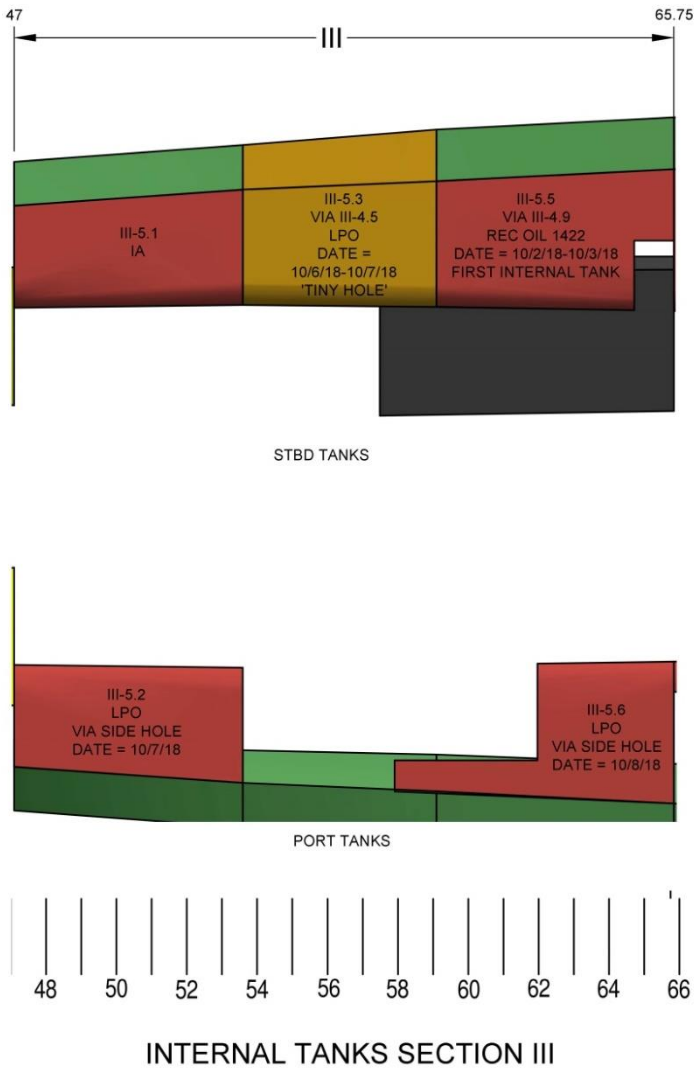


Figure 4.43. Internal Tank Section III

The internal tanks in Sections IV and V produced the most oil with regards to the internal tank recovered volumes. The oil recovered from each tank is shown in the summarized results in the Figure 4.44 below. An ESSM “Angled” tool was used on Tank V 5.1 to maneuver around an internal frame member. Tanks IV 5.1 and IV 5.3 were accessed on the same day using the “Straight Concept Tool”. Tank IV 5.4 was accessed via the “Mosquito Tool” and a drilled hole in the side of the internal tank through an eroded opening in Wing Tank IV 4.6. The remaining tanks in the section were either inaccessible or not accessed due to the fact that they were labeled as aviation gasoline (Avgas) tanks. The decision was made early on in the planning (well before the operation began) to not pursue any of the gasoline tanks for two reasons: Avgas changes properties in seawater and becomes dangerous to the skin if contacted; and it is a non-persistent oil meaning it evaporates quickly and will not contaminate the beaches if it leaked out. Approximately 5000 gallons of oil was recovered from Sections IV and V.

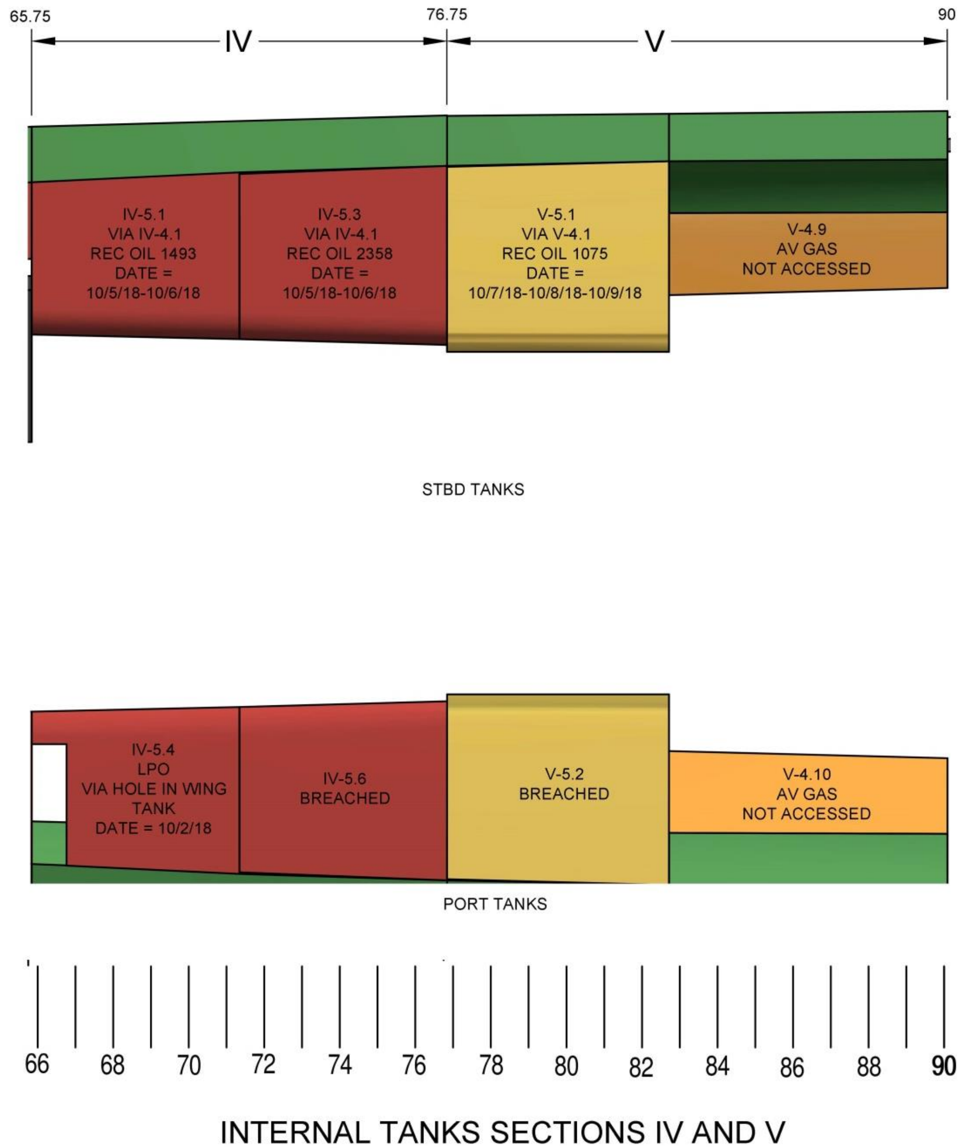


Figure 4.44. Tank Sections IV and V

There was only one internal tank in Sections VI and VII and it was not accessible as it did not have an external tank in common. Sections VIII and IX had two internal tanks each (see Figure 4.45). Section IX tanks were not accessible. Section XIII tanks were accessed late in the operation with the close-out of the last tank of this section taking place on the next to the last operational day of the project. Tank VIII 5.1 was accessed via Tank VIII 4.1 centerline tank and using an ESSM “Straight Concept Tool”, produced 2800 gallons of oil. Tank VIII 5.2 had a frame member partially blocking access, but was successfully hot tapped by using the “Angled” design tool through the outer centerline tank, Tank VIII 4.2. This tank yielded approximately 500 gallons of oil for a section total of 3300 gallons.

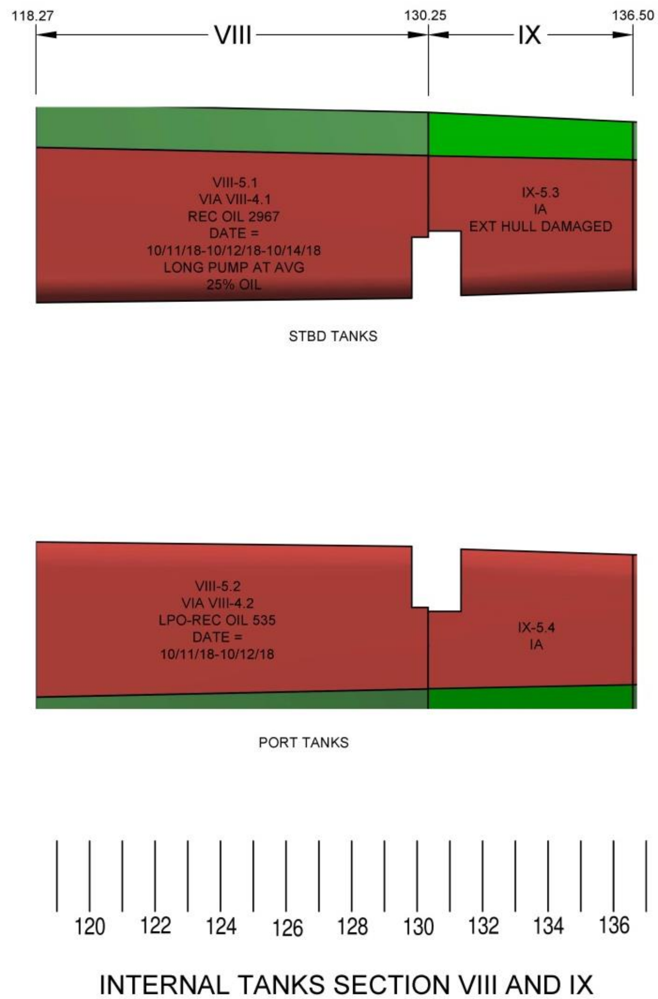


Figure 4.45. Tank Section VIII and IX

None of the internal tanks in Sections X and XI were accessible due to hull damage or steam coils inside the external tanks that denied access to the internal tanks.

Internal Tank Summary: Success cannot always be measured in numbers. The decision to go after the internal tanks during the planning phase was a solid decision. This is vital information and knowledge that will be very useful and important for future projects where obtaining internal access is necessary. SUPSALV gained a phenomenal amount of knowledge by putting prototype tools to work in the real world, in real time with oil and divers subsea. Not all of the tools worked, but the success and failures of conducting real world operations and leaning into it to get the most out of the tools on hand paid off.

In terms of efficiency and how the numbers resulted, the internal tanks were the largest drain on resources and time and produced the least reward. The amount of effort involved in accessing the internal tanks was rather high, especially when considering the amount of effort put into modeling, tool design and development, tank access, the effort required to strip the outer tank clean prior to going into the internal tank, and the actual internal tank tapping which proved to be more difficult. Roughly 24% of the total operational time on-site was spent working out problems with the internal tanks, and only half of them were actually tapped. A large percentage of the overall slop water recovered (more than 25%) came from trying to strip the access tanks to the internal tanks, but the oil recovered only amounted to 4% of the overall oil recovered. Sometimes taking the "hard road" is the only way to get results and gain the knowledge and experience needed for future investments, and this was what ESSM/GPC succeeded with on the internal tanks.

Some of the positive results of pursuing the internal tanks on the ex-USS *PRINZ EUGEN* recovery project are:

a. The contents of the internal tanks that were pumped out or tested and were found to be empty, are no longer an environmental threat to Kwajalein Atoll.
b. By using the results from the recorded tank content volumes from the accessed tanks and applying those percentages to the tanks that could not be accessed, the team was able to provide a very high confidence estimate of the total estimated oil remaining on the ex-USS *PRINZ EUGEN*.
c. The advancement in knowledge of tooling and methodology of how to access and remove the oil from the internal tanks was a major benefit of the effort.
d. Tools that were developed in theory were tried, tested, and put to use in a real subsea environment. The 2nd generation tools and augmenting technologies can now be developed with a very high degree of confidence.

### 4.8. Demobilization

Demobilization began with the removal of hoses and pumping equipment from the wreck while still positioned on the vessels over the wreck. Once that was completed, it was possible to un-nest the USNS *SALVOR* and MT *HUMBER*. The MT *HUMBER* was pulled away from the USNS *SALVOR* utilizing the mooring lines and the USAG-KA Tug *MYSTIC*. The MT *HUMBER* un-nested and then the remaining mooring lines were removed and the 50′ long fenders were pulled from the water using the MT *HUMBER*'s crane. The fenders were placed on the deck and deflated using the ESSM venturi device and shop vacuums. The MT *HUMBER* then departed the wreck site for pierside offloading. Once the MT *HUMBER* departed, the USNS *SALVOR* moved forward off of the wreck, and work commenced on recovering the mooring legs.

The MT *HUMBER* arrived at Echo pier with the Tug *MYSTIC* assisting and immediately began the ESSM equipment offload. This included two 20-foot ISO containers of equipment, components of the 2″ to 6″ pump van, the 23′ Zodiac boat, several small containers of material, and the two ESSM 50′ x 10′ Ships Fenders. The MT *HUMBER* also took on provisions for the return trip to Singapore with the cargo, the ex-USS *PRINZ EUGEN* oil, onboard. ESSM/GPC and SUPSALV arranged for the Kwajalein Pilot and Tug *MYSTIC* to assist and escort the MT *HUMBER* out of Kwajalein Atoll. The tanker left the Echo pier at 0700 on 17 October.

The first mooring leg that was worked was the Bruce anchor. The Bruce anchor was separated from the chain at the anchor safety shackle by scuba divers. Then the Bruce anchor was floated using lift bags and towed to the USNS *SALVOR* by one of the workboats, where it was lifted onboard. Following the recovery of the anchor, the chain and wire rope was pulled by the USNS *SALVOR*'s workboat and brought onboard utilizing the capstans and stoppers.

All remaining mooring legs were recovered by Tug *MYSTIC*. This was due to the USNS *SALVOR* refueling, offloading, and back-loading materials and provisions pierside. There was significant progress that was being made with Tug *MYSTIC*. The legs were recovered by wrapping the wire rope on one of the Tug *MYSTIC*'s tow drums and then pulling the chain onboard with the other tow drum. For the two shallowest mooring legs, the wire rope was removed in the water and the anchor and chain was floated and pulled to deeper water by the USNS *SALVOR*'s workboat. The anchor chain was then pulled onboard the Tug *MYSTIC* with the tow drum. Anchors were recovered one at a time and then brought pierside and placed on the pier by a pier crane.

The USNS *SALVOR* took on fuel at the fuel pier and proceeded to Echo pier to offload anchors and equipment, and back-load anchors and mooring equipment for the return trip to Singapore. All ESSM equipment was removed using the crane and HME arranged by SUPSALV via TMRs. After unloading ESSM containers and equipment, the USNS *SALVOR* returned to the wreck site to retrieve the anchors. The Tug *MYSTIC* assisted with anchor recovery.

All of the heavy material handling equipment provided to SUPSALV and ESSM/GPC planners was done by previously providing the USAG-KA point of contact, CW3 Jamie Norton, with transportation and material requests for each and every forklift, truck, crane operation, and lift. The Army point of contact for the entire operation also assisted the Tug *MYSTIC* access, financial arrangements, provisioning, and every aspect of the operational support from the Army. DD2781 Container Packing Certificates were filled out and applied. Each SUPSALV container was loaded and packed with ESSM equipment over the next 2 days and all containers were weighed and inspected. ESSM/GPC arranged shipment and applied locks and paperwork.

ESSM/GPC personnel completed the transfer of equipment to and from the USNS *SALVOR* and completed the packing and loadout of equipment being loaded into the six ESSM containers. All equipment was loaded and containers were sealed by close of business 18 October.

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# CHAPTER 5

# 5. ANALYSIS OF OPERATIONS

## 5.1. Overview

The purpose of this chapter is to provide a brief operational analysis of the oil recovered from the ex-USS *PRINZ EUGEN* and to discuss the importance of understanding the physics behind the oil behaviors. This section includes information on the recovered oil itself, methods of analysis, lessons learned, hull damage and corrosion, and future opportunities. The section on hull damage and corrosion, although very limited, provides a general view of the physical condition of the wreck. The remaining tank contents section provides a summary of all the statistics from the wreck oil recovery. A summary of the most prevalent and important lessons learned from the project is presented in the lessons learned section. Finally, the future opportunities section provides a brief look forward to what and where future operations of this nature may lead.

## 5.2. Recovered Oil

The oil recovery operation on the ex-USS *PRINZ EUGEN* removed 228,830 gallons of oil from the shipwreck. This is the official quantity recorded by the First Officer and signed off on by the Captain of the receiving tanker, MT *HUMBER*, and the designated SUPSALV representative onboard upon completion of the project. Statistics of all petroleum products recovered are summarized in Table 5.1. This includes the oil from all source tanks of the wreck, their respective percentages as compared with total volumes, and where they were recovered from.

### 5.2.1. Method of Recovery

All of the petroleum products were recovered from the wreck by using one of the ESSM Hydra-Tech SCR4 centrifugal pumps. These are specialized hydraulically powered submersible centrifugal pumps that incorporate a hybrid slurry type impeller that enhances pumping of semi-viscous products. For all the tanks except five, the pump was located on the hull of the wreck and moved up and down the hull to various section locations for pumping which allowed for minimal use of suction hose and maximized the discharge pressure capability of the pump. The other five tanks used the same pump, but it was located in a cradle on the surface near the recovery vessel and drew suction from the wreck.

### 5.2.2. Measuring Oil

The real time measurement of oil, water-in-oil emulsion, and oily water, as recovered from each origin tank of the wreck, was accomplished using an in-line flowmeter located on the tanker in the fuel receiving station. The record keeping that was maintained, was augmented by tank soundings of recovered products. Samples were collected at regular intervals from the pumped product in order to verify product type, but more importantly to ensure that only pure oil was sent to the main oil collection tanks. Product control was established to ensure that only petroleum products were directed into the designated collection tanks and that all water, oily water, and any percentage of water with the oil was sent to the slops tank.

### 5.2.3. Oil Analysis

A set of four oil samples taken from oil recovered from the ex-USS *PRINZ EUGEN* was sent from Williamsburg, Virginia to Clark Labs in New York for the purpose of conducting multiple tests and reporting the oil analysis on the recovered oil from the wreck. The tests performed included viscosity tests run on each sample at different temperatures, water content, density, flashpoint, pour point, surface tension, and interfacial tension. SUPSALV conducts oil analysis on oils recovered from oil spills and wreck oil recovery projects in order to better understand the rheology of the oil. Understanding the rheological properties of oil products being recovered and leaking into the environment allows the spill responder, the salvor, and wreck recovery planner to develop both tactical and strategic plans for recovery, storage, and disposal of the product. The ability to understand the behavior of oils in relation to subsea pumping, as well as behavior of oil on the surface of the ocean is vital to the planning of an operation.

Knowledge of oil properties allows responders to calculate the expected friction losses and design the optimal pump/recovery system. This includes the selection of the best pump type and hose size for the greatest possible outcome based on the oil type and physical situation. Knowing the density of the oil and how likely the oil will take up seawater (as in a water-in-oil emulsion), planners can better predict when systems will become buoyant and if emulsions or mousse will form. The viscosity of most oil is temperature dependent. For example, the viscosity of pure NSFO at 82 °F is less viscous than the same oil at 40 °F. Viscosity of that same oil after it has been mixed with water under agitation and high sheer forces is many times greater and increases exponentially as temperature drops.

The lab analysis results for all product types recovered from the ex-USS *PRINZ EUGEN* can be found in Appendix L. There were three oil types removed from the wreck and they are listed below in order of largest to smallest quantity recovered.

- Navy Special Fuel Oil
- Lubricating Turbine Oil
- Diesel Fuel Oil

The ex-*USS PRINZ EUGEN* also carried aviation gasoline. Planners decided early on not to pursue the Avgas due to the acidic nature and volatility of the product.

The NSFO is the same fuel type that was recovered from the World War II era tanker USS *MISSISSINEWA* oil recovery operation, which was completed in 2003. That project had close to 2 million gallons of NSFO removed from that sunken Navy oiler. That oil had a rheological signature that was very similar to the basic oil recovered from the ex-USS-*PRINZ EUGEN*.

Using the United States general classification for fuel oils, which originally had six grades, NSFO is classified as a Number 4 fuel oil. Which means it was a residual oil with a low enough viscosity so that it could be pumped and burned in ships' boilers without having to be preheated. The most prevalent measurement standard for quantifying kinematic viscosity of oil (viscosity being a measure of how readily a fluid will flow) in the international system of units (SI) is centistokes (cSt).

### 5.2.4. Recovered Product Disposal

The ship loading reports for all recovered products disposed of are located in Appendix M. These include all of the products recovered from the ex-USS *PRINZ EUGEN*, as well as used lube oil taken onboard and disposed of by the tanker MT *HUMBER.* The used lube oil was listed separately on the cargo manifest and was located in a separate tank on the vessel. This product and the tank cleaning were paid for under the charter agreement with the tanker company Global Energy Overseas Pte Ltd.

All petroleum products recovered from the ex-USS *PRINZ EUGEN* were disposed of at a fixed cost by GEO under the charter contract to the ESSM contractor Global PCCI (GPC). The MT *HUMBER* tank cleaning cost was paid for separately from the product disposal and slop/sludge disposal cost.

### 5.2.5. Final Statistics

The final statistics of all petroleum products recovered are as follows:

Table 5.1. Statistics of All Oil Recovered

| ITEM | DESCRIPTION | AMOUNT |
|---|---|---|
| 1 | ALL OIL PRODUCTS RECOVERED FROM THE EX-USS *PRINZ EUGEN* | 228,830 GAL |
| 2 | TURBINE OILS | 7900 GAL |
| 3 | DIESEL FUEL | 3500 GAL |
| 4 | NAVY SPECIAL FUEL OIL | 217,500 GAL |
| 5 | OILY WATER SLOPS RECOVERED | 280,000 GAL |
| 6 | WATER SLOPS DECANTED | 237,000 GAL |
| 7 | SOLID OILY WASTE DISPOSED | 4900 LB |
| 8 | EXTERNAL CENTERLINE TANKS | 89% OF TOTAL OIL |
| 9 | WING TANKS | 6% OF TOTAL OIL |
| 10 | INTERNAL TANKS | 5% OF TOTAL OIL |
| 11 | NUMBER OF TANKS TESTED FOR OIL CONTENT | 159 |
| 12 | NUMBER OF INACCESSIBLE TANKS | 14 |
| 13 | NUMBER OF TANKS HOT TAPPED | 92 |
| 14 | NUMBER OF HOT TAPS | OVER 100 |
| 15 | NUMBER OF TANKS ACCESSED WITH RECOVERABLE OIL | 95 |
| 16 | OIL RECOVERED BY STRIPPING (ALL TANKS) AS MEASURED BY OIL RECOVERED FROM THE SLOP TANK | 19% OF TOTAL OIL |
| 17 | OIL RECOVERED FROM ALLSTERN SECTIONS IN I,II,III | 12% OF TOTAL OIL |
| 18 | OIL RECOVERED FROM ALL MIDSHIP SECTIONS IV-XI | 68% OF TOTAL OIL |
| 19 | OIL RECOVERED FROM BOW SECTIONS XII-XIII | 20% OF TOTAL OIL |

## 5.3. Hull Damage and Corrosion

This section provides a cursory sampling of photos and notations of hull damage on the ex-USS *PRINZ EUGEN*. The tasking for the project did not include a formal damage survey. The only damaged areas that were recorded in any semblance of detail were those sections of the ship which impeded oil removal from the target list of tanks. The list of breached oil tanks can be found by reviewing Chapter 4. Previous surveys concluded that the hull would support oil removal operations in its current position. Recent dive surveys therefore concentrated on the hull plate in and around the centerline tanks, wing tanks, and internal tanks, but no new assessments were made of the main deck, superstructure, turrets, or any other area of the ship structure.

### 5.3.1. Wreck Position and Attitude

At the time that the oil removal operation was conducted, the ex-USS *PRINZ EUGEN* laid with the bow down at approximately 8–10 degrees from the horizontal. Part of the stern was out of the water; the center propeller and skeg can be seen sticking out of the water (see Figure 5.1). The port side of the ship (lagoon side) was slightly higher than the reef side of ship by an estimate of 5–8 degrees.

Figure 5.1. Center Shaft Propeller View Looking Forward with Recovery Ships in the Background

### 5.3.2. Damage

Starting at the stern, there was a significant amount of corrosion and damage in the plating (see Figure 5.2). Plating that was still intact was sagging, wash-boarded, thin in many places though not all, and much of its surface layers appeared crumbly and held together by marine growth. In the process of cleaning the hull plates in the target stern sections for the hot tap flange attachment, divers inadvertently holed a portion of the top plate on the port side while conducting standard procedure marine growth removal with chipping hammers. In at least two instances, oil leakage occurred from the residual oil trapped in the tank, which then had to be pumped out to rectify the leak. The thin wasted hull metal in these areas was a big problem for the recovery team, and the methods of access and removal other than attaching hot tap flanges had to be developed on-site (see Chapter 4, section 4.8, in this report for more details).

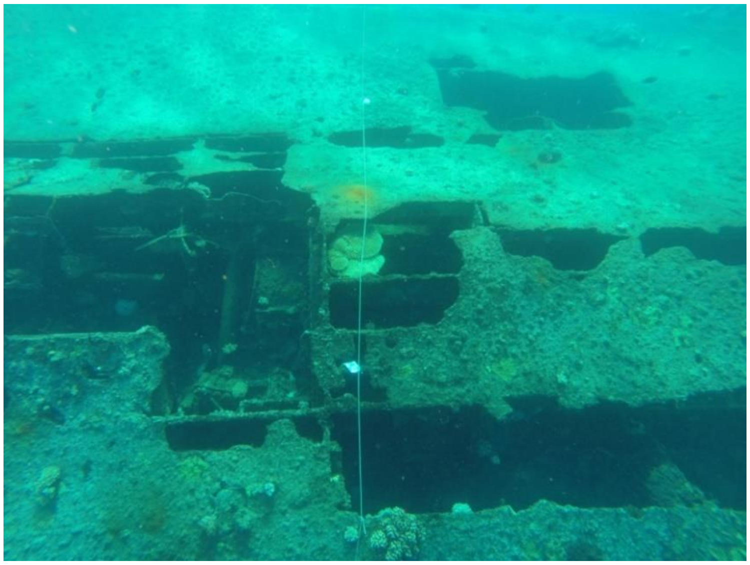


Figure 5.2. Stern Sections Wasted Metal

Hull damage and wastage on and below the port side turn-of-the bilge is extensive in hull Sections I through III, as well as down along the side shell and below the bilge keel from approximately frame 45 to about frame 90 (see Figure 5.3, Figure 5.4, Figure 5.5, and Figure 5.6).

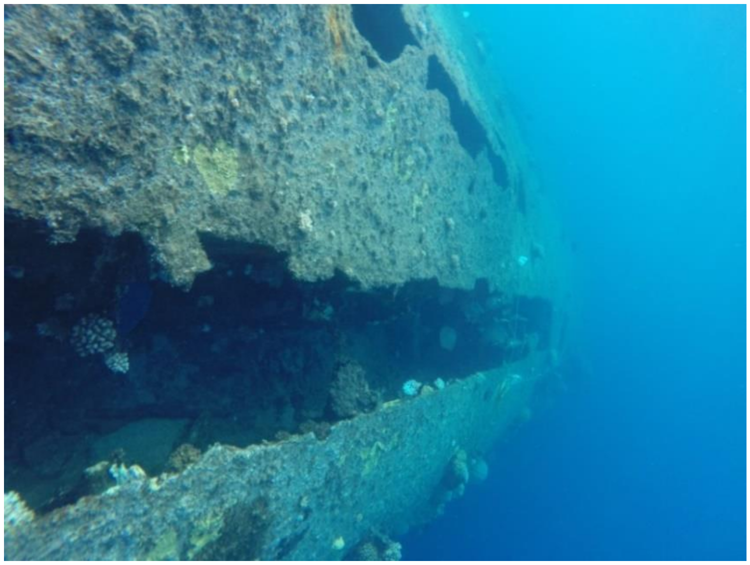


Figure 5.3. This photo shows the hull damage of Section II below the turn-of-the bilge, which is most likely from the original collision.

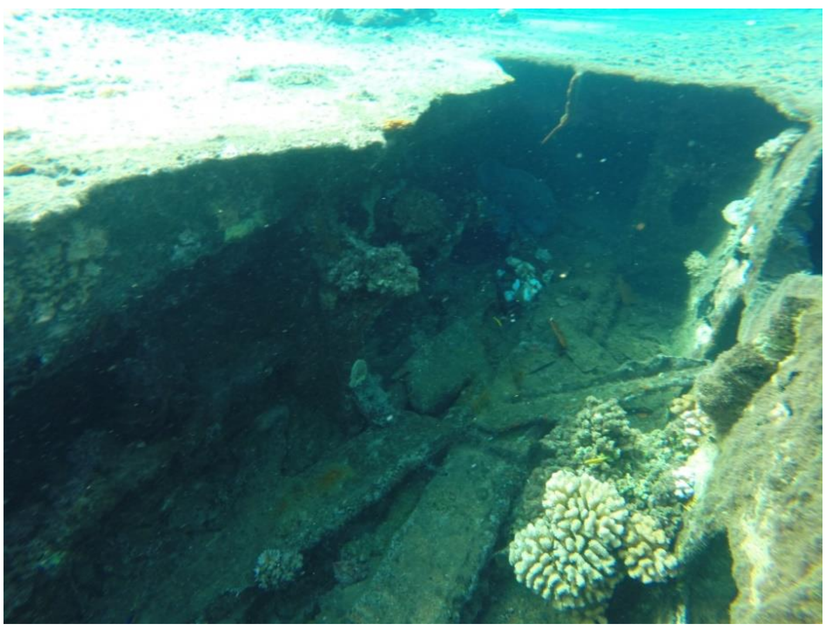


Figure 5.4. Hull Damage Port Side Aft, Estimated to have Originated from Collision with the Reef

Figure 5.5. Photo from 2017 Survey Damage Aft and Below Bilge Keel
Hull Sections III, IV, and into Section V

Figure 5.6. Aft Below Bilge Keel (2017 Survey Photo)

Hull Damage Summary:

The 3D models shown in Figure 5.7 and Figure 5.8 below show a plan view and isometric view of the hull (with exterior plating removed and the areas of most severe damage identified).

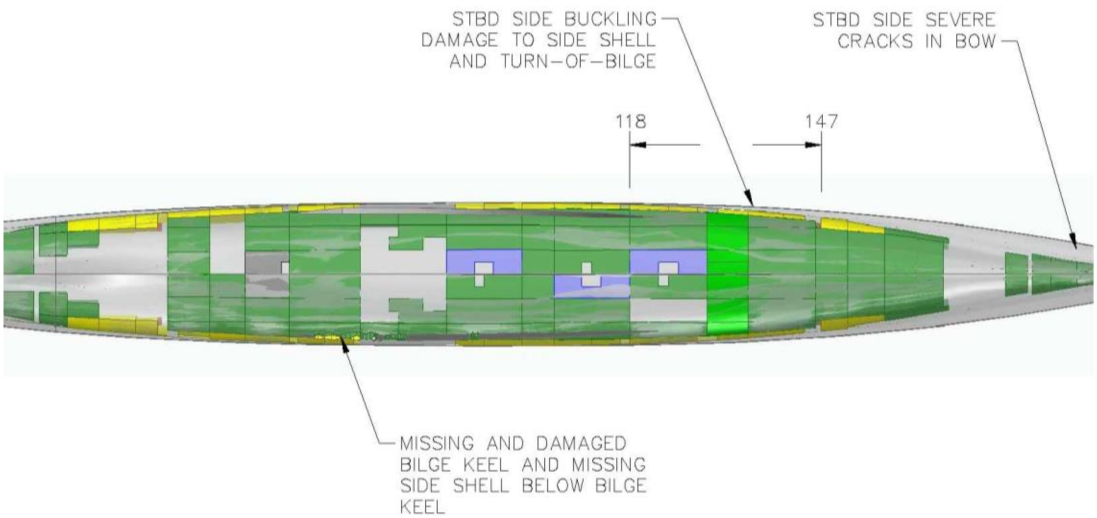



Figure 5.7. Hull Model Showing Heavily Damaged Areas of the Hull

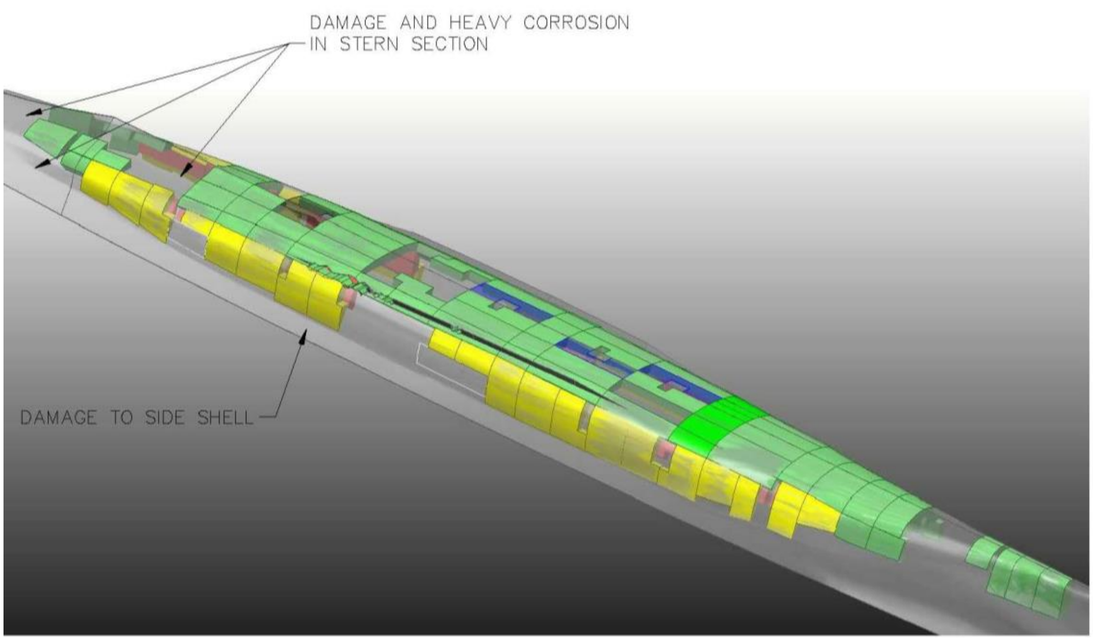



Figure 5.8. Hull Model with Damaged Sections Pointed Out at Stern and Port Side

Port side damage is extensive along roughly 100 feet of the hull. A large area of the side shell is completely missing down to the main deck (see Figure 5.5 and Figure 5.8).

### 5.3.3. Corrosion and Wastage

A data set that was recorded from the operation is the hull thickness in the area of each hot tap application. The manual record has been duplicated in this report and can be found in Appendix I. The average hull thickness (see Figure 5.9) for each section is listed in Table 5.2 below :

Table 5.2. Average Hull Thickness by Section

| SECTION | NO. OF TANKS | AVERAGE THICKNESS (INCHES) | COMMENTS |
|---|---|---|---|
| I | 2 | .250 | SOME AREAS WERE TOO THIN TO MEASURE |
| II | NA | NA | NO HULL THICKNESS MEASUREMENTS WERE RECORDED |
| III | 15 | .350 | |
| IV | 4 | .450 | |
| V | 9 | .450 | |
| VI | 5 | .690 | |
| VII | 11 | .475 | |
| VIII | 5 | .505 | |
| IX | 7 | .420 | |
| X | 6 | .410 | |
| XI | 7 | .410 | |
| XII | 2 | .365 | |
| XIII | 5 | .373 | |


Figure 5.9. Diver utilizing a Cygnus underwater ultrasonic thickness gauge to determine the hull thickness in the target area to be hot tapped. (Photo from 2017 Survey)

Figure 5.10, Figure 5.11, and Figure 5.13 show images of the hulls various damage, corrosion, and wastage.

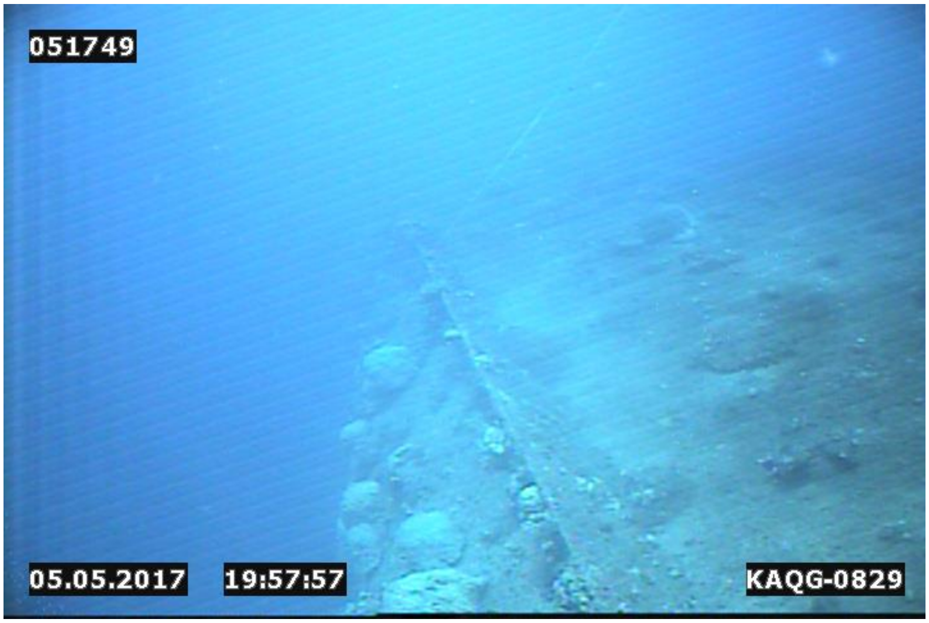



Figure 5.10. Port Side Looking Aft Along the Bilge Keel Forward of Section V and VI
The bilge keel is intact, the hull metal is much thicker and there is much less corrosion.

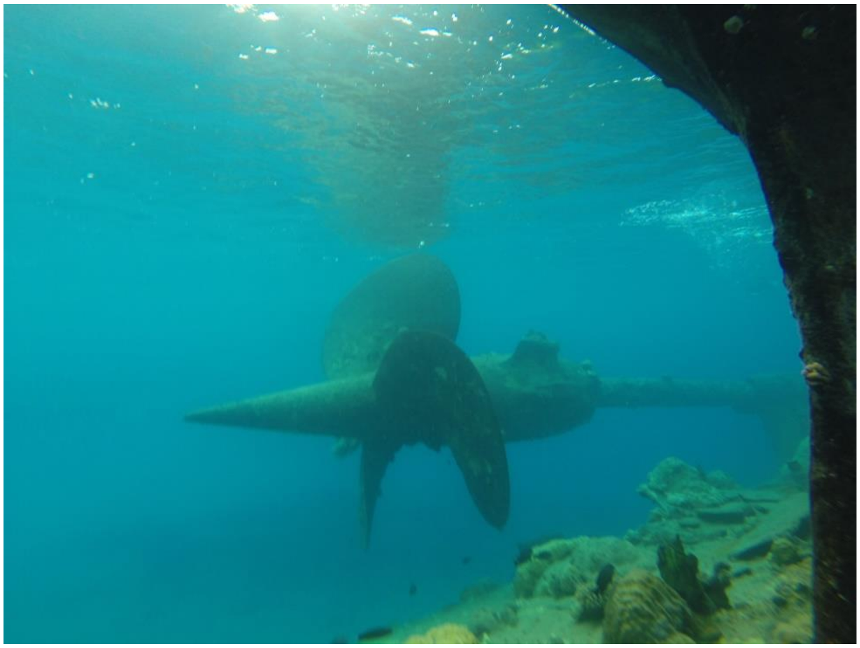


Figure 5.11. Starboard Propeller Shown with Missing Strut
The port propeller is missing and the center propeller extends partially out of the water.

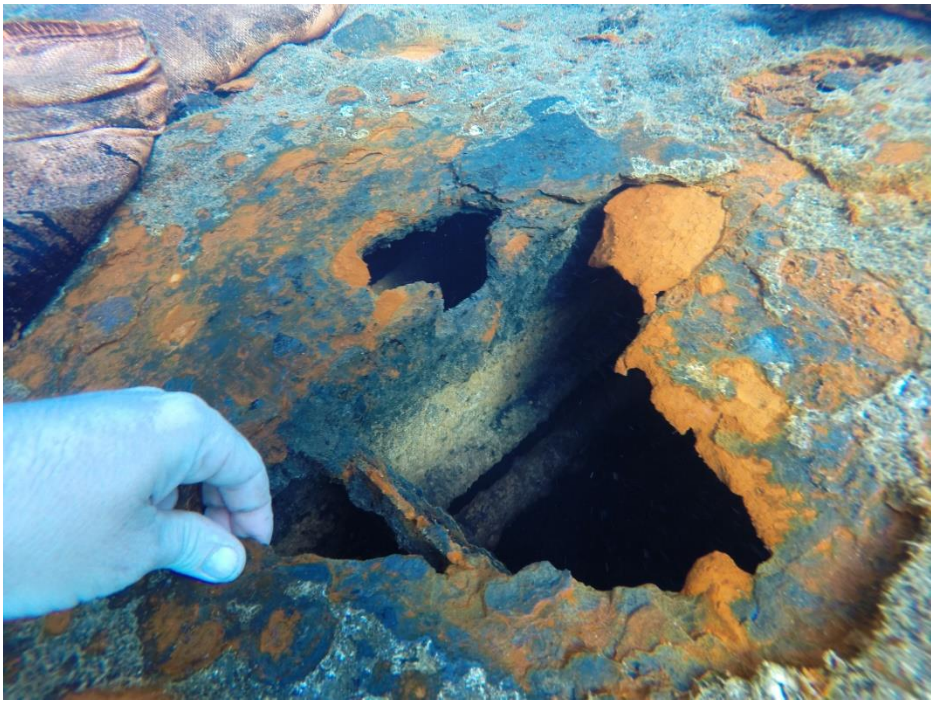


Figure 5.12. Stern sections (hull Sections I and II) are wasted away in many areas and are very thin.

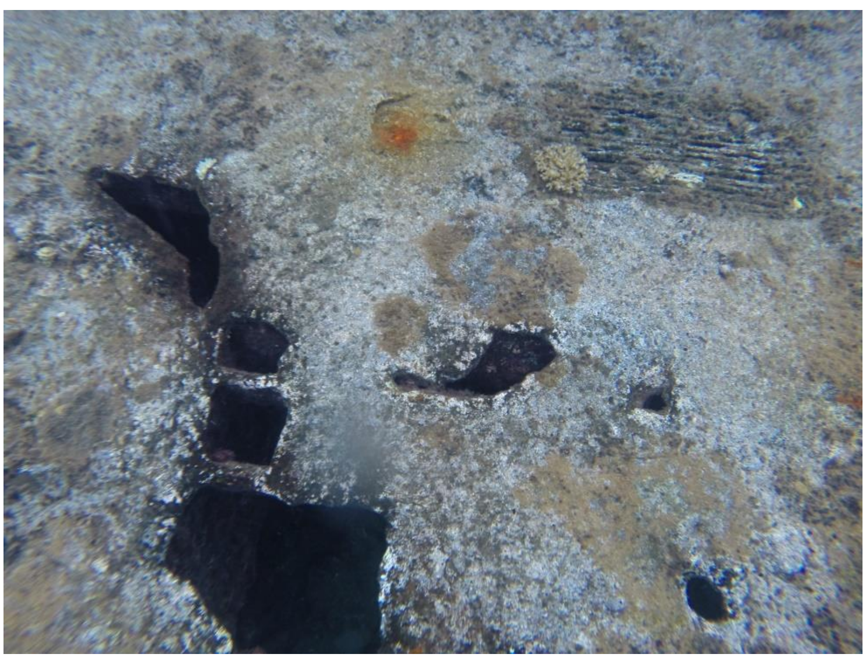


Figure 5.13. Heavy Corrosion and Wastage in the Aft Sections; Note Sea Chest Inlet in Upper Photo

### 5.4. Estimated Oil Remaining on the ex-USS *PRINZ EUGEN*

The estimated volume of oil remaining onboard the ex-USS *PRINZ EUGEN* at the completion of the oil recovery operation in October 2018, as listed in this section, is based upon the premises described below:

The recovery operation described in this report was able to successfully remove all of the pumpable oil, which was the majority of the oil believed to be on the wreck. The only tanks that could have had oil and were not tapped or accessed were left untapped because they could not be accessed with the tools on hand and the time available to the PE team. This was due to obstructions and/or damage to those tanks. Quantifying how much oil could still be in them is conjecture. The estimate herein is based upon the statistics of oil recovered from the wreck tanks that were actually tapped and pumped. Therefore, it is assumed that the only bulk oil that is likely to remain onboard would be what is left in the 13 internal tanks and the one external tank that could not be accessed. The maximum estimated volume of bulk oil is derived by applying the known average recovery percentages of the tapped internal tanks (or external tanks for Tank II 6.3) to the maximum loading volumes of the non-accessible tanks. These results are summarized in the Table 5.3 below.

The remaining tank "Clingage" (oil that clung to tank walls after pumping and stripping) volumes and random oil deposits that could possibly be located in miscellaneous spaces (such as trapped in overheads, engine rooms and other spaces throughout the wreck) was determined to be no greater than 6800 gallons. Oil remaining in other locations, as described, means that through damaged tank wall leakage, pipe deterioration or during the original capsizing, oil in small quantities could have become trapped in the overheads of spaces throughout the ship. This oil would be extremely difficult to remove without having complete safe diver access to all below deck areas, specialized suction pumps and a considerable amount of time. This of course was not possible due to damage, corrosion, and the very real safety issues involved.

Final estimates for volumes of oil remaining on the wreck are as follows:

- Clingage and entrapped oil: 6800 gallons
- Oil remaining in internal tanks: 6500 gallons

The total estimated volume of oil remaining onboard the ex-USS *PRINZ EUGEN* is approximately 13,300 gallons.

Table 5.3 summarizes the estimates per tank for all of the tanks that were not tested or tapped on the ex-USS *PRINZ EUGEN.*

Table 5.3. Worse-Case Estimate for Remaining Tank Volumes

| ESTIMATED REMAINING TANK VOLUME TABLE (INTERNAL TANKS) | | | | | |
|---|---|---|---|---|---|
| **ITEM** | **TANK SECTION AND TANK NUMBER** | **MAX ORIGINAL TANK LOADING VOLUME** | **CALCULATED AVG PERCENT RECOVERY** | **STATISTICAL EST OF REMAINING OIL VOLUME** | **TANK NOTES** |
| 1 | EXTERNAL TANK II 6.3 | 5165 | 14 | 723 | THIS TANK COULD NOT BE ACCESSED BECAUSE OF A SHAFT STRUT PHYSICALLY BLOCKING ACCESS. |
| 2 | INTERNAL TANK II 5.5 | 2098 | 4 | 83 | TANKS WERE INACCESSABLE BECAUSE OF INTERNAL PIPING BLOCKING ACCESS USING INTERNAL TAP TOOL. |
| 3 | INTERNAL TANK III 5.1 | 4452 | 4 | 178 | |
| 4 | INTERNAL TANK VII 9.1 | 4227 | 13 | 550 | TANK WAS LOCATED INSIDE A SPACE WITHOUT A TANK WALL COMMON TO THE SKIN OF THE SHIP AND COULD NOT BE ACCESSED. |
| 5 | INTERNAL TANK IX 5.3 | 5358 | 13 | 1394 | DAMAGED EXTERNAL HULL AND BUCKLED HULL PLATE |
| 6 | INTERNAL TANK IX 5.4 | 5366 | 13 | | OBSTRUCTION UNDER FLANGE |
| 7 | INTERNAL TANK X 5.1 | 4468 | 13 | 1942 | DAMAGED EXTERNAL HULL AND BUCKLED HULL PLATE |
| 8 | INTERNAL TANK X 5.2 | 4491 | 13 | | TANK X 5.2 SHARES WING TANK ACCESS VIA WING TANK X 4.2 WITH TANK X 5.4. WING TANK X 4.2 HAD OBSTRUCTIONS PREVENTING COMPLETE ACCESS WITH THE EXTENSION TAP TOOL. |
| 9 | INTERNAL TANK X 5.3 | 2985 | 13 | | DAMAGED EXTERNAL HULL AND BUCKLED HULL PLATE |
| 10 | INTERNAL TANK X 5.4 | 2991 | 13 | | SEE ITEM 8 ABOVE |
| 11 | INTERNAL TANK XI 5.1 | 3213 | 13 | 1597 | BUCKLED PLATE IN WING |
| 12 | INTERNAL TANK XI 5.2 | 3170 | 13 | | OBSTRUCTION (STEAM COILS) |
| 13 | INTERNAL TANK XI 5.3 | 3025 | 13 | | BUCKLED PLATE IN WING |
| 14 | INTERNAL TANK XI 5.4 | 2874 | 13 | | OBSTRUCTION (STEAM COILS) |
| TOTAL VOLUME | | | | 6467 | |

## 5.5. Lessons Learned/Equipment Evaluations

### 5.5.1. Equipment

The recovery equipment brought to this project included a mix of established system components, tools, and material such as the lightweight hot taps, close-outs, and pumps, and new technological components and equipment such as underwater cordless drills, hull thickness gauges, and a variety of other items. It all worked, some of it worked well, some of it did not. If there is one recurring theme or lesson to be learned, it is that while planners must always be moving forward embracing new technology, wreck recovery plans must always ensure that there is a large amount of previously tested and proven equipment on-hand to fall back on.

Another lesson that was learned was to ensure that there is always a robust capability to fabricate tools onboard the recovery vessels at the wreck site. The first part of that equation is to ensure that the operation has plenty of raw materials such as PVC piping, steel, aluminum, and structural steel. The second part is ensuring that there are welding machines, grinders, pipe benders, etc., as well as fabricators and welders on-hand. There will inevitably be some equipment that has to be fabricated and assembled on-site.

### 5.5.2. Logistics

Some areas of the world are very difficult to get to both physically and logistically. Kwajalein proved difficult to re-provision and re-supply. The ability to fly materials in and out was feasible, but not fast and with much effort and expense. The ex-USS *PRINZ EUGEN* project benefited from the fact that the wreck was only a few miles away from a U.S. Army base with an airport. There were also inhabitants, an enormous amount of material handling equipment, and other assets on the island. However, being a remote island, numerous items were not available, including parts for MHE equipment, working cranes, food supplies, and freshwater to name a few. It also seemed to be a given that, as Murphy's Law would have it, when one thing broke, the backup and the backup to the backup would break as well. Materials deemed critical to the operation were able to be obtained in a reasonable amount of time if shipped from Hawaii. Making the most out of nearby logistical assets is always a major factor in the success of a project. The PE project differed from other projects because the sheer number of tanks, taps, and pump evolutions that had to be undertaken was analogous to running a wreck oil recovery marathon.

### 5.5.3. Methodology and Planning

Many of the procedures and methods developed during the planning stages were utilized successfully throughout the project. However, some of them were modified and remodified as the project progressed. In hindsight, planners should have included the addition of a complete oil spill response subdivision that incorporated containment, collection and temporary storage systems. This would have been included in the initial budget estimates, and undoubtedly would have resulted in a significant increase in the cost. However, it would have enhanced the operation by providing a team of personnel with their own equipment, dedicated to nothing but spill response. This would have freed up wreck oil removal personnel and assets to be dedicated to the sole function of oil recovery from the wreck.

The general approach and plan of oil recovery (starting in ship Section IV and moving down and forward towards the bow) proved to be a good decision. The modifications to that plan were the incorporation of wing tanks as the dive teams worked in the deeper waters of the bow area to maximize and efficiently accomplish work with minimal bottom time.

Some of the problems that arose with tank location and priorities were the inevitability of having to go back to tanks that were already completed and "closed out" in order to access the internal tanks underneath them. The tools available to access the internal tanks required going through the original hot tap holes or installing a new flange to use as an access hole. The premise of first addressing the centerline tanks, then the wings, then the internals in sequential order was put into place to ensure that the tanks with the highest probability of oil recovery were completed first. Once again, based on the recovered oil statistics (centerline tanks 89%, wing tanks 6%, and internal tanks 5%), the decision was sound. However, that premise led to a lot of inefficiency trying to move divers, pumps, hoses, and hot tapping equipment around, tying up the whole dive team.

#### 5.5.3.1. Subsea Manifold

Another planning subject that will be modified for future use is subsea pump equipment, hoses and manifolds. Generally speaking, designing equipment that can be better utilized by divers will be a priority. Diver efficiency and making things as easy as possible should always be among the highest system design priorities. Also, the design of a new bottom distribution system may be developed and provided with enough flexibility to use on most future wreck scenarios. This of course would have to be customized and assembled on a case-by-case basis. Generally it would contain a discharge manifold assembly that ran down the entire length of the wreck. This assembly would have connection points, port and starboard, at each tank section with isolation valves. This system most likely would have reduced leakage, reduced kinks, and be much more efficient with regards to equipment movement and manpower usage.

#### 5.5.3.2. Special Efforts

Recovery of oil from the internal tanks consumed a lot of energy, time, and required special effort from the recovery team. The internal tanks yielded only a small fraction of the total oil recovered. However, the importance of being able to access and recover oil from internal tanks of a submerged wreck is very high. The increased learning curve experienced during the ex-USS *PRINZ EUGEN* recovery operation and the potential for future tool and removal methodology advancements resulting from these lessons learned were worth every minute and penny.

#### 5.5.4. Summary

In summary, there were many lessons learned during this project. In addition to the ones presented above, more lessons learned can be found in Appendix N. There are also many lessons learned hidden within the personal experience of each of the participants of the operation. If there is one lesson that is learned over and over again on each and every wreck oil recovery project, it is that there is no replacement for the hard work and ingenuity of personnel who are out there "making it happen".

### 5.6. Future Opportunities

The oil recovery operation of the ex-USS *PRINZ EUGEN* was a complete success. All of the original objectives, as listed below, were achieved:

- All of the accessible oil was removed from the wreck
- All accessed tanks were sealed to prevent future penetration, tampering, and/or leakage
- All significant operational oil releases were stopped and addressed on-site
- All recovered products were removed from the Republic of the Marshall Islands and disposed of in an appropriate and responsible manner

Advancement of systems and equipment should be undertaken quickly upon final completion of the ex-USS *PRINZ EUGEN* Delivery Order while the problems-to-be-solved are still fresh and relevant. Future potential projects and areas for technology advancement are listed below:

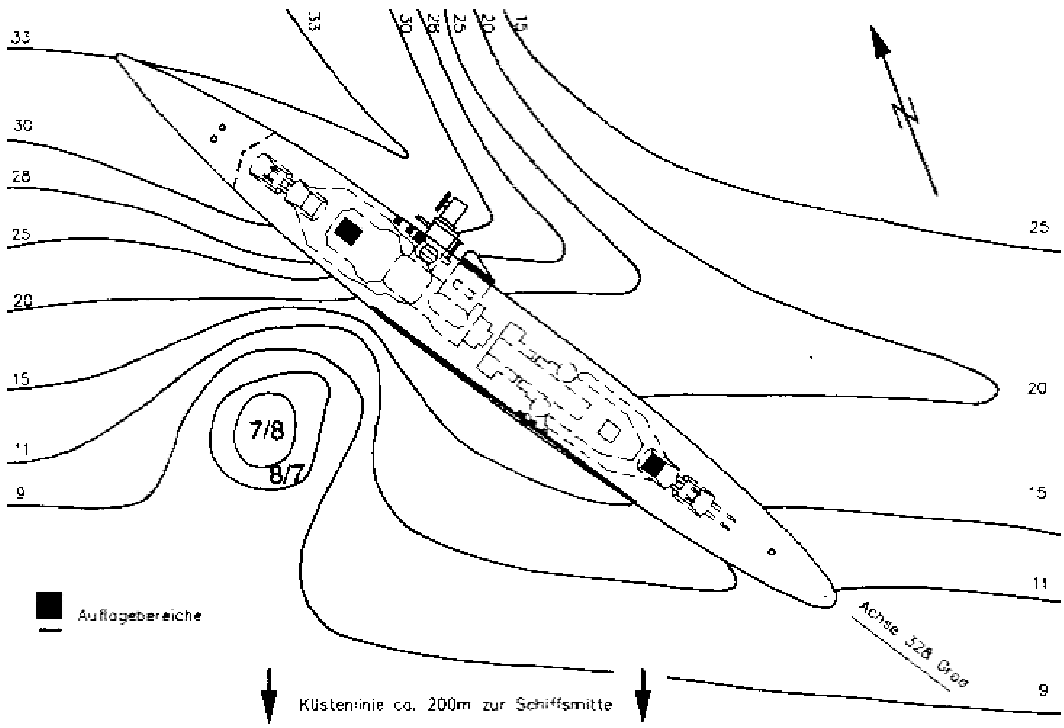
a. Underwater, thru-hull, non-invasive tank content discernment
b. Closed system thru-hull tank sampling/testing
c. Methods to recover/eliminate clinging of heavy oils and render a tank free of residual petroleum product
d. Improved diver locator and audio/visual systems
e. More accurate aids to hull navigation (for low visibility situations)
f. Modernized array of hot tap and intrusive tank access equipment that include a layered set of tools and methodologies for accessing external tanks, internal tanks, and double hull vessels
g. Utilization and development of environmentally friendly products and associated methods that chemically change the physical state of petroleum products from a liquid to an inert solid mass in order to easily seal a leaking tank that is inaccessible by mechanical means
h. Advancement in the use of underwater exothermic cutting rods and advanced exothermic systems
i. Advancement of oil recovery and pumping technologies to encompass all types of petroleum products in different environments ranging from the tropics to the arctic

The planning that was conducted in the many months leading up to the project was indispensable, as were the many tons of equipment and highly specialized techniques that were deployed throughout the operation. The real success of the oil recovery from the ex-USS *PRINZ EUGEN*, however, is attributed to the hard work, tenacity, dedication, and innovativeness of the men and women working to make it happen every day on that job. Without the right combination of dedicated and driven individuals, all true professionals in their own role in the operation, the best equipment and plans can still result in failure. That being said, having the mindset and ability to continually improve these tools and associated techniques real time, as the operational challenges dictate, leads to subsea projects that can be completed more safely, faster, with more environmental protection, and a much higher probability of success.

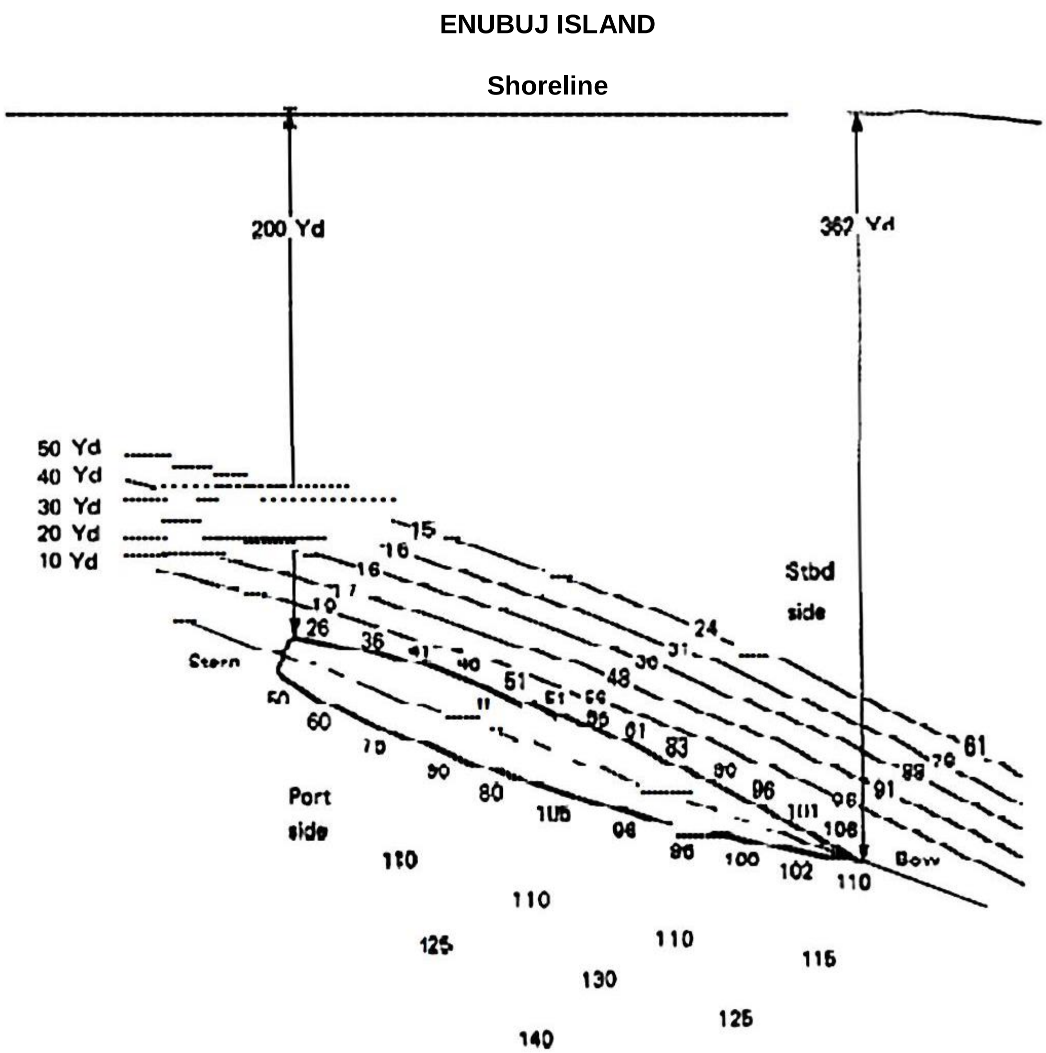
In closing, much of the current generation of subsea tools are approaching the third decade in their technological age. The further advancement of this equipment, together with the addition of new tools and techniques, will greatly benefit the oil offload of future wrecks throughout the world.

# APPENDIX A

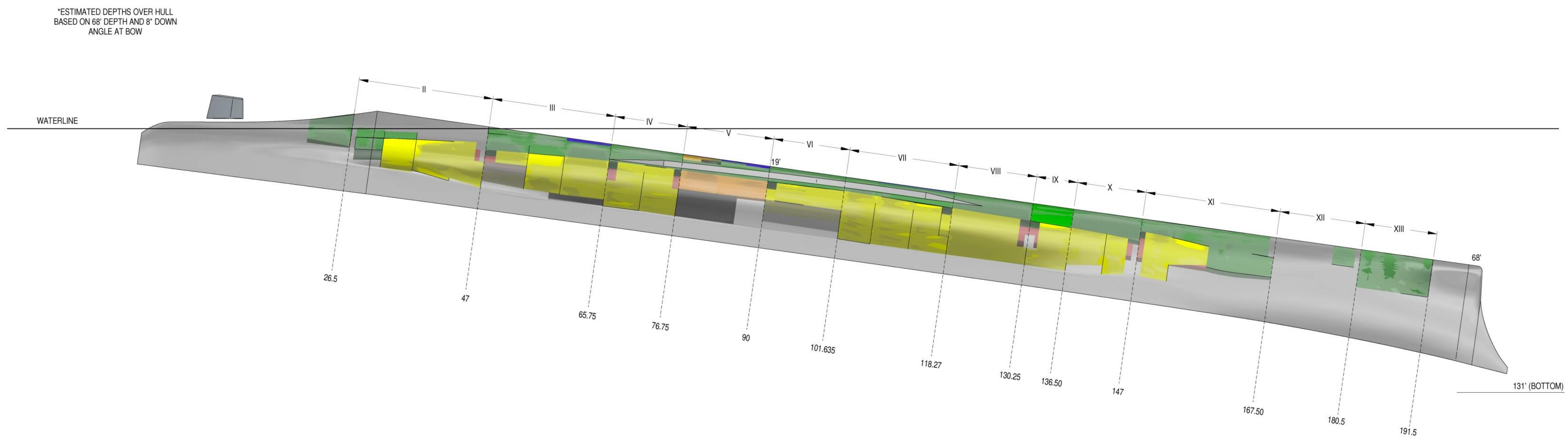
## Appendix A – Ship Depth and Inclination on the Bottom




A-1. Length 212.5M/697 Feet, Beam 21.7M/71 Feet, Depth of Hull at Side 41 Feet




A-2. Soundings Corrected to Mean Low Water
(Sourced from Summary Report on Salvage Survey of Prinz Eugen
SUPSALV Report No. 6-74, June 1974)




A-3. Hull Elevation with Water Depths

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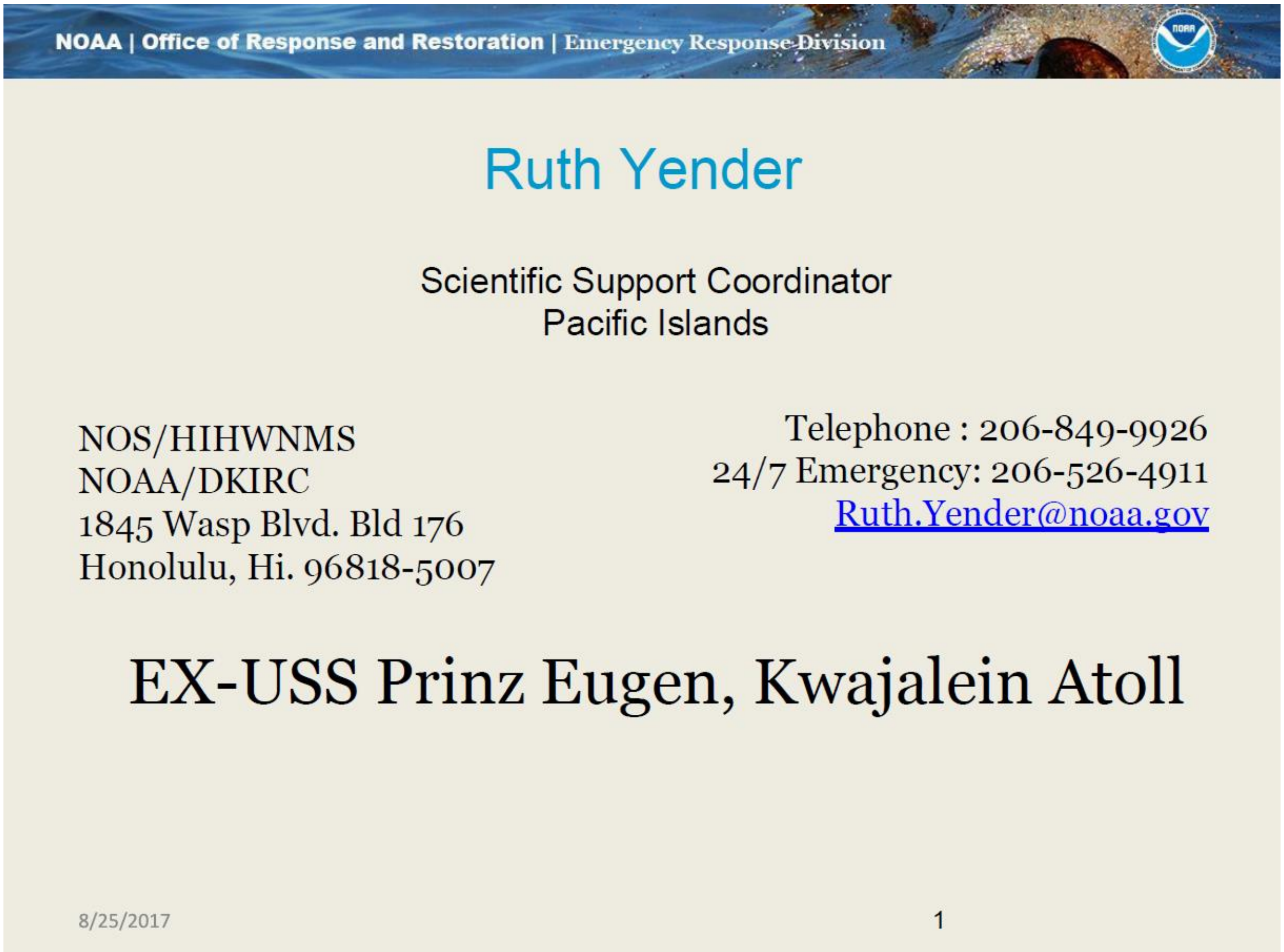
# APPENDIX B

## Appendix B – NOAA Oil Spill Trajectory Analysis



NOAA | Office of Response and Restoration | Emergency Response Division

## Incident Information

- Following WWII, the ex-USS Prinz Eugen was towed to Kwajalein Atoll, where she ultimately capsized and sank in December 1946.
- The exact fuel load at the time of sinking cannot be conclusively determined from collected historical documentation, but is estimated to have been between 733, 896 gallons and 215,000 gallons of fuel.
- SUPSALV is officially tasked and moving forward with an oil offload operation (scheduled for 1 September - 15 October) to hot tap ~ 110 tanks potentially containing oil.
- **Maximum most probable discharge is the single largest tank which is 11,610 gallons (Navy Special Fuel Oil)**.

2

NOAA | Office of Response and Restoration | Emergency Response Division

# Location

- The wreck lies completely inverted at an angle of approximately 40 degrees to the shoreline of Enubuj Island with the bow resting in approximately 110 feet of seawater and the stern in just 26 feet of sea water with the propellers awash



3

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# Navy Special Fuel Oil (NFSO)

- Navy Special Fuel Oil (NSFO) is a ship fuel, the equivalent of No. 5 heavy fuel oil that is produced by blending No. 6 fuel oil and light petroleum distillates.
- These heavy fuel oils are highly viscous and possess high specific gravities.
- Samples collected from vessel indicate an API of 17-19

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# Oil Behavior and Fate Discussion

- The nature of the release (sudden/instantaneous vs slow continuous) and the environmental conditions at the time will have a strong influence on the oil appearance and ultimate fate.
- Under turbulent ocean conditions (winds > 15 kts) the lighter components of the fuel oil (up to 25% of volume) would be predominantly mixed into the water column potentially causing high water column concentrations of PAHs in the vicinity of the wreck; under calmer conditions more of the volatile compounds would be lost to the atmosphere.
- Oil on the surface will spread out quickly forming patches of dark oil and sheen. During a previous incident with NSFO (USS Mississinewa), the oil was observed to form an emulsion under strong wind conditions (25 kts).
- Oil would be relatively persistent on the ocean surface, most likely in the form of persistent tarballs that could impact remote shorelines (depending on transport conditions due to the winds/currents).

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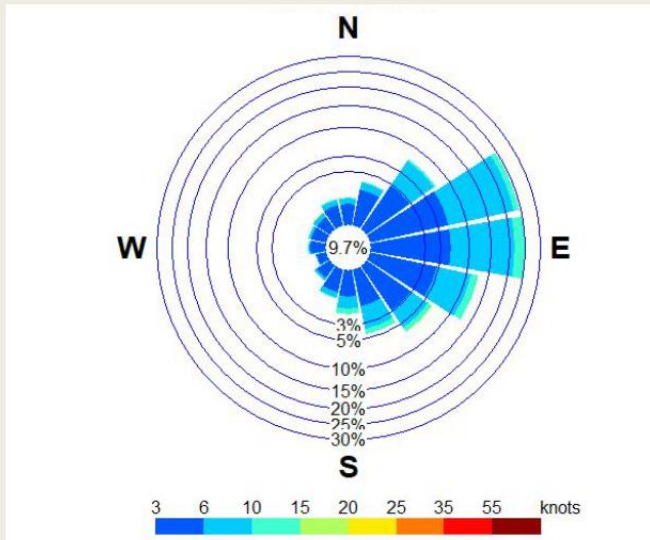
## Prevailing Winds

- Wind data from measurements on Kwajalein Island from 2006-2014 (NOAA/NOS station KWJP8)
- Persistent trade winds (blowing from ENE) are most common
- Aug-Oct tend to have reduced intensity winds (average ~<10 kts) and are more variable in direction




*Frequency of wind direction/speed in September. Winds are typically from the E (25% of the time) and ENE (25%) with speeds less<15 knots*

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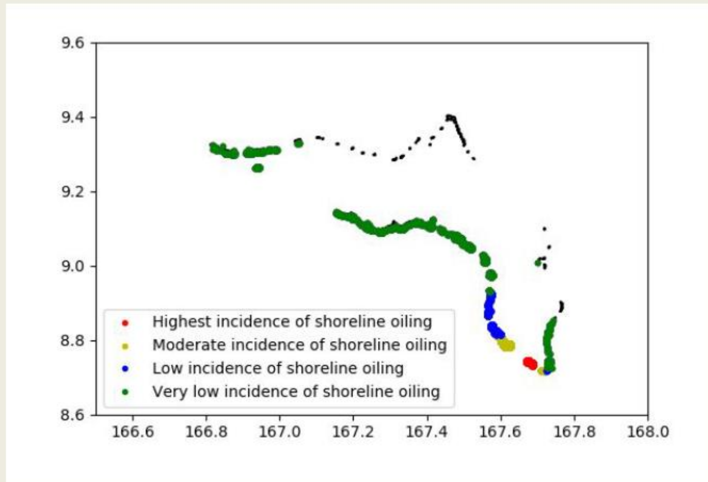
# Trajectory Discussion

- Under typical conditions (E/ENE) winds, shoreline impacts are likely on Enubuj Island with remaining oil moving through the surrounding reef and existing the lagoon to the west.
- Other shorelines within Kwajalein Atoll are at moderate to low risk of oiling.
- Impacts to islands remote from the wreck vicinity are likely to be in the form of scattered tarballs




*Density of model particles making landfall from simulations using winds measured at Kwajalein atoll in Sep/Oct 2006-2010 and average surface currents. Highest densities of particles making landfall are on Enubuj Island adjacent to wreck site. "Moderate" incidence is <40% of highest density, "Low" is < 10%, "Very Low" is <1%. Islands to the far NE were not impacted in any of the simulations.*

7

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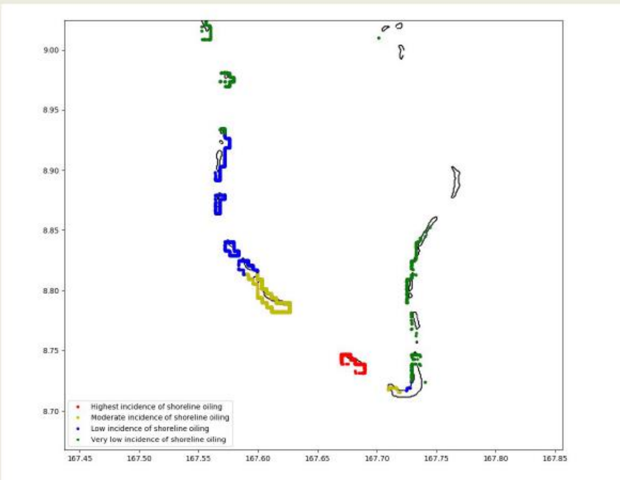
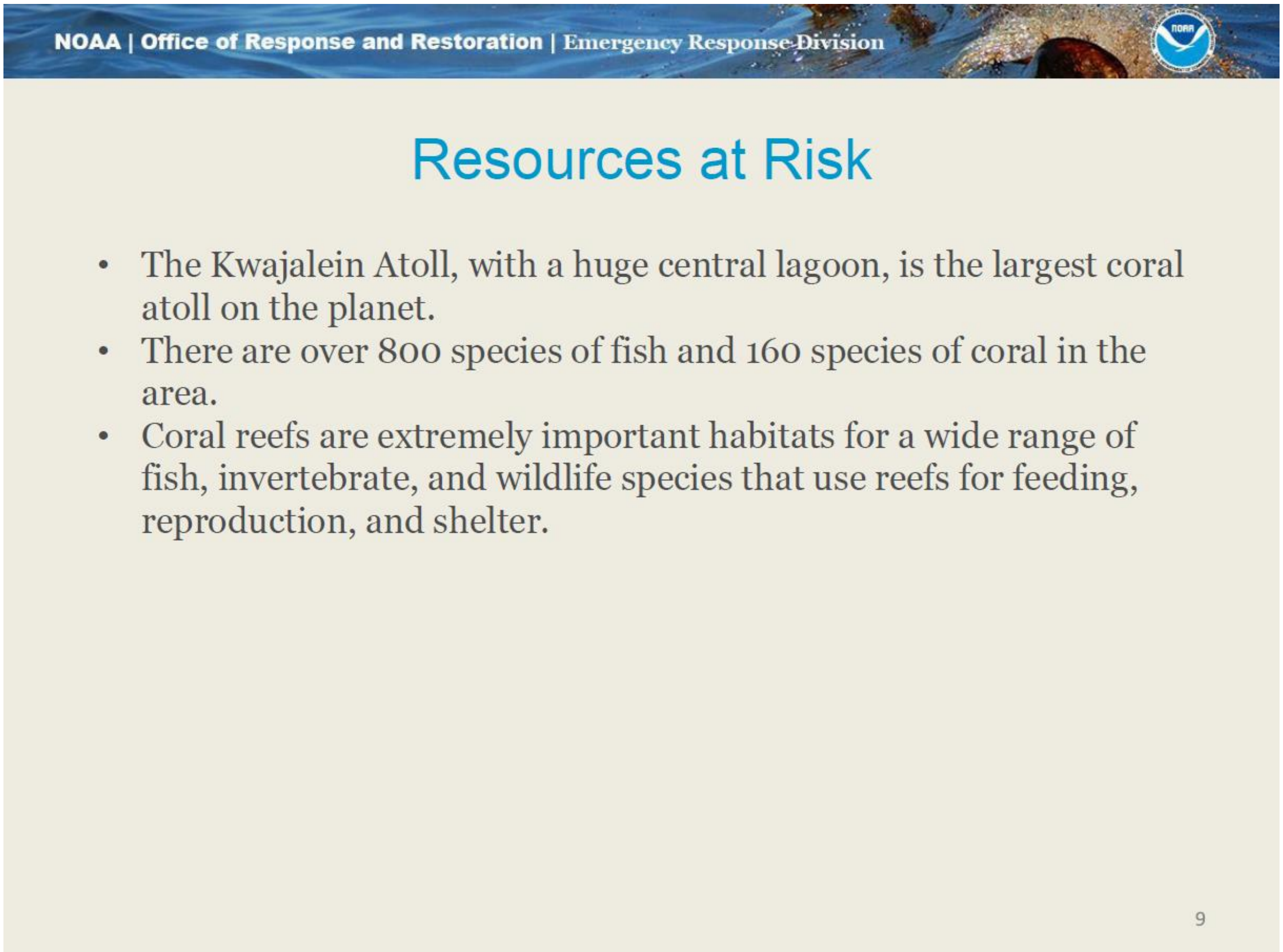
# Close-up of wreck vicinity




*Density of model particles making landfall from simulations using winds measured at Kwajalein atoll in Sep/Oct 2006-2010 and average surface currents. Highest densities of particles making landfall are on Enubuj Island adjacent to wreck site. "Moderate" incidence is <40% of highest density, "Low" is < 10%, "Very Low" is <1%. Islands to the far NE were not impacted in any of the simulations.*

8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Resources at Risk
• The Kwajalein Atoll, with a huge central lagoon, is the largest coral atoll on the planet.
• There are over 800 species of fish and 160 species of coral in the area.
• Coral reefs are extremely important habitats for a wide range of fish, invertebrate, and wildlife species that use reefs for feeding, reproduction, and shelter.
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# APPENDIX C

## Appendix C – Vessel Selection

**SUPPORT VESSEL SPECIFICATIONS AND COST ESTIMATE SUMMARIES - 020119 ML**

| | SUPPORT VESSEL | VESSEL TYPE | DWT (GALLONS) | LOA | BEAM | DRAFT NORM BALLAST (TROPICAL) | MOB DEMOB FEES | PORT FEES & OTHER | BERTH/MESS | VESSEL SPECIFIC | PORT OF DEPT-PORT OF RETURN (IF NOT SAME) | TRAVEL TIME TO KWAJ | TRAVEL TIME TO RETURN | DISPOSAL TIME | ON SITE | COST PER DAY | DAYS ON CHARTER | TANK CLEANING AND TANK CLEANING SLOPS DISP. | BUNKER COST (IF NOT INCLUDED) | BASIC COST EST FOR CHARTER | OIL DISPOSAL 500K GALS | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MT | FT | FT | FT | | USD | USD | | | DAYS | DAYS | DAYS | DAYS | USD | DAYS | USD | USD | USD | USD | |
| 1 | **RESOLVE MONARCH AND RMG 1000** | TUG BARGE (DECK BARGE RATED FOR OSRB) | 11438 | 300 | 100 | 6.82 (22.73) | | 5000 | 0 | MONARCH/ RMG 1000 | SINGAPORE | 22 | 22 | 5 | 50 | 19500 | 99 | 10000 | 531360 | **2,547,860** | 71000 | * FUEL CONSUMPTION AT 4500 GPD STEAMING AND 400 GPD MOORED. USED 2.46USD/GAL LSMGO<br>* SINCE THIS DECK BARGE IS NOT DOUBLE HULL, MAY BE DOUBLE BOTTOM. NEED TO KNOW IF THIS DECK BARGE IS VIABLE FOR INTERNATIONAL TANKER USE.<br>* ALSO NEED TO VERIFY DISPOSAL COST AND TIME ON CHARTER FOR DISPOSAL. |
| 2 | **RESOLVE TANKER 6500 DWT** | TANKER | 6500 (1.71 MILLION GALLONS) | TBD | TBD | TBD | | 5000 | 0 | UK | SINGAPORE | 23 | 23 | 5 | 50 | 15000 | 101 | 10000 | 220000 | **1,821,000** | 71000 | FUEL COST BASED ON OTHERS. NO BERTHING AVAILABILITY. NEED DECK PLAN. NEED DISPOSAL COST. AWAITING RESPONSE. |
| 3 | **GLOBAL ENERGY - LOH HONG LEONG EMAIL: LHL@GLOBALENERGY.COM.SG SINGAPORE TUG BARGE (UNNAMED) OPTION 2** | TUG BARGE DOUBLE HULL FUEL BARGE | TBD | TBD | TBD | TBD | | 5000 | 54000 | UK | SINGAPORE | 44 | 44 | 5 | 50 | 2667 | 143 | 30000 | 220000 | **711,381** | 75000 | POSSIBLE OPTION BUT SEVERAL OPERATIONAL ISSUES. DID NOT RECEIVE SPECS ON BARGE. ASSUMING NO BERTHING ON TUG. LIMITED DECK USAGE DUE TO TANKER REGS. NO MOORING LEG CAPABILITY. DOES NOT INCLUDE TANKERMAN. |
| 4 | **GLOBAL ENERGY - LOH HONG LEONG UNA SHOWN AS EXAMPLE OPTION 1A** | OIL TANKER DOUBLE HULL | 7642 (2.06 MILLION GALLONS) | 377 | 59 | 14 (22) | | 5000 | 54000 | TANKER VESSEL UNA | SINGAPORE | 20 | 20 | 5 | 50 | 8500 | 95 | 24000 | 255300 | **1,116,800** | 25000 | MUCH LARGER THAN WE NEED. WILL BE MORE DIFFICULT TO MOOR. |
| 5 | **GLOBAL ENERGY - LOH HONG LEONG HUMBER OR CONGO SHOWN AS EXAMPLE** | OIL TANKER DOUBLE HULL | 4633 (1.07 MILLION GALLONS) | 295 | 53 | 13.2 (19.4) | | 5000 | 54000 | TANKER VESSEL HUMBER | SINGAPORE | 21 | 21 | 5 | 50 | **8500** | 97 | 30000 | 250522 | **1,135,022** | 25000 | POSSIBLE OPTION. THEY DO HAVE DECK SPACE FOR TWO CONTAINERS WHILE IN KWAJ ONLY. NO HOT WORK, NO ELECTRICAL ALLOWED ON DECK (COMMON FOR TANKER) INCLUDING POWER TO VANS. POWER ONLY ON UPPER HOUSE DECKS. COMMUNICATION IN PROGRESS. SPACE FOR 12. FOOD IS ASIAN. TANKAGE VOL IS BIG PLUS. COST IS BIG PLUS. |
| 6 | **GLOBAL ENERGY - LOH HONG LEONG** | OIL TANKER DOUBLE HULL | 6800 | | | | | 5000 | 54000 | TANKER VESSEL UN-NAMED | PAPAU NEW GUINEA-SINGAPORE | 10 | 20 | 5 | 50 | 8500 | 85 | 55000 | 135000 | **942,500** | 25000 | MUCH LARGER THAN WE NEED. TECHNICAL DIFFICULTIES WITH APPROACH AND TIMING. NOT FEASABLE AT THIS TIME. |
| 7 | **GLOBAL ENERGY - LOH HONG LEONG** | OIL TANKER DOUBLE HULL | 6800 | | | | | 5000 | 54000 | TANKER VESSEL UN-NAMED | SINGAPORE | 20 | 20 | 5 | 50 | 8500 | 95 | 55000 | 250522 | **1,143,022** | 25000 | MUCH LARGER THAN WE NEED. WILL BE MORE DIFFICULT TO MOOR. |
| 8 | **MSRC CORPORATION – CARMINE DULISSE HAWAII RESPONDER TEL: 703-326-5601** | OFFSHORE SUPPLY VESSEL FOR OFFSHORE RESPONSE | 4K BBLS (168000 GALLONS) | 210 | 45 | 13.1 | | 5000 | | RESPONDER (HAWAII) | HONOLULU | 15 | 15 | 5 | 50 | 35000 | 85 | 26300 | 0 | **3,081,300** | 75000 | VESSEL IS GOOD PLATFORM EXCEPT IT DOES NOT HAVE ENOUGH TANKAGE ON BOARD. COST ESTIMATE DOES NOT INCLUDE EXTRA TANKAGE. WE WOULD NEED TO EITHER RENT STORAGE TANKS OR ADD A BARGE. FUEL COST IS INCLUDED. POC PROVIDED OTHER CONTACTS |
| 9 | **MSRC CORPORATION – CARMINE DULISSE HAWAII RESPONDER 400K BBL BARGE AND TUG TEL: 703-326-5601** | BARGE 400K BBL 9.2K/DAY HNL TUG FROM WC 15K DAY | | | | | | 5000 | | MSRC 400K BARGE | HONOLULU | 15 | 15 | 5 | 50 | 24200 | 85 | 26300 | 0 | **2,163,300** | 75000 | DOES NOT INCLUDE DISPOSAL. DO NOT HAVE A TANK CLEANING COST |
| 10 | **CLIPPER OIL – ERIC SHAHTAJI TEL: +1619-692-9701 CEL: +1-708-305-4044 EMAIL: ERIC@CLIPPEREOIL.COM** | TANKER OR TUG BARGE | | | | | | 0 | | | | | | | | | 0 | | 0 | **0** | | NO ASSETS AVAILABLE |
| 11 | **EXXON MOBIL CORPORATION TEL: 832-562-0398 CEL: 832-625-6717 OFFICE** | TANKER OR TUG BARGE | | | | | | 0 | | | | | | | | | 0 | | 0 | **0** | | NO ASSETS AVAILABLE |

Figure C-1. Support Vessel Selection and Cost Estimate Summaries, Sheet 1 of 3

| | SUPPORT VESSEL | VESSEL TYPE | DWT (GALLONS) | LOA | BEAM | DRAFT NORM BALLAST (TROPICAL) | MOB DEMOB FEES | PORT FEES & OTHER | BERTH/MESS | VESSEL SPECIFIC | PORT OF DEPT-PORT OF RETURN (IF NOT SAME) | TRAVEL TIME TO KWAJ | TRAVEL TIME TO RETURN | DISPOSAL TIME | ON SITE | COST PER DAY | DAYS ON CHARTER | TANK CLEANING AND TANK CLEANING SLOPS DISP. | BUNKER COST (IF NOT INCLUDED) | BASIC COST EST FOR CHARTER | OIL DISPOSAL 500K GALS | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MT | FT | FT | FT | | USD | USD | | | DAYS | DAYS | DAYS | DAYS | USD | DAYS | USD | USD | USD | USD | |
| 12 | **KIM HENG OFFSHORE AND MARINE HOLDINGS LTD.<br>CORPORATION OFF – THOMAS TAN, CEO PENJURU SHIPYARD NO. 48 PENJURU ROAD SINGAPORE. 609152<br>TEL: +65 6777 9990.<br>PANDAN SHIPYARD N. 9 CRESCENT<br>SINGAPORE, 128465<br>TEL: +65 6773 9610** | TANKER | 4000<br>(.95 MILLION) | 311 | 51 | 18.7 | | 5000 | 94500 | DOUBLE HULL TANKER | SINAGPORE | 20 | 20 | 5 | 45 | 21050 | 90 | 40000 | 220800 | **2,823,179** | 662879 | DOES NOT INCLUDE DISPOSAL. DO NOT HAVE A TANK CLEANING COST. SUSPECT THE HIGH DAY RATE COST IS THEIR PREMIUM TO COVER POTENTIAL LOSS OF OTHER LONGER TERM CHARTER. |
| 13 | **CLARKSONS PLATOU OFFSHORE – PAUL LOVE<br>TEL: +44 1224 256666<br>CEL: +44 770 230 2307<br>EMAIL: PAUL.LOVE@CLARSSONS.COM** | | | | | | | 0 | | | | | | | | | 0 | | 0 | **0** | | HAVE RECONTACTED THROUGH UK OFFICE 042418 |
| 14 | **AFFINITY – ANDRE NIKOLAISEN<br>TEL: +1 832-925-7501<br>CEL: +1 832-623-4798;<br>EMAIL: ANDRE.NIKOLAISEN@AFFINITYSHIP.COM** | OSV/PSV | 1799 | | | | | 5000 | 67500 | NO NAME | SINGAPORE | 20 | 20 | 10 | 50 | **12500** | 100 | 25000 | 342480 | **1,697,480** | 75000 | THIS OWNER IS WORKING ON AN ESTIMATE. TANK CLEANING IS A WAG. BERTHING IS FROM OWNER. OWNERS HAVE CONCERNS ABOUT RESIDUAL OIL PUMPING AND TANK CLEANING. NO DISPOSAL AT THIS TIME. |
| 15 | **PARETO SHIPBROKERS – KARSTEN CHRISTENSEN<br>TEL: +47 38 12 31 01<br>CEL: +47 90 84 57 55<br>EMAIL: KARSTEN@PARETOSHIP.NO** | | | | | | | 0 | | | | | | | | | 0 | | | **0** | | E MAIL FAIL |
| 16 | **UNO OFFSHORE – LEIF JOHAN ROKSTAD<br>TELL: +47 21 41 46 92<br>CEL: +47 90 06 79 70<br>EMAIL: CHARTERING@UNOOFFSHORE.NO** | | | | | | | 0 | | | | | | | | | 0 | | | **0** | | 04/15 RECONTACTED 04/20/2018 AND 4/24. NOT SHIP OWNERS. NO VESSEL AVAILABLE FOR THIS PROJECT. |
| 17 | **SWIRE PACIFIC OFFSHORE – SINGAPORE<br>SEBASTIEN CHARRIER<br>TEL: 1 832 727 7656<br>DUNCAN TELFER<br>TEL: +65 6496 8274<br>CEL: +65 9726 5076<br>EMAIL: DUNCAN.TELFER@SWIRE.COM.SG** | PSV | 2455 M^3<br>630000 | 319 | 66 | 21 | | 5000 | 81000 | MV PACIFIC LEADER | SINGAPORE | 17 | 17 | 5 | 50 | **12500** | 89 | 25000 | 342480 | **1,559,980** | 75000 | NO LONGER AVAILABLE. VESSELS UNDER ANOTHER CHARTER. |
| 18 | **POSH OFFSHORE – KELVIN TEO<br>SINGAPORE<br>TEL: +65 6839 7872<br>EMAIL: TKELVIN@PACCOFHSORE.COM.SG** | | | | | | | 0 | | | | | | | | | 0 | | | **0** | | CONTACTED AGAIN. SUSPECT THEY ARE ALL AT OTC THIS WEEK. COULD NOT GET A PROPOSAL. |
| 19 | **CISPRI AK ALEMEDA** | OSV | 105K GALS | 208 | | | | | | | | 20 | 20 | 5 | 50 | 13500 | 95 | 25000 | 76500 | **1,459,000** | 75000 | TOO SMALL-TOO FAR AWAY-BERTHING ISSUE-INTERNATIONAL TRAVEL ISSUE- NOT ENOUGH TANKAGE WITHOUT A BARGE. |
| 20 | **ANDROMEDA** | RIG VESSEL | 2519 M^3<br>666,000 | 297 | 48 | 17.7 | 715000 | 5000 | 13500 | MV ANDROMEDA | MAJURO RMI | 17 | 17 | 5 | 50 | **10135** | 89 | 25000 | 258150 | **1,265,165** | 75000 | HIGH COST. PLATFORM IS CAPABLE AND VIABLE. |

Figure C-2. Support Vessel Selection and Cost Estimate Summaries, Sheet 2 of 3

| | SUPPORT VESSEL | VESSEL TYPE | DWT (GALLONS) | LOA | BEAM | DRAFT NORM BALLAST (TROPICAL) | MOB DEMOB FEES | PORT FEES & OTHER | BERTH/MESS | VESSEL SPECIFIC | PORT OF DEPT-PORT OF RETURN (IF NOT SAME) | TRAVEL TIME TO KWAJ | TRAVEL TIME TO RETURN | DISPOSAL TIME | ON SITE | COST PER DAY | DAYS ON CHARTER | TANK CLEANING AND TANK CLEANING SLOPS DISP. | BUNKER COST (IF NOT INCLUDED) | BASIC COST EST FOR CHARTER | OIL DISPOSAL 500K GALS | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MT | FT | FT | FT | | USD | USD | | | DAYS | DAYS | DAYS | DAYS | USD | DAYS | USD | USD | USD | USD | |
| 21 | **AMOUR – MANAGING DIRECTOR STEVEN SAINT<br>1997 ANNAPOLIS EXCHANGE PKWY SUITE 300<br>ANNAPOLIS, MD 21401<br>TEL: 001 410 533-3041<br>SSAINTAMOUR@ECLIPSE.US.COM** | | | | | | | | | | | 18 | 18 | 5 | 50 | 35000 | 91 | 250000 | 450000 | **3,960,000** | 75000 | THEIR FIRST PROPOSAL WAS HIGHER THAN THIS ONE |
| 22 | **OFFSHORE – EDISON CHOUEST<br>16201 EAST MAIN STREET<br>CUT OFF, LOUISIANA 70345-3804<br>TEL: 985-601-4444<br>KIRT CHOUEST<br>LOUISIANA** | OSV/PSV | | | | | | | | | USA GULF OF MEXICO | 33 | 33 | 10 | 50 | 25000 | 126 | 25000 | 900000 | **4,375,000** | 300000 | CONTACTED 04/20/18 VIA PHONE LEFT MESSAGE EMAIL TO GEORGE.BANOS@CHOUEST.COM PHONE TO LORELEI 832-251-6665. SPOKE TO KIRT CHOUEST WHO IS VERY INTERESTED IN THE CHALLENGE AND IS WORKING ON A PROPOSAL. FUEL EST $616280 BASED ON 11 MT/DAY AT 10 KNOTS. TRUCKS TO NO - 10K. SAVE $110,000. |
| 23 | **NRC – JOHN HIELSCHER<br>NRC 3500 SUNRISE HIGHWAY SUITE T-200 BUIDLING<br>200 GREAT RIVER , NEW YORK 11739-1001<br>TEL: 631 328 2524<br>EMAIL: JHIELSCHER@NRCC.COM** | | | | | | | | | | | | | | | | 0 | | | **0** | 0 | SEE SEPARATE PROPOSAL THAT INCLUDES OIL DISPOSAL. PROPOSAL INCLUDES THE USE OF TWO OSVS WITH INTERNAL TANKAGE AND DECK TANKS (ISO 9K TNAKS) TO MAKE UP THE MINUIMUM APPROX. 500K VOLUME. COST COLUMN INCLUDES DISPOSAL COST. |
| | **NOTES:** | 1. Place holder cost of $ 75,000 was added where the company proposals did not include oil disposal | | | | | | | | | | | | | | | | | | | | |

Figure C-3. Support Vessel Selection and Cost Estimate Summaries, Sheet 3 of 3

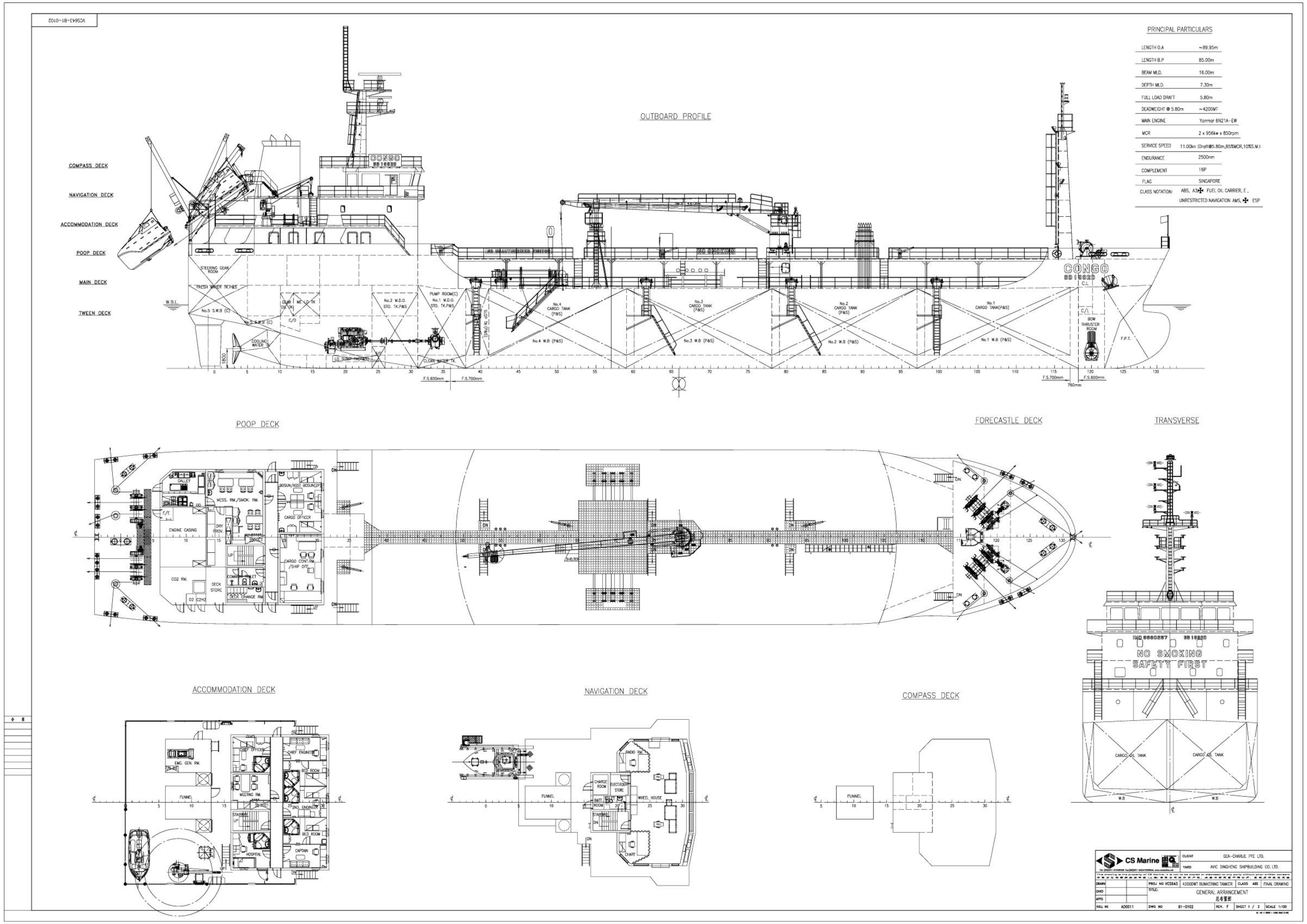

Figure C-4. MT *HUMBER* General Arrangement Sheet 1 of 2

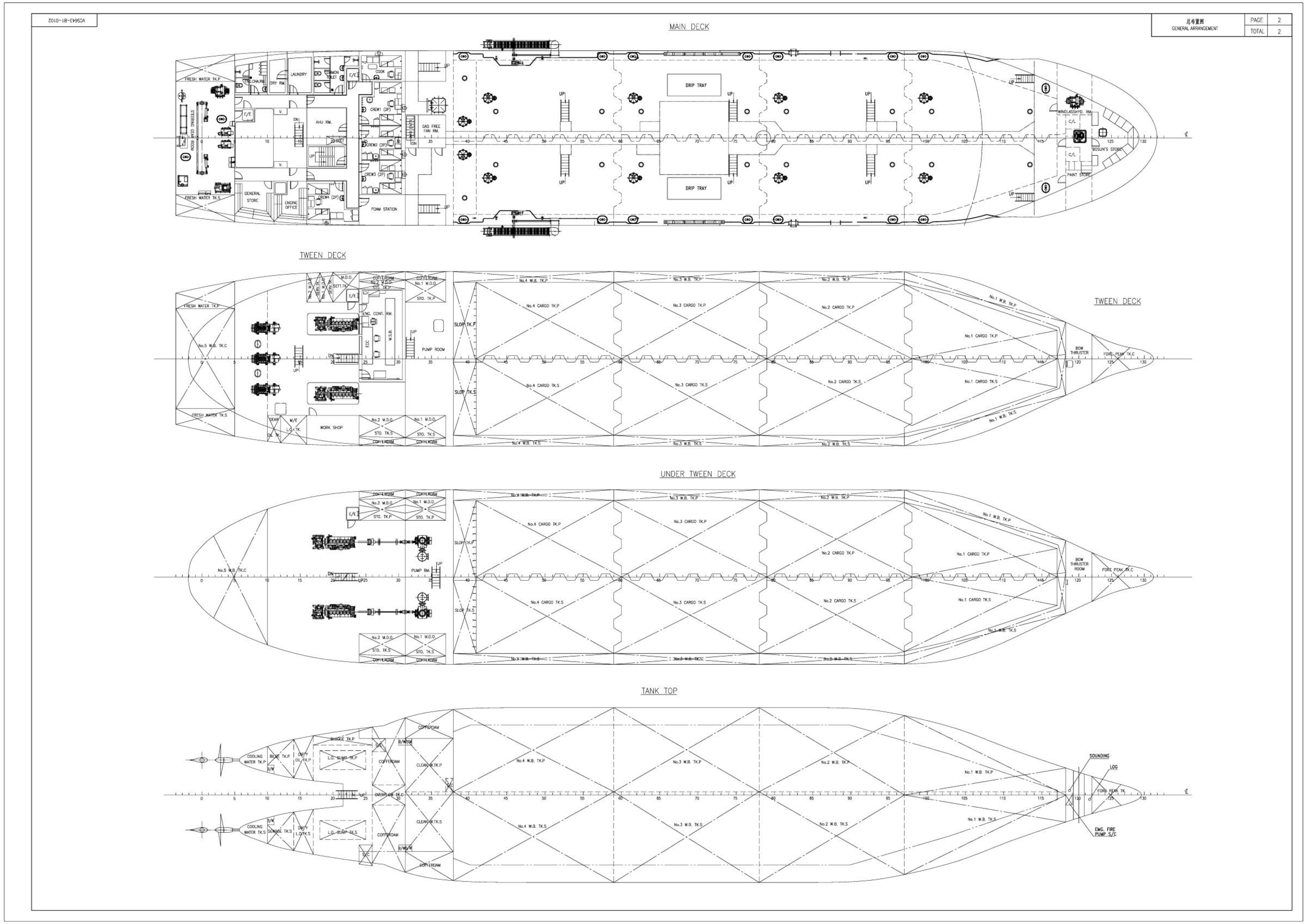


Figure C-5.  MT *HUMBER* General Arrangement Sheet 2 of 2

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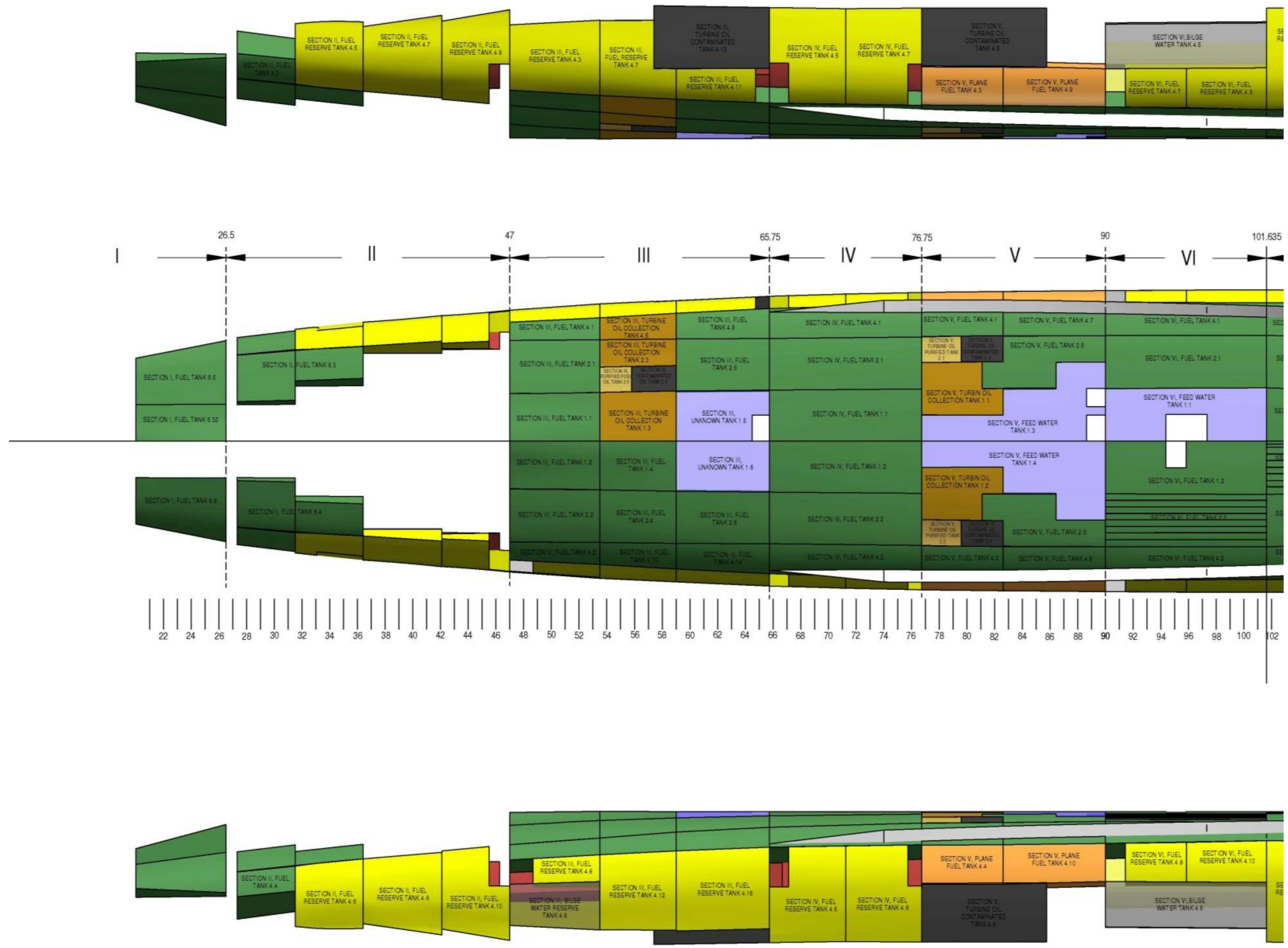
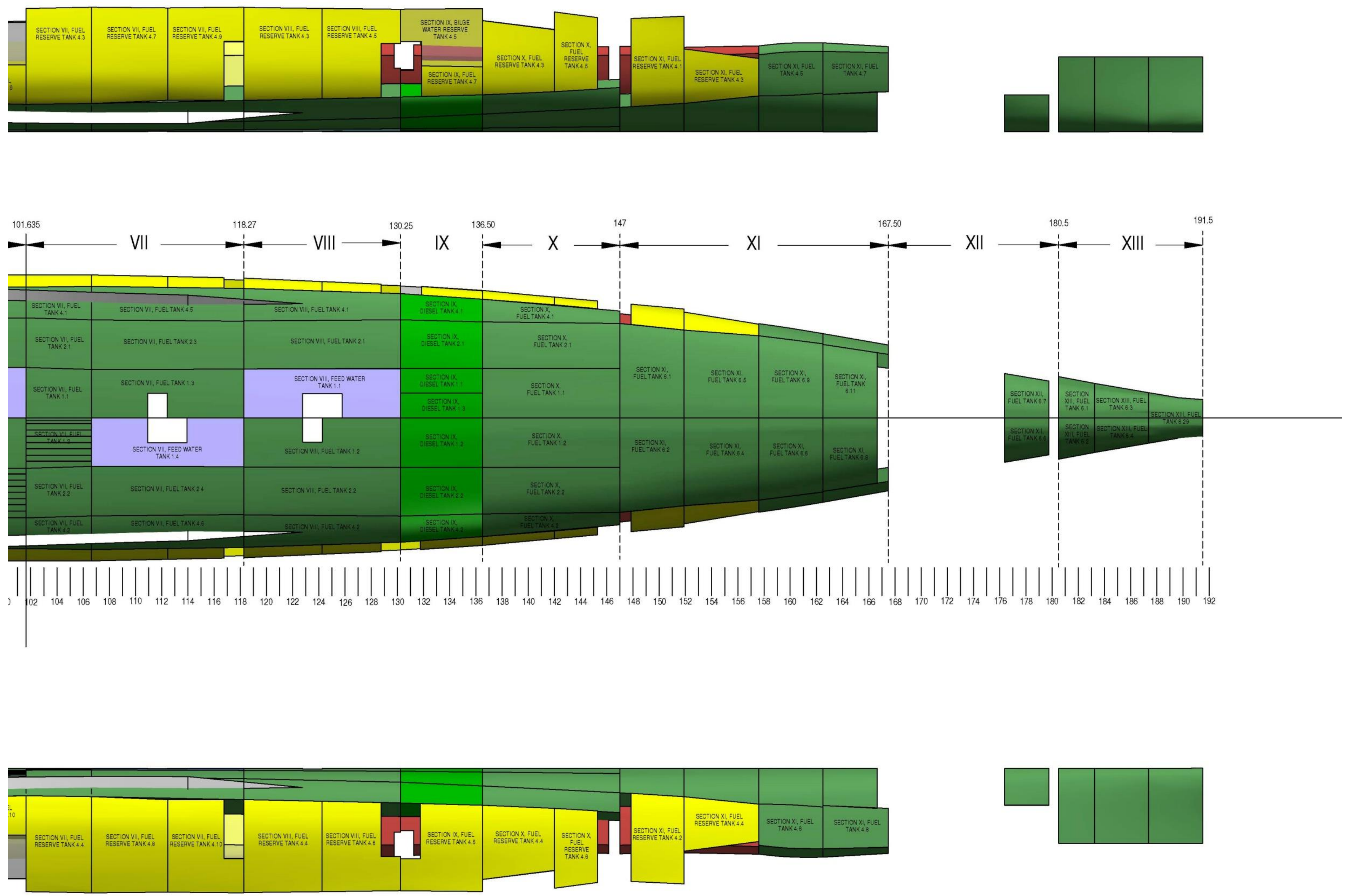
# APPENDIX D

## Appendix D – Graphical Images of Tank Locations




D-1. Ex-USS *PRINZ EUGEN* External Centerline (Green) and Wing Tank (Yellow) Sections I–VI




D-2. Ex-USS *PRINZ EUGEN* External Centerline (Green) and Wing Tank (Yellow) Sections VII–XIII

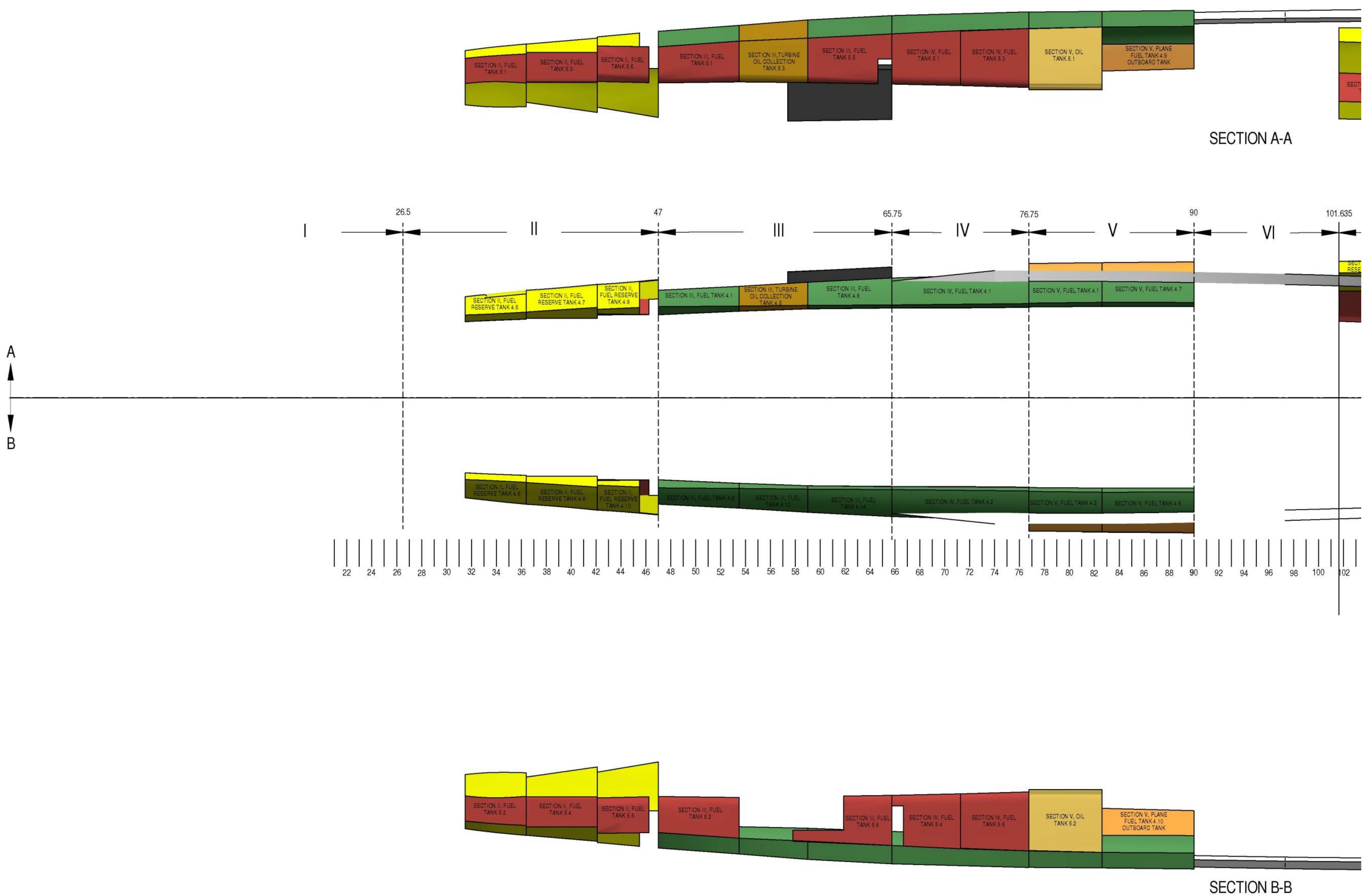



Figure D-3. Ex-USS *PRINZ EUGEN* Internal Tanks (Orange) Sections I–VII

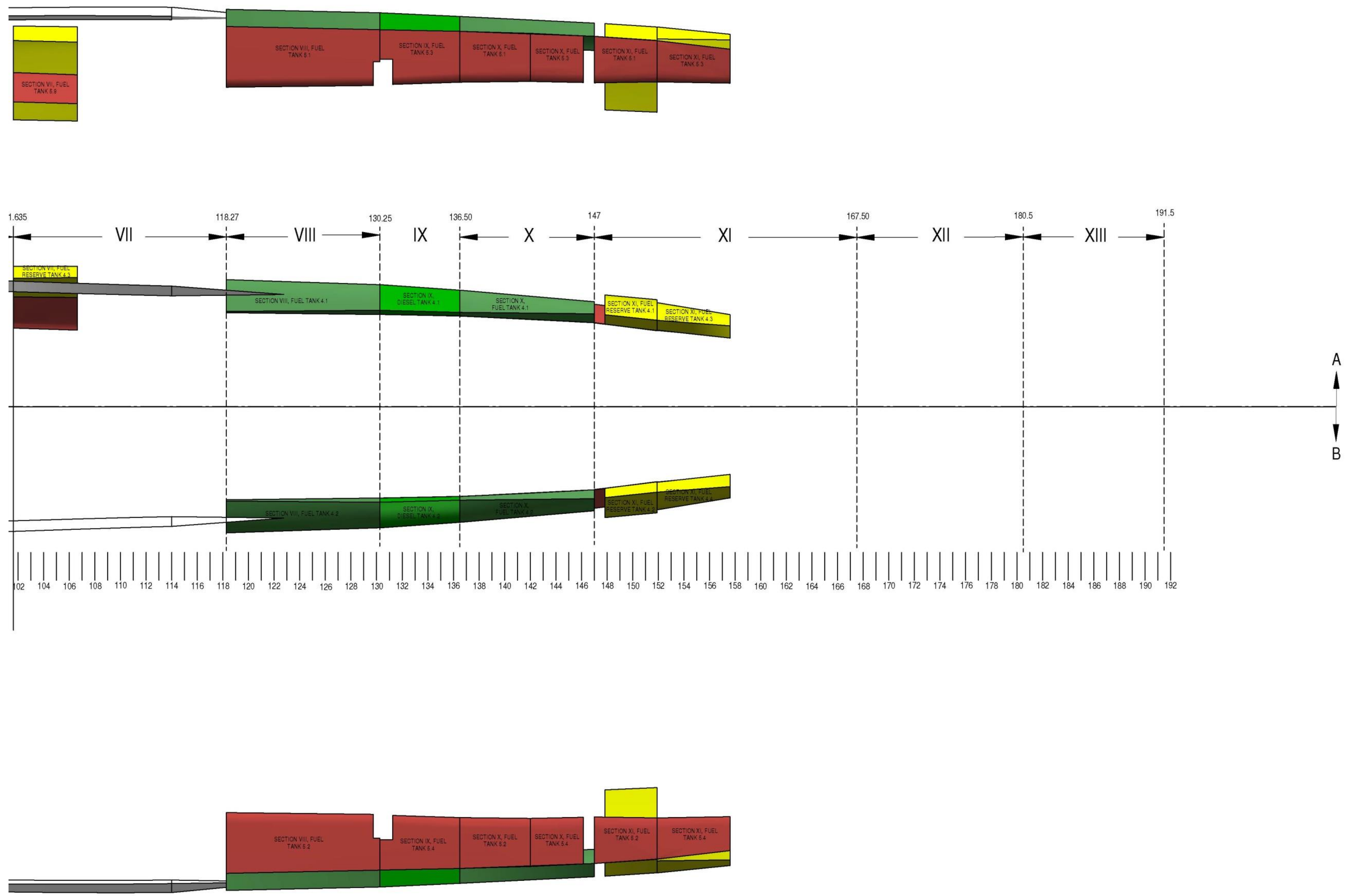



Figure D-4. Ex-USS *PRINZ EUGEN* Internal Tanks (Orange) Sections VII–XIII

# APPENDIX E

## Appendix E – Graphical Images of Grid Locations

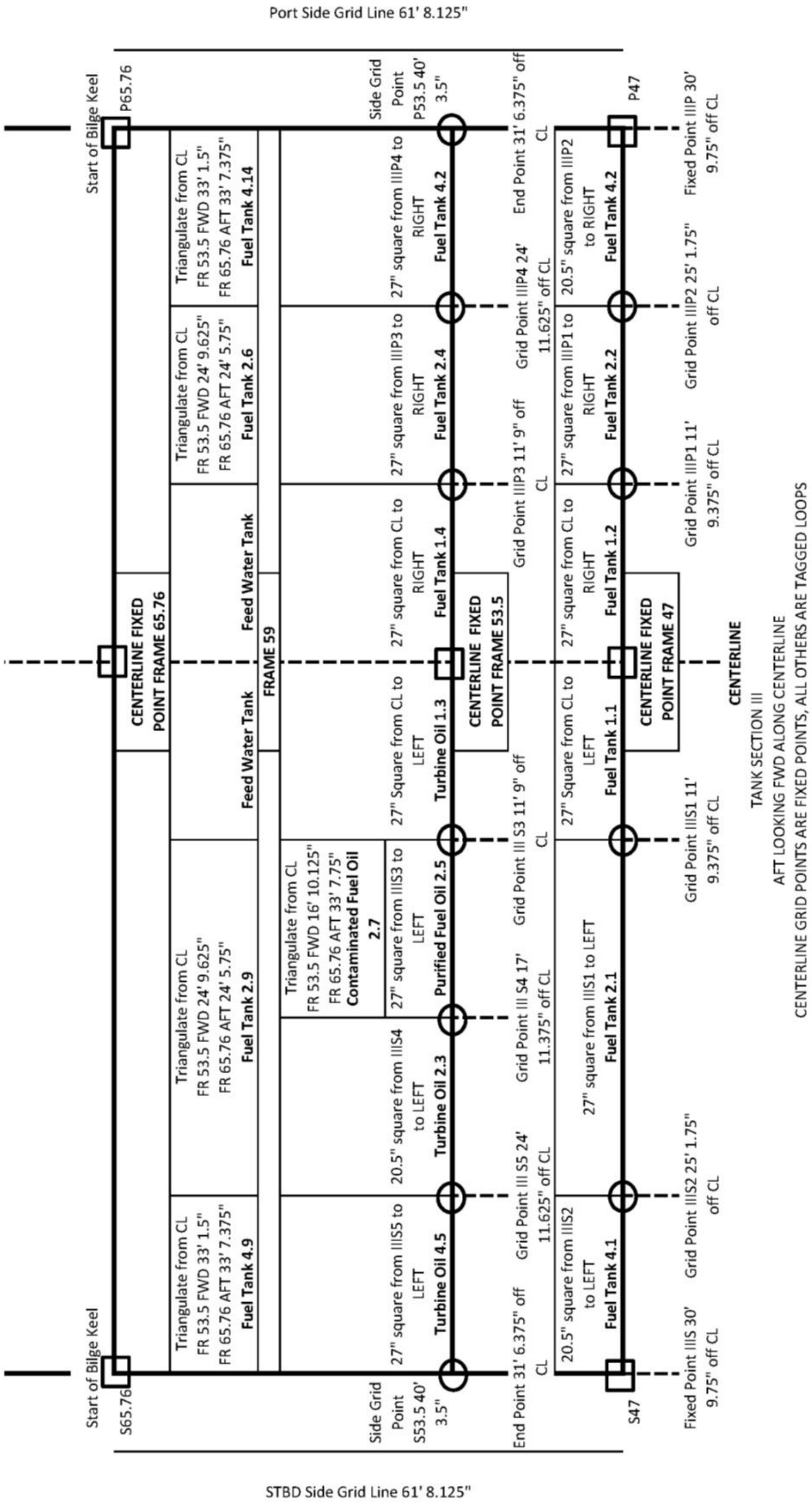



Figure E-1. Fuel Tanks Grid Line Locations - Section III Centerline Tanks

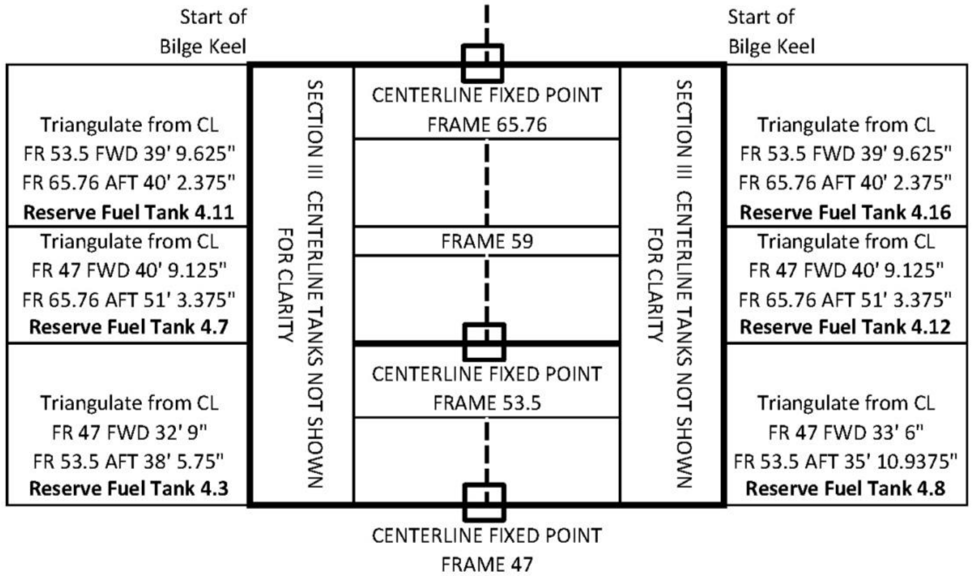



Figure E-2. Fuel Tanks Grid Line Locations - Section III Wing Tanks

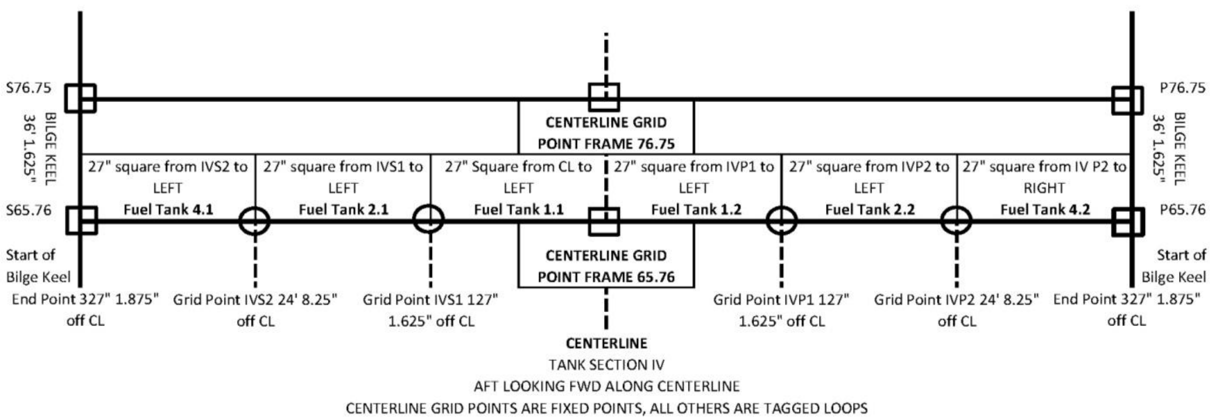



Figure E-3. Fuel Tanks Grid Line Locations - Section IV Centerline

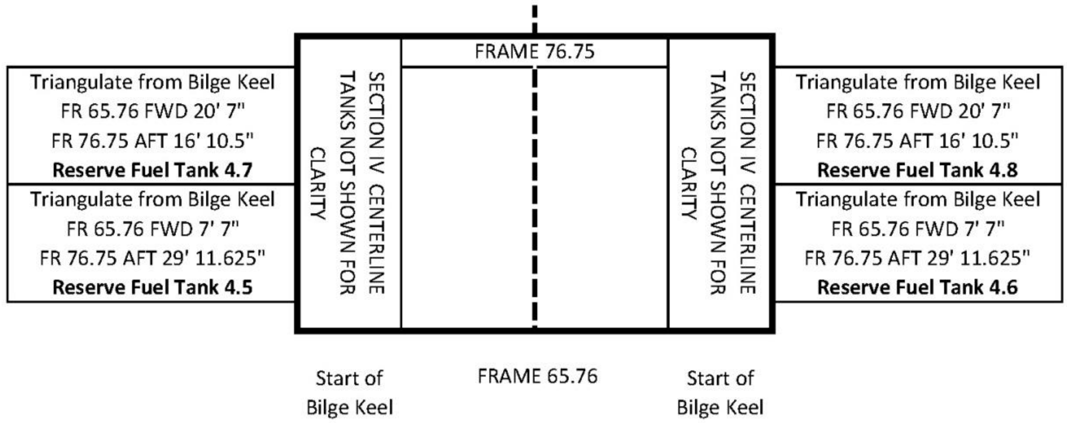



Figure E-4. Fuel Tanks Grid Line Locations - Section IV Wing Tanks

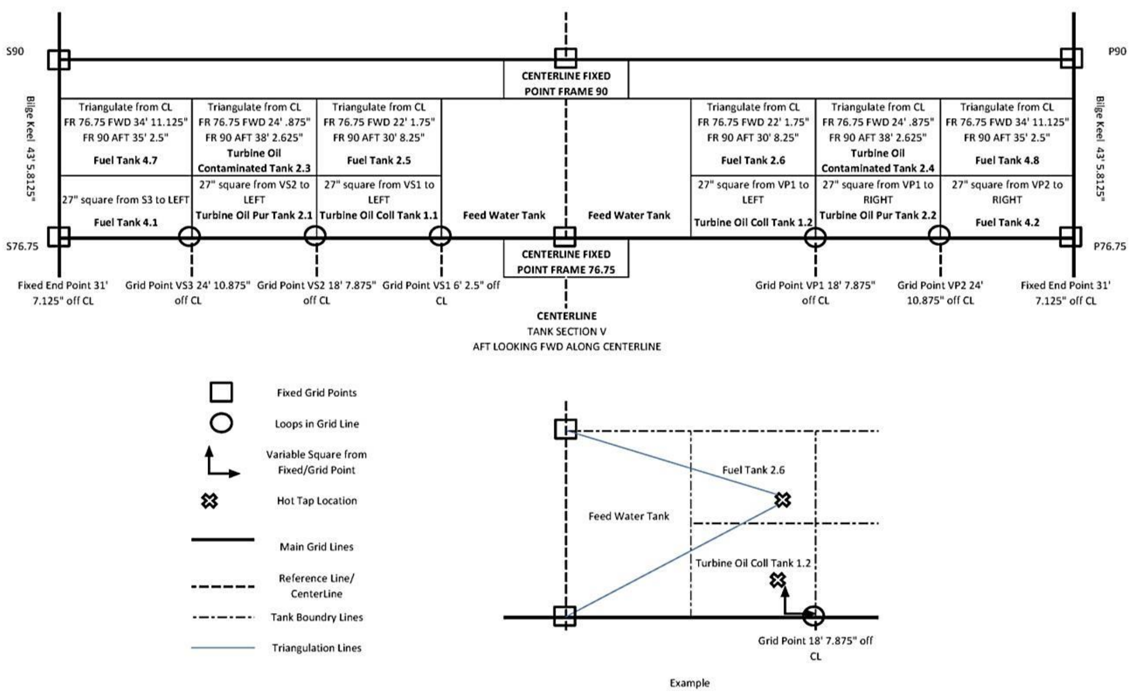



Figure E-5. Fuel Tanks Grid Line Locations - Section V Centerline

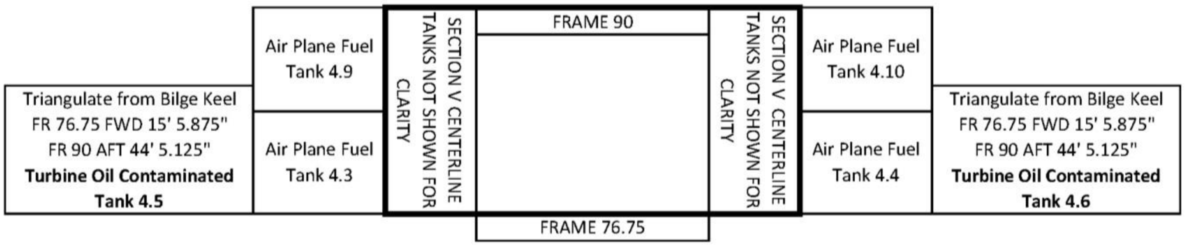



Figure E-6. Fuel Tanks Grid Line Locations - Section V Wing Tanks

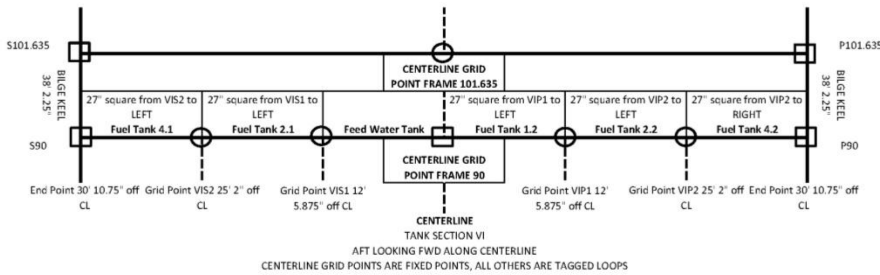



Figure E-7. Fuel Tanks Grid Line Locations - Section VI Centerline

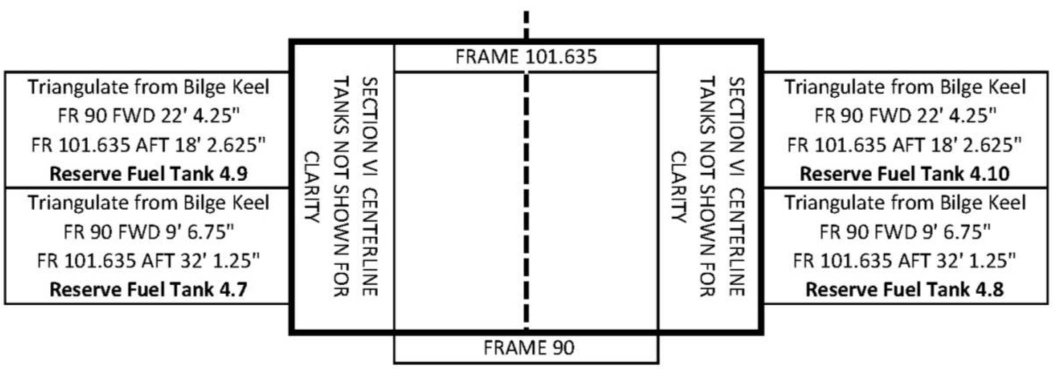



Figure E-8. Fuel Tanks Grid Line Locations - Section VI Wing Tanks

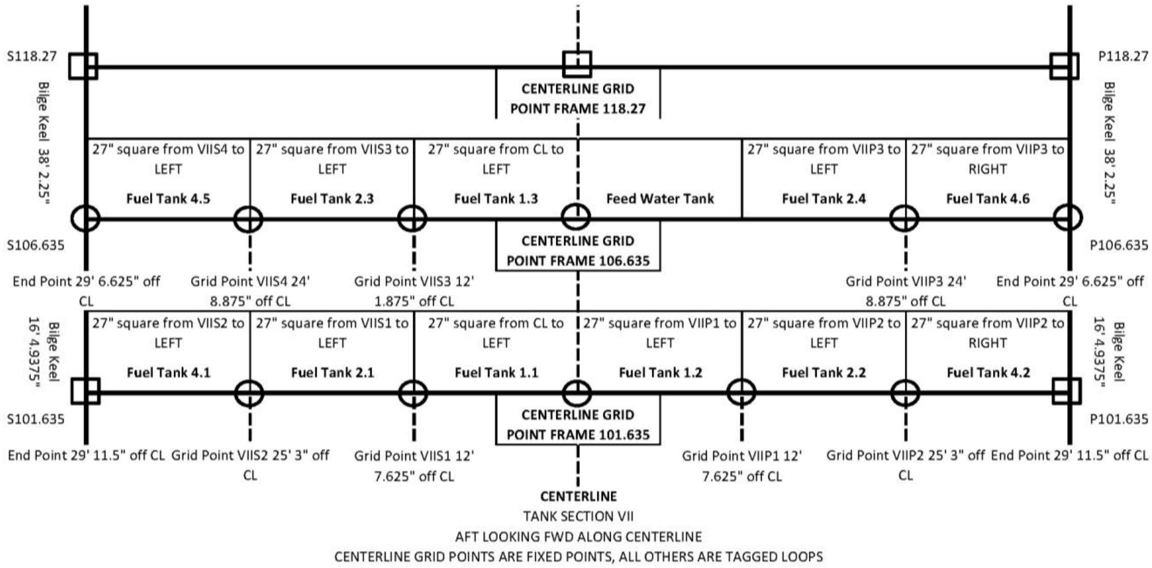



Figure E-9. Fuel Tanks Grid Line Locations - Section VII Centerline

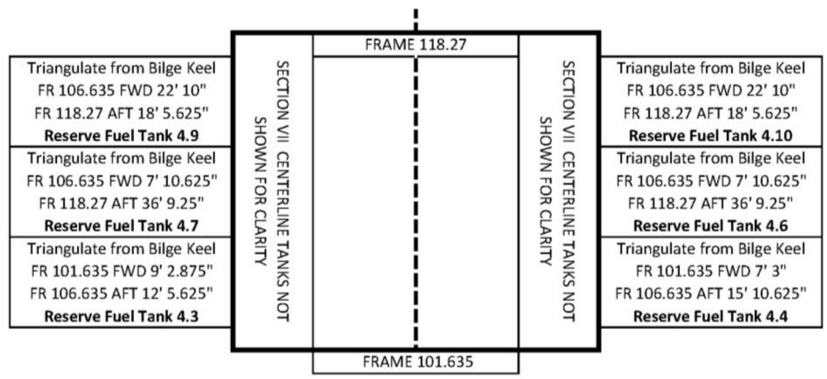



Figure E-10. Fuel Tanks Grid Line Locations - Section VII Wing Tanks

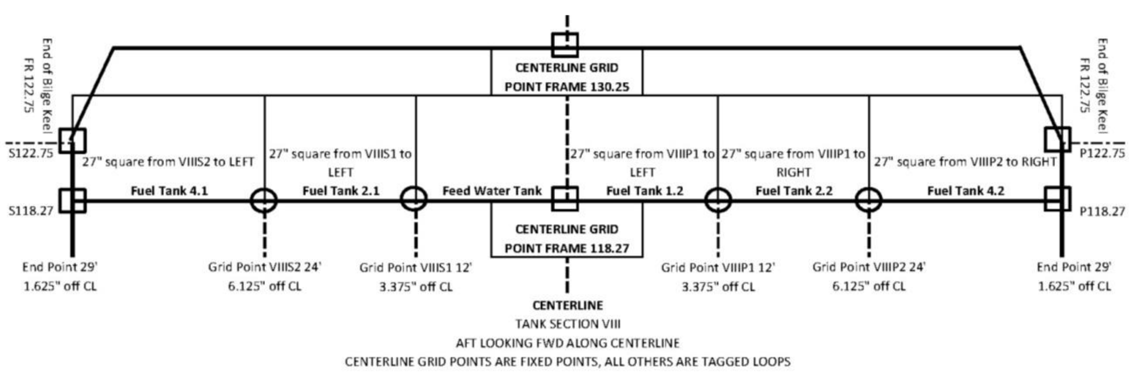



Figure E-11. Fuel Tanks Grid Line Locations - Section VIII Centerline

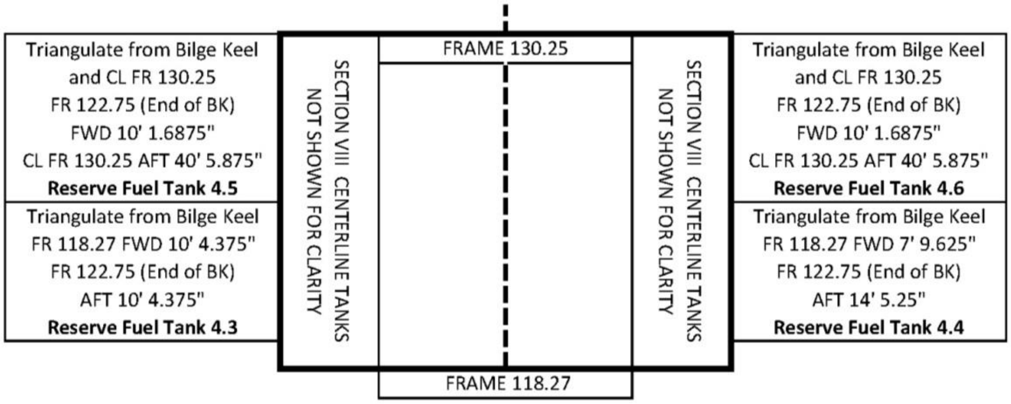



Figure E-12. Fuel Tanks Grid Line Locations - Section VIII Wing Tanks

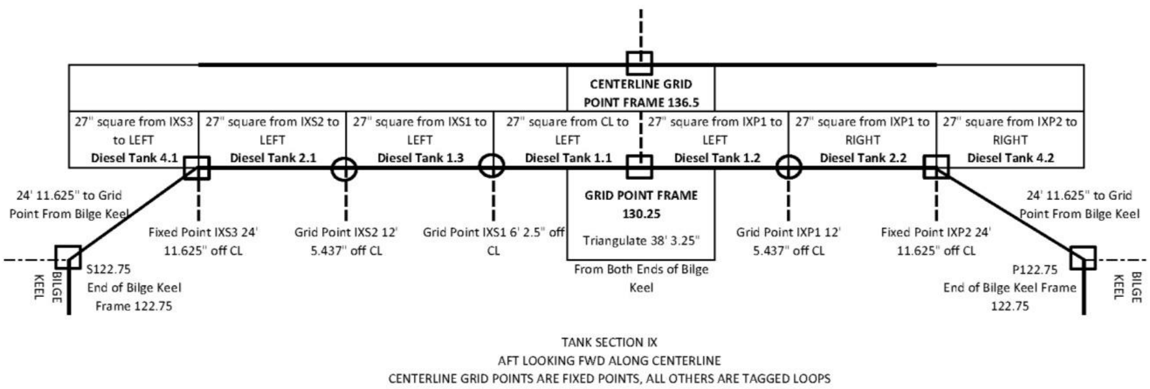



Figure E-13. Fuel Tanks Grid Line Locations - Section IX Centerline

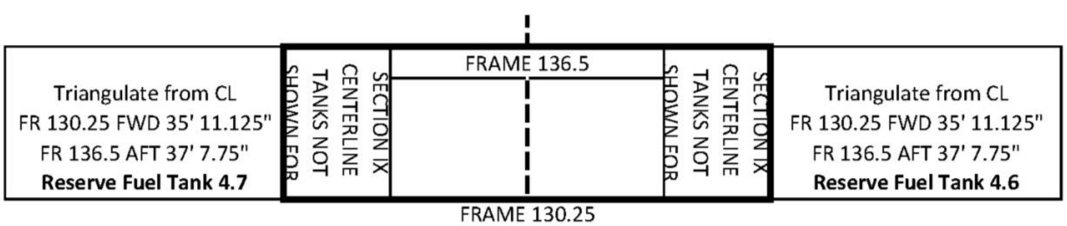



Figure E-14. Fuel Tanks Grid Line Locations - Section IX Wing Tanks

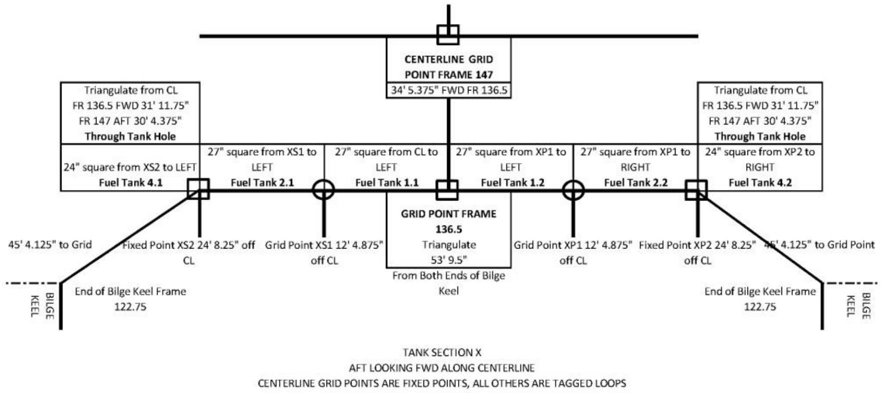



Figure E-15. Fuel Tanks Grid Line Locations - Section X Centerline

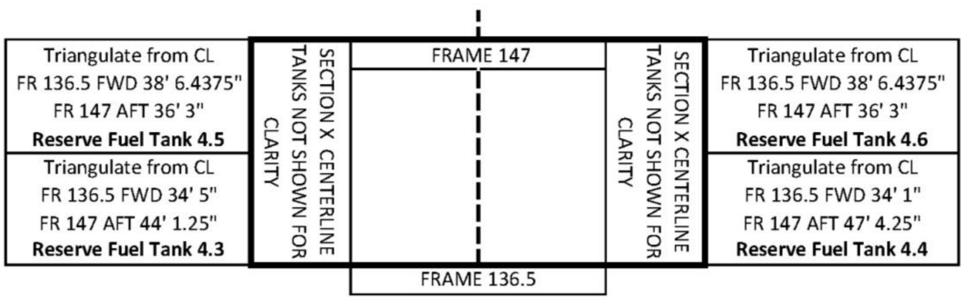



Figure E-16. Fuel Tanks Grid Line Locations - Section X Wing Tanks

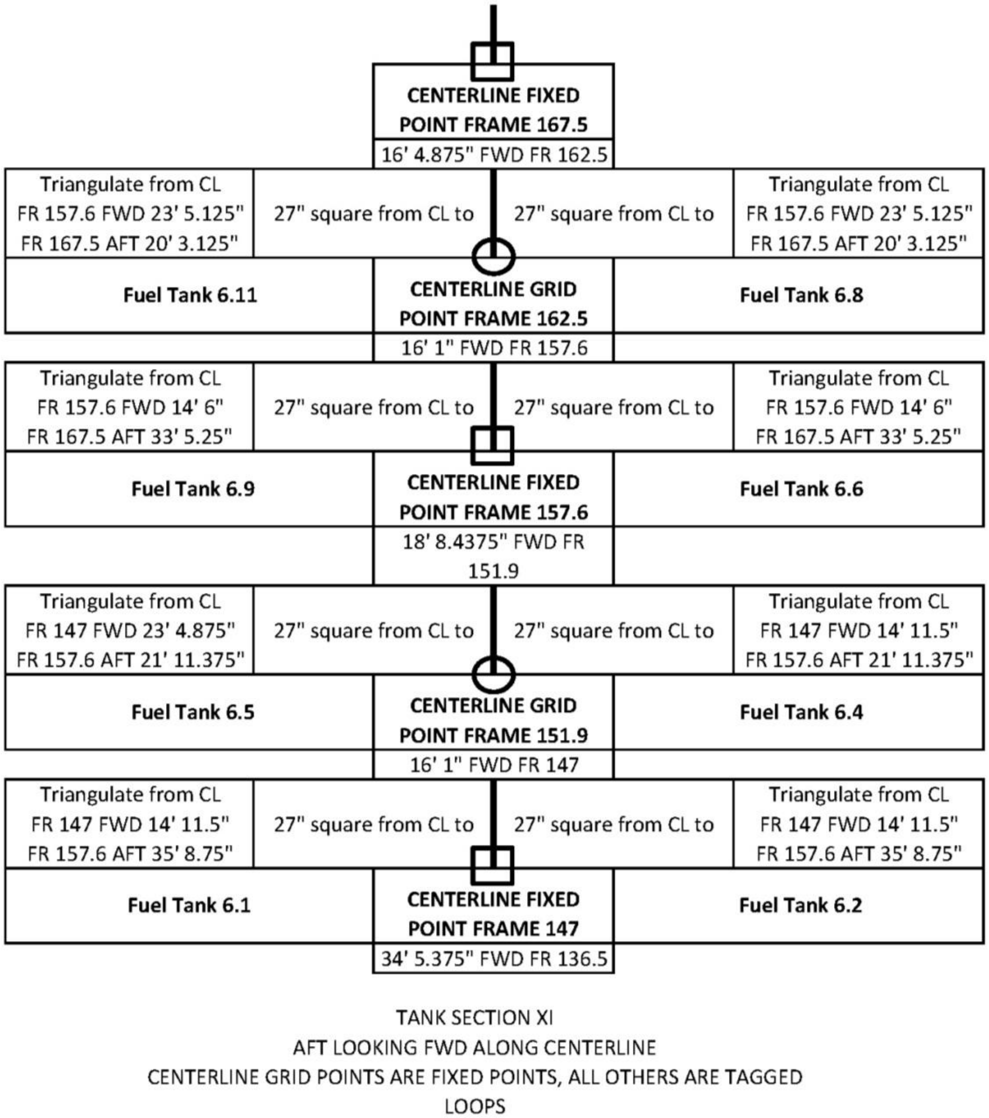



Figure E-17. Fuel Tanks Grid Line Locations - Section XI Centerline

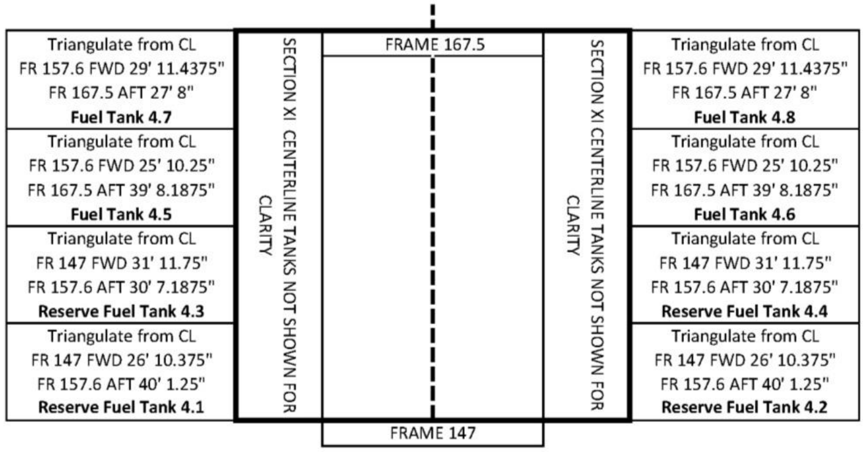



Figure E-18. Fuel Tanks Grid Line Locations - Section XI Wing Tanks

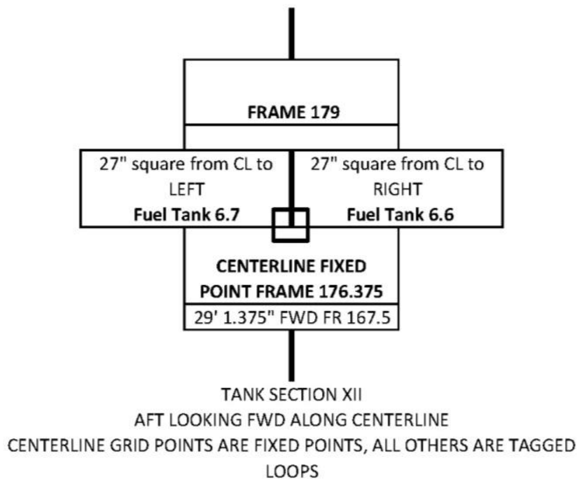



Figure E-19. Fuel Tanks Grid Line Locations - Section XII Centerline

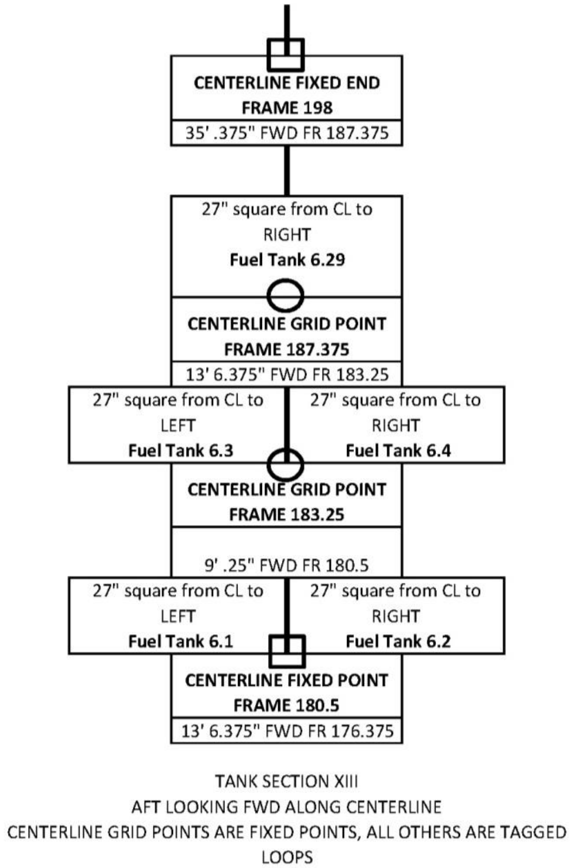



Figure E-20. Fuel Tanks Grid Line Locations - Section XIII Centerline

Table E-1. Tank Transverse Grid Lines - Tank Section III

| Tank Section III Tranverse Lines | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | yellow line, yellow tags | | | | RED Tag | white line, white tags | | |
| Total Distance both Sides | Labels | zip tie | IIIS5 | IIIS4 | IIIS3 | CL Frame 53.5 | IIIP3 | IIIP4 | zip tie |
| 34' | Distance from CL | 31' 6.375" | 24' 11.625" | 17' 11.375" | 11' 9" | CENTER | 11' 9" | 24' 11.625" | 31' 6.375" |
| | inches | 378.375 | 299.625 | 215.375 | 141 | | 141 | 299.625 | 378.375 |
| | | | | | | | | | |
| Tank Section III Tranverse Lines | | | | | | | | | |
| | | yellow line, yellow tags | | | | RED Tag | white line, white tags | | |
| Total Distance both Sides | Labels | Fixed IIIP | IIIS2 | | IIIS1 | CL Frame 47 | IIIP1 | IIIP2 | Fixed IIIS |
| 33' | Distance from CL | 30' 9.75" | 25' 1.75" | | 11' 9.375" | CENTER | 11' 9.375" | 25' 1.75" | 30' 9.75" |
| | inches | 369.75 | 301.75 | | 141.375 | | 141.375 | 301.75 | 369.75 |

Table E-2. Tank Transverse Grid Lines - Tank Section IV

| Tank Section IV Tranverse Lines | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | yellow line, yellow tags | | | RED Tag | white line, white tags | | |
| Total Distance both Sides | Labels | zip tie | IVS2 | IVS1 | CL Frame 65.76 | IVP1 | IVP2 | zip tie |
| 35' | Distance from CL | 32' 1.875" | 24' 8.25" | 12' 1.625" | CENTER | 12' 1.625" | 24' 8.25" | 32' 1.875" |
| | inches | 385.875 | 296.25 | 145.625 | | 145.625 | 296.25 | 385.875 |

Table E-3. Tank Transverse Grid Lines - Tank Section V

| Tank Section V Tranverse Lines | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | yellow line, yellow tags | | | | RED Tag | white line, white tags | | |
| Total Distance both Sides | Labels | zip tie | VS3 | VS2 | VS1 | CL Frame 76.75 | VP1 | VP2 | zip tie |
| 34' | Distance from CL | 31' 7.125" | 24' 10.875" | 18' 7.875" | 6' 2.5" | CENTER | 18' 7.875" | 24' 10.875" | 31' 7.125" |
| | inches | 379.125 | 298.875 | 223.875 | 74.5 | | 223.875 | 298.875 | 379.125 |

Table E-4. Tank Transverse Grid Lines - Tank Section VI

| Tank Section VI Tranverse Lines | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | yellow line, yellow tags | | | RED Tag | white line, white tags | | |
| Total Distance both Sides | Labels | zip tie | VIS2 | VIS1 | CL Frame 90 | VIP1 | VIP2 | zip tie |
| 33' | Distance from CL | 30' 10.75" | 25' 2" | 12' 5.875" | CENTER | 12' 5.875" | 25' 2" | 30' 10.75" |
| | inches | 370.75 | 302 | 149.875 | | 149.875 | 302 | 370.75 |

Table E-5. Tank Transverse Grid Lines - Tank Section VII

| Tank Section VII Tranverse Lines | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | yellow line, yellow tags | | | RED Tag | white line, white tags | | |
| Total Distance both Sides | Labels | zip tie | VIIS4 | VIIS3 | CL Frame 106.635 | | VIIP3 | zip tie |
| 32' | Distance from CL | 29' 6.625" | 24' 8.875" | 12' 1.875" | CENTER | | 24' 8.875" | 29' 6.625" |
| | inches | 354.625 | 296.875 | 145.875 | | | 296.875 | 354.625 |

| Tank Section VII Tranverse Lines | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | yellow line, yellow tags | | | RED Tag | white line, white tags | | |
| Total Distance both Sides | Labels | zip tie | VIIS2 | VIIS1 | CL Frame 101.635 | VIIP1 | VIIP2 | zip tie |
| 32' | Distance from CL | 29' 11.5" | 25' 3" | 12' 7.625" | CENTER | 12' 7.625" | 25' 3" | 29' 11.5" |
| | inches | 359.5 | 303 | 151.625 | | 151.625 | 303 | 359.5 |

Table E-6. Tank Transverse Grid Lines - Tank Section VIII

| Tank Section VIII Tranverse Lines | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | yellow line, yellow tags | | | RED Tag | white line, white tags | | |
| Total Distance both Sides | Labels | zip tie | VIIIS2 | VIIIS1 | CL Frame 118.27 | VIIIP1 | VIIIP2 | zip tie |
| 32' | Distance from CL | 29' 1.625" | 24' 6.125" | 12' 3.375" | CENTER | 12' 3.375" | 24' 6.125" | 29' 1.625" |
| | inches | 349.625 | 302 | 147.375 | | 147.375 | 302 | 349.625 |

Table E-7. Tank Transverse Grid Lines - Tank Section IX

| Tank Section IX Tranverse Lines | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | yellow line, yellow tags | | | RED Tag | white line, white tags | | |
| Total Distance both Sides | Labels | FIXED IXS3 | IXS2 | IXS1 | CL Frame 130.25 | | IXP1 | FIXED IXP2 |
| 27' | Distance from CL | 24' 11.625" | 12' 5.437" | 6' 2.5" | CENTER | | 12' 5.437" | 24' 11.625" |
| | inches | 299.625 | 149.437 | 74.5 | | | 149.437 | 299.625 |

Table E-8. Tank Transverse Grid Lines - Tank Section X

| Tank Section X Tranverse Lines | | | | | | |
|---|---|---|---|---|---|---|
| | | yellow line, yellow tags | | RED Tag | white line, white tags | |
| Total Distance both Sides | Labels | FIXED XS2 | XS1 | CL Frame 136.5 | XP1 | FIXED XP2 |
| 27' | Distance from CL | 24' 8.25" | 12' 4.875" | CENTER | 12' 4.875" | 24' 8.25" |
| | inches | 296.25 | 148.875 | | 148.875 | 296.25 |

Table E-9. Tank Triangulation Lines - Tank Section III

| Tank Section III | | |
|---|---|---|
| Triangulation Line Dimensions | | |
| Tank Type/# | Frame | Distance |
| Contaminated Fuel Oil 2.7 | Fr 53.5 | 16' 10.125" |
| | Fr 65.76 | 33' 7.75" |
| Fuel Tank 2.9/2.6 | Fr 53.5 | 24' 9.625" |
| | Fr 65.76 | 24' 5.75" |
| Fuel Tank 4.9/4.14 | Fr 53.5 | 33' 1.5" |
| | Fr 65.76 | 33' 7.375" |
| | | |
| Side Tanks | | |
| | | |
| Res Fuel Tank 4.3 | Fr 47 | 32' 9" |
| | Fr 53.5 | 38' 5.75" |
| Res Fuel Tank 4.8 | Fr 47 | 33' 6" |
| | Fr 53.5 | 35' 10.9375" |
| Res Fuel Tank 4.7/4.12 | Fr 47 | 40' 9.125" |
| | Fr 65.76 | 51' 3.375" |
| Res Fuel Tank 4.11/4.16 | Fr 53.5 | 39' 9.625" |
| | Fr 65.76 | 40' 2.375" |
| | | |
| Locations | Start | Distance |
| CL Fixed Frame 47 | Fr 65.76 Bilge Keel | 69' 3.375" |
| | Fr 65.76 Bilge Keel | 69' 3.375" |
| Fixed Point IIIP | Fr 65.76 Port Bilge Keel | 61' 8.25" |
| End Point Fr 53.3 | Fr 53.3 | 40' 3.625" |
| | | |
| Fixed Point IIIS | Fr 65.76 Stbd Bilge Keel | 61' 8.25" |
| End Point Fr 53.3 | Fr 53.3 | 40' 3.625" |
| | | |

Table E-10. Tank Triangulation Lines - Tank Section IV Side Tanks

| Tank Section IV | | |
|---|---|---|
| Triangulation Line Dimensions | | |
| Tank Type/# | Frame | Distance |
| Side Tanks | | |
| | | |
| Res Fuel Tank 4.5/4.6 | Fr 65.76 | 7' 7" |
| | Fr 76.75 | 29' 11.625" |
| Res Fuel Tank 4.7/4.8 | Fr 65.76 | 20' 7" |
| | Fr 76.75 | 16' 10.5" |

Table E-11. Tank Triangulation Lines - Tank Section V

| Tank Section V | | |
|---|---|---|
| Triangulation Line Dimensions | | |
| Tank Type/# | Frame | Distance |
| Fuel Tank 2.5/2.6 | Fr 76.75 | 22' 1.75" |
| | Fr 90 | 30' 8.25" |
| Contaminated Turb Oil Tank 2.3/2.4 | Fr 76.75 | 24' .875" |
| | Fr 90 | 38' 2.625" |
| Fuel Tank 4.7/4.8 | Fr 76.75 | 34' 11.125" |
| | Fr 90 | 35' 2.5" |

Table E-12. Tank Triangulation Lines - Tank Section V Side Tanks

| Tank Section V | | |
|---|---|---|
| Triangulation Line Dimensions | | |
| Tank Type/# | Frame | Distance |
| Side Tanks | | |
| | | |
| Turbine Oil Contaminated Tank 4.5/4.6 | Fr 76.75 | 15' 5.875" |
| | Fr 90 | 44' 5.125" |

Table E-13. Tank Triangulation Lines - Tank Section VI Side Tanks

| Tank Section VI | | |
|---|---|---|
| Triangulation Line Dimensions | | |
| Tank Type/# | Frame | Distance |
| Side Tanks | | |
| | | |
| Res Fuel Tank 4.7/4.8 | Fr 90 | 9' 6.75" |
| | Fr 101.635 | 32' 1.25" |
| Res Fuel Tank 4.9/4.10 | Fr 90 | 22' 4.25" |
| | Fr 101.635 | 18' 2.625" |

Table E-14. Tank Triangulation Lines - Tank Section VII Side Tanks

| Tank Section VII | | |
|---|---|---|
| Triangulation Line Dimensions | | |
| Tank Type/# | Frame | Distance |
| Side Tanks | | |
| | | |
| Res Fuel Tank 4.9/4.10 | Fr 118.27 | 18' 5.625" |
| | Fr 106.635 | 22' 10" |
| Res Fuel Tank 4.7/4.6 | Fr 118.27 | 36' 9.25" |
| | Fr 106.635 | 7' 10.625" |
| Res Fuel Tank 4.4 | Fr 106.635 | 15' 10.625" |
| | Fr 101.635 | 7' 3" |
| Res Fuel Tank 4.3 | Fr 106.635 | 12' 5.625" |
| | Fr 101.635 | 9' 2.875" |

Table E-15. Tank Triangulation Lines - Tank Section VIII Side Tanks

| Tank Section VIII | | |
|---|---|---|
| Triangulation Line Dimensions | | |
| Tank Type/# | Frame | Distance |
| Side Tanks | | |
| | | |
| Res Fuel Tank 4.5/4.6 | Fr 122.75 End of Bilge Keel | 10' 1.6875" |
| | Fr 130.25 CL | 40' 5.875" |
| Res Fuel Tank 4.4 | Fr 122.75 End of Bilge Keel | 14' 5.25" |
| | Fr 118.27 | 7' 9.625" |
| Res Fuel Tank 4.3 | Fr 122.75 End of Bilge keel | 10' 4.375" |
| | Fr 118.27 | 10' 4.375" |

Table E-16. Tank Triangulation Lines - Tank Section IX

| Tank Section IX | | |
|---|---|---|
| Triangulation Line Dimensions | | |
| Tank Type/# | Frame | Distance |
| Side Tanks | | |
| | | |
| Res Fuel Tank 4.7/4.6 | Fr 130.25 | 35' 11.125" |
| | Fr 136.5 | 37' 7.75" |
| | | |
| Locations | Start | Distance |
| CL Fixed Frame 130.25 | Fr 122.75 Bilge Keel | 38' 3.25" |
| | Fr 122.75 Bilge Keel | 38' 3.25" |
| Fixed Point IXP2 | Fr 122.75 Port Bilge Keel | 24' 11.625" |
| | | |
| Fixed Point IXS3 | Fr 122.75 Stbd Bilge Keel | 24' 11.625" |
| | | |

Table E-17. Tank Triangulation Lines - Tank Section X

| Tank Section X | | |
|---|---|---|
| Triangulation Line Dimensions | | |
| Tank Type/# | Frame | Distance |
| Through Tank Hole P/S | Fr 136.5 | 31' 11.75" |
| | Fr 147 | 30' 4.375" |
| | | |
| Side Tanks | | |
| | | |
| Res Fuel Tank 4.3 | Fr 136.5 | 34' 5" |
| | Fr 147 | 44' 1.25" |
| Res Fuel Tank 4.4 | Fr 136.5 | 34' 1" |
| | Fr 147 | 47' 4.25" |
| Res Fuel Tank 4.5/4.6 | Fr 136.5 | 38' 6.4375" |
| | Fr 147 | 36' 3" |
| | | |
| Location | Start | Distance |
| CL Fixed Frame 136.5 | Fr 122.75 Bilge Keel | 53' 9.5" |
| | Fr 122.75 Bilge Keel | 53' 9.5" |
| Fixed Point XP2 | Fr 122.75 Port Bilge Keel | 45' 4.125" |
| | | |
| Fixed Point XS3 | Fr 122.75 Stbd Bilge Keel | 45' 4.125" |
| | | |

Table E-18. Tank Triangulation Lines - Tank Section XI

| Tank Section XI | | |
|---|---|---|
| Triangulation Line Dimensions | | |
| Tank Type/# | Frame | Distance |
| Fuel Tank 6.1/6.2 | Fr 147 | 14' 11.5" |
| | Fr 157.6 | 35' 8.75" |
| Fuel Tank 6.5/6.4 | Fr 147 | 23' 4.875" |
| | Fr 157.6 | 21' 11.375" |
| Fuel Tank 6.9/6.6 | Fr 157.6 | 14' 6" |
| | Fr 167.5 | 33' 5.25" |
| Fuel Tank 6.11/6.8 | Fr 157.6 | 23' 5.125" |
| | Fr 167.5 | 20' 3.125" |
| | | |
| Side Tanks | | |
| | | |
| Res Fuel Tank 4.1/4.2 | Fr 147 | 26' 10.375" |
| | Fr 157.6 | 40' 1.25" |
| Res Fuel Tank 4.3/4.4 | Fr 147 | 31' 11.75" |
| | Fr 157.6 | 30' 7.1875" |
| Res Fuel Tank 4.5/4.6 | Fr 157.6 | 25' 10.25" |
| | Fr 167.5 | 39' 8.1875" |
| Res Fuel Tank 4.7/4.8 | Fr 157.6 | 29' 11.4375" |
| | Fr 167.5 | 27' 8" |

Centerline Tank Maybe subdivided

Table E-19. Tank Triangulation Lines - Centerline from Section XI to XIII

| Centerline from Section XI to XIII | | |
|---|---|---|
| Location | Start | Distance |
| CL Fixed Frame 147 | Fr 122.75 Bilge Keel | 87' 9.25" |
| | Fr 122.75 Bilge Keel | 87' 9.25" |
| | | |
| Centerline Grid Line | | |
| CL Fixed Frame 147 | Start | 0 |
| CL Frame 151.9 | FR 147 | 16' 1" |
| CL Fixed Frame 157.6 | FR 151.9 | 18' 8.4375" |
| CL Frame 162.5 | FR 157.6 | 16' 1" |
| CL Fixed Frame 167.5 | FR 162.5 | 16' 4.875" |
| CL Fixed Frame 176.375 | FR 167.5 | 29' 1.375" |
| CL Fixed Frame 180.5 | FR 176.375 | 13' 6.375" |
| CL Frame 183.25 | FR 180.5 | 9' .25" |
| CL Frame 187.375 | FR 183.25 | 13' 6.375" |
| CL Fixed Frame 198 | FR 187.375 | 35' .375" |

## APPENDIX F

### Appendix F – Definitions

**Bad Mousse Tank** Tank VIII 4.2: This tank had a large amount of mousse in the bottom which created a challenge for the pumping team therefore it was labeled a "Bad Mousse Tank".

**Centerline Tanks** Tanks physically located in the bottom of the vessel extending fore and aft and laterally port and starboard to the bilge keel (although some actually run under the bilge keel and share a bulkhead with the wing tanks).

**Coupon** The round section of metal cut out when using a hot tap hole saw and referred to on the job as a "biscuit" or a "puck" (it is about the same size and shape of a breakfast biscuit or hockey puck). Usually the coupon is either retained by the retaining pin integrated in the pilot drill bit, but sometimes it drops out to the bottom of the tank or if there is a frame or a pipe directly behind the hole being cut, then the coupon may get wedged.

**Coupon Removal Tool** Long piece of aluminum pipe with a blunt end sized to fit in the hot tap hole through a packing gland with the purpose of banging (acting as a large punch) to free a wedged coupon. Also referred to as a Biscuit Banger.

**Drunken Sailor** Tank XI 6.2: The tank pressure and flow rate repeatedly climbed up and down throughout the operation, reminiscent of the unstable meanderings of a drunken sailor.

**LPO** Low Percentage Oil. The acronym LPO is used to describe a pumping or stripping phenomenon where only small percentages of oil, but large percentages of water, were being taken up by the pump system. Generally used when oil recovery dropped to single-digit percentages.

**Mousse** A dark brown or black water-in-oil emulsion. The term was coined during SUPSALV's Exxon Valdez Oil Spill Recovery Operation to describe crude oil and water emulsions that were formulated in heavy wave action and increased the viscosity of the oil to something that was difficult to pump without using special equipment.

**Pump Through Vent Tube** This tool was also referred to as the PKS (Paul K Schadow) vent tube (or just vent tube). The purpose was to have a simple device that could be inserted into a tank through the hot tap hole, and allow the ingress of seawater to displace oil (used as a vent). Seawater needed to be able to flow into the tank as the oil was pulled off the highpoint outlet with the pump suction. Without this device, the pump could not pull oil out of many tanks because they were in a vacuum pressure situation with no way to displace the oil that needed to be removed. The vent tube was smaller in diameter than the hot tap hole and was inserted through the top of the T-connection and ball valve and extended into the tank beneath the oil level in the tank. The tube had a packing gland at the connection point with the valve to prevent leaking and allowed oil to flow around it, and up and out of the tank into the side of the T-connection where the suction hose was connected while seawater could be drawn down into the tube from an open valve on top of the tube, displacing the oil in the tank.

**Stinger with Mosquito Tool** An approximate 4 1/2′ long, 2″ diameter, aluminum tube with a reinforced area and suction screen on one end and a camlock fitting with an adaptor fitted to a 2″ suction hose on the other end. The screened, reinforced end was used to punch a hole into the thin metal of a degraded tank that was too severely corroded to be hot tapped. Once a hole was successfully punched through the tank, the pump was activated and the oil was recovered out through the hole. Also referred to as a Pump Wand.

**Tight Tank** This was used to refer to a tank that was not well vented. In many of the tanks the original vents had been damaged or plugged with marine growth. If this was the case it meant that they no longer had free flow transmission with the surrounding seawater. Oil could not be pumped from a tight tank without venting. These tanks were handled by:

a. Drilling small vent holes in the tank below the oil line to allow seawater to flow into the tank naturally.
b. Inserting the makeshift vent tube known as the Schadow Device.

**Tire Pump** This used the same SCR4 pump set inside a large tire so that it could float on the surface next to the tanker vessel. The Tire Pump used a long suction hose to pull oil from the tank below. This pumps' arrangement was only used for a short time during the operation and did not seem to present an obvious advantage.

**Wing Tanks** Tanks physically located on and in the side walls of the vessel, as opposed to the bottom of the vessel.

# APPENDIX G

## Appendix G – Equipment Loadout Tables

The tables below present the equipment and materials needed to support the operation that were identified, collected, assembled, sorted and stowed in vans or other containers for loadout/shipment to Kwajalein. The tables are not comprehensive, but provide a set of lists that encompass much of the major equipment shipped to Kwajalein.

Table G-1. Equipment Containers Shipping to Kwajalein 10 July 2018

| ITEM | CONTAINER DESCRIPTION | ESSM SOURCE LOCATION | USNU NUMBER | WEIGHT (LB) | GENERAL CONTENTS |
|---|---|---|---|---|---|
| 1 | HOSE VAN, VA0018-008673 | WILLIAMSBURG, VA | USNU000 071-2 | 16,800 | 4" RUBBER HOSES AND ALUMINUM MANIFOLDS |
| 2 | HOT TAP VAN, VA0018-033008 | WILLIAMSBURG, VA | USNU004 765-9 | 19,000 | EQUIPMENT, TOOLS, LARGE DRILLING EQUIPMENT |
| 3 | 2–6 INCH PUMP VAN, VA0280 | WILLIAMSBURG, VA | USNU009 358-8 | 27,380 | PUMPS, HOSES, FITTINGS |
| 4 | POLLUTION WORKSHOP VAN, VA0508 | WILLIAMSBURG, VA | USNU009 376-2 | 20,380 | DIVER TOOL KIT, HPUS, WELDING KIT, UW CUTTING KIT |
| 5 | SPARE EQUIPMENT VAN, VA1987 HAZMAT | WILLIAMSBURG, VA | USNU000 231-4 | 16,620 | BUOYS, TOOLS, HARDWARE, 23' INFLATABLE, MOORING LINE, HAZMAT |
| 6 | SALVAGE SKIMMER SYSTEM VAN, VA2220 | PORT HUENEME, CA | USNU 000 248-5 | 22,000 | PUMPS, PLASTIC/METAL SKIMMERS, SORBENT MATERIAL |

Table G-2. Summary of Hydraulic Hoses Shipping to Kwajalein

| | SUMMARY OF HYDRAULIC HOSE SHIPPING TO KWAJALEIN | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | HYD HOSE, 3/4", RUBBER | | HYD HOSE, 3/4", PLASTIC SYNFLEX | | HYD HOSE, 1", RUBBER | | HYD HOSE, 1/2", CASE DRAIN | HYD HOSE, 3/8", CASE DRAIN |
| | TOTAL FEET | EFFECTIVE WORKING FEET LENGTH | TOTAL FEET | EFFECTIVE WORKING FEET LENGTH | TOTAL FEET | EFFECTIVE WORKING FEET LENGTH | EFFECTIVE WORKING FEET LENGTH | EFFECTIVE WORKING FEET LENGTH |
| TOTAL QUANTITIES FOR ALL HOSES | 2600 | 1300 | 925 | 925 | 1150 | 325 | 1075 | 200 |

Table G-3. MIL Shipment 23 July 2018

| MIL SHIPMENT 23 JULY 2018 | | | |
|---|---|---|---|
| **ITEM** | **DESCRIPTION** | **MARK FOR:** | **QTY** |
| BOX NUMBER 1 (GRAY, 55" H X 59" L X 49" W, WT 1150 LB) | | | |
| 1 | GRID LINES | USNS *SALVOR* HOT TAP VAN | 8 BOXES |
| 2 | EXTRA/SPARE GRID LINES, WIRE AND BRAIDED LINE | MT *HUMBER* STORAGE/HOSE VAN | MISC SPOOLS |
| 3 | STEEL BRACKETS FOR ATTACHING GRID LINES, RED, WHITE, YELLOW | USNS *SALVOR* HOT TAP VAN OR MT *HUMBER* STORAGE/HOSE VAN | DOZENS |
| 4 | WIRE ROPE CLIPS FOR 1-1/4" WIRE | USNS *SALVOR* SALVAGE EQUIPMENT | 28 |
| 5 | SHACKLES, 1-1/2" CHAIN SHACKLE | MT *HUMBER* MOORING LINES | 4 |
| 6 | THIMBLES, 1-1/4" WIRE | USNS *SALVOR* MOORING EQUIPMENT | 10 |
| 7 | THIMBLES, 1" FOR BRAIDED ROPE | USNS *SALVOR* MOORING EQUIPMENT | 4 |
| 8 | SHACKLE, 1" FOR USNS *SALVOR* STEEP BEACH GEAR BUOYS | USNS *SALVOR* MOORING EQUIPMENT | 4 |
| 9 | UNDERWATER CAMERA SYSTEM WITH 650' OF CABLE | USNS *SALVOR* HOT TAP VAN | 1 |
| 10 | MONITOR FOR DIVE CAMERA | USNS *SALVOR* HOT TAP VAN | 1 |
| 11 | BOX CONTAINING AIR HORNS (4), FLASHLIGHTS (18), AND REELS (10) FOR GRID WIRES TARPS 10' X 12' (5) | MT *HUMBER* STORAGE/HOSE VAN | 1 SET |
| 12 | FLOWMETER HOFFER CONTROLS (CALIBRATED FOR 100 CST OIL) | MT *HUMBER* | 1 |
| 13 | MIST PUMP AND INJECTION NOZZLES, PVC MOUNTING PIPE | USNS *SALVOR* WORK STATION | 1 |
| 14 | MANUALS (ROPE, SPLICING, AND WIRE ROPE) | MT *HUMBER* SHOP VAN OR USNS *SALVOR* SHOP VAN | MISC |
| 15 | HOSE CLAMPS | SHOP VAN, MT *HUMBER* | 12 |

Table G-3. MIL Shipment 23 July 2018 (Cont'd)

| MIL SHIPMENT 23 JULY 2018 | | | |
|---|---|---|---|
| **ITEM** | **DESCRIPTION** | **MARK FOR:** | **QTY** |
| 16 | EXTENSION CORD, SINGAPORE POWER CONVERTER, HDMI CONVERTER, LAMINATED TANK DRAWINGS (4 EXTERNAL, 4 INTERNAL) | MT *HUMBER* | MULTIPLE SETS |
| BOX NUMBER 2 (GREEN, 85" L X 44" W X 48" H, WT 724 LB) | | | |
| 1 | PRINTER AND PAPER | | 1 |
| 2 | CLOCK | | 1 |
| 3 | ANGLE BRACKETS FOR GRID SYSTEM | | 8 |
| 4 | INTERNAL TANK DRILLING TOOLS | | 8 |
| 5 | TRIPOD | | 1 |
| 6 | BISCUIT BANGER | | 1 |
| 7 | TANK PLANNING DRAWINGS | | MISC |
| 8 | DOCUMENTS, NOTEBOOKS, PENS, AND LAMINATED GRID LINE LOCATION SHEETS | | SETS |

Table G-4. Equipment from ESSM Base Singapore and ESSM Base CAX for the ex-USS *PRINZ EUGEN* Oil Recovery Project as of 1 June 2018

| **EQUIPMENT FROM ESSM BASE SINGAPORE AND ESSM BASE CAX FOR THE EX-USS *PRINZ EUGEN* OIL RECOVERY PROJECT AS OF 06-01-18** | | | | | | |
|---|---|---|---|---|---|---|
| **ITEM** | **DESCRIPTION** | **SYSTEM NUMBER** | **ESSM NO.** | **BASE ORIGIN** | **QTY** | **COMMENTS** |
| 1 | SALVAGE SHOP VAN | S37100-0002 | VA0125A | SPO | 1 | STAGED AT ESSM BASE SINGAPORE AND READY FOR LOADING ON THE USNS *SALVOR* |
| 2 | HOT TAP TRAINING SYSTEM | P10110-0003 | | SPO | 1 | STAGED IN THE SALVAGE SHOP VAN ABOVE |
| 3 | DETACHABLE LINKS, # 5'S | | | SPO | 4 | NUMBER 5'S, STAGED IN SINGAPORE |
| 4 | DETACHABLE LINKS, # 6'S | | | SPO | 4 | NUMBER 6'S, STAGED IN SINGAPORE |
| 5 | STATO ANCHORS, 6000-LB | OVER I/O | | SPO | 2 | PRE-STAGED AT ESSM SINGAPORE ON 23 MAY 2018 |
| 6 | CHAIN 2-1/4" DILOC 45' HALF SHOTS | OVER I/O | CH0040 | SPO | 2 | ONE SHOT OF CHAIN CUT INTO TWO SHORT HALVES |
| 7 | FENDERS, SHIP | | FN2071 | SPO | 2 | FENDERS HAVE BEEN REMOVED FROM THE CONTAINER AND WILL BE REMOVED FROM PALLETS TO BE LOADED USING VAN SLINGS. ALL ANCILLARY GEAR WILL BE INCLUDED AND IS LOADED IN THE SALVAGE SHOP VAN. FENDERS TO BE LOADED ONTO THE MT *HUMBER* |
| 8 | WIRE ROPE | | WR0159 | SPO | 1 | 1-1/4" X 100' (FOUR WIRE ROPES PER REEL), STAGED IN SINGAPORE |
| 9 | PEAR SHAPED, #4 DETACHABLE LINKS | | LK0190 | CAX | 4 | 1-1/4"–1-9/16" (WIRE TO PLASMA), (NO HAIR PIN) LOADED FROM ESSM BASE CAX |
| 10 | PEAR SHAPED, #4 DETACHABLE LINKS | | LK0190M | CAX | 2 | 1-1/4"–1-9/16" (WIRE TO PLASMA), (WITH HAIR PIN) LOADED FROM ESSM BASE CAX |

Table G-4. Equipment from ESSM Base Singapore and ESSM Base CAX for the ex-USS *PRINZ EUGEN* Oil Recovery Project as of 1 June 2018 (Cont'd)

| **EQUIPMENT FROM ESSM BASE SINGAPORE AND ESSM BASE CAX FOR THE EX-USS *PRINZ EUGEN* OIL RECOVERY PROJECT AS OF 06-01-18** | | | | | | |
|---|---|---|---|---|---|---|
| **ITEM** | **DESCRIPTION** | **SYSTEM NUMBER** | **ESSM NO.** | **BASE ORIGIN** | **QTY** | **COMMENTS** |
| 11 | SHACKLE BOLT, SAFETY BOLT TYPE, 1-3/8" | | | CAX | 18 | 1-3/8" SAFETY SHACKLES, HS ALLOY 20 T (USED FOR 1-1/4" WIRE ROPE) LOADED FROM ESSM BASE CAX |
| 12 | DETACHABLE LINKS, 1-5/8" | | LK1976M | CAX | 8 | 1-5/8" DETACHABLE LINKS LOADED FROM ESSM BASE CAX |
| 13 | 1-1/4" SAFETY SHACKLE | OVER I/O | | CAX | 4 | LOADED FROM ESSM BASE CAX |
| 14 | 1-3/4" SAFETY SHACKLE | OVER I/O | | CAX | 4 | LOADED FROM ESSM BASE CAX |
| 15 | MOORING LINE 1.5" DIA, 12 X 12 BRAID BOB, 740' W/THIMBLE EYES | | | CAX | 4 | CORTLAND (221KIP BS) X APPROXIMATELY 740' EACH LOADED FROM ESSM BASE CAX |
| 16 | MOORING LINE 1.5" DIA, 12 X 12 BRAID BOB, 350' W/THIMBLE EYES | | | CAX | 4 | CORTLAND (221KIP BS) X APPROXIMATELY 350' EACH LOADED FROM ESSM BASE CAX |
| 17 | LINE, 1" BRAID, AMSTEEL BLUE | OVER I/O | | CAX | 1 | 1" DIA AMSTEEL BLUE BRAID (98,100-LB BS) (1200'). THIMBLE ON ONE END/BARE ON OTHER END. LOADED FROM ESSM BASE CAX |
| 18 | LINE, 1" BRAID, ULTRA BLUE | OVER I/O | | CAX | 1 | 1" DIA ULTRA BLUE BRAID (530') (22,500-LBS BS). BARE ENDS. LOADED FROM ESSM BASE CAX |
| 19 | LINE, BLACK POLY, 3 STRAND X 6" CIRC | OVER I/O | | CAX | 1 | 6" CIRC. BLACK POLY (230') (52,000-LB BS) THIMBLES ON BOTH ENDS LOADED FROM ESSM BASE CAX |

Table G-4. Equipment from ESSM Base Singapore and ESSM Base CAX for the ex-USS *PRINZ EUGEN* Oil Recovery Project as of 1 June 2018 (Cont'd)

| **EQUIPMENT FROM ESSM BASE SINGAPORE AND ESSM BASE CAX FOR THE EX-USS *PRINZ EUGEN* OIL RECOVERY PROJECT AS OF 06-01-18** | | | | | | |
|---|---|---|---|---|---|---|
| **ITEM** | **DESCRIPTION** | **SYSTEM NUMBER** | **ESSM NO.** | **BASE ORIGIN** | **QTY** | **COMMENTS** |
| 20 | 6" CIRC SYNTHETIC BRAID POLY MOORING LINES W/THIMBLES, 700' | PROCURED AND CARRIED ON MT *HUMBER* | | MT *HUMBER* | 4 | 700', EACH 6" SYNTHETIC BRAID RATED 38MT (84,000-LB BS) WILL BE LOCATED 1 EACH P/S ON MT *HUMBER* BOW AND STERN |
| 21 | SCREW PIN, 1-1/4" | | | USNS *SALVOR* | 2 | |
| 22 | SAFETY SHACKLE, 1-1/4" | | | USNS *SALVOR* | 2 | |
| 23 | SCREW PIN, 1-3/8" | | | USNS *SALVOR* | 1 | |
| 24 | SAFETY SHACKLE, 1-3/8" | | | USNS *SALVOR* | 2 | |
| 25 | SCREW PIN, 1-1/2" | | | USNS *SALVOR* | 3 | |
| 26 | SAFETY SHACKLE, 1-1/2" | | | USNS *SALVOR* | 6 | |
| 27 | SCREW PIN, 1-3/4" | | | USNS *SALVOR* | 9 | |
| 28 | SAFETY SHACKLE, 1-3/4" | | | USNS *SALVOR* | 20 | |
| 29 | SCREW PIN, 2" | | | USNS *SALVOR* | 5 | |
| 30 | SAFETY SHACKLE, 2" | | | USNS *SALVOR* | 12 | |
| 31 | SAFETY SHACKLE, 2-3/8" | | | USNS *SALVOR* | 1 | |
| 32 | SAFETY SHACKLE, 2-1/2" | | | USNS *SALVOR* | 9 | |
| 33 | SAFETY SHACKLE, 2-3/4" | | | USNS *SALVOR* | 9 | |
| 34 | NATO LINKS | | | USNS *SALVOR* | 6 | |
| 35 | PLATE SHACKLE PINS (VARIOUS SIZES) | | | USNS *SALVOR* | 14 | |

Table G-4. Equipment from ESSM Base Singapore and ESSM Base CAX for the ex-USS *PRINZ EUGEN* Oil Recovery Project as of 1 June 2018 (Cont'd)

| **EQUIPMENT FROM ESSM BASE SINGAPORE AND ESSM BASE CAX FOR THE EX-USS *PRINZ EUGEN* OIL RECOVERY PROJECT AS OF 06-01-18** | | | | | | |
|---|---|---|---|---|---|---|
| **ITEM** | **DESCRIPTION** | **SYSTEM NUMBER** | **ESSM NO.** | **BASE ORIGIN** | **QTY** | **COMMENTS** |
| 36 | SHACKLE SCREW PIN, 2-3/4" | | | USNS *SALVOR* | 8 | |
| 37 | CHAIN HOOK, ANCHOR | | | USNS *SALVOR* | 7 | |
| 38 | SNATCH BLOCK (VARIOUS SIZES) | | | USNS *SALVOR* | 20 | |
| 39 | DETACHABLE LINK (VARIOUS SIZES) | | | USNS *SALVOR* | 26 | |
| 40 | TURNBUCKLE (VARIOUS SIZES) | | | USNS *SALVOR* | 15 | |
| 41 | PELICAN HOOK (VARIOUS SIZES) | | | USNS *SALVOR* | 8 | |
| 42 | FATHOMS OF CHAIN, 1-1/2" | | | USNS *SALVOR* | 2 | |
| 43 | WIRE ROPE BRIDLES | | | USNS *SALVOR* | 3 | |
| 44 | PLASMA CROWN PENDANTS W/HARD EYES AND NATO LINKS, 130' (4" CIRC) | | | USNS *SALVOR* | 2 | |
| 45 | PLASMA LINES, 100', (4" CIRC) W/HARD EYES ON BOTH ENDS | | | USNS *SALVOR* | 2 | |
| 46 | AMSTEEL LINE, 600', W/HARD EYES AND 3/4" NATO LINKS ON BOTH ENDS | | | USNS *SALVOR* | 1 | |
| 47 | AMSTEEL LINE, 440', W/HARD EYES ON BOTH ENDS | | | USNS *SALVOR* | 1 | |
| 48 | PLASMA LINES, 1500', W/HARD EYES ON BOTH ENDS | | | USNS *SALVOR* | 2 | |

Table G-4. Equipment from ESSM Base Singapore and ESSM Base CAX for the ex-USS *PRINZ EUGEN* Oil Recovery Project as of 1 June 2018 (Cont'd)

| **EQUIPMENT FROM ESSM BASE SINGAPORE AND ESSM BASE CAX FOR THE EX-USS *PRINZ EUGEN* OIL RECOVERY PROJECT AS OF 06-01-18** | | | | | | |
|---|---|---|---|---|---|---|
| **ITEM** | **DESCRIPTION** | **SYSTEM NUMBER** | **ESSM NO.** | **BASE ORIGIN** | **QTY** | **COMMENTS** |
| 49 | BRUCE ANCHOR, 3000# | | | USNS *SALVOR* | 1 | MDSU |
| 50 | SPECTRA LINE, 600' OF 3" CIRC | | | USNS *SALVOR* | 2 | MDSU |

Table G-5. 2–6″ Pump Van VA0280 (USNU 009-358-8) SN SHSB1003328

| 2–6" PUMP VAN VA0280 (USNU 009-358-8) SN SHSB1003328 | | | | |
|---|---|---|---|---|
| **LOADOUT WEIGHT = 27,380 LBS** | | | | |
| **ITEM** | **DESCRIPTION** | **ESSM** | **SN** | **QTY** |
| 1 | WIRE MESH CONTAINER, CONTAINER NUMBER 1 | | | |
| 1A | DRILL, DL07 | DR0010A | 000240 | 1 |
| 1B | DRILL, DL07 | DR0010A | 000236 | 1 |
| 1C | DRILL PRESS, UW HYDRAULIC | DR0011 | H2102 | 1 |
| 1D | HYDRAULIC GRINDER | TL3420 | 032814057 | 1 |
| 1E | CHIPPING HAMMER, HYDRAULIC | TL1006 | 1704 | 1 |
| 1F | HOT TAP KIT | HT0007 | 008 | 1 |
| 1G | DRILL PRESS KIT | KT0050 | 008 | 1 |
| 1H | LARGE MAGNET | MG0020 | 004 | 1 |
| 1I | SORBENT PADS, BUNDLES | NA | NA | 2 |
| 2 | CONTAINER NUMBER 2 | | | 1 |
| 2A | 14" TERMINATION CAPS | NA | NA | 40 |
| 2B | 4" TERMINATION CAPS | NA | NA | 40 |
| 2C | SETS OF SECURITY HARDWARE FOR TERMINATION CAPS | NA | NA | 105 |
| 2D | 4" CAMLOCK CAPS | NA | NA | 24 |
| 2E | 4" CAMLOCK PLUGS | NA | NA | 24 |
| 2F | ELBOWS | NA | NA | 12 |
| 2G | TEES | NA | NA | 4 |
| 3 | WIRE MESH CONTAINER, CONTAINER NUMBER 4 (WM) | | | 1 |
| 3A | 4" ROUND FLANGE | NA | NA | 50 |
| 3B | 4" TEE FLANGE | NA | NA | 50 |
| 3C | 4" PUMP | PUO305 | 4T299 | 1 |
| 3D | 4" PUMP | PUO305 | 4T302 | 1 |
| 3E | DOP-160 | PUO840 | 344554-13 | 1 |
| 3F | 4" PLASTIC BALL VALVE | NA | NA | 5 |
| 4 | ALUMINUM BASKET, CONTAINER NUMBER 5 | | | 1 |
| 4A | 14" TERMINATION CAPS | NA | NA | 65 |
| 4B | 4" TERMINATION CAPS | NA | NA | 65 |
| 5 | ALUMINUM CONTAINER/RACK (HOSE BOX) | | | 1 |
| 5A | 100' HYDRAULIC HOSE X 1" | NA | NA | 4 |
| 5B | 25' HYDRAULIC HOSE X 1" | NA | NA | 4 |
| 5C | 50' HYDRAULIC HOSE X 3/4" | NA | NA | 4 |
| 5D | 50' HYDRAULIC HOSE CASE DRAIN, 1/2" W/SNAPTITES | NA | NA | 8 |
| 5E | 100' CASE DRAIN X 1/2" WITH AQ QD'S | NA | NA | 2 |
| 5F | 175' TWIN LINE SYNFLEX HYDRAULIC X 3/4" W/10 QD'S | NA | NA | 1 |
| 6 | HPU - ELECTRIC HYDRAULIC POWER UNIT, 480, THREE PHASE (PRIMARY HPU FOR PUMPING) | PW0040 | 10031BDJ | 1 |

Table G-5. 2–6″ Pump Van VA0280 (USNU 009-358-8) SN SHSB1003328 (Cont'd)

| **2–6" PUMP VAN VA0280 (USNU 009-358-8) SN SHSB1003328** | | | | |
|---|---|---|---|---|
| **LOADOUT WEIGHT = 27,380 LBS** | | | | |
| **ITEM** | **DESCRIPTION** | **ESSM** | **SN** | **QTY** |
| 7 | SPARE PARTS KIT FOR THE ELECTRO HYDRAULIC HPU | PW0042 | 009102 | 1 |
| 8 | SAUSAGE BOOM, SORBENT BOOM, 10' SECTIONS | NA | NA | 10 |
| 9 | OIL SORBENT PAD, BUNDLE | NA | NA | 15 |
| 10 | 4" FUEL HOSE WITH LOCKING CAMLOCKS, 400' (4 X50') AND 8 X 25' SECTIONS | NA | NA | 1 |

Table G-6. Spare Equipment/Boat Van VA1987 (USNU 000-231-4) SN 1202-19

| SPARE EQUIPMENT/BOAT VAN VA1987 (USNU 000-231-4) SN 1202-19 | | | | |
|---|---|---|---|---|
| LOADOUT WEIGHT = 16,620 LBS | | | | |
| **ITEM** | **DESCRIPTION** | **ESSM** | **SN** | **QTY** |
| 1 | EHPU ELECTRIC, 480 3-PH POWERED HPU, MOD 11, 15- OR 26-GPM, 3275 LBS, 80" X 48" X 70" | PW0040 | 10050BDJ | 1 |
| 2 | MOORING LINE PALLET, 1.5" BOB, 121K LBS MBS, 4 X 750' LENGTHS, 4 X 340' LENGTHS, AND 240' OF 6" CIRC POLY | NA | NA | 1 SET |
| 3 | SAUSAGE BOOM SORBENT, 10' LENGTHS | NA | NA | 56 |
| 4 | WATER COOLERS | NA | NA | 3 |
| 5 | SPARE AC UNIT FOR VANS | NA | NA | 1 |
| 6 | MT 12-GAL BOAT FUEL TANKS | NA | NA | 2 |
| 7 | INFLATABLE BOAT, 23' | WB0732 | ZDCA229Z G001 | 1 |
| 8 | FLOOR BOARDS FOR 23' BOAT | NA | NA | 1 SET |
| 9 | HAZMAT LOAD | | | |
| 9A | SAFETY SOLVENT III BD 1501/AEROLSOLS | NA | NA | 6 |
| 9B | HANNA RUBBER ADHESIVE | NA | NA | 8 |
| 9C | WD-40 AEROSOLS | NA | NA | 24 |
| 9D | LPS 3 AEROSOLS | NA | NA | 24 |
| 9E | SCOTCHKOTE COATING FD ELECTRICAL | NA | NA | 2 |
| 9F | SC2000 AND UTR 20G ADHESIVE | NA | NA | 2 |
| 9G | LPS PRESOLVE/DEGREASER AEROSOLS | NA | NA | 24 |
| 9H | MISC, LUBRICANTS, ELECTRIC CLEANERS AEROSOLS | NA | NA | 22 |
| 10 | SPARE EHPU W/SLING AND SPARE PARTS KIT | | | 1 |
| 11 | COOLER | | | 1 |

Table G-7. Hose and Fuel Station Van VA0018 (USNU 000-071-2) SN 008673

| **HOSE AND FUEL STATION VAN VA0018 (USNU 000-071-2) SN 008673** | | | | |
|---|---|---|---|---|
| **LOADOUT WEIGHT = 16,800** | | | | |
| **ITEM** | **DESCRIPTION** | **ESSM** | **SN** | **QTY** |
| 1 | 4" X 10' SUCTION HOSE | NA | NA | 5 |
| 2 | 4" X 20' SUCTION HOSE | NA | NA | 35 |
| 3 | 4" X 50' SUCTION HOSE | NA | NA | 10 |
| 4 | SAUSAGE BOOM, 10' LENGTHS | NA | NA | 100 |
| 5 | 4" PUMP FLOAT, TIRE | NA | NA | 2 |
| 6 | 26" BIKE | NA | NA | 4 |
| 7 | FUEL TRANSFER STATION MANIFOLD BASKET | | | 1 EA |
| 7A | 4" FLOWMETER | NA | NA | 1 |
| 7B | 4" FUEL STATION MANIFOLD | NA | NA | 1 |
| 7C | ROUND FLANGES | NA | NA | 75 |
| 7D | TEE FLANGES | NA | NA | 50 |
| 7E | HOSE FLOATS | NA | NA | 14 |
| 7F | 4" SHORT SUCTION HOSES | NA | NA | 6 |
| 7G | STEEP SCRAPERS | NA | NA | 6 |
| 8 | ALUMINUM DIVE BASKET NO 1 | | | |
| 8A | HARD FLOATS | NA | NA | 6 |
| 8B | INFLATABLE BUOYS | NA | NA | 10 |
| 8C | BUOY HAND PUMP | NA | NA | 3 |
| 9 | ALUMINUM DIVE BASKET NO 2 | | | |
| 9A | PUMP, 4" HT | PU0305 | 4T300 | 1 |
| 9B | PUMP, 4" PU0305 | PU0305 | 4T301 | 1 |
| 9C | PUMP, DOP 160 | PU0840 | 344554-12 | 1 |
| 9D | HARD FLOATS | NA | NA | 2 |
| 9E | ZINC INGOTS W/BOLTS | NA | NA | 9 |
| 9F | PLASTIC BALL VALVE, 4" | NA | NA | 5 |
| 9G | INFLATABLE BUOYS | NA | NA | 3 |

Table G-8. Hot Tap Van VA0018B 033008 (USNU 004-765-9) SN CAX36748

| HOT TAP VAN VA0018B 033008 (USNU 004-765-9) SN CAX36748 | | | | |
|---|---|---|---|---|
| LOADOUT WEIGHT = 19,000 LBS | | | | |
| ITEM | DESCRIPTION | ESSM | SN | QTY |
| 1 | SLING KIT (MISC SLINGS AND SHACKLES), P-307 CERTIFIED | | | 1 |
| 2 | HYDRAULIC HOSE REEL W/SYNFLEX | RL0015 | 2040785 | 1 SET |
| 3 | HYDRAULIC HOSE REEL W/SYNFLEX HOSE, -10 QD | NA | NA | 56 |
| 4 | 4' LADDER | NA | NA | 1 |
| 5 | SALVAGE DRUMS W/TRASH CAN, HALF PLASTIC BARREL, AND 10 HEAVY-DUTY TRASH BAGS W/HANDLES (SALVAGE BAGS) IN EACH DRUM | NA | NA | 2 |
| 6 | 3" FLOWMETER MANIFOLD | NA | NA | 1 |
| 7 | SPOOL OF ULTRA BLUE LINE (MBS= 24,000 LBS), 1" X 530' | LN1600 | NA | 1 |
| 8 | AMSTEEL BLUE, 1" X 1200' (MBS = 98,000 LBS) | NA | NA | 1 |
| 9 | TOTE, CONTAINS HATS, COVERALLS, LAUNDRY BAGS, AND RAIN GEAR. | NA | NA | 4 |
| 10 | WAFFLE BOX, NO NUMBER | | | 1 |
| 10A | CLOTH RAGS | NA | NA | 2 BX |
| 10B | SHOP TOWELS | NA | NA | 6 BX |
| 10C | SORBENT PADS | NA | NA | 4 BX |
| 10D | TRASH BAGS | NA | NA | 2 BX |
| 10E | SIMPLE GREEN CLEANER | NA | NA | 5 GAL |
| 10F | SPRAY NINE CLEANER | NA | NA | 2 CASE |
| 10G | DISH GLOVES | NA | NA | 3 DOZ |
| 11 | 6' FOLDING TABLE | NA | NA | 1 |
| 12 | ANCHOR, 125FX FORTRESS | NA | NA | 1 |
| 13 | TRANSFORMER, 480 TO 220 SINGLE | NA | NA | 1 |
| 14 | COPPER SAMPLING TUBES | NA | NA | 4 |
| 15 | BUBBA BAR AND SPARE MAGNETS (SET = 1 BAR AND 2 MAGNETS) | NA | NA | 2 SET |
| 16 | TOTE | | | 2 |
| 16A | GASKETS, ROUND | NA | NA | 30 |
| 16B | GASKETS, TEE | NA | NA | 30 |
| 17 | WAFFLE BOX, NO 1 | | | |
| 17A | 1" X 600' POLY PRO LINE | NA | NA | 2 |
| 17B | SHACKLES, ROPE THIMBLES, AND SNAP HOOKS IN A GRAY CONTAINER | NA | NA | MISC |
| 17C | 4 LEG WIRE ROPE SLINGS OF VARIOUS LENGTHS | NA | NA | 3 |
| 17D | 1/2" WIRE ROPE SLINGS OF VARIOUS LENGTHS | NA | NA | 1 |

Table G-8. Hot Tap Van VA0018B 033008 (USNU-004-765-9) SN CAX36748 (Cont'd)

| **HOT TAP VAN VA0018B 033008 (USNU 004-765-9) SN CAX36748** | | | | |
|---|---|---|---|---|
| **LOADOUT WEIGHT = 19,000 LBS** | | | | |
| **ITEM** | **DESCRIPTION** | **ESSM** | **SN** | **QTY** |
| 17E | 1/2" CHAIN, VARIOUS LENGTHS, 5'–25' | NA | NA | 11 |
| 17F | ASSORTED SPOOLS OF LINE (1/4", 3/8") | | | MISC |
| 17G | CHAFFING GEAR | | | |
| 17H | LIFE JACKETS | NA | NA | 2 |
| 17I | LIFT BAG, MEDIUM HEAVY-DUTY | NA | NA | 1 |
| 17J | HARD ANCHOR FLOATS | NA | NA | 3 |
| 17K | SOFT INFLATABLE FLOATS | NA | NA | 4 |
| 17L | INFLATABLE LIFT BAGS, SMALL LIGHT-DUTY | NA | NA | 6 |
| 18 | WAFFLE BOX, NO 2 | | | |
| 18A | BAGS OF QUIKRETE | NA | NA | 4 |
| 18B | QUICK SETTING CEMENT | NA | NA | 6 |
| 18C | SHOP TOWELS | NA | NA | 6 |
| 18D | JERRY CANS, 5-GAL | NA | NA | 3 |
| 18E | 1/2" POLY LINE, PARTIAL ROLLS | NA | NA | 2 |
| 18F | CHAFFING GEAR | NA | NA | MISC PCS |
| 18G | PICK AXE | NA | NA | 3 |
| 18H | PLASTIC CONTAINER W/RUBBER GLOVES | NA | NA | |
| 19 | WAFFLE BOX, NO 3 | | | |
| 19A | TARPS | NA | NA | 8 |
| 19B | FOLDOUT TABLE | NA | NA | 1 |
| 19C | BLACK STEEL FOLDING CHAIRS | NA | NA | 10 |
| 19D | FOLDING CLOTH CHAIRS | NA | NA | 13 |
| 19E | LIFE JACKETS | NA | NA | 6 |
| 19F | CANOPY SIDES | NA | NA | 8 |
| 20 | WAFFLE BOX, NO 4 | | | |
| 20A | DEVCON CAN | NA | NA | 12 |
| 20B | DAWN SOAP | NA | NA | 14 |
| 20C | FAST CURE 4200 | NA | NA | 12 |
| 20D | CAULKING GUN | NA | NA | 2 |
| 20E | TRASH BAGS | NA | NA | 1 BOX |
| 20F | SCRUB BRUSHES | NA | NA | 16 |
| 20G | 5-GAL BUCKETS | NA | NA | 10 |
| 20H | BUNGEE CORDS, 12", 18", 24" | NA | NA | 10 |
| 20I | SANDBAGS, EMPTY BAGS | NA | NA | 115 |
| 20J | ORANGE MESH BAGS | NA | NA | 25 |
| 20K | ROUND POINT SHOVEL | NA | NA | 4 |
| 21 | WAFFLE BOX, NO 5 | | | |

Table G-8. Hot Tap Van VA0018B 033008 (USNU 004-765-9) SN CAX36748 (Cont'd)

| HOT TAP VAN VA0018B 033008 (USNU 004-765-9) SN CAX36748 | | | | |
|---|---|---|---|---|
| LOADOUT WEIGHT = 19,000 LBS | | | | |
| **ITEM** | **DESCRIPTION** | **ESSM** | **SN** | **QTY** |
| 21A | LIGHTWEIGHT HOT TAP | HT0006 | SN 009162 | 1 |
| 21B | LIGHTWEIGHT HOT TAP | HT0006 | SN 009163 | 1 |
| 21C | LIGHTWEIGHT HOT TAP | HT0006 | SN 009168 | 1 |
| 21D | 4" BRASS BALL VALVES | NA | NA | 5 |
| 21E | HOT TAP MAGNETS | NA | NA | 6 |
| 21F | DRILL PRESS ADAPTOR | NA | NA | 1 |
| 21G | FISH NET | NA | NA | 1 |
| 21H | AIR HOLE PLUGS | NA | NA | 1 |
| 21I | SINKABLE TOOL BOX (DIVER BOX) | NA | NA | 2 |
| 21J | MAGNETIC ARM CLAMPS | NA | NA | 7 |
| 22 | WAFFLE BOX, NO 6 | | | |
| 22A | BLACK POLY LINE, 6" X 25' | NA | NA | 1 |
| 22B | SHACKLE, 1-3/8" | NA | NA | 18 |
| 22C | SHACKLE, 1-1/4" | NA | NA | 4 |
| 22D | SHACKLE, 1-3/4" | NA | NA | 4 |
| 22E | PEAR SHAPED LINKS | NA | NA | 14 |
| 23 | WAFFLE BOX, NO 7 | | | |
| 23A | 3/4" X 50' HYDRAULIC HOSE | NA | NA | 12 |
| 23B | 3/4" X 20' HYDRAULIC HOSE | NA | NA | 3 |
| 23C | 3/4" X 150' SYNFLEX W/-10 ENDS | NA | NA | 1 |
| 23D | 3/4" X 20' SYNFLEX W/-10 | NA | NA | 1 |
| 23E | COUPLE SHORT LENGTH HOSES, -12 | NA | NA | 2 |
| 24 | TOOL BOX | | | 1 |

Table G-9. Pollution Shop Van Loadout VA0508 (USNU 009-376-2)

| POLLUTION SHOP VAN LOADOUT VA0508 (USNU 009-376-2) | | | | |
|---|---|---|---|---|
| **LOADOUT WEIGHT = 20,380 LBS** | | | | |
| **ITEM** | **DESCRIPTION** | **ESSM** | **SN** | **QTY** |
| 1 | UNDERWATER BATTERY POWERED TOOL | TBD | TBD | TBD |
| 2 | TRANSFORMER | XF0010 | J10H109 13 | TBD |
| 3 | PATCHING KIT | LP0030 | PM6-045 | TBD |
| 4 | HYDRAULIC POWER UNIT | PW0012 | U1138 | TBD |
| 5 | HYDRAULIC D HOSE REEL | RL0015 | 24114493 | TBD |
| 6 | UNDERWATER CUTTING KIT | KT0558 | P0558C-1 | TBD |
| 7 | FOLDOUT CANOPY | NA | NA | 4 |
| 8 | LARGE CANOPY W/TENT POLES | NA | NA | 1 |
| 9 | AIR HOSES | NA | NA | 4 |
| 10 | BOX FANS | NA | NA | 2 |
| 11 | VAN SLINGS W/SHACKLES | TBD | TBD | 4 |
| 12 | GATORADE POWDER | NA | NA | 35 |
| 13 | RADIO HEADSETS | TBD | TBD | 10 |
| 14 | RADIO HEADSETS, INTRINSICALLY SAFE | TBD | TBD | 4 |
| 15 | REFRIGERATOR | NA | NA | 1 |
| 16 | MICROWAVE | NA | NA | 1 |
| 17 | CONTAINMENT POOLS | CP3010 | TBD | 4 |
| 18 | TELEVISION SET | NA | NA | 1 |
| 19 | DVD PLAYER W/CABLES | NA | NA | 1 |
| 20 | COOLER | NA | NA | 1 |
| 21 | UNDERWATER TOOL KIT | TL3400 | 003569 | |
| 21A | 4-1/2" WIDE CHISELS | NA | NA | 6 |
| 21B | 3" WIDE CHISELS | NA | NA | 6 |
| 21C | 2" WIDE CHISELS | NA | NA | 6 |
| 21D | 1" WIDE CHISELS | NA | NA | 6 |
| 21E | 2-WAY FLOW DIVIDER (1 HERE AND 2 IN VA2220 FROM PHE) | NA | NA | 3 |
| 21F | 4" GRINDING CUPS | NA | NA | 6 |
| 21G | 4" WIRE CUP BRUSHES | NA | NA | 8 |
| 21H | 7" GRINDING DISC | NA | NA | 80 |
| 21I | SEAL KITS FOR EACH TOOL | NA | NA | MULT |
| 21J | HYDRAULIC GRINDER | TL1000A | 2750 | TBD |

Table G-9. Pollution Shop Van Loadout VA0508 (USNU 009-376-2) (Cont'd)

| POLLUTION SHOP VAN LOADOUT VA0508 (USNU 009-376-2) | | | | |
|---|---|---|---|---|
| LOADOUT WEIGHT = 20,380 LBS | | | | |
| **ITEM** | **DESCRIPTION** | **ESSM** | **SN** | **QTY** |
| 21K | CHIPPING HAMMER | TL1006 | 1103 | 1 |
| 21L | HYDRAULIC DRILL | DR0010A | 31815025 | 1 |
| 21M | CHIPPING HAMMER | TL1006 | 1895 | 1 |
| 21N | WIRE ROPE, 63' | NA | NA | 2 |
| 21O | CONTAINMENT POOL | CP3000 | 23050-43 | 1 |
| 21P | UNDERWATER THICKNESS GAUGE | UG0010 | 11631 | 1 |
| 21Q | UNDERWATER ON/OFF SWITCH | TL004B | 001 | 1 |
| 21R | 5-GAL BUCKET W/1/2" LINE | NA | NA | 2 |
| 21S | UNDERWATER DATA LOGGER | DL0010 | 79847 | 1 |
| 21T | UNDERWATER DRILL PRESS | DL0020 | SN001 | 1 |
| 21U | UNDERWATER DRILL KIT | DR0025 | 1325 | 1 |
| 21V | MAX BEAM SEARCH LIGHT | KT0450 | 3430 | 1 |
| 21W | TANK PLAN DRAWINGS, LAMINATED | NA | NA | 2 |
| 21X | OFFICE SUPPLY KIT, MARKERS, CLIPBOARDS, PAPER, PENS, DRY ERASE, AND WET ERASE | NA | NA | 1 |
| 21Y | PORTABLE TABLES | NA | NA | 2 |
| 22 | 4' TABLE, FOLDOUT | | | 1 |

Table G-10. Miscellaneous Items with CAX36744

| MISCELLANEOUS ITEMS W/CAX36744 | | | | |
|---|---|---|---|---|
| **ITEM** | **DESCRIPTION** | **ESSM** | **SN** | **QTY** |
| 1 | TEE FLANGE | | | 50 |
| 2 | ROUND FLANGE | | | 75 |
| 3 | 5" STEEL CAP | | | 105 |
| 4 | 14" STEEL CAP | | | 105 |
| 5 | MISCELLANEOUS HEAVY SHACKLES | | | 20 |
| 6 | 2" X 50' MOORING LINE, POLY | | | 1 |
| 7 | 4" HOSE FLOATS | | | 14 |
| 8 | 4" SHORT SUCTION HOSES | | | 6 |
| 9 | 4" FLOWMETER | | | 1 |
| 10 | 4" MANIFOLD | | | 2 |
| 11 | STEEL SCRAPER | | | 6 |
| 12 | 4" X 10' SUCTION HOSE | | | 5 |
| 13 | 4" X 20' SUCTION HOSE | | | 35 |
| 14 | 4" X 50' SUCTION HOSE | | | 10 |
| 15 | SAUSAGE BOOM, 10' LNGTHS | | | 100 |
| 16 | 4" PUMP FLOAT, TIRE | | | 2 |
| 17 | 26" BIKE | | | 4 |
| 18 | HARD FLOATS | | | 6 |
| 19 | INFLATABLE BUOYS | | | 10 |
| 20 | SALVAGE DRUMS | | | 2 |
| 21 | -12 X 50' HYDRAULIC HOSE | | | 12 |
| 22 | -12 X 200' HYDRAULIC HOSE | | | 2 |
| 23 | MISCELLANEOUS CLEANING SUPPLIES | | | 1 |
| 24 | ABSORBENT PADS | | | 25 BAGS |
| 25 | 4" BALL VALVE, BRASS | | | 10 |
| 26 | 10' X 10' CANOPY | | | 4 |
| 27 | 20' X 30' CANOPY | | | 1 |
| 28 | SMART TV | | | 1 |
| 29 | DVD PLAYER | | | 1 |
| 30 | REFRIGERATOR | | | 1 |
| 31 | COFFEE MAKER | | | 2 |
| 32 | MICROWAVE OVEN | | | 1 |
| 33 | BOX FAN | | | 2 |
| 34 | AMSTEEL BLUE LINE, SPOOL, 1200' | | | 1 |
| 35 | TABLE | | | 1 |
| 36 | CHAIR, METAL | | | 10 |
| 37 | CHAIR, FOLDOUT | | | 12 |
| 38 | WATER COOLER | | | 5 |
| 39 | MISCELLANEOUS PPE, CONTAINER | | | 4 |

Table G-11. Salvage Skimmer System Van VA2220 (USNU 000-248-5)

| SALVAGE SKIMMER SYSTEM VAN VA2220 (USNU 000-248-5) | | | | |
|---|---|---|---|---|
| **ITEM** | **DESCRIPTION** | **ESSM** | **PN** | **QTY** |
| 1 | CONTAINMENT POOL, MCHRY,5'X5'X12", COOLEY URE | CP3000 | 5' X 5' X 12" | 4 |
| 2 | KIT, BOAT, INFLATABLE, 15' | KT0603 | | 1 |
| 3 | KIT, OIL CONTAINMENT BOOM, MODEL USS-26 | KT0601 | | 1 |
| 4 | KIT, OIL MOP | KT0602 | | 1 |
| 5 | KIT, OIL STORAGE BLADDER, 500-GALLON | KT0604 | | 1 |
| 6 | KIT, SKIM-PAK SYSTEM | KT0600 | | 1 |
| 7 | MOTOR, OUTBOARD, 15-HP, 4-STRK, SH SFT (OR SERIES) (ALT) | MT0015A | | 1 |
| 8 | MOTOR, OUTBOARD, 15-HP, 4-STROKE (ALT) | MT0010 | | 1 |
| 9 | MOTOR, OUTBOARD, 15-HP, 4-STROKE (PRI) | MT0015 | 15ML (4-STR) BF | 2 |
| 10 | PALLET, STORAGE, 84"X41"X7" USS26 AND USS26SB | BM0875 | DWG 6777302 | 1 |
| 11 | SKIMMER, HARBOR, MINI-MAX | SK0900 | AB127 | 1 |
| 12 | SPARE PARTS KIT, FOR MT0010 MOTOR (ALT) | MT0011 | | 1 |
| 13 | SPARE PARTS KIT, FOR MT0015 MOTOR (PRI) | MT0017 | | 1 |
| 14 | SPARE PARTS KIT, FOR MT0015A MOTOR (ALT) | MT0017A | | 1 |
| 15 | MISCELLANEOUS EQUIPMENT | NA | | AR |

# APPENDIX H

## Appendix H – Chronology

### April

ESSM/GPC PE team members were assigned to the project. Testing of the hot tap system, fasteners, and drills continued and the concept for the Internal Tank Hot Tap Tool was developed. Procurement for the necessary materials for PE project was initiated. Tanker Vessel selection and Salvage vessel selection and verification was initiated.

### May

Formal funding for the PE project was received. The Internal Tank Hot Tap tool and the hot tap system were developed. The ESSM systems, major equipment and ISO 20-foot shipping containers were assembled at ESSM Base CAX and equipment being procured and loaded for the operation. The Operations Plan was developed in more detail. Design and testing of internal hot tap tools and equipment and fabrication of close-out caps and tools was initiated. The tanker vessel selection process continued and negotiations with multiple companies commenced. The Preliminary Mooring Plan, the Spill Response Plan, the transportation logistics, lodging, and provisioning were put into place. The procurement and location of mooring support equipment commenced including the cutting slicing and testing of mooring line and addition of thimbles, boxing of jewelry.

Travel to Singapore was completed 20–26 May with NAVSEA Representative Kemp Skudin, ESSM/GPC Pollution Coordinator Ron Worthington, and ex-USS *PRINZ EUGEN* Wreck Recovery Project Manager Craig Moffatt. Contract negotiations with Global Energy Overseas Pte Ltd were completed and a ship check of MT *HUMBER* was performed. The PE team attended a planning meeting with USN CTF-73, the USNS *SALVOR* team, the MDSU 1-8 Team, and SUPSALV. A second ship check was performed on the USNS *SALVOR* and the MT *HUMBER* with divers, Federal On Scene Coordinator LTCMDR Tim Emge CTF-73 the USN CTF-73 divers.

### June

Systems were procured and developed for the ex-USS *PRINZ EUGEN* project. The hot tap systems were tested and the flanges, close-out caps, and the Internal Tank Hot Tap tool were fabricated and packed in the 20-foot ISO containers. The procurements for major items and the packing of components in ESSM containers were completed.

NAVSEA Representative Stephanie Bocek, Dive Coordinator Paul Schadow, and Pollution Coordinator Ron Worthington traveled to Hawaii to conduct diver training 11–15 June in Honolulu, Hawaii at ESSM Base, Hawaii. The shipment of containers from to Kwajalein Atoll began in mid-June and containers were trucked to the rail yard in Portsmouth, Virginia. Containers from CAX then went by rail to the Port of Long Beach California.

During the week of 18–20 June, CAX ESSM containers were in transit via train to Long Beach, California for transfer to a Matson Lines container ship for round about transit to Kwajalein.

**25 July 2018**

MT *HUMBER* entered a Singapore shipyard for a scheduled work package.

**5 August 2018**

The MT *HUMBER* oil tanker was deck loaded with ESSM equipment for transport to Kwajalein Atoll including fenders, hydraulic oil, and mooring equipment.

**6 August 2018**

The MT *HUMBER* loaded low sulfur marine gas oil to use for the ships bunker fuel for the round trip to and from Kwajalein RMI. A Condition Survey was performed on the MT *HUMBER* under contract to Global PCCI (GPC) by the Royal Marine Company of Singapore. SUPSALV ESSM containers arrived at Kwajalein Atoll.

**7 August 2018**

The MT *HUMBER* departs Singapore anchorage with destination Kwajalein Atoll RMI.

**11 August 2018**

USNS *SALVOR* departed Jakarta, Indonesia (actual date unknown) where it had been participating in a Cooperation Afloat Readiness And Training (CARAT) Exercise The USNS *SALVOR* arrived in Singapore and loadout for USNS *SALVOR* began.

**12 August 2018**

Loadout continued on the USNS *SALVOR.*

**13 August 2018**

USNS *SALVOR* completed loadout including ESSM equipment in Singapore and departed there on 13 August arriving in Kwajalein on 28 August.

**18 August 2018**

Half of the MDSU Company detachment (7 personnel) departed Singapore and arrived in Kwajalein on 20 August in order to begin bottom surveys of the wreck and obtain depths and bottom conditions for placement of the anchors.

**20 August 2018**

MDSU Divers Group I team (seven personnel) arrived on-site to do the wreck survey, bottom bathymetric installation of buoys, and pre-operational cleaning on the wreck.

**26 August 2018**

ESSM/GPC personnel Group I departed Cheatham Williamsburg, Virginia and Port Hueneme, California to Kwajalein Atoll.

**27 August 2018**

Group II ESSM/GPC personnel departed Pearl Harbor, Hawaii and Anchorage, Alaska for Kwajalein Atoll. CTF-73 C7F Salvage officer LCDR Tim Emge arrived in Kwajalein.

**28 August 2018**

MT *HUMBER* arrives Kwajalein Atoll and is escorted into anchorage by Tug *MYSTIC* and USAG-KA Pilot under fiscal agreement with SUPSALV.

USNS *SALVOR* arrived Kwajalein Atoll and is escorted to Echo Pier by Tug *MYSTIC* and USAG-KA Pilot.

ESSM/GPC personnel from Cheatham Williamsburg, Virginia and Port Hueneme, California arrived at Kwajalein Atoll.

Divers and ESSM/GPC personnel commence unloading the mooring equipment and hot tap equipment from the shipping containers located in the staging area with priority of outfitting the USNS *SALVOR*.

A meeting was conducted onboard the USNS *SALVOR* for logistics, arrangements, and mooring plans.

All Kwajalein Atoll shore-side cranes (four) were down for repair. The 40-ton crane on the USNS *SALVOR* was utilized for equipment lifts and uploads.

**29 August 2018**

ESSM/GPC personnel continued prepping equipment containers to be loaded onto the USNS *SALVOR* and the MT *HUMBER*.

MDSU Group I divers began prepping the mooring equipment. Mooring legs #1 and #2 were positioned at the wreck site using USAG Tug *MYSTIC* under direction of USNS MDSU. MDSU Detachment personnel, second group, arrived at Kwajalein Atoll.

Using the Rigid Hull Inflatable Boat (RHIB), ESSM/GPC and CTF-73 operations personnel proceeded to the MT *HUMBER* to meet with its Captain and crew to discuss the logistics of the pier operations with or without shore-side crane service.

**30 August 2018**

With assistance from USAG-KA Warrant Officer CW3 Jamie Norton, an outside contractor working on-site was located and approached with a request for use of their crane to finish the loadout of ESSM and other equipment.

The loadout of the USNS *SALVOR* was completed. Mooring legs #3 and #4 were positioned at the wreck site using the Army Garrison (USAG-KA) provided, *LT-102 MYSTIC* Tugboat (hereafter called out as, Tug *MYSTIC*). ESSM/GPC personnel staged the SUPSALV equipment containers for upload onto the deck of the MT *HUMBER*. ESSM/GPC personnel Group II and five additional MDSU divers, from Pearl Harbor, Hawaii and Anchorage, Alaska, arrived at Kwajalein Atoll.

A meeting was conducted with the USNS *SALVOR*, and MT *HUMBER* Captains, and additional stakeholders to finalize the mooring plans.

A working shore-crane was finally made available. The San Juan Construction Company allowed use of their crane to load the USNS *SALVOR.* Equipment containers were moved to the pier for upload onto the USNS *SALVOR.*

Six remaining supplemental Dive Team personnel arrived to complete the compliment of personnel to 20.

**31 August 2018**

The USNS *SALVOR* left the pier and dropped mooring legs #5 and #6 at the wreck site. The MT *HUMBER* transited to Echo Pier to load operations equipment.

Dives commenced from the 24′ Boom Handling Boat (BHB) to set marker buoys at 25′ water depth for Saturday's (1 September) mooring evolution.

Completed staging of all ESSM oil response onshore resources; in preparations for rapid deployment, in the event of an oil spill.

**1 September 2018**

The Tug *MYSTIC* was in transit until 1300. Provisions were loaded onto the MT *HUMBER* and final preparations were completed to prepare the vessel to leave Echo Pier. A frozen food freezer failure occurred on the MT *HUMBER* and some extra food provisions had to be transported to shore to be stored in freezers located by U.S. Army CW3 POC Jamie Norton.

The USNS *SALVOR* was placed in a four-point moor over the wreck site.

The remaining ESSM operations equipment was staged on the MT *HUMBER* at Echo Pier.

Pre-mission repair and maintenance was accomplished on a RHIB, two 24′ BHBs, and the air compressors with the 42″ boom containers (donated to USAG).

NAVSEA and the ESSM/GPC Project Manager conducted a spill response plan review meeting with USAG-KA stakeholders and responders in Kwajalein Atoll including USAG-KA environmental personnel, emergency responders, and USA personnel.

**2 September 2018**

The MT *HUMBER* departed Echo Pier at 0700 with USAG-KA Tug *MYSTIC* to assist in mooring operations. The MT *HUMBER* moved into its initial mooring location.

Eight ESSM/GPC personnel transferred from the shore hotel to the MT *HUMBER* and three remained onshore to travel each day by boat.

The MT *HUMBER* was placed into mooring position, assisted by the USAG-KA Tug *MYSTIC* and a workboat from the USNS *SALVOR*. Kwajalein Vessel Pilot Captain “Sully” Sullivan directed positioning. Master Diver Kevin Parsons directed divers and the ESSM/GPC personnel involved in the anchoring and Captain Allan of the MT *HUMBER* directed all tanker propulsion and crew functions.

ESSM/GPC personnel inflated and launched two ship fenders.

ESSM/GPC personnel set up preliminary fuel receiving station on the MT *HUMBER*.

ESSM/GPC personnel set up the ESSM 23′ Inflatable Boat.

An afternoon squall created anchor holding issues. The MT *HUMBER* bow anchor did not hold and had to be reset.

**3 September 2018**

ESSM/GPC personnel set up hot tap work stations and the Hot Tap Van and Shop Van on the USNS *SALVOR*. Three ESSM/GPC personnel remained onshore to support shore efforts with fueling and BHB boat repairs. ESSM/GPC personnel onboard the MT *HUMBER* began setting up tarps, work stations, and securing lines for the inflatable fenders (refer to Appendix O).

The MDSU team members and USNS *SALVOR* crew moved the MT *HUMBER* into a better position over the wreck and reset the MT *HUMBER* bow anchor.

Twelve ESSM/GPC personnel and one SUPSALV representative were on the project. Three ESSM/GPC personnel and one SUPSALV personnel lodged onshore temporarily. All other personnel lodged onboard the MT *HUMBER*.

The MT *HUMBER* remained un-nested for 24 hours.

**4 September 2018**

The Tug *MYSTIC* transited to the wreck site and successfully dropped an additional mooring leg for the MT *HUMBER*. The USNS *SALVOR* stern anchor line and the MT *HUMBER* starboard and stern anchor mooring lines were swapped out to give vessels a better hold in the moor.

The two vessels shifted together into the final “Rafted” position directly over the wreck site, per the ESSM Operations Plan.

The ESSM 25′ RHIB transferred personnel, provisions, and assisted with the mooring operations.

ESSM/GPC Operations team members on the USNS *SALVOR* began prepping hot taps, backups, and hydraulic power stations.

Operations team members on the MT *HUMBER* made up new fender lines, continued working the fuel station, and started laying out product hoses.

Several of the MDSU team members began diving and clearing obstacles to install the tank navigations grid system.

Part of the dive team continued cleaning the hull for preparation of grid system deployment.

**5 September 2018**

Divers on the ex-USS *PRINZ EUGEN* continued cleaning the hull and installed grid lines on the bilge keels. Bottom hoses and Y-fittings were installed on the bottom of the wreck.

ESSM/GPC personnel pressure tested the fuel receiving station piping, hoses, and valves onboard the MT *HUMBER*.

The first trash and solid waste pickup by LCS 8 Supply/Trash boat occurred.

Ships crews adjusted and doubled-up the mooring lines on the MT *HUMBER*.

The #3 anchor was found to have jammed flukes and was lying on its side.

**6 September 2018**

The USNS *SALVOR* and MT *HUMBER* rafted and held well.

A brow (ship-to-ship gangway) was provided by the MT *HUMBER* per charter contract to be used for daily personnel transit back and forth between the vessels. The brow was taken up and stowed onboard the tanker using the MT *HUMBER* deck crane every evening to prevent damage during unattended evening squalls. The same procedure was used throughout the entire operation.

The divers worked the bilge lines and installed transverse lines at frames 65 and 76, as well as performed some cleaning of the surfaces to be drilled. Drilling of test holes and documenting breached tanks commenced. The PE tanks in Section IV and V were tested.

- 12 of 173 tanks tested
- 4 of 12 tanks contained recoverable oil
- 0 of 4 tanks hot tapped
- 0 gallons of oil recovered

**7 September 2018**

The divers cleaned and prepped four tanks for hot tapping. The divers also continued with test hole drilling. Positioned the main oil recovery pump and “bottom hose” on the wreck approximately 200 feet. Set up 400′ of product hose, from the MT *HUMBER* to wreck.

Some of the existing leaks were patched with epoxy.

Divers continued clearing obstacles and installed components of the tank navigation grid system.

- 17 of 173 tanks tested
- 9 of 17 tanks contain recoverable oil
- 0 of 9 tanks hot tapped
- 0 gallons of oil recovered

**8 September 2018**

The first hot tap and the first tank pumping Tank IV 1.2 centerline were accomplished.

The USNS *SALVOR* constructed a special cofferdam to deal with the perceived potential issue of contaminated water take up into their water-making equipment onboard. The MT *HUMBER* water-maker was not an issue.

- 18 of 173 tanks tested
- 10 of 17 tanks contain recoverable oil
- 1 of 9 tanks hot tapped
- 2400 total gallons of oil recovered

ESSM/GPC Spill Response Team (ESSM/GPC SRT) and all hands responded to a large leak at 0200 when the watch on the USNS *SALVOR* reported a large amount of oil in the water. The spill was cleaned up and the leak was located in the bilge keel connection hardware of Section VII.

RDML Brakke toured the ex-USS *PRINZ EUGEN* operations site.

**9 September 2018**

Divers hot tapped and pumped in Section IV. Hole tested and cleaned in Section V.

- 3 hot taps and 2 tanks pumped
- 19 of 173 tanks tested
- 11 of 19 tanks contain recoverable oil
- 4 of 11 tanks hot tapped
- 7100 total gallons of oil recovered

Note: The leaks located by divers were cleaned up and patched with Devcon Sticks (concrete bags).

**10 September 2018**

Tank tested, hot tapped, and pumped from Section IV and V.

- 23 of 173 tanks tested
- 13 of 23 tanks contain recoverable oil
- 6 of 13 tanks hot tapped
- 11,100 total gallons of oil recovered

Note: ESSM/GPC SRT responded to continuous leaks throughout the day. Divers responded subsea by patching and the PE recovery team pumping out the tanks.

**11 September 2018**

Section V was pumped, and Section VI was cleaned and tested.
The tanks in Section IV were closed out, but not sealed.

- 28 of 173 tanks tested
- 17 of 28 tanks contain recoverable oil
- 11 of 17 hot tapped
- 16,000 gallons total of oil recovered

Five tanks were closed out.

**12 September 2018**

Pumping from Section V began. Cleaned and tested centerline tanks in Sections VI and VII and hot tapped Sections VI and VII.

- 36 of 173 tanks tested
- 25 of 36 tanks contain recoverable oil
- 17 of 25 tanks hot tapped
- 29,500 total gallons of oil recovered

**13 September 2018**

Tested in Section VII, hot tapped Section VII, and cleaned Section VIII. Pumped and stripped from Sections VI and VII. The tanks in Section VI were closed with caps.

- 42 of 173 tanks tested.
- 31 of 42 tanks contain recoverable oil
- 23 of 31 hot tapped
- 40,000 total gallons of oil recovered

The Spill Response Team was (SRT) deployed to respond to a large leak.

**14 September 2018**

Pumped from Section VII, stripped Section VII, cleaned Section IX, and hot tapped and pumped from Section VIII.

- 46 of 173 tanks tested
- 34 of 46 tanks contain recoverable oil
- 29 of 34 tanks hot tapped
- 49,300 total gallons of oil recovered

Many tanks had venting problems that slowed down the process. The snorkel (Schadow Vent Tube) was first used to assist with venting. The "Floating Tire Pump" was deployed at end of day to be used on the first tanks of the next section.

ESSM/GPC personnel Matt Wenner departed for Virginia.

The process for locating, cleaning, testing, and hot tapping tanks was refined to reduce the amount of cleaning required to make diving operations more efficient.

**15 September 2018**

Cleaned and drilled Section IX. Pumped Section VIII and used the Tire Pump for the first time on this project.

- 49 of 173 tanks tested
- 37 of 49 tanks contain recoverable oil
- 32 of 37 tanks hot tapped
- 62,800 total gallons of oil recovered

Tank VIII 4.2 was leaking and SRT was in continuous service. The Tire Pump removed after pumping three tanks due to excessive air lock issues, replaced with the original type bottom pump. The flange on Tank VIII 4.2 caused the leak. Pumping went late into the evening to eliminate the source of the leak.

**16 September 2018**

The stripping of Section VIII was completed, Section VIII was closed out, and cleaned and hot tapped Section IX.

- 49 of 173 tanks tested
- 37 of 49 tanks contain recoverable oil
- 32 of 37 tanks hot tapped
- 70,200 total gallons of oil recovered

Issues with fire hose pressure when used with the Schadow Vent Tube; it creates tank pressure issues and forces extra unwanted water into the pump suction.

**17 September 2018**

Hot tapped and pumped from Section IX, diesel section. Cleaned and tested in Section X.

- 54 of 173 tanks tested
- 41 of 49 tanks contain recoverable oil
- 37 of 41 tanks hot tapped
- 73,400 total gallons of oil recovered
- 15 of the hot tapped and pumped tanks permanently sealed

Onboard issues include: Running low on some food provisions. Food provisions were unable to be obtained locally. Internet access was an issue as the service had problems with connectivity and satellite. More materials for the project were ordered, including more close-out caps, vent close-out devices, fasteners, and gaskets.

**18 September 2018**

Hot tapped and pumped in Sections IX and X. Cleaned and tested Section XI.

- 61 of 173 tanks tested
- 45 of 61 tanks contain recoverable oil
- 42 of 45 tanks hot tapped
- 78,100 total gallons of oil recovered

Ordered materials listed on previous day as well as tools, sockets, drivers lost by divers, and another 2000′ of sorbent boom.

**19 September 2018**

Diver station, oil receiving station, and oil samples were all checked for radiation using a certified radiation meter (RADIACMETER) IM-265/PDQ. All radiation present was considered normal background.

Dive operations slowed down due to increased diving depth.

- 74 of 173 tanks tested
- 52 of 74 tanks contain recoverable oil
- 46 of 52 tanks hot tapped
- 83,500 total gallons of oil recoverable
- 15 of the hot tapped and pumped tanks permanently sealed

**20 September 2018**

Hot tapped and pumped Section XI, divers started test drills on the Wing Tanks.

- 81 of 173 tanks tested
- 54 of 81 tanks contain recoverable oil
- 50 of 54 tanks hot tapped
- 105,400 total gallons of oil recovered

Conflicts with tank close-outs and planning for internal tank taps described below.

**21 September 2018**

Plates were attached to the tanks in Sections XII and XIII. Hot tapped in Section XII, and continued testing Wing Tanks. A diver went into the diver recompression chamber for the bends. Three tanks in Section XI were stripped.

- 87 of 173 tanks tested
- 56 of 87 tanks contain recoverable oil
- 52 of 56 tanks hot tapped
- 110,900 total gallons of oil recovered
- 15 of the hot tapped and pumped tanks permanently sealed

**22 September 2018**

Several emergency pumping transfers occurred including having to switch from Tank XIII 6.1 to Tank XIII 6.3. An early switch occurred from Tank XIII 6.3 to Tank XIII 6.4 and an emergency switch back to Tank XIII 6.3 when it was discovered that the side of the tank was cracked and leaking badly down deeper on the side shell. Diver time at depth and having to switch out divers more frequently was an issue. ESSM/GPC SRT deployed four times. The leak was monitored through the night.

The MT *HUMBER* continued to have food issues. Seven pallets of boom and parts delivery were received with a trash run.

No time for internal tank meeting this day.

Sections XII and XIII were pumped and stripped.

- 103 of 173 tanks tested
- 66 of 103 tanks contain recoverable oil
- 57 of 66 tanks hot tapped
- 129,500 total gallons of oil recovered

**23 September 2018**

Pumped and stripped Section XIII. Two wing sections were tested. The previous late night pumping caused a late start. A close call diver emergency occurred; umbilical air problem. The diver was recovered by inflatable boat.

- 105 of 173 tanks tested
- 65 of 105 tanks contain recoverable oil (corrected number from yesterday)
- 58 of 65 tanks hot tapped
- 148,200 total gallons of oil recovered

**24 September 2018**

Section XIII tanks were closed out. The tanks in Sections XII and XIII were stripped. Wing Tank VIII 4.6 was stripped. A beach survey was conducted via RHIB for oil that escaped during the leaks on 22 September. Found only trace amounts of oil (about a cup full of stringy black oil partially subsurface) in the water about 3 miles north of Ebeye. No visible oil on any of the shorelines from Ebeye up to the next channel out of the Atoll.

ESSM/GPC SRT out recovering oil from a spill from a hose that pulled apart from loose dogs. Divers inspected and cleaned Section I, II, III centerline tanks.

- 119 of 173 tanks tested
- 66 of 119 tanks contain recoverable oil (corrected number from yesterday)
- 59 of 66 hot tapped
- 149,300 total gallons of oil recovered

**25 September 2018**

The Wing Tanks in Sections VII and VIII were pumped. Divers inspected and cleaned Section I, II, and III centerline tanks. Test drilling in Section III.

- 134 of 173 tanks tested
- 76 of 134 tanks contain recoverable oil recovered
- 62 of 76 tanks hot tapped
- 153,200 total gallons of oil recovered
- 15 of the hot tapped and pumped tanks permanently sealed

**26 September 2018**

Pumped and stripped the Sections XI and VIII Wing Tanks. Test drilled in Sections I and III centerline.

- 138 of 173 tanks tested
- 76 of 138 tanks contain recoverable oil
- 64 of 76 tanks hot tapped
- 155,400 total gallons of oil recovered

There were continuous problems with the hose becoming air bound as well as kinked hoses causing excessive back pressure.

**27 September 2018**

Pumped and stripped Wing Tanks in Section XI. Test drilled Section I and hot tapped Section III.

- 141 of 173 tanks tested
- 78 of 141 tanks contain recoverable oil
- 64 of 78 tanks hot tapped
- 155,400 total gallons of oil recovered
- 2 tanks inaccessible

**28 September 2018**

Hot tapped and pumped Section III, turbine oil.

- 141 of 173 tanks tested
- 2 of 173 tanks inaccessible
- 78 of 141 tanks contain recoverable oil
- 70 of 78 tanks hot tapped
- 160, 000 total gallons of oil recovered

Problems occurred with internal framing, pucks not dropping, as well as thin metal causing flanging issues.

**29 September 2018**

Oil from a leaky hole in Section III was pumped using a scoop/suction head. Tanks common to each other as Tank III 1.4 was stripped, and then when doing the final strip, pulled 2600 gallons from the tank.

Section IV Wing Tank tapped but all wings in that section were empty.

- 142 of 173 tanks tested
- 2 of 173 tanks inaccessible
- 80 of 141 tanks contain recoverable oil
- 75 of 80 tanks hot tapped
- 166,500 total gallons of oil recovered

The flowmeter stopped working due to debris picked up during the "Mosquito" stinger pump operations where the suction tip is pushed into a rough space and picks up rust, silt, and debris. Quantity readings were obtained from soundings.

**30 September 2018**

External Center Tank III 4.9.

- 142 of 173 tanks tested
- 2 of 173 tanks inaccessible
- 80 of 142 tanks contain recoverable oil
- 78 of 80 tanks hot tapped
- 169,100 total gallons of oil recovered

The flowmeter stopped working due to clogging issues again. The meter was cleaned, but problems were due to pump failure.

**1 October 2018**

While attempting to flush the entire hose system, it was found that the pump was unable to send the product to the surface. The 4′ centrifugal pump was changed out with a pump from the surface. Once the pump was installed in the system, pumping operations resumed.

Cleaning, flanging, and tapping for internal tank access points. Working close-outs of all tanks.

Tank I 6.32 was hot tapped.

- 144 of 173 tanks tested
- 2 of 173 tanks inaccessible
- 80 of 144 tanks contain recoverable oil
- 81 of 81 tanks hot tapped
- 171,600 total gallons of oil recovered

**2 October 2018**

Hot tapped and pumped Internal Tank III 5.5 via Tank III 4.9, first internal hot tap and pump. Section II Wing Tanks.

- 146 of 173 tanks tested
- 2 of 173 tanks inaccessible
- 82 of 146 tanks contain recoverable oil
- 82 of 82 tanks hot tapped
- 177,000 total gallons of oil recovered

**3 October 2018**

Internal tanks Tank II 5.6. Tank III 5.5 stripped and closed. Tank I 6.32 was pumped.

- 149 of 173 tanks tested
- 2 of 173 tanks inaccessible
- 83 of 149 tanks contain recoverable oil
- 83 of 83 tanks hot tapped
- 207,000 total gallons of oil recovered (includes oil settled from oily water slops)

**4 October 2018**

Internal Tanks III 5.1 and III 5.3 were pumped repeatedly all day. Leaking oil from Tank X 4.2 caused SRT to deploy both boats. Hole at Tank X 4.2 had to be domed and a new hole will have to be cut.

The internal tanks in Sections II and IV were prepped by cleaning and putting in new hot taps. Tank III 5.3 and Tank V 5.1 were hot tapped.

- 151 of 173 tanks tested
- 3 of 173 tanks inaccessible (one internal, one external)
- 85 of 151 tanks contain recoverable oil
- 83 of 83 tanks hot tapped
- 207,200 total gallons of oil recovered

Successfully surveyed three additional internal tanks (two breached). One contained oil. Some additional tanks were prepared for internal tank hot taps.

**5 October 2018**

Internal Tank IV 5.1 was pumped via Tank IV 4.1. Internal Tanks IV 5.3 and IV 5.1 were both pumped from one hot tap hole in Tank IV 4.1 center tank.

- 154 of 173 tanks tested
- 3 of 173 tanks inaccessible
- 88 of 154 tanks contain recoverable oil
- 88 of 88 tanks hot tapped
- 211,000 total gallons of oil recovered

Oil leaked from the flange in Tank X 4.2 and was skimmed using two support boats. The hole was domed and another had to be cut.

**6 October 2018**

Internal Tank III 5.3 was pumped via centerline Tank III 4.5. Pumped and closed Internal Tank III 5.3 via Tank IV 4.1.

- 154 of 173 tanks tested
- 3 of 173 tanks inaccessible
- 88 of 154 tanks contain recoverable oil
- 88 of 88 tanks hot tapped
- 213,961 total gallons of oil recovered

**7 October 2018**

The pumping setup was accomplished using an off-set tool to work past the frame member in the bottom of an internal tank due to a pipe obstruction.

Stripped and closed Internal Tank III 5.3.

- 155 of 173 tanks tested
- 6 of 173 tanks inaccessible
- 88 of 155 tanks contain recoverable oil
- 88 of 88 tanks hot tapped
- 213,900 total gallons of oil recovered

**8 October 2018**

Internal Tank V 5.1 hot tapped. Turbine oil from Tank V 5.1 was pumped via Tank V 4.1 center tank.

- 157 of 173 tanks tested
- 6 of 173 tanks inaccessible
- 90 of 157 tanks contain recoverable oil
- 90 of 90 tanks hot tapped
- 213,900 total gallons of oil recovered

Observed a vent hole was leaking turbine oil a short time after tapping Internal Tank V 5.1 and plugged with a DC plug. ESSM/GPC SRT boats skimmed oil using a sorbent boom. Internal Tanks III 5.2 and III 5.6 were pumped via a side shell puncture and “Mosquito” tool.

**9 October 2018**

Internal Tank V 5.1 was stripped and closed. Hot tapped Tank VIII 5.2.

- 157 of 173 tanks tested
- 7 of 173 tanks inaccessible
- 90 of 157 tanks contain recoverable oil
- 90 of 90 tanks hot tapped
- 218,100 total gallons of oil recovered

**10 October 2018**

A meeting was conducted with the Harbor Pilot and both vessel Captains to discuss vessel separation, pulling out of the moor, and anchor recovery plans. Hot tapped and closed out tanks Section VIII and IX:

- 157 of 173 tanks tested
- 8 of 173 tanks inaccessible
- 90 of 157 tanks contain recoverable oil
- 90 of 90 tanks hot tapped
- 218,100 total gallons of oil recovered

The diver's "glugged" some oil out of the hoses. The RHIB skimmed oil while the 24′ BHB performed scuba diver support operations off the wreck's stern. Squalls over the PE project site shut down operations late in the afternoon for a couple of hours.

**11 October 2018**

Two hot taps and pumping in Tanks VIII 5.1 via VIII 4.1 and 5.2 via VIII 4.2. The starboard hot tap one was done straight forward and the port was done with the off-set tool due to a pipe obstruction. Pumping on both tanks only yielded 510 gallons of good oil, but yielded probably three times that amount in water for the slops tank. The skimming boat deployed several times with minimal findings. Let the tanks settle until the next day.

- 159 of 173 tanks tested
- 9 of 173 tanks inaccessible
- 92 of 159 tanks contain recoverable oil
- 92 of 92 tanks hot tapped
- 218,600 total gallons of oil recovered

**12 October 2018**

Pumped and stripped Tank VIII 5.2 via VIII 4.2. Recovered 245 gallons of oil and then the tank was stripped all morning and closed out late in the morning. The pump was moved to Internal Tank VIII 5.1 via VIII 4.1 and it was pumped again (the first pump was the previous day). Recovered 2588 gallons of oil and more in slops. Then rested the tank, so to speak, and resumed with recovering 61 gallons then pumped twice more still getting oil.

Also, "camera spotted" Wing Tank XI 4.4 and found a steam coil inside. The steam coil made the tank inaccessible for an internal hot tap so it was closed and domed. Flange tested for accessibility. Divers spent the day leak testing and applying Devcon. Tank VIII 5.1 still needs stripping and the pump needs to be moved aft to the broach area to pump out an overhang that has trapped oil port side aft.

A hull inspection was performed prior to removing grid lines. All grid lines were removed. Also flushed and removed all hoses, pumps, and tools. A shore exercise was planned to be conducted with the locals the next day. Seven to ten ESSM/GPC crew members were assigned to help clean the beach.

Additional time was spent prepping for demobilization.

- 159 of 173 tanks tested
- 14 of 173 tanks inaccessible
- 92 of 159 tanks contain recoverable oil
- 92 of 92 tanks hot tapped
- 221,400 total gallons of oil recovered

**13 October 2018**

A beach cleanup was conducted on the Carlson Island with MDSU divers and ESSM/GPC personnel as part of an outreach program for the people of the island.

- 159 of 173 tanks tested
- 14 of 173 tanks inaccessible
- 92 of 159 tanks contain recoverable oil
- 92 of 92 tanks hot tapped
- 221,500 total gallons of oil recovered

**14 October 2018**

Pumped and closed out Tank VIII 5.1 via Tank VIII 4.1.

- 159 of 173 tanks tested
- 14 of 173 tanks inaccessible
- 92 of 159 tanks contain recoverable oil
- 92 of 92 tanks hot tapped
- 221,500 gallons of oil recovered

Quality Assurance check, divers performed a video and visual check on the entire ex-USS *PRINZ EUGEN* from the stern section to the bow to check and ensure that all close-out caps were installed, sealed, and not leaking. All brackets and clamps were removed or sealed in place if they could not be removed. All pumping equipment was removed upon the completion of pump operations. All pump equipment and hoses were removed from the wreck.

**15 October 2018**

Started demobilization of all of the operations and associated equipment.

**16 October 2018**

Equipment demobilization resumed. Mooring legs #1 through #9 were removed. The MT *HUMBER* transited to the pier for unloading.

**17 October 2018**

ESSM/GPC personnel were transited to the shore. The MT *HUMBER* departed Kwajalein Atoll at 0700. The USNS *SALVOR* transited to the pier for offload.

**18 October 2018**

ESSM/GPC personnel completed repacking equipment containers and prepping for transport. The USNS *SALVOR* departed the pier.

**19 October 2018**

ESSM/GPC personnel departed Kwajalein Atoll heading to Williamsburg, Virginia and Port Hueneme, California.

**21 October 2018**

The USNS *SALVOR* departed Kwajalein Atoll.

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# APPENDIX I

## Appendix I – Hot Tap Station Log

**PRINZ EUGEN OIL RECOVERY - HOT TAP STATION LOG - 022019 ML**

| ITEM | DATE | SECTION NUMBER | TANK NO. | GRID LOCATION | PORT/ STBD | | TANK CONTENT | 85% OF MAX VOLUME | CLEANED TANK TOP | | THICKNESS MM | TEST DRILL | | OBSERVED CONTENTS | HOT TAP COMPLETE FLANGE | | HOT TAP COMPLETE HOT TAP | | CLOSE OUT TANK | | | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MONTH/ DAY | | | NAMES | | INTERNAL/ EXTERNAL | TANK DESCRIPTION | GALLONS | DATE | TIME | ULTRA-SONIC | DATE | TIME | OIL, WATER, OR AIR | DATE | TIME | DATE | TIME | CAP DATE | CAP TIME | DEVCON | |
| | **EXTERNAL CENTER TANKS** | | | | | | | | | | | | | | | | | | | | | |
| 1 | 09/26 | **I** | **6.5** | 27" SQ OFF FWD TIP OF OUTBD STRUT PALM | STBD | EXTERNAL | FUEL OIL | 8573 | 09/26 | 1321 | 0.250 | 09/26 | | AIR | | | | | | | | |
| 2 | 09/24 | **I** | **6.6** | VISUAL INSPECTION | PORT | EXTERNAL | FUEL OIL | 8587 | | | | | | | | | | | | | | |
| 3 | 09/26 | **I** | **6.32** | 27" SQ OFF FWD TIP OF INBD STRUT PALM | CL | EXTERNAL | FUEL OIL | 10835 | 09/26 | 1346 | 0.265 | 09/26<br>09/27 | | AIR/OIL | 10/01 | 0945 | 10/01 | 1015 | 10/02 | 1030 | | |
| 4 | 9/24 | **II** | **6.3** | | STBD | EXTERNAL | FUEL OIL | 5165 | | | | | | | | | | | | | | |
| 5 | 09/24 | **II** | **6.4** | VISUAL INSPECTION | PORT | EXTERNAL | FUEL OIL | 5207 | | | | | | | | | | | | | | |
| 6 | 09/25 | **III** | **1.1** | 27" SQ FROM CL FRAME 47 TO LEFT | STBD | EXTERNAL | FUEL OIL | 6058 | 09/25 | | 0.520 | 09/25 | 1113 | OIL | 09/28 | | 09/28 | 1520 | 09/29 | 1730 | | |
| 7 | 09/24 | **III** | **1.2** | 27" SQ FROM CL FRAME 47 TO RIGHT | PORT | EXTERNAL | FUEL OIL | 6267 | 09/24 | 1243 | 0.060 | 09/26 | | WATER | | | | | | | | |
| 8 | 09/25 | **III** | **1.3** | 27" SQ FROM CL FRAME 53.5 TO LEFT | STBD | EXTERNAL | TURBINE OIL | 6605 | 09/25 | 0838 | 0.500 | 09/25 | 0905 | OIL | 09/28 | | 09/28 | 1406 | 09/28 | 1720 | | |
| 9 | 09/25 | **III** | **2.5** | 27" SQ FROM IIIS3 TO LEFT | STBD | EXTERNAL | TURBINE OIL | 1112 | 09/25 | | 0.450 | 09/25 | 0915 | OIL | 09/28 | 1210 | 09/28 | 1222 | 09/28 | 1612 | | |
| 10 | 09/25 | **III** | **2.7** | TRIANGULATE LEFT CL FR 53.5 FWD 16' 10" FR 65.75 AFT 33' 8" | STBD | EXTERNAL | TURBINE OIL | 1432 | 09/25 | 1815 | 0.510 | 09/25 | 1815 | OIL | 09/27 | 1540 | 09/28 | 0832 | 09/29 | 09/38 | | |
| 11 | 09/25 | **III** | **2.3** | 20.5" SQ FROM IIIS4 TO LEFT | STBD | EXTERNAL | TURBINE OIL | 2988 | 09/25 | 0920 | 0.480 | | 0930<br>0950 | AIR/OIL | 09/28 | 1050 | 09/28 | 1111<br>1145 | 09/28 | 1840 | | 1ST AND 2ND HOT TAPS BROKE THE DRILL BIT; 1145 TRIED PUMPING. |
| 12 | 09/25 | **III** | **4.5** | 27" SQ FROM IIIS5 TO LEFT | STBD | EXTERNAL | TURBINE OIL | 2935 | 09/25 | | 0.295 | 09/25 | 0955 | WATER | 10/04 | 1305 | 10/05 | | 10/07 | 1140 | | 10/04 HOT TAP FOR INTERNAL TANK. |
| 13 | 09/24 | **III** | **1.4** | 27" SQ FROM CL FR 53.5 TO RIGHT | PORT | EXTERNAL | FUEL OIL | 5445 | 09/24 | 1230 | 0.425 | 09/25 | | AIR/OIL | 09/30 | 1005 | 09/30 | 1035 | 10/01 | 1053 | | |
| 14 | 09/25 | **III** | **2.1** | 27" SQ FROM IIIS1 TO LEFT | STBD | EXTERNAL | FUEL OIL | 6853 | 09/25 | | 0.395 | 09/25 | 1103 | OIL | 09/29 | 0855 | 09/29 | 0920 | 09/29 | 1545 | | |

Figure I-1. Hot Tap Station Log, Sheet 1 of 14

| ITEM | DATE | SECTION NUMBER | TANK NO. | GRID LOCATION | PORT/ STBD | | TANK CONTENT | 85% OF MAX VOLUME | CLEANED TANK TOP | | THICKNESS MM | TEST DRILL | | OBSERVED CONTENTS | HOT TAP COMPLETE FLANGE | | HOT TAP COMPLETE HOT TAP | | CLOSE OUT TANK | | | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MONTH/ DAY | | | NAMES | | INTERNAL/ EXTERNAL | TANK DESCRIPTION | GALLONS | DATE | TIME | ULTRA-SONIC | DATE | TIME | OIL, WATER, OR AIR | DATE | TIME | DATE | TIME | CAP DATE | CAP TIME | DEVCON | |
| 15 | 09/24 | III | 2.2 | 27" SQ FROM IIIP1 TO RIGHT | PORT | EXTERNAL | FUEL OIL | 6896 | | | | | | | | | | | | | | |
| 16 | 09/24 | III | 2.4 | 27" SQ FROM IIIP3 TO RIGHT | PORT | EXTERNAL | FUEL OIL | 5585 | 09/24 | | 0.315<br>0.125 | | | OIL | PUNCHED THROUGH WHEN PREPPING FOR HOT TAP AND WAS LEFT OPEN TO SEA. | | | | | | | DIVER USED CHIPPING HAMMER TO MARK LOCATION, WHILE SWIMMING OVER NOTICED OIL COMING FROM MARKED LOCATION. |
| 17 | 09/26 | III | 2.6 | TRIANGULATE RIGHT FROM CL FR 53.5 FWD 24' 9.6" FR 65.75 AFT 24' 5.75" | PORT | EXTERNAL | FUEL OIL | 7155 | 09/26 | | 0.295 | 09/26 | 1208 | WATER | | | | | | | | |
| 18 | 09/26 | III | 2.9 | TRIANGULATE LEFT FROM CL FR53.5 FWD 24' 9.6" FR65.75 AFT 24' 5.75" | STBD | EXTERNAL | FUEL OIL | 5350 | 09/26 | 1042 | 0.535 | 09/26 | | AIR/OIL | 09/28<br>09/29 | 1120<br>0902 | 09/29 | 1143 | 09/29 | 1500 | | |
| 19 | 09/25 | III | 4.1 | 20.5" SQ FROM IIIS2 TO LEFT | STBD | EXTERNAL | FUEL OIL | 2927 | 09/25 | 1015 | 0.345 | 09/25 | | OIL | 09/28 | 1850 | 09/29 | 1000 | 10/09 | | | |
| 20 | 09/24 | III | 4.2 | 20.5" SQ FROM IIIP2 TO RIGHT | PORT | EXTERNAL | FUEL OIL | 2943 | | | | | | | | | | | | | | |
| 21 | 09/24 | III | 4.10 | 27" SQ FROM IIIP4 TO RIGHT | PORT | EXTERNAL | FUEL OIL | 2909 | | | | | | | | | | | | | | |
| 22 | 09/24 | III | 4.14 | TRIANGULATE RIGHT FROM CL FR 53.5 FWD 33' 1.5" FR 65.75 AFT 33' 7.375" | PORT | EXTERNAL | FUEL OIL | 4336 | | | | | | | | | | | | | | |
| 23 | 09/25 | III | 4.9 | TRIANGULATE LEFT FROM CL FR 53.5 FWD 33' 1.5" FR 65.75 AFT 33' 7.375" | STBD | EXTERNAL | FUEL OIL | 4296 | 09/25 | 1840 | 0.435 | 09/25<br>09/26 | | AIR/OIL | 09/28 | 0928 | 09/28 | 0953 | 10/03 | 1825 | | |
| 24 | 09/06 | IV | 1.1 | 27" SQ FROM CL TO LEFT *2ND HOT TAP | STBD | EXTERNAL | FUEL OIL | 12600 | | 1429 | 0.470 | | 1451 | OIL | 09/08 | 1654 | | 1-2 HRS TOTAL | 09/09<br>09/10 | 1650 | 09/14 | 09/10 RECAP TO ADD GASKET. 13 MIN FOR 1.1, 14 MIN FOR INSTALL SCREWS (12). |
| 25 | 09/06 | IV | 1.2 | 27" SQ FROM IVP1 TO LEFT *1ST HOT TAP | PORT | EXTERNAL | FUEL OIL | 12547 | | 1421 | 0.620 | | 1433 | OIL | 09/08 | 1520 | 09/08 | 1549 (:19) | 09/10 | 1651 (4TH)<br>1525 (4TH) | 09/14 | 09/10 RECAP 9/10 TO ADD GASKET. 6 MORE MINS TO TORQUE DOWN; USE LONG SCREWS FOR FLANGE. |
| 26 | 09/06 | IV | 2.1 | 27" SQ FROM IVS1 TO LEFT - CUTTER BROKE OFF INSIDE AND HAD VENT HOLE SAW | STBD | EXTERNAL | FUEL OIL | 11083 | | 1500 | 0.255 | | 1523 | AIR/WATER | 09/09 | 0930 | 09/09 | 1011 (:12) | 09/10 | 1415 (4TH)<br>1425 (4TH)<br>1440 (4TH) | 09/14 | 09/10 RECAP TO ADD GASKET. DRILLED LOW VENT HOLE ACCIDENTALLY INTO V 2.1. DRILLED ANOTHER MORE AFT; GOT SUCTION (WATER) STILL VENTING. |

Figure I-2. Hot Tap Station Log, Sheet 2 of 14

| ITEM | DATE | SECTION NUMBER | TANK NO. | GRID LOCATION | PORT/ STBD | | TANK CONTENT | 85% OF MAX VOLUME | CLEANED TANK TOP | | THICKNESS MM | TEST DRILL | | OBSERVED CONTENTS | HOT TAP COMPLETE FLANGE | | HOT TAP COMPLETE HOT TAP | | CLOSE OUT TANK | | | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MONTH/ DAY | | | NAMES | | INTERNAL/ EXTERNAL | TANK DESCRIPTION | GALLONS | DATE | TIME | ULTRA-SONIC | DATE | TIME | OIL, WATER, OR AIR | DATE | TIME | DATE | TIME | CAP DATE | CAP TIME | DEVCON | |
| 27 | 09/06 | IV | 2.2 | 27" SQ FROM IVP2 TO LEFT | PORT | EXTERNAL | FUEL OIL | 10925 | | 1417 | NO READING | | 1418 | WATER | | | | | | | | TEST DRILLED, NOTHING |
| 28 | 09/06 | IV | 4.1 | 27" SQ FROM IVS2 TO LEFT | STBD | EXTERNAL | FUEL OIL | 8190 | | 1800 | 0.755 | | 1806 | OIL | 09/09 | 1040 | | 1353 | 09/10 | 1623 (4TH)<br>1624 (4TH)<br>1632 (4TH) | 09/14 | 09/10 RECAP TO ADD GASKET. USE LONG SCREWS. |
| 29 | 09/06 | IV | 4.2 | 27" SQ FROM IVP2 TO RIGHT | PORT | EXTERNAL | FUEL OIL | 8195 | | | | | | | | | | | | | | DAMAGED |
| 30 | 09/11 | V | 2.5 | TRIANGULATE LEFT FR 76.75 FWD 22' 1.75" FR 90 AFT 30' 8.25" | STBD | EXTERNAL | FUEL OIL | 6423 | 09/11 | 0832 | 0.550 | | 1455 | OIL | 09/11 | 1812 | | | 09/12 | 1307 | | |
| 31 | 09/11 | V | 2.6 | TRIANGULATE RIGHT FR 76.75 FWD 22' 1.75" FR 90 AFT 30' 8.25" | PORT | EXTERNAL | FUEL OIL | 6402 | 09/11 | 1325 | 0.480 | | 1355<br>1403 | AIR/OIL | 09/11 | 1457 | 09/11 | 1735 | 09/12 | 0828 | 09/14 | 8 MIN BLEED AIR |
| 32 | 09/09 | V | 4.1 | 27" SQ LEFT FROM VS3 | STBD | EXTERNAL | FUEL OIL | 4697 | | 0855 | 0.445 | | 0930 | AIR/OIL | | 1420 | NA | NA (SEE NOTE 2) | 09/11 | 1643 | 09/14 | ADDITIONAL VENT. VENTED AIR FOR 4 HOURS PRIOR TO EXTRACTING OIL.<br>09/10 ADDED 2-5/8" VENT HOLE. |
| 33 | 09/06 | V | 4.2 | 27" SQ RIGHT FROM VP2 | PORT | EXTERNAL | FUEL OIL | 4700 | | | | | | | | | | | | | | |
| 34 | 09/10 | V | 4.7 | TRIANGULATE LEFT FROM FR 76.75 FWD 34' 11.125" FR 90 AFT 35' 2.5" | STBD | EXTERNAL | FUEL OIL | 5974 | 09/10 | 9/10 | 0.385 | | | AIR/OIL | 09/11 | 1252 | 09/11 | 1316 | 09/12 | 0915 | 09/14 | TEST HOLE OUTSIDE HOT TAP FLANGE HOLE. |
| 35 | 09/10 | V | 4.8 | TRIANGULATE RIGHT FROM FR 76.75 FWD 34' 11.125" FR 90 AFT 35' 2.5" | PORT | EXTERNAL | FUEL OIL | 6008 | 09/10 | 9/10 | 0.385 | | | AIR/OIL | 09/11 | 1000 | 09/11 | 1028 | 09/11 | 1413 | 09/14 | FIRST PUMP @ 20 GPM, REQUIRED VENT HOLE (VENT 13/2). |
| 36 | 09/07 | V | 1.1 | 27" SQ LEFT FROM VS1 | STBD | EXTERNAL | TURBINE OIL COLLECTION | 6536 | 09/07 | 1705 | 0.480 | | 1751 | OIL | | 1522 | 09/10 | | 09/11 | 0900 | 09/14 | OIL OUT RIGHT AWAY. |
| 37 | 09/07 | V | 1.2 | 27" SQ LEFT FROM VP1 | PORT | EXTERNAL | TURBINE OIL COLLECTION | 6452 | 09/07 | 1650 | 0.575 | | 1700 | AIR/OIL | 09/11 | | 09/11 | 0930 | 09/11 | 1348 | 09/14 | LESS THAN 1 MIN AIR BLEEDING THEN OIL OUT OF TEST HOLE. |
| 38 | 09/06 | V | 2.1 | 27" SQ LEFT FROM VS2 | STBD | EXTERNAL | TURBINE OIL PURIFIED | 1450 | 09/06 | 1600 | NA | | 1605 | WATER | | | | | | | | ACCIDENTALLY DRILLED HOLE WHEN TRYING TO VENT IV 2.1. |
| 39 | 09/07 | V | 2.2 | 27" SQ RIGHT FROM VP1 | PORT | EXTERNAL | TURBINE OIL PURIFIED | 1450 | 09/07 | 1620 | 0.335 | | 1642 | AIR/OIL | 09/10 | | 09/11 | 0850 | 09/11 | 1043 | 09/14 | BLED AIR FOR 1 HOUR, THEN OIL. |
| 40 | 09/10 | V | 2.3 | TRIANGULATE LEFT FR 76.75 FWD 24' .875" FR 90 AFT 38' 2.625" | STBD | EXTERNAL | DIRT OIL TANK | 1495 | 09/10 | 1755 | 0.495 | | | WATER | | | | | | | | |

Figure I-3. Hot Tap Station Log, Sheet 3 of 14

| ITEM | DATE | SECTION NUMBER | TANK NO. | GRID LOCATION | PORT/ STBD | | TANK CONTENT | 85% OF MAX VOLUME | CLEANED TANK TOP | | THICKNESS MM | TEST DRILL | | OBSERVED CONTENTS | HOT TAP COMPLETE FLANGE | | HOT TAP COMPLETE HOT TAP | | CLOSE OUT TANK | | | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MONTH/ DAY | | | NAMES | | INTERNAL/ EXTERNAL | TANK DESCRIPTION | GALLONS | DATE | TIME | ULTRA-SONIC | DATE | TIME | OIL, WATER, OR AIR | DATE | TIME | DATE | TIME | CAP DATE | CAP TIME | DEVCON | |
| 41 | 09/10 | V | 2.4 | TRIANGULATE RIGHT FR 76.75 FWD 24' .875" FR 90 AFT 38' 2.625" | PORT | EXTERNAL | DIRT OIL TANK | 1495 | 09/10 | 1823 | | | | WATER | | | | | | | | |
| 42 | 09/11 | VI | 1.2 | 27" SQ LEFT FROM VIP1 | PORT | EXTERNAL | FUEL OIL | 12914 | 09/11 | 1850 | 0.595 | 09/11 | 1857 | OIL | 09/12 | 1155 | 09/12 | 1240 | 09/13 | 0929 | 09/14 | TEST HOLE DRILL BIT BROKE; USED PUNCH TO DRIVE THROUGH AND INSTALL BOLT. |
| 43 | 09/11 | VI | 2.1 | 27" SQ LEFT FROM VIS1 | STBD | EXTERNAL | FUEL OIL | 10264 | 09/11 | 1839 | 0.745 | 09/11 | | OIL | 09/12 | 1050 | 09/12 | 1117 | 09/13 | 1000 | 09/14 | 2 BROKEN FLANGE BOLTS. 1 HOLE LEAKED. USED PUDDY FROM TOOL BOX. |
| 44 | 09/12 | VI | 2.2 | 27" SQ RIGHT FROM VIP1 | PORT | EXTERNAL | FUEL OIL | 10330 | 09/12 | 1014 | 0.701 | 09/12 | 1023 | OIL | 09/12 | 1445 | 09/12 | 1549 | 09/13 | 0908 | 09/14 | MOVED HOT TAP HOLE TO VI P1 RIGHT DUE TO SEA CHEST LOCATION. 11 OF 12 FLANGE BOLTS. |
| 45 | 09/11 | VI | 4.1 | 27" SQ LEFT FROM VIS2 | STBD | EXTERNAL | FUEL OIL | 9411 | 09/11 | 1815 | 0.723 | 09/11 | 1825 | WATER | | | | | | | | |
| 46 | 09/12 | VI | 4.2 | 27" SQ RIGHT FROM VIP2 | PORT | EXTERNAL | FUEL OIL | 9334 | 09/12 | 1034 | 0.685 | 09/12 | 1042 | AIR/OIL | 09/12 | 1618 | 09/12 | 1710 | 09/13 | 0847 | 09/14 | DIP STICK HAD OIL @ 2FT. STARTED TO ADD VENT, BUT STOPPED. |
| 47 | 09/12 | VII | 1.1 | 27" SQ LEFT FROM CL FRAME 101.6 | STBD | EXTERNAL | FUEL OIL | 5831 | 09/12 | 1223 | 0.495 | | 1442<br>1458 | AIR/OIL | 09/13 | 1240 | 09/13 | 1305 | 09/13 | 1630 | | USED PKS VENT TEE FITTING/TEE. CLOSED TANK AFTER 1ST PUMP |
| 48 | 09/12 | VII | 1.2 | 27" SQ LEFT FROM VIIP1 | POR | EXTERNAL | FUEL OIL | 5955 | 09/12 | 1213 | 0.620 | 09/12 | 1301 | OIL | 09/13 | 0940 | 09/13 | 1158 | 09/14 | 0950 | | TEST HOLE BOLT STUCK UNDER FLANGE. LOOSENED FLANGE TO REMOVE BOLT. FLANGE COMPLETED AT 1040. |
| 49 | 09/06 | VII | 1.3 | 27" SQ LEFT FROM CL FRAME 106.6 | STBD | EXTERNAL | FUEL OIL | 12840 | 09/12 | 1750 | 0.590 | | 0 | OIL | 09/13 | 1700 (9 OF 12 BLT) | 09/14 | 1155 | 09/14 | 1400 | | GOT OIL WHEN INSTALLING CENTER GRID LINE HARD POINT. |
| 50 | 09/12 | VII | 2.1 | 27" SQ LEFT FROM VIIS1 | STBD | EXTERNAL | FUEL OIL | 5189 | 09/12 | 1230 | 0.470 | | 1450<br>1500 | WATER/OIL | 09/13 | 1330 | 09/13 | 1346 | 09/14 | 1035 | | TEST DRILL LOOKED TO BE WATER, BUT ENDED UP BEING OIL. |
| 51 | 09/12 | VII | 2.2 | 27" SQ LEFT FROM VIIP2 | PORT | EXTERNAL | FUEL OIL | 5102 | 09/12 | 1200 | 0.443 | | 1253 | OIL | 09/13 | 1055 | 09/13 | 1119<br>1145 | 09/14 | 0925 | | HOT TAP DIDN'T GO THROUGH. BISCUIT BANGER CONFIRMED IT DID, E.G. PUSHED THE BISCUIT THROUGH. |
| 52 | 09/12 | VII | 2.3 | 27" SQUARE LEFT FROM VIIS3 | STBD | EXTERNAL | FUEL OIL | 11239 | 09/12 | 1755 | 0.525 | 09/13 | 1418 | OIL | 09/13 | 1745 | 09/14 | 1125 | 09/14 | 1240 | | |
| 53 | 09/12 | VII | 2.4 | 27" SQ LEFT FROM VIIP3 | PORT | EXTERNAL | FUEL OIL | 11221 | 09/12 | 1745 | 0.455 | NA | NA | NA | 09/13 | 1443 | 09/13 | 1538 | 09/14 | 0905 | | |
| 54 | 09/12 | VII | 4.1 | 27" SQ LEFT FROM VIIS2 | STBD | EXTERNAL | FUEL OIL | 4037 | 09/12 | | 0.440 | | 1455<br>1508 | AIR/OIL | 09/13 | 1842 | 09/14 | 0945 | 09/14 | 1740 | | DIP STICK HAD OIL @ 2FT. HAVING TROUBLE GETTING SUCTION |

Figure I-4. Hot Tap Station Log, Sheet 4 of 14

| ITEM | DATE MONTH/ DAY | SECTION NUMBER | TANK NO. | GRID LOCATION NAMES | PORT/ STBD | INTERNAL/ EXTERNAL | TANK CONTENT TANK DESCRIPTION | 85% OF MAX VOLUME GALLONS | CLEANED TANK TOP DATE | CLEANED TANK TOP TIME | THICKNESS MM ULTRA-SONIC | TEST DRILL DATE | TEST DRILL TIME | OBSERVED CONTENTS OIL, WATER, OR AIR | HOT TAP COMPLETE FLANGE DATE | HOT TAP COMPLETE FLANGE TIME | HOT TAP COMPLETE HOT TAP DATE | HOT TAP COMPLETE HOT TAP TIME | CLOSE OUT TANK CAP DATE | CLOSE OUT TANK CAP TIME | CLOSE OUT TANK DEVCON | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 55 | 09/12 | **VII** | **4.2** | 27" SQ RIGHT FROM VIIP2 | PORT | EXTERNAL | FUEL OIL | 4029 | 09/12 | 1140 | 0.445 | | 1150<br>1207 | AIR/WATER/ OIL | 09/12 | 1749 | 09/12 | 1820 | 09/13 | 1052 | | DIP STICK HAD OIL @ 2 FT. 11 OF 12 FLANGE BOLTS. (SEE NOTE 4) |
| 56 | 09/12 | **VII** | **4.5** | 27" SQ LEFT FROM VIIS4 | STBD | EXTERNAL | FUEL OIL | 9141 | 09/12 | 1800 | 0.410 | 09/13 | 1420<br>1435 | AIR/OIL | 09/13 | 1815 | 09/14 | 1015 | 09/14 | 1650 | | |
| 57 | 09/12 | **VII** | **4.6** | 27" SQ RIGHT FROM VIIP3 | PORT | EXTERNAL | FUEL OIL | 9136 | 09/12 | 1742 | 0.335 | NA | NA | NA | 09/13 | 1522 | 09/13 | 1553 | 09/14 | 0852 | | 1600 HOT TAP VENTED AIR. TRYING PKS VENT TOOL, PUMP CURVE MAY HAVE LOST PUMP PRIME, SHOT OF AIR MAY HAVE BEEN CAUSE. (SEE NOTE 5) |
| 58 | 09/13 | **VIII** | **1.2** | 27" SQ LEFT FROM VIIIP1 | PORT | EXTERNAL | FUEL OIL | 12465 | 09/13 | 1510 | 0.480 | | 1710 | AIR/OIL | 09/14 | 1530 | 09/15 | 0907 | 09/16 | 1350 | | |
| 59 | 09/13 | **VIII** | **2.1** | 27" SQ LEFT FROM VIIIS1 | STBD | EXTERNAL | FUEL OIL | 11453 | 09/13 | 1515 | 0.540 | | 1711 | AIR/OIL | 09/14 | 1612 | 09/14 | 1903 | 09/16 | 1640 | | 9/13 PLUG FOR NIGHT. FLANGE BOLT BLEEDING AIR DURING INSTALLATION. |
| 60 | 09/13 | **VIII** | **2.2** | 27" SQ RIGHT FROM VIIIP1 | PORT | EXTERNAL | FUEL OIL | 11678 | 09/13 | 1508 | 0.620 | | | AIR/OIL | 09/14 | 1500 | 09/15 | 0942 | 09/15 | 2150 | | 11 OF 12 BOLTS INSTALLED. |
| 61 | 09/07 | **VIII** | **4.1** | 27" SQ LEFT FROM VIIIS2 | STBD | EXTERNAL | FUEL OIL | 8782 | NA | NA | 0.445 | | | OIL 9/7 | 09/14 | 1712 | 09/14 | 1830 | 09/15 | 1025 | | OIL WHEN INSTALLING BILGE KEEL. GRID HARD POINT, 2ND FLANGE FOR INTERNAL HOT TAP. |
| 62 | 09/07 | **VIII** | **4.2** | 27" SQ RIGHT FROM VIIIP2 | PORT | EXTERNAL | FUEL OIL | 8832 | NA | NA | 0.440 | | | 9/7 AIR/OIL | 09/14 | 1415 | 09/15 | 1630 | 09/28 | 09/15 | | OIL DURING GRID INSTALL. FLANGE BOLT LEAKING AIR BEFORE TORQUE. |
| 63 | 09/15 | **IX** | **1.2** | 27" SQ LEFT FROM IXP1 | PORT | EXTERNAL | DIESEL | 7051 | 09/15 | | 0.515 | 09/15 | 0902 | OIL | 09/16 | | 09/17 | 0830 | 09/17 | 1053 | | 9/15 REBOLT FLANGE. USED PKS VERSION 2 VENT TUBE TO STRIP TANK. |
| 64 | 09/14 | **IX** | **1.3** | 27" SQ LEFT FROM CL | STBD | EXTERNAL | DIESEL | 3654 | 09/14 | 1558 | 0.589 | NA | NA | WATER | | | | | | | | DIESEL TANK |
| 65 | 09/14 | **IX** | **2.1** | 27" SQ LEFT FROM IXS2 | STBD | EXTERNAL | DIESEL | 5889 | 09/14 | 1627 | 0.550 | NA | NA | 9/15 AIR/OIL | 09/17 | 1340 | 09/17 | 1357 | 09/17 | 1625 | | DIESEL TANK |
| 66 | 09/15 | **IX** | **2.2** | 27" SQ LEFT OF 1XP2 | PORT | EXTERNAL | DIESEL | 5995 | 09/15 | 0912 | 0.460 | NA | NA | AIR/OIL | 09/17 | 0955 | 09/17 | 1010 | 09/17 | 1115 | | DIESEL TANK LOCATED BASED ON PREVIOUS TANK LOCATIONS |
| 67 | 09/14 | **IX** | **4.1** | 27" SQ LEFT FROM IXS3 | STBD | EXTERNAL | DIESEL | 4000 | 09/14 | 1634 | 0.370 | NA | NA | AIR/OIL | 09/17 | 1550 | 09/17 | 1615 | 09/17 | 1715 | | DIESEL TANK |
| 68 | 09/14 | **IX** | **4.2** | 27" SQ RIGHT FROM IXP2 | PORT | EXTERNAL | DIESEL | 4016 | 09/14 | 0930 | 0.435 | | 0937 | AIR/OIL | 09/17 | | 09/17 | 1100 | 09/17<br>10/10 | 1230 | | 9/19 DIESEL TANK CAP SHOWED AIR/OPENED. 10/10 CAMERA OBSTRUCTION INACCESSIBLE |

Figure I-5. Hot Tap Station Log, Sheet 5 of 14

| ITEM | DATE | SECTION NUMBER | TANK NO. | GRID LOCATION | PORT/ STBD | | TANK CONTENT | 85% OF MAX VOLUME | CLEANED TANK TOP | | THICKNESS MM | TEST DRILL | | OBSERVED CONTENTS | HOT TAP COMPLETE FLANGE | | HOT TAP COMPLETE HOT TAP | | CLOSE OUT TANK | | | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MONTH/ DAY | | | NAMES | | INTERNAL/ EXTERNAL | TANK DESCRIPTION | GALLONS | DATE | TIME | ULTRA-SONIC | DATE | TIME | OIL, WATER, OR AIR | DATE | TIME | DATE | TIME | CAP DATE | CAP TIME | DEVCON | |
| 69 | 09/14 | IX | 1.1 | 27" SQ LEFT FROM IXS1 | STBD | EXTERNAL | DIESEL | 3205 | 09/14 | 1617 | 0.570 | NA | NA | AIR/OIL | 09/18 | 0830 | 09/18 | 0900 | 09/18 | 1005 | | DIESEL TANK - FLANGE INSTALLATION WAS DIFFICULT DUE TO SEA CHEST IN THE AREA. |
| 70 | 09/17 | X | 1.1 | 27" SQ LEFT FROM CL | STBD | EXTERNAL | FUEL OIL | 11310 | 09/17 | | 0.435 | 09/17 | 1211 | OIL | 09/18 | 1035 | 09/18 | | 09/27 | 1500 | | HOT TAP ISSUES, FLANGE MAYBE LOCATED ON A FRAME. |
| 71 | 09/17 | X | 1.2 | 27" SQ LEFT FROM XP1 | PORT | EXTERNAL | FUEL OIL | 11081 | 09/17 | 0820 | 0.505 | 09/17 | | AIR/OIL/ WATER | 09/18 | 1505 | 09/18 | 1530 | 09/18 | 1613 | | AFTER HOT TAP AND BLEEDING AIR, SAW A TRACE OF OIL, BUT WITH BALL VALVE OPEN ONLY WATER - NO PUMP. |
| 72 | 09/17 | X | 2.1 | 27" SQ LEFT FROM XS1 | STBD | EXTERNAL | FUEL OIL | 9918 | 09/17 | 1225 | 0.395 | 09/17 | 1230 | OIL | 09/18 | 0945 | 09/18 | 1010 | 09/18 | 1350 | | |
| 73 | 09/17 | X | 2.2 | 27" SQ RIGHT FROM XP1 | PORT | EXTERNAL | FUEL OIL | 10085 | 09/17 | 0940 | 0.385 | 09/17 | | AIR | 09/18 | 1618 | 09/18 | 1705 | 09/19 | 0942 | | |
| 74 | 09/17 | X | 4.1 | 24" SQ LEFT FROM XS2 | STBD | EXTERNAL | FUEL OIL | 5128 | 09/17 | 1245 | 0.355 | 09/17 | 1305 | WATER | | | | | | | | |
| 75 | 09/17 | X | 4.2 | 24' SQ RIGHT FROM XP2 | PORT | EXTERNAL | FUEL OIL | 5133 | 09/17 | 0935 | 0.380 | 09/17 | | AIR | 09/19 | | 09/19 | 0925 | 09/19<br>10/14 | 1220<br>1445 | | FLANGED IN 9/18, TORQUED 9/19. HOT TAP BISCUIT WAS IN THE WAY OF THE CAP, KNOCKED OUT. REDOMED. (SEE NOTE 6) |
| 76 | 09/18 | XI | 6.1 | 27" SQ LEFT FROM CL 2ND HOLE: TRIANGULATE FWD FROM FR 147 14' 11.5" FROM FR 157.6 AFT 35' 8.75" | STBD | EXTERNAL | FUEL OIL | 16021 | 09/18 | 1534 | 0.730<br>0.505 | 09/18 | 1543 | AIR/OIL<br>9/19 1120 | 09/19 | 1310 | 09/19 | 1420 | 09/19 | 1605 | | TWO TEST HOLES REQUIRED TO ENSURE THAT THESE TANKS ARE SINGLE TANKS AND NOT DOUBLE TANKS. CONFIRMED SINGLE TANK. |
| 77 | 09/18 | XI | 6.2 | 27" SQ RIGHT FROM CL 2ND HOLE: TRIANGULATE FWD FROM FR 147 14' 11.5" FROM FR 157.6 AFT 35' 8.75" | PORT | EXTERNAL | FUEL OIL | 17472 | 09/18 | 1548 | 0.515 | 09/18 | 1551<br>1600 | AIR/OIL | 09/19 | 1518 | 09/19 | 1538 | 09/21 | | | |
| 78 | 09/18 | XI | 6.4 | 27" SQ RIGHT FROM CL 2ND HOLE: TRIANGULATE FWD FROM FR 147 14' 11.5" FROM FR 157.6 AFT 21' 11.4" | PORT | EXTERNAL | FUEL OIL | 19030 | 09/18 | 1630 | 0.485 | 09/18 | 1634 | AIR/OIL<br>9/19 1850 | 09/19 | 1750 | 09/19 | 1825 | 09/21 | 0925 | | BLEED AIR AFTER HOT TAP. |
| 79 | 09/18 | XI | 6.5 | 27" SQ LEFT FROM CL FR 151.9 FR 147 FWD 23' 4.9" FR 157.6 AFT 21' 11.4" | STBD | EXTERNAL | FUEL OIL | 14232 | 09/18 | 1558 | 0.505 | 09/18<br>09/19 | 0945<br>0503 | AIR/WATER | | | | | | | | |
| 80 | 09/19 | XI | 6.6 | 27" SQ RIGHT FROM CL FR 157.6 FR 157.6 FWD 14" 6" THEN AFT FROM FR 167.5 33' 5.25" | PORT | EXTERNAL | FUEL OIL | 14975 | 09/19 | 0820 | 0.455 | 09/19 | 0825 | OIL | 09/20 | 0935 | 09/20 | 1003 | 09/20 | 1200 | | TEST HOLE OUTSIDE OF FLANGE. |
| 81 | 09/19 | XI | 6.9 | 27" SQ LEFT FROM CL FR 157.6 2ND HOLE: TRIANGULATE FROM FR 162.5 FWD 14' 6" FR 167.5 AFT 33' 5.25" | STBD | EXTERNAL | FUEL OIL | 12756 | 09/19 | 0823 | 0.475 | 09/19 | 0834 | OIL | 09/20 | 1115 | 09/20 | 1143 | 09/21 | | | TEST HOLE OUTSIDE OF FLANGE. |

Figure I-6. Hot Tap Station Log, Sheet 6 of 14

| ITEM | DATE | SECTION NUMBER | TANK NO. | GRID LOCATION | PORT/ STBD | | TANK CONTENT | 85% OF MAX VOLUME | CLEANED TANK TOP | | THICKNESS MM | TEST DRILL | | OBSERVED CONTENTS | HOT TAP COMPLETE FLANGE | | HOT TAP COMPLETE HOT TAP | | CLOSE OUT TANK | | | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MONTH/ DAY | | | NAMES | | INTERNAL/ EXTERNAL | TANK DESCRIPTION | GALLONS | DATE | TIME | ULTRA-SONIC | DATE | TIME | OIL, WATER, OR AIR | DATE | TIME | DATE | TIME | CAP DATE | CAP TIME | DEVCON | |
| 82 | 09/19 | **XI** | **6.8** | 27" SQ RIGHT FROM CL FR 162.5 2ND HOLE: TRIANGULATE FROM FR 157.6 FWD 23' 5.125" FR 167.5 AFT 20' 3.125" | PORT | EXTERNAL | FUEL OIL | 10993 | 09/19 | | 0.440 | 09/19 | 0905 | OIL | 09/20 | | 09/20 | 1310 | 09/21 | 1412 | | |
| 83 | 09/19 | **XI** | **6.11** | 27" SQ LEFT FROM CL FR162.5 2ND HOLE: TRIANGULATE FROM FR 157.6 FWD 23' 5.125" FR 167.5 AFT 20' 3.125" | STBD | EXTERNAL | FUEL OIL | 9295 | 09/19 | 0850 | 0.405 | 09/19 | 0857 | AIR/OIL | 09/20 | 1340 | 09/20 | 1400 | 09/21 | 1154 | | TWO TEST HOLES REQUIRED TO ENSURE THAT THESE TANKS ARE SINGLE TANKS AND NOT DOUBLE TANKS. |
| 84 | 09/21 | **XII** | **6.6** | 27" SQ FROM RIGHT FROM CL OF FR 176.375 | PORT | EXTERNAL | FUEL OIL | 4938 | 09/21 | 0908 | 0.365 | 09/21 | | AIR/OIL | 09/21 | 1255 | 09/21 | 1315 | 09/24 | 1130 | | |
| 85 | 09/21 | **XII** | **6.7** | 27" SQ FROM LEFT OF CL FR 176.375 | STBD | EXTERNAL | FUEL OIL | 3942 | 09/21 | 0910 | 0.365 | 09/21 | | AIR/OIL | 09/21 | | 09/21 | 1346 | 09/22 | 1220 | | |
| 86 | 09/21 | **XIII** | **6.1** | 27" SQ FROM LEFT OF CL FR 180.5 | STBD | EXTERNAL | FUEL OIL | 7974 | 09/21 | 0852 | 0.345 | 09/21 | | AIR/OIL | 09/22 | 0935 | 09/22 | 0950 | 09/23 | 1700 | | |
| 87 | 09/21 | **XIII** | **6.2** | 27" SQ FROM RIGHT OF CL FR 180.5 | PORT | EXTERNAL | FUEL OIL | 7984 | 09/21 | 0856 | 0.450 | 09/21 | | AIR/OIL | 09/22 | 1018 | 09/22 | 1034 | 09/24 | 0930 | | |
| 88 | 09/21 | **XIII** | **6.3** | 27" SQ FROM LEFT OF CL FR 183.25 | STBD | EXTERNAL | FUEL OIL | 9802 | 09/21 | 0836 | 0.360 | 09/21 | | AIR/OIL | 09/22 | 1443 | 09/22 | 1508 | 09/23 | 1512 | | FLANGE LEAKED OIL - WAS MISSED TEST HOLE UNDER FLANGE GASKET. |
| 89 | 09/21 | **XIII** | **6.4** | 27" SQ FROM RIGHT OF CL FR 183.25 | PORT | EXTERNAL | FUEL OIL | 9828 | 09/21 | 0842 | 0.345 | 09/21<br>09/22 | | AIR/OIL | 09/22 | 1420 | 09/22 | 1428 | 09/23 | 1555 | | |
| 90 | 09/21 | **XIII** | **6.29** | 27"SQ FROM RIGHT OF CL FR 187.25 | CL | EXTERNAL | FUEL OIL | 14359 | 09/21 | 0822 | 0.360 | 09/21 | | AIR/OIL | 09/22 | 1600 | 09/22 | 1615 | 09/23 | 1415 | | |
| | | | | | | | CENTERLINE EXTERNAL TANKS | 686331 | | | | | | | | | | | | | | |

Figure I-7. Hot Tap Station Log, Sheet 7 of 14

| ITEM | DATE | SECTION NUMBER | TANK NO. | GRID LOCATION | PORT/ STBD | | TANK CONTENT | 85% OF MAX VOLUME | CLEANED TANK TOP | | THICKNESS MM | TEST DRILL | | OBSERVED CONTENTS | HOT TAP COMPLETE FLANGE | | HOT TAP COMPLETE HOT TAP | | CLOSE OUT TANK | | | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MONTH/ DAY | | | NAMES | | INTERNAL/ EXTERNAL | TANK DESCRIPTION | GALLONS | DATE | TIME | ULTRA-SONIC | DATE | TIME | OIL, WATER, OR AIR | DATE | TIME | DATE | TIME | CAP DATE | CAP TIME | DEVCON | |
| | **EXTERNAL WING TANKS** | | | | | | | | | | | | | | | | | | | | | |
| 91 | 09/25 | II | 4.3 | 16' 8.6" | STBD | EXTERNAL | FUEL OIL | 3406 | 09/25 | 1310 | 0.340 | 09/25 | | WATER | | | | | | | | LOCATION LINE START FR 65.75 RUN AFT TO OB STRUT ARM PALM (151' 5.25"). DRILL LOCATION IS 16' 8.6" AFT OF TANK 4.5. |
| 92 | 09/24 | II | 4.4 | 16' 8.6" | PORT | EXTERNAL | FUEL OIL | 3406 | | | | | | | | | | | | | | LOCATION LINE START FR 65.75 RUN AFT TO OB STRUT ARM PALM (151' 5.25"). DRILL LOCATION IS 16' 8.6" AFT OF TANK 4.6. |
| 93 | 09/25 | II | 4.5 | 16' .375" | STBD | EXTERNAL | RES FUEL OIL | 2904 | 09/25 | 1305 | 0.355 | 09/25 | | WATER | 10/03 | 1310 | 10/03 | 1343 | 10/04 | 1755 | | LOCATION LINE START FR 65.75 RUN AFT TO OB STRUT ARM PALM (151' 5.25"). DRILL LOCATION IS 16' 3.75" AFT OF TANK 4.7. HOT TAP FOR IT 5.1. |
| 94 | 09/24 | II | 4.6 | 16' .375" | PORT | EXTERNAL | RES FUEL OIL | 2904 | | | | | | | | | | | | | | LOCATION LINE START FR 65.75 RUN AFT TO OB STRUT ARM PALM (151' 5.25"). DRILL LOCATION IS 16' 8.6" AFT OF TANK 4.8. |
| 95 | 09/25 | II | 4.7 | 19' 3.375" | STBD | EXTERNAL | RES FUEL OIL | 4362 | 09/25 | 1301 | 0.340 | NA | NA | OIL | 09/30 | | 10/01 | 0935 | 10/7 | (SEE NOTE 8) | | LOCATION LINE START FR 65.75 RUN AFT TO OB STRUT ARM PALM (151' 5.25"). DRILL LOCATION IS 19' 3.8" AFT OF TANK 4.9. RE-HOT TAP TO SUIT IT TOOL. |
| 96 | 09/24 | II | 4.8 | 19' 3.375" | PORT | EXTERNAL | RES FUEL OIL | 4362 | | | | | | | | | | | | | | LOCATION LINE START FR 65.75 RUN AFT TO OB STRUT ARM PALM (151' 5.25"). DRILL LOCATION IS 19' 3.8" AFT OF TANK 4.10. |
| 97 | 09/25 | II | 4.9 | 76' 4" | STBD | EXTERNAL | RES FUEL OIL | 3934 | 09/25 | 1255 | 0.355 | | | WATER | 10/03 | | 10/04 | | 10/06 | 0956 | | LOCATION START LINE FR 65.75 RUN AFT TO OB STRUT ARM PALM (151' 5.25"). DRILL LOCATION IS 76' 4" AFT FROM START. HOT TAP FOR IT 5.5. |
| 98 | 09/24 | II | 4.10 | 76' 4" | PORT | EXTERNAL | RES FUEL OIL | 3934 | | | | | | | | | | | | | | LOCATION LINE START FR 65.75 RUN AFT TO OB STRUT ARM PALM (151' 5.25"). DRILL LOCATION IS 76' 4" AFT FROM START. |
| 99 | 09/25 | III | 4.3 | TRIANGULATE FROM CL FR 47 FWD 32'9" AFT FROM FR 53.5 38' 5.8" | STBD | EXTERNAL | RES FUEL OIL | 5873 | 09/25 | | 0.340 | 09/25 | 1700 | AIR/OIL 1805 | 09/30 | 1640 | 09/30 | 1820 | 10/01 | 1418 | | |
| 100 | 09/24 | III | 4.8 | TRIANGULATE FROM CL FR 47 FWD 33' 6" AFT FROM FR 53.5 35' 10.9" | PORT | EXTERNAL | RES FUEL OIL | 2354 | | | | | | | | | | | | | | |
| 101 | 09/25 | III | 4.7 | TRIANGULATE FROM CL FR 47 FWD 40'9" AFT FROM FR 65.76 51' 3.4" | STBD | EXTERNAL | RES FUEL OIL | 4914 | 09/25 | 1730 | 0.330 | 09/25 | | WATER | | | | | | | | |
| 102 | 09/24 | III | 4.12 | TRIANGULATE FROM CL FR 47 FWD 40'9" AFT 51' 3.4" FROM FR 65.76 | PORT | EXTERNAL | RES FUEL OIL | 5691 | | | | | | | | | | | | | | |
| 103 | 09/25 | III | 4.11 | TRIANGULATE FROM CL OF FR 53.5 FWD 39'9.6" AFT FROM FR 65.76 40' 2.4" | STBD | EXTERNAL | RES FUEL OIL | 3770 | 09/25 | 1607 | 0.350 | 09/25 | 1615 | OIL | 09/29 | | 09/29 | 1705 | 09/29 | 1810 | | |

Figure I-8. Hot Tap Station Log, Sheet 8 of 14

| ITEM | DATE | SECTION NUMBER | TANK NO. | GRID LOCATION | PORT/ STBD | | TANK CONTENT | 85% OF MAX VOLUME | CLEANED TANK TOP | | THICKNESS MM | TEST DRILL | | OBSERVED CONTENTS | HOT TAP COMPLETE FLANGE | | HOT TAP COMPLETE HOT TAP | | CLOSE OUT TANK | | | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MONTH/ DAY | | | NAMES | | INTERNAL/ EXTERNAL | TANK DESCRIPTION | GALLONS | DATE | TIME | ULTRA-SONIC | DATE | TIME | OIL, WATER, OR AIR | DATE | TIME | DATE | TIME | CAP DATE | CAP TIME | DEVCON | |
| 104 | 09/26 | III | 4.13 | TRIANGULATE FROM CL FR 47 FWD 56' 1.25" AFT FROM FR 65.75 49' 1.25" | STBD | EXTERNAL | TURBINE OIL | 5839 | 09/26 | | NA | 09/26 | 1010 | WATER | | | | | | | | LOCATION LINE MADE UP ON-SITE. |
| 105 | 09/24 | III | 4.16 | TRIANGULATE FROM RIGHT CL OF FR 53.5 FWD 39'9.6" AFT FROM FR 65.76 40' 2.4" | PORT | EXTERNAL | RES FUEL OIL | 8211 | | | | | | | | | | | | | | |
| 106 | 09/18 | IV | 4.5 | TRIANGULATE FROM BILGE KEEL FR 65.75 FWD 7'7" & AFT FROM FR 76.75 29' 11.6" | STBD | EXTERNAL | RES FUEL OIL | 6594 | 09/18 | 1345 | 0.360 | 09/18 | | OIL/WATER | 09/29 | | 09/29 | 1443 | | | | WHEN INSTALLING THE HOT TAP FLANGE, THE TEST HOLE SHOWED ONLY WATER. |
| 107 | 09/18 | IV | 4.6 | TRIANGULATE FROM BILGE KEEL FR 65.75 FWD 7'7" & AFT FROM FR 76.75 29' 11.6" | PORT | EXTERNAL | RES FUEL OIL | 6594 | | | | | | | | | | | | | | |
| 108 | 09/18 | IV | 4.7 | TRIANGULATE FROM BILGE KEEL FR 65.75 FWD 20'7" & AFT FROM FR 76.75 16' 10.5" | STBD | EXTERNAL | RES FUEL OIL | 7287 | 09/18 | 1355 | 0.360 | 09/18 | | WATER | | | | | | | | |
| 109 | 09/18 | IV | 4.8 | TRIANGULATE FROM BILGE KEEL FR 65.75 FWD 20'7" & AFT FROM FR 76.75 16' 10.5" | PORT | EXTERNAL | RES FUEL OIL | 7287 | | | | | | | | | | | | | | |
| 110 | | V | 4.3 | SEE NOTE | STBD | EXTERNAL | PLANE FUEL | 1308 | | | | | | | | | | | | | | AVIATION GAS TANKS WERE NOT ACCESSED. |
| 111 | | V | 4.4 | SEE NOTE | PORT | EXTERNAL | PLANE FUEL | 1308 | | | | | | | | | | | | | | AVIATION GAS TANKS WERE NOT ACCESSED. |
| 112 | | V | 4.9 | SEE NOTE | STBD | EXTERNAL | PLANE FUEL | 1308 | | | | | | | | | | | | | | AVIATION GAS TANKS WERE NOT ACCESSED. |
| 113 | | V | 4.10 | SEE NOTE | PORT | EXTERNAL | PLANE FUEL | 1308 | | | | | | | | | | | | | | AVIATION GAS TANKS WERE NOT ACCESSED. |
| 114 | 09/19 | V | 4.5 | TRIANGULATE FROM BILGE KEEL FR 76.75 FWD 15'5.9" AND FROM FR 90 AFT 44'5" | STBD | EXTERNAL | TURBINE OIL | 6896 | 09/19 | | 0.190 | 09/20 | 1043 | WATER | | | | | | | | |
| 115 | 09/19 | V | 4.6 | TRIANGULATE FROM BILGE KEEL FR 76.75 FWD 15'5.9" AND FROM FR 90 AFT 44'5" | PORT | EXTERNAL | TURBINE OIL | 6872 | | | | | | | | | | | | | | |
| 116 | 09/19 | VI | 4.7 | TRIANGULATE FROM BILGE KEEL FR 90 FWD 9'6.8" AND AFT FROM FR 101.635 32' 1" | STBD | EXTERNAL | RES FUEL OIL | 3765 | 09/19 | 1840 | 0.350 | 09/19 | 1842 | WATER | | | | | | | | |
| 117 | 09/19 | VI | 4.8 | TRIANGULATE FROM BILGE KEEL FR 90 FWD 9'6.8" AND AFT FROM FR 101.635 32' 1" | PORT | EXTERNAL | RES FUEL OIL | 3765 | 09/19 | 1708 | N/A | 09/19 | 1720 | WATER | | | | | | | | |

Figure I-9. Hot Tap Station Log, Sheet 9 of 14

| ITEM | DATE | SECTION NUMBER | TANK NO. | GRID LOCATION | PORT/ STBD | | TANK CONTENT | 85% OF MAX VOLUME | CLEANED TANK TOP | | THICKNESS MM | TEST DRILL | | OBSERVED CONTENTS | HOT TAP COMPLETE FLANGE | | HOT TAP COMPLETE HOT TAP | | CLOSE OUT TANK | | | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MONTH/ DAY | | | NAMES | | INTERNAL/ EXTERNAL | TANK DESCRIPTION | GALLONS | DATE | TIME | ULTRA-SONIC | DATE | TIME | OIL, WATER, OR AIR | DATE | TIME | DATE | TIME | CAP DATE | CAP TIME | DEVCON | |
| 118 | 09/19 | VI | 4.9 | TRIANGULATE FROM BILGE KEEL FR 90 FWD 22'4" AND AFT FROM FR 101.635 18'2.6" | STBD | EXTERNAL | RES FUEL OIL | 5001 | 09/19 | 1855 | 0.350 | 09/19 | 1902 | WATER | | | | | | | | |
| 119 | 09/19 | VI | 4.10 | TRIANGULATE FROM BILGE KEEL FR 90 FWD 22'4" AND AFT FROM FR 101.635 18'2.6" | PORT | EXTERNAL | RES FUEL OIL | 5001 | 09/19 | 1808 | 0.390 | 09/19 | 1817 | WATER | | | | | | | | |
| 120 | 09/20 | VII | 4.3 | TRIANGULATE FROM BILGE KEEL FROM FR 101.635 FWD 9'2.9" AFT FROM FR 106.635 12' 5.6" | STBD | EXTERNAL | RES FUEL OIL | 7250 | 09/20 | 1155 | 0.370 | 09/20 | 1158 | WATER | | | | | | | | |
| 121 | 09/20 | VII | 4.4 | TRIANGULATE FROM BILGE KEEL FROM FR 101.635 FWD 7'3" AFT FROM FR 106.635 10' 6.3" | PORT | EXTERNAL | RES FUEL OIL | 7250 | 09/20 | 1310 | N/A | 09/20 | 1322 | AIR/OIL | 9/20<br>09/25 | 1545 | 09/25 | 1618 | 09/25 | 1748 | | 10/14 1030 REMOVE AND REGASKET DUE TO LEAK. |
| 122 | 09/20 | VII | 4.7 | TRIANGULATE FROM BILGE KEEL FROM FR 106.635 FWD 7'10.6" AFT FROM FR 118.27 36' 9.3" | STBD | EXTERNAL | RES FUEL OIL | 8346 | 09/20 | 1215 | 0.320 | 09/20 | 1217 | WATER | | | | | | | | |
| 123 | 09/20 | VII | 4.8 | TRIANGULATE FROM BILGE KEEL FROM FR 106.635 FWD 7'10.6" AFT FROM FR 118.27 36' 9.3" | PORT | EXTERNAL | RES FUEL OIL | 8346 | 09/20 | 1333 | N/A | 09/20 | | AIR/OIL | 09/25 | 1515 | 09/25 | 1715 | 09/25 | 1812 | | VENT HOLE WAS TRIED. STOPPED AND PUT NEW HOLE. |
| 124 | 09/20 | VII | 4.9 | TRIANGULATE FROM BILGE KEEL FR 106.635 FWD 22'10" FR 118.27 AFT 18'5.6" | STBD | EXTERNAL | RES FUEL OIL | 6985 | 09/20 | 1228 | 0.350 | 09/20 | 1230 | WATER | | | | | | | | |
| 125 | 09/20 | VII | 4.10 | TRIANGULATE FROM BILGE KEEL FR 106.635 FWD 22'10" FR 118.27 AFT 18'5.6" | PORT | EXTERNAL | RES FUEL OIL | 6985 | 09/20 | 1338 | 0.330 | 09/20 | | WATER | | | | | | | | |
| 126 | 09/22 | VIII | 4.3 | TRIANGULATE FROM BILGE KEEL FR 118.27 FWD 10' 4.375" FR 122.75 (END OF BK) AFT 10' 4.375 | STBD | EXTERNAL | RES FUEL OIL | 7686 | 09/22 | 1527 | 0.345 | 09/22 | 1530 | OIL | 09/26 | 0958 | 09/26 | 1030 | 09/26 | 1250 | | |
| 127 | 09/22 | VIII | 4.4 | TRIANGULATE FROM BILGE KEEL FR 118.27 FWD 7' 9.6" FR 122.75 (END OF BK) AFT 14' 5.25" | PORT | EXTERNAL | RES FUEL OIL | 7686 | 09/22 | | 0.260 | 09/22 | 1310 | OIL | 09/24 | 1615 | 09/25 | 1130 | 09/25 | 1608 | | |
| 128 | 09/22 | VIII | 4.5 | TRIANGULATE FROM BILGE KEEL AND CL FR 130.25. FR 122.75 (END OF BK) FWD 10' 1.6875" CL FR 130.25 AFT 40' 5.875" | STBD | EXTERNAL | RES FUEL OIL | 5987 | 09/22 | 1455 | 0.320 | 09/22 | 1508 | OIL/WATER | | | | | | | | AFTER PUMPING TANK 4.3, THE TEST HOLE WAS NOTED AS ONLY WATER, DID NOT HOT TAP. |
| 129 | 09/22 | VIII | 4.6 | TRIANGLUATE FROM BILGE KEEL AND CL FR 130.25. FR 122.75 (END OF BK) FWD 10' 1.6875" CL FR 130.25 AFT 40' 5.875" | PORT | EXTERNAL | RES FUEL OIL | 5987 | 09/22 | 1314 | 0.345 | 09/22 | 1318 | OIL | 09/24 | 1010 | 09/24 | 1440 | 09/25 | 1530 | | 9/25 RE-HOT TAP. |
| 130 | 09/22 | IX | 4.6 | TRIANGULATE FROM CL FR 130.25 FWD 35' 11.125" FR 136.5 AFT 37' 7.75" | PORT | EXTERNAL | RES FUEL OIL | 5258 | 09/22 | | 0.350 | 09/22 | 1255 | AIR/WATER | | | | | | | | |

Figure I-10. Hot Tap Station Log, Sheet 10 of 14

| ITEM | DATE | SECTION NUMBER | TANK NO. | GRID LOCATION | PORT/ STBD | | TANK CONTENT | 85% OF MAX VOLUME | CLEANED TANK TOP | | THICKNESS MM | TEST DRILL | | OBSERVED CONTENTS | HOT TAP COMPLETE FLANGE | | HOT TAP COMPLETE HOT TAP | | CLOSE OUT TANK | | | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MONTH/ DAY | | | NAMES | | INTERNAL/ EXTERNAL | TANK DESCRIPTION | GALLONS | DATE | TIME | ULTRA-SONIC | DATE | TIME | OIL, WATER, OR AIR | DATE | TIME | DATE | TIME | CAP DATE | CAP TIME | DEVCON | |
| 131 | 09/22 | IX | 4.7 | TRIANGULATE FROM CL FR 130.25 FWD 35' 11.125" FR 136.5 AFT 37' 7.75" | STBD | EXTERNAL | RES FUEL OIL | 2502 | 09/22 | 1430 | 0.225 | 09/22 | 1437 | WATER | | | | | | | | |
| 132 | 09/23 | X | 4.3 | TRIANGULATE FROM CL FR 136.5 FWD 34' 5" FR 147 AFT 44' 1.25" | STBD | EXTERNAL | RES FUEL OIL | 4069 | 09/23 | 1211 | 0.210 | 09/23 | | AIR/OIL/ WATER | | | | | | | | |
| 133 | 09/22 | X | 4.4 | TRIANGULATE FROM CL FR 136.5 FWD 34' 1" FR 147 AFT 47' 4.25" | PORT | EXTERNAL | RES FUEL OIL | 4069 | 09/22 | 0945 | 0.285 | 09/22 | 0942 | AIR/WATER | | | | | | | | STILL VENTILATING AIR INTERMITTLY FROM VENT HOLE. 10/11 CLOSED VENT. |
| 134 | 09/22 | X | 4.5 | TRIANGULATE FROM CL FR 136.5 FWD 38' 6.4" FR 147 AFT 36' 3" | STBD | EXTERNAL | RES FUEL OIL | 2074 | 09/22 | 1405 | 0.205 | 09/22 | 1402 | WATER | | | | | | | | |
| 135 | 09/22 | X | 4.6 | TRIANGULATE FROM CL FR 136.5 FWD 38' 6.4" FR 147 AFT 36' 3" | PORT | EXTERNAL | RES FUEL OIL | 2074 | 09/22 | 1230 | | 09/22 | 1245 | WATER | | | | | | | | |
| 136 | 09/21 | XI | 4.1 | TRIANGULATE FROM CL FR 147 FWD 26' 10.375" FR 157.6 AFT 40' 1.25" | STBD | EXTERNAL | RES FUEL OIL | 3038 | 09/21 | 1100 | 0.285 | 09/21 | | WATER | | | | | | | | |
| 137 | 09/21 | XI | 4.2 | TRIANGULATE FROM CL FR 147 FWD 26' 10.375" FR 157.6 AFT 40' 1.25" | PORT | EXTERNAL | RES FUEL OIL | 3038 | 09/21 | 1008 | 0.285 | 09/21<br>09/22 | | AIR/OIL | 09/23 | | 09/23 | 1822 | 10/11 | 1630 | | 10/11 CAMERA INACCESSIBLE DUE TO MULTIPLE OBSTRUCTIONS. IT CAPPED THIS (CLEAN TANK). |
| 138 | 09/21 | XI | 4.3 | TRIANGULATE FROM CL FR 147 FWD 31' 11.75" FR 157.6 AFT 30' 7" | STBD | EXTERNAL | RES FUEL OIL | 3012 | 09/21 | 1040 | 0.365 | 09/21 | | WATER | | | | | | | | |
| 139 | 09/21 | XI | 4.4 | TRIANGULATE FROM CL FR 147 FWD 31' 11.75" FR 157.6 AFT 30' 7" | PORT | EXTERNAL | RES FUEL OIL | 3012 | 09/21 | 1023 | 0.335 | 09/21 | | WATER | | | 10/11 | 1700 | 10/11 | 1645 | | 10/11 HOT TAPPED TANK HAD MULTIPLE OBSTRUCTIONS. 11/12 CAMERA SCANED CLEAN TANK FOUND MULTIPLE STEAM COILS THUS INACCESSIBLE FOR INTERNAL HOT TAP. |
| 140 | 09/22 | XI | 4.5 | TRIANGULATE FROM CL FR 157.6 FWD 25' 10.25" FR 167.5 AFT 39' 8.1875" | STBD | EXTERNAL | FUEL OIL | 5361 | 09/22 | 0831 | 0.175 | 09/22 | | WATER | | | | | | | | |
| 141 | 09/21 | XI | 4.6 | TRIANGULATE FROM CL FR 157.6 FWD 25' 10.25" FR 167.5 AFT 39' 8.1875" | PORT | EXTERNAL | FUEL OIL | 5355 | 09/21 | 1305 | 0.365 | 09/21 | | WATER | | | | | | | | |
| 142 | 09/23 | XI | 4.7 | TRIANGULATE FROM CL FR 157.6 FWD 29' 11.4" FR 167.5 AFT 27' 8" | STBD | EXTERNAL | FUEL OIL | 4491 | 09/23 | 1043 | 0.200 | 09/23 | | WATER | | | | | | | | |
| 143 | 09/23 | XI | 4.8 | TRIANGULATE FROM CL FR 157.6 FWD 29' 11.4" FR 167.5 AFT 27' 8" | PORT | EXTERNAL | FUEL OIL | 4470 | 09/23 | 1117 | 0.310 | 09/23 | | AIR/OIL | 09/26 | | 09/26 | | 09/27 | 1120 | | |
| | | | | | | | WING TANKS EXTERNAL SUBTOTAL | 254485 | | | | | | | | | | | | | | |

Figure I-11. Hot Tap Station Log, Sheet 11 of 14

| ITEM | DATE | SECTION NUMBER | TANK NO. | GRID LOCATION | PORT/ STBD | | TANK CONTENT | 85% OF MAX VOLUME | CLEANED TANK TOP | | THICKNESS MM | TEST DRILL | | OBSERVED CONTENTS | HOT TAP COMPLETE FLANGE | | HOT TAP COMPLETE HOT TAP | | CLOSE OUT TANK | | | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MONTH/ DAY | | | NAMES | | INTERNAL/ EXTERNAL | TANK DESCRIPTION | GALLONS | DATE | TIME | ULTRA-SONIC | DATE | TIME | OIL, WATER, OR AIR | DATE | TIME | DATE | TIME | CAP DATE | CAP TIME | DEVCON | |
| **INTERNAL TANKS** | | | | | | | | | | | | | | | | | | | | | | **SEE ATTACHMENT FOR INTERNAL TANK LOCATION INSTRUCTIONS** |
| 144 | 10/03 | II | 5.1 | EXTERNAL TANK SECTION II, TANK 4.5 | STBD | INTERNAL | FUEL OIL | 1369 | NA | NA | NA | NA | NA | NA | 10/03 | | 10/04 | 1204 | 10/04 | 1755 | | HOT TAP USING BALL VALVE AND CONCEPT EXTENTION TOOL. |
| 145 | 10/03 | II | 5.2 | | PORT | INTERNAL | FUEL OIL | 1339 | | | | | | | | | | | | | | |
| 146 | 10/03 | II | 5.3 | EXTERNAL TANK SECTION II, TANK 4.7 | STBD | INTERNAL | FUEL OIL | 2288 | NA | NA | NA | NA | NA | NA | | | 10/05 | NOT COMP | 10/06 | 1600 | | POSSIBLE ONLY HOT TAP PILOT BIT WENT THROUGH. NO FURTHER VIDEO INSPECTION. |
| 147 | 10/03 | II | 5.4 | | PORT | INTERNAL | FUEL OIL | 2272 | | | | | | | | | | | | | | |
| 148 | 10/03 | II | 5.5 | EXTERNAL TANK SECTION II, TANK 4.9 | STBD | INTERNAL | FUEL OIL | 2098 | NA | NA | NA | NA | NA | NA | 10/03 | | | | | | | INTERNAL PIPE IN WAY OF USING INTERNAL HOT TAP TOOL. NOT ACCESSIBLE. |
| 149 | 10/03 | II | 5.6 | DIVER ACCESS THROUGH HULL | PORT | INTERNAL | FUEL OIL | 2114 | | | | 10/03 | 1520 | AIR/OIL | | | | | 10/03 | | 10/03 | DIVER PUNCHED HOLE. DC PLUG AND DEVCON. |
| 150 | 10/09 | III | 5.1 | | STBD | INTERNAL | FUEL OIL | 4452 | | | | | | | | | | | | | | |
| 151 | 10/07 | III | 5.2 | DIVER THROUGH EXTERNAL TANK | PORT | INTERNAL | FUEL OIL | 4446 | NA | NA | NA | NA | NA | WATER | | | | | | | | DIVER WITH HOLE SAW AND HAND DRILL, PILOT BIT ONLY. |
| 152 | 10/08 | III | 5.6 | DIVER THROUGH EXTERNAL TANK | PORT | INTERNAL | FUEL OIL | 3865 | NA | NA | NA | NA | NA | OIL | | | | 2-5/8" HOLE SAW | 10/07 | 1600 | | DIVER WITH HOLE SAW AND HAND DRILL USED SMALL FLAT PLATE MECHANICAL PLUG/PATCH. |
| 153 | 09/30 | III | 5.5 | EXTERNAL TANK SECTION III, TANK 4.9 | STBD | INTERNAL | FUEL OIL | 5070 | 09/30 | | NA | NA | NA | NA | NA | NA | 10/01 | 1355 | 10/03 | 1825 | | 09/30 VIDEO INSPECTION. FIRST INTERNAL HOT TAP! |
| 154 | 10/04 | III | 5.3 | EXTERNAL TANK SECTION III, TANK 4.5 | STBD | INTERNAL | TURBINE OIL | 4156 | NA | NA | NA | NA | NA | NA | 10/04 | 1700 | 10/05 | 1320 | | | | 10/04 VIDEO INSPECTION. INTERNAL PIPE. HOLE SAW BROKE. PILOT HOLE ONLY. |
| 155 | 10/03 | IV | 5.1 | EXTERNAL TANK SECTION IV, TANK 4.1 | STBD | INTERNAL | FUEL OIL | 5778 | 10/03 | | NA | NA | NA | NA | 10/04 | 1700 | 10/04 | 1548 | 10/06 | 1026 | | OIL NOTED AT VENT. |
| 156 | 10/02 | IV | 5.4 | DIVER THROUGH EXTERNAL TANK SECTION III, TANK4.7 | PORT | INTERNAL | FUEL OIL | 5070 | 10/02 | 0455 | NA | 10/02 | 0958 | AIR/OIL | | | | | NA | NA | | PUNCHED THROUGH WITH HAMMER. LEFT OPEN TO SEAWATER. |

Figure I-12. Hot Tap Station Log, Sheet 12 of 14

| ITEM | DATE | SECTION NUMBER | TANK NO. | GRID LOCATION | PORT/ STBD | | TANK CONTENT | 85% OF MAX VOLUME | CLEANED TANK TOP | | THICKNESS MM | TEST DRILL | | OBSERVED CONTENTS | HOT TAP COMPLETE FLANGE | | HOT TAP COMPLETE HOT TAP | | CLOSE OUT TANK | | | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MONTH/ DAY | | | NAMES | | INTERNAL/ EXTERNAL | TANK DESCRIPTION | GALLONS | DATE | TIME | ULTRA-SONIC | DATE | TIME | OIL, WATER, OR AIR | DATE | TIME | DATE | TIME | CAP DATE | CAP TIME | DEVCON | |
| 157 | 10/03 | IV | 5.3 | EXTERNAL TANK SECTION IV, TANK 4.1 | STBD | INTERNAL | FUEL OIL | 6787 | 10/03 | | NA | NA | NA | NA | 10/03 | 1805 | 10/05 | 1125 | 10/06 | 1010 | | |
| 158 | 10/02 | IV | 5.6 | DIVER THROUGH EXTERNAL TANK SECTION III, TANK 4.7 | PORT | INTERNAL | FUEL OIL | 6798 | | | | | | | | | | | | | | |
| 159 | 10/04 | V | 5.1 | EXTERNAL TANK SECTION V, TANK 4.1 | STBD | INTERNAL | PURE TURBINE OIL | 8309 | NA | NA | NA | NA | NA | | 10/04 | 1730 (SEE NOTE 9) | 10/08 | 1430 (SEE NOTE 9) | | | | 10/04 VIDEO INSPECTION. INTERNAL FRAME. |
| 160 | 10/01 | V | 5.2 | | PORT | INTERNAL | PURE TURBINE OIL | 8299 | | | | | | | | | | | | | | |
| 161 | NA | VII | 9.1 | | STBD | INTERNAL | FUEL OIL | 4227 | | | | | | | | | | | | | | |
| 162 | 10/10 | VIII | 5.1 | EXTERNAL TANK SECTION VIII, TANK 4.1 | STBD | INTERNAL | FUEL OIL | 13540 | NA | NA | NA | NA | NA | NA | 10/10 | | | 55 MINS | 10/14 | 1300 | | NEW HOT TAP FLANGE ADDED. PIPE IN THE WAY, BUT STRAIGHT TOOLING COULD SLIP THROUGH. 10/11 OFFICE. |
| 163 | 10/09 | VIII | 5.2 | EXTERNAL TANK SECTION VIII, TANK 4.2 | PORT | INTERNAL | FUEL OIL | 13540 | NA | NA | NA | NA | NA | NA | 10/09 | | | 45 MINS | | | | 10/11 NEW HOT TAP FLANGE ADDED. HOT TAPPED. 10/14 CLOSED LONG STRIP TO STRAIGHT, LESS THAN 1% |
| 164 | NA | IX | 5.3 | | STBD | INTERNAL | FUEL OIL | 5358 | | | | | | | | | | | | | | |
| 165 | 10/10 | IX | 5.4 | | PORT | INTERNAL | FUEL OIL | 5366 | | | | | | | | | | | | | | INTERNAL PIPING IN THE WAY OF IT HOT TAP. |
| 166 | NA | X | 5.1 | | STBD | INTERNAL | FUEL OIL | 4468 | | | | | | | | | | | | | | |
| 167 | 10/12 | X | 5.2 | | PORT | INTERNAL | FUEL OIL | 4491 | | | | | | | | | | | | | | HOT FLANGE ON LONG STIFFENER. |
| 168 | NA | X | 5.3 | | STBD | INTERNAL | FUEL OIL | 2985 | | | | | | | | | | | | | | |
| 169 | 10/12 | X | 5.4 | | PORT | INTERNAL | FUEL OIL | 2991 | | | | | | | | | | | | | | 10/12 TEST HOLE SHOWED OBSTRUCTION, INACCESSIBLE FOR IT HOT TAP. |
| 170 | 10/12 | XI | 5.1 | | STBD | INTERNAL | FUEL OIL | 3213 | | | | | | | | | | | | | | TEST HOLES COMFIRMED SYMETRY IS SAME AS PORT SIDE (I.E., STEAM COIL OBSTRUCTIONS). |
| 171 | 10/11 | XI | 5.2 | | PORT | INTERNAL | FUEL OIL | 3170 | | | | | | | | | | | | | | INTERNAL PIPING IN THE WAY OF IT HOT TAP. CAMERA SHOWS STEAM COILS. |

Figure I-13. Hot Tap Station Log, Sheet 13 of 14

| ITEM | DATE | SECTION NUMBER | TANK NO. | GRID LOCATION | PORT/ STBD | | TANK CONTENT | 85% OF MAX VOLUME | CLEANED TANK TOP | | THICKNESS MM | TEST DRILL | | OBSERVED CONTENTS | HOT TAP COMPLETE FLANGE | | HOT TAP COMPLETE HOT TAP | | CLOSE OUT TANK | | | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MONTH/ DAY | | | NAMES | | INTERNAL/ EXTERNAL | TANK DESCRIPTION | GALLONS | DATE | TIME | ULTRA-SONIC | DATE | TIME | OIL, WATER, OR AIR | DATE | TIME | DATE | TIME | CAP DATE | CAP TIME | DEVCON | |
| 172 | 10/12 | XI | 5.3 | | STBD | INTERNAL | FUEL OIL | 3025 | | | | | | | | | | | | | | TEST HOLES COMFIRMED SYMETRY IS SAME AS PORT SIDE (I.E., STEAM COIL OBSTRUCTIONS). |
| 173 | 10/11 | XI | 5.4 | | PORT | INTERNAL | FUEL OIL | 2874 | | | | | | | | | | | | | | EXTERNAL TANK WAS FLANGED/HOT TAPPED CAMERA INSPECTION SHOWED A PIPE IN THE WAY OF THE IT HOT TAP USE. |
| | | | | | | | INTERNAL TANK SUBTOTAL | 143759 | | | | | | | | | | | | | | |

| NOTES |
|---|
| NOTE 1: FLANGE WAS LOCATED TO THE LEFT OF THE TEST HOLE LOOKING DOWNHILL. DIVERS WERE DIRECTED TO LOCATE THE FLANGE TO THE RIGHT OF THE TEST HOLE WHEN LOOKING DOWNHILL. MIGHT BE LOW IN THE TANK AND/OR ON THE TANK BULKHEAD/FRAMING. |
| NOTE 2: ADDED A SECOND HOT TAP FLANGE TO SUIT USING AN INTERNAL HOT TAP TOOL. FIRST FLANGE LOCATION WAS CORRECT, BUT THE INTERNAL STRUCTURE WAS IN THE WAY. AN ATTEMPT WAS MADE WITH AN ANGLED TOOL FROM THE SECOND FLANGE LOCATION. |
| NOTE 3: WATER/SLOPS 17,010 AS OF 9/12/18 1500. |
| NOTE 4: HOT TAP 9/13 @ 0820, FIRST PUMP, SUCTION ISSUES, INSPECTION VALVE NO OIL. |
| NOTE 5: USED PKS VENT, REV 2, PVC VENT TUBE TO STRIP TANK. |
| NOTE 6: THE BISCUIT WAS ON THE FRAME MEMBER. PS USED SMALL BACKING PLATE ONCE THE BISCUIT WAS KNOCKED OUT TO SECURE THE CAP. |
| NOTE 7: REDOMED BY PULLING THE OLD FLANGE OFF, INSTALLING X FLANGE WITHOUT BOLTING, AND ATTACHING THE TOGGLE WITH GROMMETS AND GASKETS. THE BIG DOME WAS RELATIVELY CLEAN. ONLY A SMALL AMOUNT OF OIL WAS IN THE BIG DOME AND A FEW DROPS IN THE TANK. |
| NOTE 8: THE PUCK WAS IN THE WAY OF CLOSE OUT. |
| NOTE 9: RELOCATED THE HOT TAP FLANGE DUE TO INTERNAL STIFFENER. AN ANGLED HOT TAP WAS USED TO HOT TAP DUE TO THE 2ND HOT TAP FLANGE HAVING AN INTERNAL FRAME MEMBER IN THE WAY. |

| | |
|---|---|
| | LIGHT BLUE: OIL TANKS THAT EITHER PRODUCED WATER WHEN TESTED OR PRODUCED ONLY WATER AFTER HOT TAPPING (HT). |
| | BROWN: OIL TANKS THAT PRODUCED OIL OR LOW PERCENTAGE OIL (LPO) IN WATER WHEN PUMPED. |
| | PINK: AVIATION GASOLINE TANKS THAT WERE NOT ACCESSED. |

| | |
|---|---|
| | GRAY BLUE: BREACHED, TANKS THAT HAVE SIGNIFIANT WASTAGE OR SO MUCH STRUCTURAL DAMAGE THAT IT IS OPEN TO THE SEA. |
| | ORANGE: TANKS THAT ARE INACCESSIBLE DUE TO STRUCTURAL DAMAGE, HAVE OILS PIPED, OR STRUCTURE THAT PREVENTS HOT TAPPING. |

Figure I-14. Hot Tap Station Log, Sheet 14 of 14

# APPENDIX J

## Appendix J – Pump Station Log

**PRINZ EUGEN OIL RECOVERY - PUMP STATION LOG - 020119 ML**

| ITEM | DATE | SECTION NUMBER | TANK NO. | PORT/ STBD | TANK TYPE | TANK CONTENT | 85% OF MAX VOLUME | DESIGNATED RECEIVING TANK OIL | DESIGNATED RECEIVING TANK WATER/SLOPS | DIVER OBSERVED CONTENTS | FIRST PUMP | | | SECOND PUMP | | | FUEL METER | | TOTAL VOLUME PUMPED | ESTIMATED VOLUMES | | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MONTH/ DAY | | | | INTERNAL/ EXTERNAL | STATED CONTENT | GALLONS | NUMBER PORT/ STBD | NUMBER PORT/ STBD | OIL/H2O/AIR | START TIME | STOP TIME | AVERAGE FLOW RATE | START TIME | STOP TIME | AVERAGE FLOW RATE | START | END | GALLONS | WATER/SLOPS | OIL | |
| EXTERNAL CENTER TANKS | | | | | | | | | | | | | | | | | | | | | | |
| 1 | | I | 6.5 | STBD | EXTERNAL | FUEL OIL | 8573 | | | | | | | WATER | | | | | | | | WATER |
| 2 | | I | 6.6 | PORT | EXTERNAL | FUEL OIL | 8587 | | | | | | | BREACHED | | | | | | | | BREACHED |
| 3 | 10/03 | I | 6.32 | CL | EXTERNAL | FUEL OIL | 10835 | 2 STBD | 4 STBD | OIL | 0849 | 0914 | | 1013 | 1032 | | 0 | 2146 | 2146 | 2146 | 0 | CLOSED OUT WHEN NO APPRECIABLE OIL WAS RECOVERED AND WATER TURNED OUT TO BE A DIFFERENT CHEMICAL. "PURPLE WATER" WITH A STRONG CHEMICAL SMELL AND SMALL AMOUNT OF OIL ON THE SURFACE OF THE SAMPLE. THE WATER WAS RECOVERED WITH A LIGHT COATING OF OIL ON TOP. BELIEVED AT THE TIME TO BE AIRCRAFT DE-ICING FLUID THAT LEAKED FROM A SIDE TANK. |
| 4 | | II | 6.3 | STBD | EXTERNAL | FUEL OIL | 5165 | | | | | | | INACCESSIBLE | | | | | | | | INACCESSABLE DUE TO LOCATION UNDER STRUT |
| 5 | | II | 6.4 | PORT | EXTERNAL | FUEL OIL | 5207 | | | | | | | BREACHED | | | | | | | | BREACHED |
| 6 | 09/29 | III | 1.1 | STBD | EXTERNAL | FUEL OIL | 6058 | 2 STBD | 4 STBD | OIL | 1554<br>1707 | 1617<br>1722 | | 1633 | 1653 | | 0 | 1650<br>632<br>665 | 2947 | 1892 | 1055 | GOOD FLOW, PUMPED WELL FOR A SHORT TIME. GOOD VENT.<br>(SEE NOTE 1) |
| 7 | | III | 1.2 | PORT | EXTERNAL | FUEL OIL | 6267 | | | | | | | WATER | | | | | | | | WATER |
| 8 | 09/28 | III | 1.3 | STBD | EXTERNAL | TURBINE OIL | 6605 | 2 STBD | 4 STBD | OIL | 1620<br>1815 | 1658<br>1829 | | 1708<br>1830 | 1715<br>1835 (FLUSH) | | 0 | 2600<br>540<br>606<br>994 | 4740 | 2807 | 1933 | GOOD FLOW, CLEAN TURBINE OIL.<br>(SEE NOTE 1) |
| 9 | 09/28 | III | 2.5 | STBD | EXTERNAL | TURBINE OIL | 1112 | 2 STBD | 4 STBD | OIL | 1438 | 1457 | | 1550 | 1605 | | 0 | 1118<br>0501 | 1619 | 867 | 752 | TURBINE OIL WITH TWO DIFFERENT LEVELS OF COLOR AND CONSISTENCY. ONE LIGHT AND ONE DARK. THE ONE LIGHT HAD A LOT OF WATER IN EMULSION, SETTLED OUT OVER TIME. |
| 10 | 09/29 | III | 2.7 | STBD | EXTERNAL | TURBINE OIL | 1432 | 2 STBD | 4 STBD | OIL | 0841<br>0928 | 0900<br>0932 | | 0913 | 0928 | | 0 | 868<br>616<br>183 | 1667 | 1312 | 355 | GOOD FLOW, PUMPED QUICK, DIRTY TURBINE OIL.<br>(SEE NOTE 1) |
| 11 | 09/28<br>10/07 | III | 2.3 | STBD | EXTERNAL | TURBINE OIL | 2988 | 2 STBD | 4 STBD | OIL | 1321<br>1024<br>1136 | 1433<br>1046<br>1141 (FLUSH) | | 1726<br>1049 | 1803<br>1125 | | 0<br>0 | 1333<br>2145<br>973<br>1000<br>277 | 5728 | 4021 | 1707 | PROBLEM HOLE/BISCUIT LOW FLOW @ 12 GPM SMALL AMOUNT OF OIL FIRST TIME, BETTER FLOW AND LARGER AMOUNT ON SECOND PUMP. III 2.3 195 and 1512.<br>(SEE NOTE 1) |
| 12 | | III | 4.5 | STBD | EXTERNAL | TURBINE OIL | 2935 | | | | | | | WATER | | | | | | | | WATER |
| 13 | 09/30<br>10/01 | III | 1.4 | PORT | EXTERNAL | FUEL OIL | 5445 | 2 STBD | 4 STBD | OIL | 1443<br>1718<br>1008 | 1509<br>1930<br>1048 | | 1641 | 1718 | | 0 | 994<br>656<br>3614<br>1586<br>(UNDETERMINED) | 8436 | 5816 | 2620 | GOOD FLOW, AIR AT FIRST ONLY 1 TO 2% OIL. 2620 ON FIRST PUMP, ONLY SMALL AMOUNT ON SECOND PUMP. TOTAL VOLUME PUMPED.<br>(SEE NOTE 1) |
| 14 | 09/29 | III | 2.1 | STBD | EXTERNAL | FUEL OIL | 6853 | 2 STBD | 4 STBD | OIL | 1526 | 1538 | | | | | 0 | 711 | 711 | 711 | 0 | GOOD FLOW BUT ONLY PULLED TRACE AMOUNTS OF OIL<br>(E.G. LESS THAN 1% PER SAMPLE TO SLOPS) |
| 15 | | III | 2.2 | PORT | EXTERNAL | FUEL OIL | 6896 | | | | | | | BREACHED | | | | | | | | BREACHED |

Figure J-1. Pump Station Log, Sheet 1 of 13

| ITEM | DATE | SECTION NUMBER | TANK NO. | PORT/ STBD | TANK TYPE | TANK CONTENT | 85% OF MAX VOLUME | DESIGNATED RECEIVING TANK OIL | DESIGNATED RECEIVING TANK WATER/SLOPS | DIVER OBSERVED CONTENTS | FIRST PUMP | | | SECOND PUMP | | | FUEL METER | | TOTAL VOLUME PUMPED | ESTIMATED VOLUMES | | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MONTH/ DAY | | | | INTERNAL/ EXTERNAL | STATED CONTENT | GALLONS | NUMBER PORT/ STBD | NUMBER PORT/ STBD | OIL/H2O/AIR | START TIME | STOP TIME | AVERAGE FLOW RATE | START TIME | STOP TIME | AVERAGE FLOW RATE | START | END | GALLONS | WATER/SLOPS | OIL | |
| 16 | 09/29 | III | 2.4 | PORT | EXTERNAL | FUEL OIL | 5585 | 2 STBD | 4 STBD | OIL | | | | | | | 0 | 0 | 0 | 0 | 0 | LEAKY HOLE VACCUM PUMPED 8776 GALLONS OF WATER AT ABOUT 1% OIL TO SLOPS. DIVER USED CHIPPING HAMMER TO MAKE LOCATION. WHILE SWIMMING OVER NOTICED OIL LEAKING FROM THE LOCATION. |
| 17 | | III | 2.6 | PORT | EXTERNAL | FUEL OIL | 7155 | | | | | | | WATER | | | | | | | | WATER |
| 18 | 09/29 | III | 2.9 | STBD | EXTERNAL | FUEL OIL | 5350 | 2 STBD | 4 STBD | OIL | 1220 | 1310 | | 1407 | 1443 | | 0 | 2686<br>1414 | 4100 | 1963 | 2137 | AIR ISSUES TRYING TO PUMP. USED SCHADOW TUBE VALVE OPEN WITH NO FIRE HOSE. GOOD FLOW NSFO. |
| | 10/02 | | | | | | | | | | | | | | | | | 2686<br>1414 | | | | |
| 19 | 09/29 | III | 4.1 | STBD | EXTERNAL | FUEL OIL | 2927 | 2 STBD | 4 STBD | OIL | 1449<br>1453 | 1453 (FLUSH)<br>1509 | | | | | 0 | 883<br>437 | 15802 | 12538 | 3264 | "OIL WELL" INITIALLY PUMPED WITH GOOD FLOW, GOT NO OIL, CLOSED HOLE. LATER FLANGE WAS LEAKING, BACK IN ON 10/02 AND PUMPED 2572 GALLONS FROM TANK. THEN 202, THEN 265, THEN AGAIN 225, THEN ONLY A SMALL PERCENTAGE AS TANK STRIPPED FOUR MORE TIMES TRYING TO GET SPACE CLEAR TO ACCESS THE INTERNAL TANK 5.1. |
| | 10/02 | | | | | | | | | | 0825<br>1019<br>1031<br>1059<br>1438<br>1519<br>1539 | 1000<br>1030<br>1051 (FLUSH)<br>1107<br>1502<br>1537<br>1548 | | | | | | 3292<br>321<br>579<br>161<br>1238<br>750<br>532 | | | | |
| | 10/04 | | | | | | | | | | 0850<br>0934<br>0948 | 0917<br>0948<br>1009 | | | | | | 1109<br>693<br>563 | | | | |
| 20 | 10/08 | III | 4.2 | PORT | EXTERNAL | FUEL OIL | 2943 | | | | 1634 | 1700 | | BREACHED | | | | 1491 | | | | BREACHED |
| | 10/09 | | | | | | | | | | 1431<br>1522<br>1609 | 1521<br>1546<br>1628 | | | | | | 1794<br>1223<br>736 | | | | |
| 21 | | III | 4.1 | PORT | EXTERNAL | FUEL OIL | 2909 | | | | | | | BREACHED | | | | | | | | BREACHED |
| 22 | | III | 4.14 | PORT | EXTERNAL | FUEL OIL | 4336 | | | | | | | BREACHED | | | | | | | | BREACHED |
| 23 | 09/29 | III | 4.9 | STBD | EXTERNAL | FUEL OIL | 4296 | 2 STBD | 4 STBD | OIL | 0943<br>1046 | 1036<br>1101 | 83 | | | | 0 | 3805<br>0782 | 13363 | 10377 | 2986 | THIS TANK WAS HOT TAPPED ON 09/28, PUMPED AND STRIPPED THREE TIMES 0N 09/30. THEN ACCESSED AGAIN TO PUMP III 5.1 (FIRST INTERNAL HOT TAP) 10/2 THEN PUMPED AGAIN ON 10/03 STRIPPED AND CLOSED THE TANK AND CAPPED ON 10/03.<br>(SEE NOTE 1) |
| | 09/30 | | | | | | | | | | 1008<br>1105<br>1228 | 1055<br>1218<br>1300 | | | | | | 3076<br>4592<br>1108 | | | | |
| | 10/02 | | | | | | | | | | | | | | | | | | | | | |
| | 10/03 | | | | | | | | | | | | | | | | | | | | | |
| 24 | 09/09 | IV | 1.1 | STBD | EXTERNAL | FUEL OIL | 12600 | 2 STBD | 4 STBD | OIL | | | | | | | | | | | 1025 | CLOSED THIS AFTER STRIPPING. TIME 1641. |
| 25 | 09/08 | IV | 1.2 | PORT | EXTERNAL | FUEL OIL | 12547 | 2 STBD | 4 STBD | OIL | 1614 | 1640 | | 1701 | 1710 | | | | 5493 | 1422 | 4071 | PUMPED AT APPROXIMATELY 77 GPM. PUMPED MOST OF THE OIL, THEN AIR, THEN OIL AGAIN AND CLOSED ON 9/I0.<br>(SEE NOTE 1) |
| | 09/10 | | | | | | | | | | 1230 | 1240 | | 1328 | 1337 | | | 577<br>524 | | | | |

Figure J-2. Pump Station Log, Sheet 2 of 13

| ITEM | DATE | SECTION NUMBER | TANK NO. | PORT/ STBD | TANK TYPE | TANK CONTENT | 85% OF MAX VOLUME | DESIGNATED RECEIVING TANK OIL | DESIGNATED RECEIVING TANK WATER/SLOPS | DIVER OBSERVED CONTENTS | FIRST PUMP | | | SECOND PUMP | | | FUEL METER | | TOTAL VOLUME PUMPED | ESTIMATED VOLUMES | | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MONTH/ DAY | | | | INTERNAL/ EXTERNAL | STATED CONTENT | GALLONS | NUMBER PORT/ STBD | NUMBER PORT/ STBD | OIL/H2O/AIR | START TIME | STOP TIME | AVERAGE FLOW RATE | START TIME | STOP TIME | AVERAGE FLOW RATE | START | END | GALLONS | WATER/SLOPS | OIL | |
| 26 | 09/09<br>09/10 | IV | 2.1 | STBD | EXTERNAL | FUEL OIL | 11083 | 2 STBD | 4 STBD | OIL | 1021<br>1414 | 1025<br>1433 | | 1114 | | | 0 | 1004 | 2940 | 1004 | 1936 | PUMPED THIS 4 TIMES INCLUDING 1500 GALLONS IN 45 MINUTES THROUGH A PILOT HOLE AT 10 GPM. |
| 27 | | IV | 2.2 | PORT | EXTERNAL | FUEL OIL | 10925 | | | | | | | BREACHED | | | | | | | | BREACHED WATER |
| 28 | 09/10 | IV | 4.1 | STBD | EXTERNAL | FUEL OIL | 8190 | 2 STBD | 4 STBD | OIL | 1454 | 1500 | | 1606 | 1610 | | 0 | 649<br>363 | 1012 | 1012 | 0 | NO SIGNIFICANT OIL, ONLY OPENED BRIEFLY AT LOW FLOW. STRIPPED THREE TIMES. |
| 29 | | IV | 4.2 | PORT | EXTERNAL | FUEL OIL | 8195 | | | | | | | BREACHED | | | | | | | | BREACHED WATER |
| 30 | 09/12 | V | 2.5 | STBD | EXTERNAL | FUEL OIL | 6423 | 2 STBD | 4 STBD | OIL | 0938 | 1100 | | 1249 | 1302 | | | 5539<br>819 | 6358 | 1458 | 4900 | OPENED AND CLOSED ON SAME DAY. (SEE NOTE 1) |
| 31 | 09/11<br>09/12 | V | 2.6 | PORT | EXTERNAL | FUEL OIL | 6402 | 2 STBD | 4 STBD | OIL | 1742<br>0815 | 1759<br>0825 | 74 | | | | 0 | 1233<br>874 | 2107 | 2107 | 0 | PUMPED 09/11, NO OIL PUMPED 09/12, WATER NO OIL. (SEE NOTE 1) |
| 32 | 09/10<br>09/11 | V | 4.1 | STBD | EXTERNAL | FUEL OIL | 4697 | 2 STBD | 4 STBD | OIL | 1618<br>1627 | 1742<br>1638 | | 0919 | 0933 | | | 3442<br>517 (STRIP 2)<br>828 (STRIP 1) | 4787 | 1831 | 2956 | SMALL 2 INCH VENT HOLE WAS CUT AFTER VENTING ISSUES. PUMPED WELL AFTER VENT HOLE WAS CUT. STRIPPED AND CLOSED ON 09/11. (SEE NOTE 1) |
| 33 | | V | 4.2 | PORT | EXTERNAL | FUEL OIL | 4700 | | | | | | | BREACHED | | | | | | | | BREACHED WATER |
| 34 | 09/11<br>09/12 | V | 4.7 | STBD | EXTERNAL | FUEL OIL | 5974 | 2 STBD | 4 STBD | OIL | 1435<br>0841 | 1608<br>0902 | 80 | 0831 | 0852 | | | 5290<br>1240 | 6530 | 2185 | 4345 | OIL STRIP AND CLOSE. |
| 35 | 09/11 | V | 4.8 | PORT | EXTERNAL | FUEL OIL | 6008 | 2 STBD | 4 STBD | OIL | 1051<br>1312 | 1058<br>1325 | 55 | 1355 | 1408 | | 0 | 11<br>655<br>770 | 1436 | 1436 | 0 | VENT ISSUES. PUMPED, STRIPPED, AND CLOSED ON 09/11. NO SIGNIFICANT OIL. LOW PERCENTAGE OF OIL RECOVERED. (SEE NOTE 1) |
| 36 | 09/10<br>09/11 | V | 1.1 | STBD | EXTERNAL | TURBINE OIL COLLECTION | 6536 | 2 STBD | 4 STBD | OIL | 1748<br>0835 | 1757<br>0852 | 50 | 1815 | 1824 | | 0 | 1466<br>453<br>574 | 2493 | 1439 | 1054 | PUMP 1 = 1054<br>PUMP 2 = LPO<br>PUMP 3 = STRIPPED AND CLOSED |
| 37 | 09/11 | V | 1.2 | PORT | EXTERNAL | TURBINE OIL COLLECTION | 6452 | 2 STBD | 4 STBD | OIL | 0940 | 0953 | | 1332 | 1345 | | 0 | 1075<br>738 | 1813 | 1238 | 575 | (SEE NOTE 1) |
| 38 | | V | 2.1 | STBD | EXTERNAL | TURBINE OIL PURIFIED | 1450 | | | | | | | WATER | | | | | | | | WATER |
| 39 | 09/11 | V | 2.2 | PORT | EXTERNAL | TURBINE OIL PURIFIED | 1450 | 2 STBD | 4 STBD | OIL | 1005 | 1040 | | | | | 0 | 887 | 887 | 887 | 0 | PUMPED 1005 TO 1040, CLOSE OUT ALL WATER. |
| 40 | | V | 2.3 | STBD | EXTERNAL | DIRT OIL TANK | 1495 | | | | | | | WATER | | | | | | | | WATER |

Figure J-3. Pump Station Log, Sheet 3 of 13

| ITEM | DATE | SECTION NUMBER | TANK NO. | PORT/ STBD | TANK TYPE | TANK CONTENT | 85% OF MAX VOLUME | DESIGNATED RECEIVING TANK OIL | DESIGNATED RECEIVING TANK WATER/SLOPS | DIVER OBSERVED CONTENTS | FIRST PUMP | | | SECOND PUMP | | | FUEL METER | | TOTAL VOLUME PUMPED | ESTIMATED VOLUMES | | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MONTH/ DAY | | | | INTERNAL/ EXTERNAL | STATED CONTENT | GALLONS | NUMBER PORT/ STBD | NUMBER PORT/ STBD | OIL/H2O/AIR | START TIME | STOP TIME | AVERAGE FLOW RATE | START TIME | STOP TIME | AVERAGE FLOW RATE | START | END | GALLONS | WATER/SLOPS | OIL | |
| 41 | | V | 2.4 | PORT | EXTERNAL | DIRT OIL TANK | 1495 | | | | | | | WATER | | | | | | | | WATER |
| 42 | 09/12 | VI | 1.2 | PORT | EXTERNAL | FUEL OIL | 12914 | | | OIL | 1316 | 1420 | | | | | 0 | 4588 | 5410 | 2215 | 3195 | GOOD OIL RIGHT AWAY, CLOSED AFTER PUMP/STRIP ON 09/13. SECOND PUMP GOT ONLY LPOS. (SEE NOTE 1) |
| | 09/13 | | | | | | | | | | 0911 | 0926 | | | | | | 822 | | | | |
| 43 | 09/12 | VI | 2.1 | STBD | EXTERNAL | FUEL OIL | 10264 | | | OIL | 1132 | 1215 | | | | | 0 | 3144 | 4479 | 2369 | 2110 | ALL OIL ON FIRST PUMP. CLOSED AFTER STRIPPING ON SECOND PUMP. (SEE NOTE 1) |
| | 09/13 | | | | | | | | | | 0933 | 0955 | | | | | | 1335 | | | | |
| 44 | 09/12 | VI | 2.2 | PORT | EXTERNAL | FUEL OIL | 10330 | | | OIL | 1557 | 1632 | | | | | | 2057 | 3059 | 1768 | 1291 | ALL OIL ON FIRST PUMP. CLOSED AFTER STRIPPING ON SECOND PUMP. |
| | 09/13 | | | | | | | | | | 0851 | 0903 | | | | | 0 | 1002 | | | | |
| 45 | | VI | 4.1 | STBD | EXTERNAL | FUEL OIL | 9411 | | | | | | | WATER | | | | | | | | WATER |
| 46 | 09/12 | VI | 4.2 | PORT | EXTERNAL | FUEL OIL | 9334 | 2 PORT | 4 STBD | OIL | 1719 | 1757 | | | | | 0 | 2632 | 3489 | 1427 | 2062 | ALL OIL ON FIRST PUMP. CLOSED AFTER STRIPPING ON SECOND PUMP. |
| | 09/13 | | | | | | | | | | 0822 | 0837 | | | | | | 862 | | | | |
| 47 | 09/13 | VII | 1.1 | STBD | EXTERNAL | FUEL OIL | 5831 | 2 PORT | 4 STBD | OIL | 1314 | | | 1457 | 1628 | | 0 | 5142 | 5142 | 1284 | 3858 | TANK WAS TIGHT AND NOT WELL NATURALLY VENTED. USED SCHADOW TUBE VENT. |
| 48 | 09/13 | VII | 1.2 | PORT | EXTERNAL | FUEL OIL | 5955 | 2 PORT | 4 STBD | OIL | 1239 | 1309 | | | | | 0 | 1963 | 2620 | 1626 | 994 | OIL PULLED ON FIRST PUMP AND SECOND PUMP YIELDED LPO. TANK WAS CLOSED. |
| | 09/14 | | | | | | | | | | 0932 | 0946 | | | | | | 657 | | | | |
| 49 | 09/14 | VII | 1.3 | STBD | EXTERNAL | FUEL OIL | 12840 | 2 PORT | 4 STBD | OIL | 1246 | 1329 | | 1344 | 1352 | | 0 | 2262<br>664 | 3286 | 1279 | 2007 | FIRST PUMP GOT ALL THE OIL, SECOND PUMP WAS STRIPPING ONLY. (SEE NOTE 1) |
| 50 | 09/14 | VII | 2.1 | STBD | EXTERNAL | FUEL OIL | 5189 | 2 PORT | 4 STBD | OIL | 0954 | 1009 | | 1017 | 1025 | | 0 | 928<br>1375 | 1303 | 946 | 357 | PUMPED 09/14, BUT OIL ENDED QUICKLY. SECOND PUMP STRIPPED CLEAN AND CLOSED. |
| 51 | 09/13 | VII | 2.2 | PORT | EXTERNAL | FUEL OIL | 5102 | 2 PORT | 4 STBD | OIL | 1149 | 1219 | | | | | 0 | 1602 | 2297 | 1515 | 782 | PULLED GOOD OIL FIRST PUMP. SECOND PUMP STRIPPED CLEAN AND CLOSED. (SEE NOTE 1) |
| | 09/14 | | | | | | | | | | 0907 | 0923 | | | | | | 695 | | | | |
| 52 | 09/14 | VII | 2.3 | STBD | EXTERNAL | FUEL OIL | 11239 | 2 PORT | 4 STBD | OIL | 1139 | 1155 | | 1218 | 1227 | | 0 | 1445<br>432 | 1877 | 1516 | 361 | PULLED GOOD OIL FIRST PUMP. SECOND PUMP STRIPPED CLEAN AND CLOSED. (SEE NOTE 1) |
| 53 | 09/13 | VII | 2.4 | PORT | EXTERNAL | FUEL OIL | 11221 | 2 PORT | 4 STBD | OIL | 1641 | 1706 | | | | | 0 | 1466 | | | | PULLED GOOD OIL FIRST PUMP. SECOND PUMP STRIPPED CLEAN AND CLOSED. |
| | 09/14 | | | | | | | | | | 0854 | 0902 | | | | | | 416 | 1882 | 1089 | 793 | |
| 54 | 09/14 | VII | 4.1 | STBD | EXTERNAL | FUEL OIL | 4037 | 2 PORT | 4 STBD | OIL | 1043 | 1112 | | 1658 | 1735 | | 0 | 2128 | 2128 | 2128 | 0 | FIRST PUMP DIFFICULT, TANK HAD NO NATURAL VENT, DID NOT PULL ANY SIGNIFICANT OIL ONLY LPOS. CLOSED SECOND TIME. |

Figure J-4. Pump Station Log, Sheet 4 of 13

| ITEM | DATE | SECTION NUMBER | TANK NO. | PORT/ STBD | TANK TYPE | TANK CONTENT | 85% OF MAX VOLUME | DESIGNATED RECEIVING TANK OIL | DESIGNATED RECEIVING TANK WATER/SLOPS | DIVER OBSERVED CONTENTS | FIRST PUMP | | | SECOND PUMP | | | FUEL METER | | TOTAL VOLUME PUMPED | ESTIMATED VOLUMES | | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MONTH/ DAY | | | | INTERNAL/ EXTERNAL | STATED CONTENT | GALLONS | NUMBER PORT/ STBD | NUMBER PORT/ STBD | OIL/H2O/AIR | START TIME | STOP TIME | AVERAGE FLOW RATE | START TIME | STOP TIME | AVERAGE FLOW RATE | START | END | GALLONS | WATER/SLOPS | OIL | |
| 55 | | VII | 4.2 | PORT | EXTERNAL | FUEL OIL | 4029 | 2 PORT | 4 STBD | WATER | 1034 | | | | | | 0 | 163 | 163 | 163 | 0 | WATER (PRIME PUMP).<br>(SEE NOTE 1) |
| 56 | 09/14 | VII | 4.5 | STBD | EXTERNAL | FUEL OIL | 9141 | 2 PORT | 4 STBD | OIL | 1445 | 1639 | | | | | 0 | 7938 | 7938 | 1343 | 6595 | FIRST PUMP OIL @ 1455. CLOSED AFTER STRIPPING. |
| 57 | 09/13 | VII | 4.6 | PORT | EXTERNAL | FUEL OIL | 9136 | 2 PORT | 4 STBD | OIL | 1709<br>(1740 VENT) | 1852 | | | | | 0 | 5650 | 6584 | 2516 | 4068 | VENT ISSUES PUMPED ON 09/13. STRIPPED AND CLOSED ON 09/14. |
| | 09/14 | | | | | | | | | | 0838 | 0848 | | | | | | 934 | | | | |
| 58 | 09/15 | VIII | 1.2 | PORT | EXTERNAL | FUEL OIL | 12465 | 2 PORT | 4 STBD | OIL | 1103<br>1351 | 1333<br>1408 (FLUSH) | | | | | 0 | 424 | 3433 | 3433 | 0 | TIRE SUCTION PUMP AND VENT ISSUES, LPO. |
| | 09/16 | | | | | | | | | | 1317 | 1341 | | | | | | 1609 | | | | |
| 59 | 09/16 | VIII | 2.1 | STBD | EXTERNAL | FUEL OIL | 11453 | 2 PORT | 4 STBD | OIL | 1408<br>1715 | 1606<br>1732 | | 1621 | 1700 | | 0 | 8661<br>4010<br>1719 | 14771 | 7517 | 7254 | TIRE PUMP. DIFFICULT WITH AIR AND VENT ISSUES. |
| 60 | 09/15 | VIII | 2.2 | PORT | EXTERNAL | FUEL OIL | 11678 | 2 PORT | 4 STBD | OIL | 2006 | 2105 | | 2123 | 2142 | | 0 | 2779<br>1875 | 4654 | 2994 | 1660 | |
| 61 | 09/15 | VIII | 4.1 | STBD | EXTERNAL | FUEL OIL | 8782 | 2 PORT | 4 STBD | OIL | 0850 | 0949 | | 1002 | 1027 | | 0 | 3770<br>1276 | 9850 | 6836 | 3014 | TIRE PUMP PUMPED, STRIPPED, AND CLOSED. |
| | 09/25 | | | | | | | | | | 1309 | 1356 | | | | | | 1855 | | | | |
| | 09/26 | | | | | | | | | | 1418<br>1609 | 1459<br>1620 | | 1519<br>1653 | 1550<br>1659 (FLUSH) | | | 1416<br>823<br>535<br>175 | | | | |
| 62 | 09/15 | VIII | 4.2 | PORT | EXTERNAL | FUEL OIL | 8832 | 2 PORT | 4 STBD | OIL | 1627 | 1929 | | | | | 0 | 8230 | 11520 | 2621 | 8899 | "BAD BOY MOUSSE TANK" FLANGE LEAKED BADLY CAUSING SPILL RESPONSE BOATS TO BE DEPLOYED. THIS TANK WAS PUMPED LATE INTO THE EVENING TO ALEVIATE THE LEAK FROM THE FLANGE AND ENDED UP PULLING A LARGE AMOUNT OF HEAVY MOUSSE FROM THE TANK. |
| | 09/16 | | | | | | | | | | 1745 | 1810 | | 1819 | 1833 | | | 1784<br>461 | | | | |
| | 09/28 | | | | | | | | | | 0844 | 0908 | | 0909 | 0913 | | | 892<br>153 | | | | |
| 63 | 09/17 | IX | 1.2 | PORT | EXTERNAL | DIESEL | 7051 | 2 PORT | 4 STBD | OIL | 0917<br>1035 | 0948<br>1045 | | 1006 | 1026 | | 0 | 339<br>1025<br>801 | 2165 | 1428 | 737 | DIESEL TANK, LIGHT DIESEL FUEL (BLACK AND DIRTY WITH SOME EMULSION IN THE TANK BOTTOMS). THE LIGHTER DENSITY ALLOWED THE PUMP DISCHARGE HOSE ON THE BOTTOM TO FLOAT. |
| 64 | | IX | 1.3 | STBD | EXTERNAL | DIESEL | 3654 | | | | | | | WATER | | | | | | | | WATER |
| 65 | 09/17 | IX | 2.1 | STBD | EXTERNAL | DIESEL | 5889 | 2 PORT | 4 STBD | OIL | 1430 | 1517 | | 1617 | 1624 | | 0 | 2951<br>442 | 3393 | 1628 | 1765 | CONTENTS, FIRE HOSE CREATED DIFFICULTY GETTING PRODUCT. FINALLY PULLED GOOD DIESEL OIL FLOW AFTER SHUTTING OFF FIRE HOSE. PRODUCT HOSE FLOATED WITH DIESEL. |
| 66 | 09/17 | IX | 2.2 | PORT | EXTERNAL | DIESEL | 5995 | 2 PORT | 4 STBD | OIL | 1056 | 1110 | | | | | | 1200 | 1200 | 1200 | 0 | PUMPED BUT DID NOT PULL ANY OIL. CLOSED OUT, WATER ONLY. |
| 67 | 09/17 | IX | 4.1 | STBD | EXTERNAL | DIESEL | 4000 | 2 PORT | 4 STBD | OIL | 1646 | 1704 | | | | | 0 | 1566 | 1566 | 1035 | 531 | NSFO/DIESEL, LOOKS LIKE NSFO IN DIESEL TANK. |
| 68 | 09/17 | IX | 4.2 | PORT | EXTERNAL | DIESEL | 4016 | 2 STBD | 4 STBD | OIL | 1118 | 1134 | | 1213 | 1224 | | 0 | 1000<br>817 | 1817 | 1645 | 172 | PUMPED TWICE BEFORE CLOSING OUT. |

Figure J-5. Pump Station Log, Sheet 5 of 13

| ITEM | DATE | SECTION NUMBER | TANK NO. | PORT/ STBD | TANK TYPE | TANK CONTENT | 85% OF MAX VOLUME | DESIGNATED RECEIVING TANK OIL | DESIGNATED RECEIVING TANK WATER/SLOPS | DIVER OBSERVED CONTENTS | FIRST PUMP | | | SECOND PUMP | | | FUEL METER | | TOTAL VOLUME PUMPED | ESTIMATED VOLUMES | | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MONTH/ DAY | | | | INTERNAL/ EXTERNAL | STATED CONTENT | GALLONS | NUMBER PORT/ STBD | NUMBER PORT/ STBD | OIL/H2O/AIR | START TIME | STOP TIME | AVERAGE FLOW RATE | START TIME | STOP TIME | AVERAGE FLOW RATE | START | END | GALLONS | WATER/SLOPS | OIL | |
| 69 | 09/18 | IX | 1.1 | STBD | EXTERNAL | DIESEL | 3205 | | | | 0910 | 1001 | | | | | 0 | 1004 | 1004 | 1004 | 0 | LOW FLOW, POORLY VENTED, USING SAD DEVICE BUT NO OIL RECOVERED |
| 70 | 09/18 | X | 1.1 | STBD | EXTERNAL | FUEL OIL | 11310 | 2 PORT | 4 STBD | OIL | 1353 | 1523 | | 1540 | 1606 | | 0 | 6234<br>1965 | 12816 | 8632 | 4184 | BAD BISCUIT - GOOD OIL FLOW STARTING AT 330 GALLONS ON THE TOTALIZER WITH AVERAGE FLOW RATE OF 30 GPM VIA A HOLE WITH A PUCK STUCK IN HOLE. RESTRIPED HOLE TO REMOVE THE PUCK ON 09/27 FOR THE EXTRA 1562 OF LPO WATER AND 152 GALLONS OF OIL. |
| | 09/27 | | | | | | | | | | 1152<br>1309 | 1202 (FLUSH)<br>1342 | | 1352 | 1446 | | | 854<br>1562<br>2201 | | | | |
| 71 | 09/18 | X | 1.2 | PORT | EXTERNAL | FUEL OIL | 11081 | 2 PORT | 4 STBD | AIR/OIL/WATER | | | | | | | | | | | 0 | THE TEST HOLE FOR THIS TANK SHOWED AIR AND TRACES OF OIL IN THE AIR PLUME. AFTER TAPPING HOLE AND BLEEDING AIR, THERE WAS HOWEVER NO TRACE OF OIL AND NO OIL WITH VALVE WIDE OPEN. HOLE WAS CLOSED WITHOUT PUMPING.<br>NO OIL IN HOLE AFTER TAPPING - ONLY WATER |
| 72 | 09/18 | X | 2.1 | STBD | EXTERNAL | FUEL OIL | 9918 | 2 PORT | 4 STBD | OIL | 1020<br>1314 | 1037<br>1336 | | 1235 | 1302 | | 0 | 1478<br>2320<br>1682 | 5480 | 4910 | 570 | PUMP AND STRIP TANK. STRAIGHT FORWARD STRIP TO LESS THAN 1%. |
| 73 | 09/19 | X | 2.2 | PORT | EXTERNAL | FUEL OIL | 10085 | 2 PORT | 4 STBD | OIL | 0821<br>0929 | 0845<br>0937 | | 0901 | 0925 | | 0 | 1336<br>987<br>348 | 2671 | 2442 | 229 | USED FIRE HOSE AND SCHADOW DEVICE TO PUMP WITH DIFFICULTY. STRIPPED ON FIRST AND SECOND PUMPING. |
| 74 | 09/18 | X | 4.1 | STBD | EXTERNAL | FUEL OIL | 5128 | | | | | | | WATER | | | 0 | | | | 0 | WATER |
| 75 | 09/19 | X | 4.2 | PORT | EXTERNAL | FUEL OIL | 5133 | 2 PORT | 4 STBD | OIL | 0956 | 1030 | | 1130 | 1214 | | 0 | 596<br>786 | 1382 | 1202 | 180 | BAD VENT- USED SAD DEVICE AND FIRE HOSE TO HELP VENT TANK. PULLED SMALL AMOUNT OF GOOD OIL THEN PUMPED CLEAN AND CLOSED TANK. WENT BACK AND CLOSED AGAIN. |
| 76 | 09/19 | XI | 6.1 | STBD | EXTERNAL | FUEL OIL | 16021 | 2 PORT | 4 STBD | OIL | 1447 | 1510 | 62 | 1525 | 1602 | 48 | 0 | 1419<br>1765 | 3184 | 2851 | 333 | FIRST PUMP CONDUCTED USING SCHADOW TOOL, AIR ISSUES. OIL TAKEN QUICKLY, VERY LARGE TANK BUT NOT MUCH OIL. STRIPPED AND CLOSED ON SECOND PUMP. |
| 77 | 09/19 | XI | 6.2 | PORT | EXTERNAL | FUEL OIL | 17472 | 2 PORT | 4 STBD | OIL | 1610 | 1800 | | 1814 | 1853 | | 0 | 6523<br>1852 | 11570 | 6453 | 5117 | DRUNKEN SAILOR - FLOW RATE SAILOR. USED FIRE HOSE WITH SAD INSERTED. STRIPPED FOUR TIMES RECOVERING 4792, 44, 105, AND 176. FINAL STRIP ON 09/21, RECOVERED 176 GALLONS OIL. |
| | 09/20 | | | | | | | | | | 0819 | 0848 | | 0859 | 0900 (FLUSH) | | | 1784<br>53 | | | | |
| | 09/21 | | | | | | | | | | 0825 | 0850 (STRIP) | | 1814 | 1853 | | | 1358 | | | | |
| 78 | 09/20 | XI | 6.4 | PORT | EXTERNAL | FUEL OIL | 19030 | 2 PORT | 4 STBD | OIL | 0942 | 1110 | | | | | 0 | 5245 | 6508 | 3015 | 3493 | FIRE HOSE USED, BUT SAD DEVICE WAS ONLY PARTIALLY INSERTED. SECURED FIRE HOSE AS IT WAS NOT HELPING, THEN PUMPED GOOD OIL. STRIPPED AGAIN, BUT NO OIL REMOVED OTHER THAN A SMALL PERCENTAGE. STRIPPED AND CLOSED ON 09/21. |
| | 09/21 | | | | | | | | | | 0858 | 0924 (STRIP) | | | | | | 1263 | | | | |
| 79 | | XI | 6.5 | STBD | EXTERNAL | FUEL OIL | 14232 | | | | | | | WATER | | | 0 | | | | 0 | WATER |
| 80 | 09/20 | XI | 6.6 | PORT | EXTERNAL | FUEL OIL | 14975 | 2 PORT | 4 STBD | OIL | 1121 | 1153 | | | | | 0 | 1730 | 1730 | 1730 | 0 | PUMPED BUT TOOK IN NO OIL, WATER ONLY. CLOSED AFTER SHORT PUMP SESSION. |
| 81 | 09/20 | XI | 6.9 | STBD | EXTERNAL | FUEL OIL | 12756 | 2 PORT | 4 STBD | OIL | 1202 | 1430 | | | | | 0 | 12110<br>419 (FLUSH) | 15599 | 4087 | 11512 | FIRST PUMP 11257 GALLONS OIL. SECOND PUMP STRIPPED ON 09/21. TOOK ANOTHER 255 GALLONS OIL. CLOSED AFTER SECOND STRIP. |
| | 09/21 | | | | | | | | | | 0935 | 1012 | | 1032 | 1053 | | | 1934<br>1136 | | | | |

Figure J-6. Pump Station Log, Sheet 6 of 13

| ITEM | DATE | SECTION NUMBER | TANK NO. | PORT/ STBD | TANK TYPE | TANK CONTENT | 85% OF MAX VOLUME | DESIGNATED RECEIVING TANK OIL | DESIGNATED RECEIVING TANK WATER/SLOPS | DIVER OBSERVED CONTENTS | FIRST PUMP | | | SECOND PUMP | | | FUEL METER | | TOTAL VOLUME PUMPED | ESTIMATED VOLUMES | | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MONTH/ DAY | | | | INTERNAL/ EXTERNAL | STATED CONTENT | GALLONS | NUMBER PORT/ STBD | NUMBER PORT/ STBD | OIL/H2O/AIR | START TIME | STOP TIME | AVERAGE FLOW RATE | START TIME | STOP TIME | AVERAGE FLOW RATE | START | END | GALLONS | WATER/SLOPS | OIL | |
| 82 | 09/21 | XI | 6.8 | PORT | EXTERNAL | FUEL OIL | 10993 | 2 PORT | 4 STBD | OIL | 1206 | 1318 | | 1339 | 1410 | | 0 | 5621/1238 | 6859 | 1956 | 4903 | FIRST PUMP STARTED WITH FIRE HOSE THEN TURNED OFF AS IT WAS COUNTER PRODUCTIVE, THEN PULLED 4840 GALLONS. STRIPPED WITHOUT FIRE HOSE AND PULLED ANOTHER 63 GALLONS, BUT USED IT TO CLEAR HOSE AFTERWARD. |
| 83 | 09/20 | XI | 6.11 | STBD | EXTERNAL | FUEL OIL | 9295 | 2 PORT | 4 STBD | OIL | 1536 | 1702 | | | | | 0 | 7833 | 9773 | 2782 | 6991 | 1ST PUMP BLEW OUT GASKET IN BOTTOM FLANGE, CAUSED SMALL SPILL USING FIRE HOSE WITH TOO MUCH PRESSURE. PUMPED ON TANK DECREASE PROBLEM WITH SPILL. TOOK 6846 GALLONS OF OIL. STRIPPED NEXT DAY 09/21 TOOK 145 GALLONS AND CLOSED TANK. |
| | 09/21 | | | | | | | | | | 1104 | 1148 | | | | | | 1940 | | | | |
| 84 | 09/22 | XII | 6.6 | PORT | EXTERNAL | FUEL OIL | 4938 | 2 PORT | 4 STBD | OIL | 0915 | 1125 | | | | | 0 | 2240 | 5664 | 5477 | 187 | FIRE HOSE/SCHADOW VENT TUBE DOWN PART WAY. DIFFICULTY GETTING A SUCTION. LOTS OF AIR IN TANK AND AIR CAUSING PUMP ISSUES, NEVER GOT A FLOW RATE OVER 30 GPM. VERY LITTLE OIL RECOVERED. MOST DIFFICULT TANK TO-DATE. |
| | 09/24 | | | | | | | | | | 0824<br>0939 | 0854<br>1040 | | 1112 | 1117 | | | 1411<br>144<br>1869 | | | | |
| 85 | 09/22 | XII | 6.7 | STBD | EXTERNAL | FUEL OIL | 3942 | 2 PORT | 4 STBD | OIL | 1130<br>1210 | 1205<br>1212 (FLUSH) | | | | | 0 | 55<br>1083 | 1138 | 1138 | 0 | HARD TIME GETTING ANY KIND OF VENT, BUT FINALLY GOT IT TO FLOW AT ABOUT 30 GPM USING FIRE HOSE AND SCHADOW DEVICE. NO OIL RECOVERED. |
| 86 | 09/22 | XIII | 6.1 | STBD | EXTERNAL | FUEL OIL | 7974 | 2 PORT | 4 STBD | OIL | 1233 | 1513 | | | | | 0 | 6153<br>914 | 7555 | 1533 | 6022 | ESTABLISHED FLOW USING FIRE HOSE. TURNED DOWN AND PUMPED AT LOW FLOW FOR HOURS, FINALLY STOPPED TO SWITCH PUMP TO LEAKING FLANGE AT 6.3. THIS HAD MORE OIL, STOPPED PREMATURELY WHILE PUMPING TO PUMP OUT ANOTHER TANK THAT WAS LEAKING. SECOND PUMP ONLY RECOVERED 175 GALLONS NEXT DAY. CLOSED. |
| | 09/23 | | | | | | | | | | 1602 | 1617 | | 1650 | 1656 | | | 945<br>457 | | | | |
| 87 | 09/23 | XIII | 6.2 | PORT | EXTERNAL | FUEL OIL | 7984 | 2 PORT | 4 STBD | OIL | 1720 | 1828 | | | | | 0 | 7183 | 8594 | 2117 | 6477 | USED FIRE HOSE INITIALLY, BUT OIL CAME UP FAST INDICATING LARGE VOLUME OF OIL, AND PUMPED AT 115 GPM THROUGH MOST OF SESSION. STRIPPED AND CLOSED ON THE 24TH. |
| | 09/24 | | | | | | | | | | 0824 | 0854 | | | | | | 1411 | | | | |
| 88 | 09/22 | XIII | 6.3 | STBD | EXTERNAL | FUEL OIL | 9802 | 2 PORT | 4 STBD | OIL | 2016<br>1526 | 2051<br>1624 | | 2107<br>1830 | 2147<br>2147 | | 0 | 1830<br>659<br>1954<br>4230 | 10240 | 5248 | 4992 | "CRACK BABY" - THIS WAS THE LEAKY FLANGE, THE TEST HOLE WAS UNDER THE GASKET. PUMPED THIS ONE TO 840 GALLONS OF OIL THEN STRIPPING AT HIGH PERCENTAGE. STOPPED EARLY TO MOVE TO 6.4 WHICH HAD A PROBLEM. CAME BACK AT 1830 BECAUSE THIS TANK WAS FOUND TO HAVE A CRACK THAT WAS LEAKING BADLY. PUMPING HEAVY OIL OUT OF THIS TANK CAN ONLY GET ABOUT 45 GPM AVERAGE DUE TO VENT LEVEL. SUSPECT COMMUNICATION WITH LOWER TANK (6.29). STOPPED AND PUMPED TANK THREE TIMES P1=840, P2 = 3955, P3 =197. |
| | 09/23 | | | | | | | | | | 1430 | 1505 | | | | | | 1567 | | | | |
| 89 | 09/22 | XIII | 6.4 | PORT | EXTERNAL | FUEL OIL | 9828 | 2 PORT | 4 STBD | OIL | 1626 | 1822 | | | | | 0 | 1204 | 9708 | 1793 | 7915 | STARTED WITH GOOD FLOW. GOT OIL AT 243 GALLONS. PUMPING AT HIGH FLOW RATE IN THE 80'S. 2ND PUMP NO DEVICE, GOOD FLOW 100 GPM GOT ONLY 84 GALLONS. CLOSED ON 09/23. |
| | 09/23 | | | | | | | | | | 1509 | 1540 | | | | | | 8504 | | | | |
| 90 | 09/23 | XIII | 6.29 | CL | EXTERNAL | FUEL OIL | 14359 | 2 PORT | 4 STBD | OIL | 1053 | 1403 | | 1041 | 1408 (FLUSH) | | 0 | 765<br>13576 | 14341 | 2651 | 11690 | "HONEY HOLE" - PUMPED THIS LARGE TANK OUT AFTER A LATE START FROM THE PREVIOUS LONG NIGHT. GOOD NATURAL VENT PULLED LARGE AMOUNT OF OIL. STRIPPED IT FOR QUITE A WHILE. CAPPED AND CLOSED. |
| | | | | | | CENTERLINE EXTERNAL TANKS | 686331 | | | | | | | | | | | | | 175011 | 164971 | |

Figure J-7. Pump Station Log, Sheet 7 of 13

| ITEM | DATE | SECTION NUMBER | TANK NO. | PORT/ STBD | TANK TYPE | TANK CONTENT | 85% OF MAX VOLUME | DESIGNATED RECEIVING TANK OIL | DESIGNATED RECEIVING TANK WATER/SLOPS | DIVER OBSERVED CONTENTS | FIRST PUMP | | | SECOND PUMP | | | FUEL METER | | TOTAL VOLUME PUMPED | ESTIMATED VOLUMES | | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MONTH/ DAY | | | | INTERNAL/ EXTERNAL | STATED CONTENT | GALLONS | NUMBER PORT/ STBD | NUMBER PORT/ STBD | OIL/H2O/AIR | START TIME | STOP TIME | AVERAGE FLOW RATE | START TIME | STOP TIME | AVERAGE FLOW RATE | START | END | GALLONS | WATER/SLOPS | OIL | |
| **EXTERNAL WING TANKS** | | | | | | | | | | | | | | | | | | | | | | |
| 91 | | II | 4.3 | STBD | EXTERNAL | FUEL OIL | 3406 | | | | | | | WATER | | | | | | | | WATER |
| 92 | | II | 4.4 | PORT | EXTERNAL | FUEL OIL | 3406 | | | | | | | BREACHED | | | | | | | | BREACHED |
| 93 | | II | 4.5 | STBD | EXTERNAL | RES FUEL OIL | 2904 | | | | | | | WATER | | | | | | | | WATER |
| 94 | | II | 4.6 | PORT | EXTERNAL | RES FUEL OIL | 2904 | | | | | | | BREACHED | | | | | | | | BREACHED |
| 95 | 10/02<br>10/03 | II | 4.7 | STBD | EXTERNAL | RES FUEL OIL | 4362 | 2 STBD | 4 STBD | OIL | 1604<br>1120 | 1647<br>1151 | | 1700 | 1717 | | 0 | 1883<br>786<br>1120 | 3789 | 2857 | 932 | PUMPING USING SCHADOW TOOL WITH VENT VALVE CLOSED. |
| 96 | | II | 4.8 | PORT | EXTERNAL | RES FUEL OIL | 4362 | | | | | | | BREACHED | | | | | | | | BREACHED |
| 97 | | II | 4.9 | STBD | EXTERNAL | RES FUEL OIL | 3934 | | | | | | | WATER | | | | | | | | WATER |
| 98 | | II | 4.1 | PORT | EXTERNAL | RES FUEL OIL | 3934 | | | | | | | BREACHED | | | | | | | | BREACHED |
| 99 | 10/01 | III | 4.3 | STBD | EXTERNAL | RES FUEL OIL | 5873 | 2 STBD | 4 STBD | OIL | 1122<br>1354 | 1230<br>1411 | 60 | 1246 | 1258 | | 0 | 3532<br>773<br>880 | 5185 | 2695 | 2490 | TRIED PUMPING FROM THIS WING TANK, BUT WITH VERY POOR RESULTS. COULD NOT GET A GOOD SUCTION ON THE HTSCR4 PUMP. STOPPED PUMPING, PULLED PUMP UP TO RHIB BOAT ON SURFACE WHERE CONNECTIONS WERE MADE AND REPLACED THE PUMP WITH ANOTHER ONE FROM THE SURFACE. PUMPING RESUMED IMMEDIATELY WITH GOOD FLOW. |
| 100 | | III | 4.8 | PORT | EXTERNAL | RES FUEL OIL | 2354 | | | | | | | BREACHED | | | | | | | | BREACHED |
| 101 | | III | 4.7 | STBD | EXTERNAL | RES FUEL OIL | 4914 | | | | | | | WATER | | | | | | | | WATER |
| 102 | | III | 4.12 | PORT | EXTERNAL | RES FUEL OIL | 5691 | | | | | | | BREACHED | | | | | | | | BREACHED |
| 103 | | III | 4.11 | STBD | EXTERNAL | RES FUEL OIL | 3770 | | | | | | | WATER | | | | | | | | THIS TANK WAS LISTED AS HAVING OIL, BUT WHEN IT WAS HOT TAPPED AND FLANGED, THERE WAS NO OIL IN IT AND IT WAS CLEAN. |
| 104 | | III | 4.13 | STBD | EXTERNAL | TURBINE OIL | 5839 | | | | | | | WATER | | | | | | | | WATER |
| 105 | | III | 4.16 | PORT | EXTERNAL | RES FUEL OIL | 8211 | | | | | | | BREACHED | | | | | | | | BREACHED |
| 106 | | IV | 4.5 | STBD | EXTERNAL | RES FUEL OIL | 6594 | | | | | | | WATER | | | | | | | | ALTHOUGH PREVIOUSLY TESTED FOR OIL, WHEN ACCESSSED THIS TANK SHOWED ONLY WATER. |
| 107 | | IV | 4.6 | PORT | EXTERNAL | RES FUEL OIL | 6594 | | | | | | | BREACHED | | | | | | | | BREACHED |

Figure J-8. Pump Station Log, Sheet 8 of 13

| ITEM | DATE | SECTION NUMBER | TANK NO. | PORT/ STBD | TANK TYPE | TANK CONTENT | 85% OF MAX VOLUME | DESIGNATED RECEIVING TANK OIL | DESIGNATED RECEIVING TANK WATER/SLOPS | DIVER OBSERVED CONTENTS | FIRST PUMP | | | SECOND PUMP | | | FUEL METER | | TOTAL VOLUME PUMPED | ESTIMATED VOLUMES | | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MONTH/ DAY | | | | INTERNAL/ EXTERNAL | STATED CONTENT | GALLONS | NUMBER PORT/ STBD | NUMBER PORT/ STBD | OIL/H2O/AIR | START TIME | STOP TIME | AVERAGE FLOW RATE | START TIME | STOP TIME | AVERAGE FLOW RATE | START | END | GALLONS | WATER/SLOPS | OIL | |
| 108 | | IV | 4.7 | STBD | EXTERNAL | RES FUEL OIL | 7287 | | | | | | | WATER | | | | | | | | WATER |
| 109 | | IV | 4.8 | PORT | EXTERNAL | RES FUEL OIL | 7287 | | | | | | | BREACHED | | | | | | | | BREACHED |
| 110 | | V | 4.3 | STBD | EXTERNAL | PLANE FUEL | 1308 | | | AVAITION FUEL TANKS WERE NOT ACCESSED | | | | | | | | | | | | DID NOT ACCESS AVIATION GASOLINE TANKS |
| 111 | | V | 4.4 | PORT | EXTERNAL | PLANE FUEL | 1308 | | | AVAITION FUEL TANKS WERE NOT ACCESSED | | | | | | | | | | | | DID NOT ACCESS AVIATION GASOLINE TANKS |
| 112 | | V | 4.9 | STBD | EXTERNAL | PLANE FUEL | 1308 | | | AVAITION FUEL TANKS WERE NOT ACCESSED | | | | | | | | | | | | DID NOT ACCESS AVIATION GASOLINE TANKS |
| 113 | | V | 4.1 | PORT | EXTERNAL | PLANE FUEL | 1308 | | | AVAITION FUEL TANKS WERE NOT ACCESSED | | | | | | | | | | | | DID NOT ACCESS AVIATION GASOLINE TANKS |
| 114 | | V | 4.5 | STBD | EXTERNAL | TURBINE OIL | 6896 | | | | | | | WATER | | | | | | | | WATER |
| 115 | | V | 4.6 | STBD | EXTERNAL | RES FUEL OIL | 1938 | | | | | | | WATER | | | | | | | | WATER |
| 116 | | VI | 4.7 | STBD | EXTERNAL | RES FUEL OIL | 3765 | | | | | | | WATER | | | | | | | | WATER |
| 117 | | VI | 4.8 | PORT | EXTERNAL | RES FUEL OIL | 3765 | | | | | | | WATER | | | | | | | | WATER |
| 118 | | VI | 4.9 | STBD | EXTERNAL | RES FUEL OIL | 5001 | | | | | | | WATER | | | | | | | | WATER |
| 119 | | VI | 4.1 | PORT | EXTERNAL | RES FUEL OIL | 5001 | | | | | | | WATER | | | | | | | | WATER |
| 120 | | VII | 4.3 | STBD | EXTERNAL | RES FUEL OIL | 7250 | | | | | | | WATER | | | | | | | | WATER |
| 121 | 09/25 | VII | 4.4 | PORT | EXTERNAL | RES FUEL OIL | 7250 | 2 STBD | 4 STBD | OIL | 1638 | 1704 | | 1708 | 1735 | | 0 | 1733<br>981 | 2714 | 1485 | 1229 | POOR FLOW FIRST TIME, USED FIRE HOSE AT FIRST THEN OFF. SECOND TIME THE SAME RESULT. |
| 122 | | VII | 4.7 | STBD | EXTERNAL | RES FUEL OIL | 8346 | | | | | | | WATER | | | | | | | | WATER |
| 123 | 09/25 | VII | 4.8 | PORT | EXTERNAL | RES FUEL OIL | 8346 | 2 STBD | 4 STBD | AIR/OIL | 1042<br>1112 | 1047 (FLUSH)<br>1220 | | 1535<br>1745 | 1650<br>1805 | | 0 | 661<br>408<br>2010<br>1197 | 4276 | 3958 | 318 | BAD BISCUIT IN HOLE. LOW FLOW DUE TO BAD VENT. DRILLING VENT HOLE, THEN DRILLED NEW HOT TAP HOLE. |
| 124 | | VII | 4.9 | STBD | EXTERNAL | RES FUEL OIL | 6985 | | | | | | | WATER | | | | | | | | WATER |
| 125 | | VII | 4.1 | PORT | EXTERNAL | RES FUEL OIL | 6985 | | | | | | | WATER | | | | | | | | WATER |
| 126 | 09/26 | VIII | 4.3 | STBD | EXTERNAL | RES FUEL OIL | 7686 | 2 STBD | 4 STBD | OIL | 1041<br>1115 | 1113<br>1130 | | 1223<br>1240 | 1235<br>1247 (FLUSH) | | 0 | 2930<br>485<br>778<br>770 | 4963 | 2879 | 2084 | STARTED WITH FIRE HOSE THEN WENT TO GOOD NATURAL VENT. PUMPED OIL THEN STRIPPED OUT AND CLOSED. |

Figure J-9. Pump Station Log, Sheet 9 of 13

| ITEM | DATE | SECTION NUMBER | TANK NO. | PORT/ STBD | TANK TYPE | TANK CONTENT | 85% OF MAX VOLUME | DESIGNATED RECEIVING TANK OIL | DESIGNATED RECEIVING TANK WATER/SLOPS | DIVER OBSERVED CONTENTS | FIRST PUMP | | | SECOND PUMP | | | FUEL METER | | TOTAL VOLUME PUMPED | ESTIMATED VOLUMES | | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MONTH/ DAY | | | | INTERNAL/ EXTERNAL | STATED CONTENT | GALLONS | NUMBER PORT/ STBD | NUMBER PORT/ STBD | OIL/H2O/AIR | START TIME | STOP TIME | AVERAGE FLOW RATE | START TIME | STOP TIME | AVERAGE FLOW RATE | START | END | GALLONS | WATER/SLOPS | OIL | |
| 127 | 09/25 | VIII | 4.4 | PORT | EXTERNAL | RES FUEL OIL | 7686 | 2 STBD | 4 STBD | OIL | 1226 | 1328 | | 1543 | 1603 | | 0 | 3333<br>1128 | 4461 | 2091 | 2370 | POOR VENT, USED FIRE HOSE ALL THE WAY IN, THEN PART WAY THROUGH PUMPING OPERATION THE SYSTEM OPENED UP AND FLOW RATE SHOT UP TO 108 GPM. SUSPECT HOSE WAS KINKED AND THEN BECAME UNKINKED. |
| 128 | | VIII | 4.5 | STBD | EXTERNAL | RES FUEL OIL | 5987 | | | OIL | | | | | | | 0 | | | | | TANK VIII 4.5 WAS SIMILAR TO TANK VIII 4.3. AFTER 4.3 WAS STRIPPED, 4.5 WAS EMPTY. RECOVERED OIL IS ALL LISTED IN VIII 4.3. |
| 129 | 09/24<br>09/25 | VIII | 4.6 | PORT | EXTERNAL | RES FUEL OIL | 5987 | 2 STBD | 4 STBD | OIL | 1535<br>1404<br>1513 | <br>1423<br>1513 | FINAL STOP 15:10 | 1650<br>1432 | <br>1510 | | 0 | 2010<br>1319<br>1277<br>309 | 4915 | 4068 | 847 | NOT GOOD NATURAL VENT. BEST WE COULD GET WAS 18 TO 20 GPM FLOW RATE FIRE HOSE UNABLE TO PUT IN VERY FAR. PUMPED TO 1% FOR LONG TIME. NEEDED TO BE STRIPPED. STRIPPED 2 MORE TIMES ON THE 25TH AND CLOSED OUT. (SEE NOTE 1) |
| 130 | | IX | 4.6 | PORT | EXTERNAL | RES FUEL OIL | 5258 | | | | | | | WATER | | | | | | | | AIR/WATER |
| 131 | | IX | 4.7 | STBD | EXTERNAL | RES FUEL OIL | 2502 | | | | | | | WATER | | | | | | | | WATER |
| 132 | | X | 4.3 | STBD | EXTERNAL | RES FUEL OIL | 4069 | | | | | | | WATER | | | | | | | | WATER |
| 133 | | X | 4.4 | PORT | EXTERNAL | RES FUEL OIL | 4069 | | | | | | | WATER | | | | | | | | AIR/WATER |
| 134 | | X | 4.5 | STBD | EXTERNAL | RES FUEL OIL | 2074 | | | | | | | WATER | | | | | | | | WATER |
| 135 | | X | 4.6 | PORT | EXTERNAL | RES FUEL OIL | 2074 | | | | | | | WATER | | | | | | | | WATER |
| 136 | | XI | 4.1 | STBD | EXTERNAL | RES FUEL OIL | 3038 | | | | | | | WATER | | | | | | | | WATER |
| 137 | 09/24 | XI | 4.2 | PORT | EXTERNAL | RES FUEL OIL | 3038 | 2 STBD | 4 STBD | AIR/OIL | 1243 | 1300 | | 1414 | 1437 | | 0 | 918<br>1051 | 1969 | 1693 | 276 | PUMPING STARTED AND EVIDENTLY THE DISCHARGE HOSE BETWEEN THE PUMP BECAME DISCONECTED, SPILLED ABOUT 20 GALLONS. PUMPED AGAIN, GOT 276 GALLONS. STRIPPED IN CLOSED. |
| 138 | | XI | 4.3 | STBD | EXTERNAL | RES FUEL OIL | 3012 | | | | | | | WATER | | | | | | | | WATER |
| 139 | | XI | 4.4 | PORT | EXTERNAL | RES FUEL OIL | 3012 | | | | | | | WATER | | | | | | | | WATER |
| 140 | | XI | 4.5 | STBD | EXTERNAL | FUEL OIL | 5361 | | | | | | | WATER | | | | | | | | WATER |
| 141 | | XI | 4.6 | PORT | EXTERNAL | FUEL OIL | 5355 | | | | | | | WATER | | | | | | | | WATER |
| 142 | | XI | 4.7 | STBD | EXTERNAL | FUEL OIL | 4491 | | | | | | | WATER | | | | | | | | WATER |
| 143 | 09/26<br>09/27 | XI | 4.8 | PORT | EXTERNAL | FUEL OIL | 4470 | 2 STBD | 4 STBD | AIR/OIL | 1830<br>1056 | 2002<br>1101 | | | | | 0 | 1338<br>214 | 1552 | 1441 | 111 | AIR BOUND TRYING TO PUMP. THIS TANK PUMPED LATE INTO EVENING OF 09/26, BUT HAD MULTIPLE FAILURES DUE TO AIR. PUMPED 111 GALLONS, BUT WITH MULTIPLE HOURS OF FRUITLESS EFFORT, NO MORE OIL WAS RECOVERED. TANK CLOSED ON 09/27 WHEN NO MORE OIL CAME OUT OPEN VALVE I.E. TANK MT. |
| | | | | | | WING TANKS SUBTOTAL | 249552 | | | | | | | | | | | | | 23167 | 10657 | |

Figure J-10. Pump Station Log, Sheet 10 of 13

| ITEM | DATE | SECTION NUMBER | TANK NO. | PORT/ STBD | TANK TYPE | TANK CONTENT | 85% OF MAX VOLUME | DESIGNATED RECEIVING TANK OIL | DESIGNATED RECEIVING TANK WATER/SLOPS | DIVER OBSERVED CONTENTS | FIRST PUMP | | | SECOND PUMP | | | FUEL METER | | TOTAL VOLUME PUMPED | ESTIMATED VOLUMES | | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MONTH/ DAY | | | | INTERNAL/ EXTERNAL | STATED CONTENT | GALLONS | NUMBER PORT/ STBD | NUMBER PORT/ STBD | OIL/H2O/AIR | START TIME | STOP TIME | AVERAGE FLOW RATE | START TIME | STOP TIME | AVERAGE FLOW RATE | START | END | GALLONS | WATER/SLOPS | OIL | |
| **INTERNAL TANKS** | | | | | | | | | | | | | | | | | | | | | | |
| 144 | 10/04 | II | 5.1 | STBD | INTERNAL | FUEL OIL | 1369 | 2 STBD | 4 STBD | | 1604<br>1746 | 1617<br>1752 (FLUSH) | | 1714 | 1725 | | 0 | 833<br>733<br>232 | 1798 | 1798 | 0 | INTERNALY TAPPED AND THEN CLOSED AFTER GETTING NOTHING BUT WATER. ACCIDENTAL CLOSE. |
| 145 | | II | 5.2 | PORT | INTERNAL | FUEL OIL | 1339 | | | | | | | BREACHED | | | | | | | | BREACHED |
| 146 | 10/06 | II | 5.3 | STBD | INTERNAL | FUEL OIL | 2288 | 2 STBD | 4 STBD | | 1518 | 1557 | | | | | 0 | 1401 | 1401 | 1401 | 0 | INTERNAL TAP VIA II 4.7 WING TANK. LPO. |
| 147 | | II | 5.4 | PORT | INTERNAL | FUEL OIL | 2272 | | | | | | | BREACHED | | | | | | | | BREACHED |
| 148 | | II | 5.5 | STBD | INTERNAL | FUEL OIL | 2098 | | | | | | | INACCESSIBLE | | | | | | | | INACCESSIBLE DUE TO INTERNAL PIPE BLOCKING HOT TAP HOLE |
| 149 | 10/03 | II | 5.6 | PORT | INTERNAL | FUEL OIL | 2114 | 2 STBD | 4 STBD | AIR/OIL/WATER | 1519 | 1716 | | | | | 0 | 5824 | 5824 | 5824 | 0 | PUNCHED HOLE IN SIDE OF TANK USING MOSQUITO STINGER TOOL, LPO RECOVERED TO SLOPS |
| 150 | 10/06<br>10/07 | III | 5.1 | STBD | INTERNAL | FUEL OIL | 4452 | | | | | | | INACCESSIBLE | | | | | | | | INACCESSIBLE |
| 151 | 10/07 | III | 5.2 | PORT | INTERNAL | FUEL OIL | 4446 | 2 STBD | 4 STBD | | 1533 | 1540 | | | | | 0 | 281 | 281 | 281 | 0 | DIVER ACCESSED TANK THROUGH THE SIDE WALL USING HAND DRILL WITH HOLE SAW BIT LPO |
| 152 | 10/08 | III | 5.6 | PORT | INTERNAL | FUEL OIL | 3865 | 2 STBD | 4 STBD | | 0847<br>1555 | 1110<br>1601 (FLUSH) | | 1500 | 1551 | | 0 | 6001<br>1710<br>365 | 8076 | 8076 | 0 | HOLE THROUGH SIDE WALL USING 2" HOLE SAW. ALL PRODUCT TO SLOPS. |
| 153 | 10/02 | III | 5.5 | STBD | INTERNAL | FUEL OIL | 5070 | 2 STBD | 4 STBD | | 1214<br>1402 | 1256<br>1420 | | 1315 | 1331 | | 0 | 2184<br>690<br>682 | 4991 | 3498 | 1422 | FIRST INTERNAL TANK HOT TAP THROUGH III 4.9 |
| | 10/03 | | | | | | | | | | 1740 | 1814 | | | | | | 1435 | | | | |
| 154 | 10/06 | III | 5.3 | STBD | INTERNAL | TURBINE OIL | 4156 | 2 STBD | 4 STBD | | 1118 | 1135 | | 1238 | 1325 | | 0 | 632<br>1573 | 4004 | 4004 | 0 | INTERNAL TANK VIA III 4.5 ONLY THE BIT MADE IT THROUGH DUE TO OBSTRUCTION AND THE DRILL HOLE WAS CALLED "TINY HOLE", TWO STRIPS AND LPO. |
| | 10/07 | | | | | | | | | | 0857 | 0942 | | 0930 | 1011 | | | 867<br>932 | | | | |
| 155 | 10/05 | IV | 5.1 | STBD | INTERNAL | FUEL OIL | 5778 | 2 STBD | 4 STBD | | 0827 | 0902 | | 0914 | 0928 | | 0 | 2120<br>773 | 2893 | 1400 | 1493 | INTERNAL TAPPED VIA IV 4.1 CL TANK. SCHADOW TUBE USED IN THE OUTER TANK TO HELP VENT. CLOSED ON 10/06. |
| 156 | 10/02 | IV | 5.4 | PORT | INTERNAL | FUEL OIL | 5070 | 2 STBD | 4 STBD | | | | | | | | | | | 1500 | 0 | DIVERS ENTERED TANK VIA MOSQUITO TECHNIQUE INSIDE WALL VIA EXTERNAL WING, PUMPED WATER. LPO OF LESS THAN 1%. |
| 157 | 10/05 | IV | 5.3 | STBD | INTERNAL | FUEL OIL | 6787 | 2 STBD | 4 STBD | OIL | 1124<br>1242 | 1141<br>1253 | | 1200<br>1427 | 1218<br>1446 | | 0 | 724<br>915<br>700<br>1298 | 6136 | 4398 | 2358 | INTERNAL TOOL VIA IV 4.1 |
| | 10/06 | | | | | | | | | | 0927<br>1022 | 0956 | | 0944<br>1046 | 1011 | | | 844<br>759<br>896 | | | | |
| 158 | | IV | 5.6 | PORT | INTERNAL | FUEL OIL | 6798 | | | | | | | BREACHED | | | | | | | | PUNCHED HOLE IN SIDE OF TANK USING 2" BIT AND USED STINGER TO PUMP WATER/OIL. |

Figure J-11. Pump Station Log, Sheet 11 of 13

| ITEM | DATE | SECTION NUMBER | TANK NO. | PORT/ STBD | TANK TYPE | TANK CONTENT | 85% OF MAX VOLUME | DESIGNATED RECEIVING TANK OIL | DESIGNATED RECEIVING TANK WATER/SLOPS | DIVER OBSERVED CONTENTS | FIRST PUMP | | | SECOND PUMP | | | FUEL METER | | TOTAL VOLUME PUMPED | ESTIMATED VOLUMES | | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MONTH/ DAY | | | | INTERNAL/ EXTERNAL | STATED CONTENT | GALLONS | NUMBER PORT/ STBD | NUMBER PORT/ STBD | OIL/H2O/AIR | START TIME | STOP TIME | AVERAGE FLOW RATE | START TIME | STOP TIME | AVERAGE FLOW RATE | START | END | GALLONS | WATER/SLOPS | OIL | |
| 159 | 10/07 | V | 5.1 | STBD | INTERNAL | PURE TURBINE OIL | 8309 | 2 STBD | 4 STBD | AIR/OIL | 1349 | 1423 | | 1525 | 1531 | | 0 | 1150<br>187 | 9700 | 8625 | 1075 | TURBINE OIL VENT LEAKER PUT HOT TAP IN TO V 5.1 VIA V 4.1. USED INTERNAL TAP TOOL MADE UP WITH OFFSET SHAFT. 38 OR SO MINUTES TO DRILL INTERNAL. THEN SET UP TO PUMP LATER IN THE DAY. BEFORE SET UP TO PUMP, LEAK DISCOVERED IN THE VENT HOLE, AND PRODUCT ESCAPED. ESTIMATED 1200 GALLONS. PUMPED ON 10/09 AND AFTER MUCH DIFFICULTY WITH AIR FROM TANK, RECIEVED 1075 GALLONS AND MORE IN SLOPS. |
| | 10/08 | | | | | | | | | | 1724 | 1739 | | 1741 | 1747 | | | 145<br>373 | | | | |
| | 10/09 | | | | | | | | | | 0835 | 1037 | | 1234 | 1330 | | | 5878<br>1967 | | | | |
| 160 | | V | 5.2 | PORT | INTERNAL | PURE TURBINE OIL | 8299 | | | | | | | BREACHED | | | | | | | | BREACHED |
| 161 | | VII | 9.1 | STBD | INTERNAL | FUEL OIL | 4227 | | | | | | | INACCESSIBLE | | | | | | | | INACCESSIBLE |
| 162 | 10/11 | VIII | 5.1 | STBD | INTERNAL | FUEL OIL | 13540 | | | | 1152 | 1320 | | | | | 0 | 2924 | 16785 | 13818 | 2967 | INTERNAL TANK VIII 5.1 VIA VIII 4.1 PULLED 220 GALLONS OF GOOD OIL AFTER HOSE CLEARED, THEN PUMPED FOR 80 MINUTES AT 27 GPM GETTING 25% OF OIL. SECOND PUMP ON 10/12 PULLED 2588 GALLONS. |
| | 10/12 | | | | | | | | | | 1140<br>1532 | 1255<br>1606 | | 1411<br>1657 | 1441<br>1735 | | | 3209<br>1062<br>1107<br>1335 | | | | |
| | 10/13 | | | | | | | | | | 1218 | 1306 | | 1359 | 1446 | | | 1263<br>1684 | | | | |
| | 10/14 | | | | | | | | | | 1057 | 1231 | | 1419 | 1445 | | | 3098<br>1103<br>189 | | | | |
| 163 | 10/11 | VIII | 5.2 | PORT | INTERNAL | FUEL OIL | 13540 | | | DAMAGED | 1447<br>1730 | 1532<br>1754 | | 1617 | 1635 | | 0 | 1595<br>594<br>688 | 5022 | 4487 | 535 | INTERNAL TANK HOT TAP PORT SIDE PRODUCED A LOT OF AIR FROM THE TANK. FIRST PUMP OIL ONLY 121 GALLONS THEN OIL AT 10 TO 25% BY VOLUME IN SAMPLES. SECOND PUMP AFTER SETTLING 169 GALLONS THEN DRIBBLING LPO TILL CLOSED BY RW & DAN N. ON 10/12. |
| | 10/12 | | | | | | | | | | 0915 | 0959 | | 1022 | 1053 | | | 1330<br>815 | | | | |
| 164 | | IX | 5.3 | STBD | INTERNAL | FUEL OIL | 5358 | | | | | | | INACCESSIBLE | | | | | | | | INACCESSIBLE; DAMAGED EXTERNAL HULL AND BUCKLED HULL PLATE. |
| 165 | | IX | 5.4 | PORT | INTERNAL | FUEL OIL | 5366 | | | | | | | INACCESSIBLE | | | | | | | | INACCESSIBLE |
| 166 | | X | 5.1 | STBD | INTERNAL | FUEL OIL | 4468 | | | | | | | INACCESSIBLE | | | | | | | | INACCESSIBLE; DAMAGED EXTERNAL HULL AND BUCKLED HULL PLATE. |
| 167 | | X | 5.2 | PORT | INTERNAL | FUEL OIL | 4491 | | | | | | | INACCESSIBLE | | | | | | | | INACCESSIBLE |
| 168 | | X | 5.3 | STBD | INTERNAL | FUEL OIL | 2985 | | | | | | | INACCESSIBLE | | | | | | | | INACCESSIBLE; DAMAGED EXTERNAL HULL AND BUCKLED HULL PLATE. |
| 169 | | X | 5.4 | PORT | INTERNAL | FUEL OIL | 2991 | | | | | | | INACCESSIBLE | | | | | | | | INACCESSIBLE |
| 170 | | XI | 5.1 | STBD | INTERNAL | FUEL OIL | 3213 | | | | | | | INACCESSIBLE | | | | | | | | INACCESSIBLE |
| 171 | | XI | 5.2 | PORT | INTERNAL | FUEL OIL | 3170 | | | | | | | INACCESSIBLE | | | | | | | | INACCESSIBLE |
| 172 | | XI | 5.3 | STBD | INTERNAL | FUEL OIL | 3025 | | | | | | | INACCESSIBLE | | | | | | | | INACCESSIBLE |

Figure J-12. Pump Station Log, Sheet 12 of 13

| ITEM | DATE | SECTION NUMBER | TANK NO. | PORT/ STBD | TANK TYPE | TANK CONTENT | 85% OF MAX VOLUME | DESIGNATED RECEIVING TANK OIL | DESIGNATED RECEIVING TANK WATER/SLOPS | DIVER OBSERVED CONTENTS | FIRST PUMP | | | SECOND PUMP | | | FUEL METER | | TOTAL VOLUME PUMPED | ESTIMATED VOLUMES | | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MONTH/ DAY | | | | INTERNAL/ EXTERNAL | STATED CONTENT | GALLONS | NUMBER PORT/ STBD | NUMBER PORT/ STBD | OIL/H2O/AIR | START TIME | STOP TIME | AVERAGE FLOW RATE | START TIME | STOP TIME | AVERAGE FLOW RATE | START | END | GALLONS | WATER/SLOPS | OIL | |
| 173 | | XI | 5.4 | PORT | INTERNAL | FUEL OIL | 2874 | | | | | | | INACCESSIBLE | | | | | | | | INACCESSIBLE |
| | | | | | | INTERNAL TANK SUBTOTAL | 143759 | | | | | | | | | | | | | 0.41 | 0.07 | |
| | | | | | | | | | | | | | | | | | | | | % OF WATER TAKEN UP VS TOTAL WORKING VOLUME OF ALL TANKS IN THIS SECTION | % OF OIL RECOVERED VS TOTAL OIL THAT COULD HAVE BEEN IN THE SECTION | |

| NOTES |
|---|
| NOTE 1: DOES NOT INCLUDE UNDETERMINED FLOW FROM METER DOWN |

| | |
|---|---|
| LIGHT BLUE | LIGHT BLUE: OIL TANKS THAT EITHER PRODUCED WATER WHEN TESTED OR PRODUCED ONLY WATER AFTER HOT TAPPING (HT). |
| BROWN | BROWN: OIL TANKS THAT PRODUCED OIL OR LOW PERCENTAGE OIL (LPO) IN WATER WHEN PUMPED. |
| PINK | PINK: AVIATION GASOLINE TANKS THAT WERE NOT ACCESSED. |
| GRAY BLUE | GRAY BLUE: BREACHED, TANKS THAT HAVE SIGNIFIANT WASTAGE OR SO MUCH STRUCTURAL DAMAGE THAT IT IS OPEN TO THE SEA. |
| ORANGE | ORANGE: TANKS THAT ARE INACCESSIBLE DUE TO STRUCTURAL DAMAGE, HAVE OILS PIPED, OR STRUCTURE THAT PREVENTS HOT TAPPING. |

Figure J-13. Pump Station Log, Sheet 13 of 13

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# APPENDIX K

## Appendix K – *PRINZ EUGEN* Drawings and Images

Figure K-1. *PRINZ EUGEN* in Port

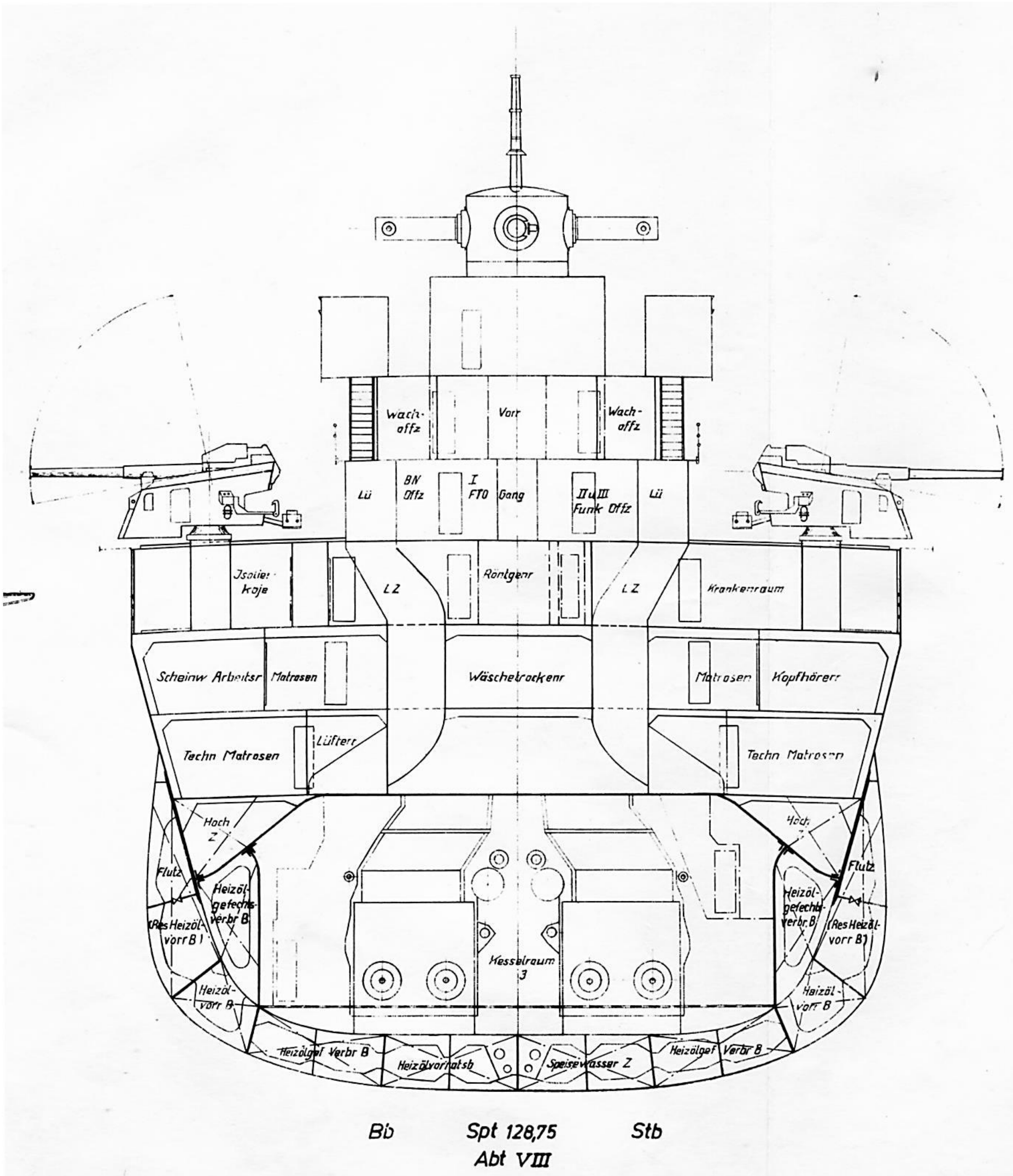


Figure K-2. *PRINZ EUGEN* Sample Cross Section of the Hull at Frame 128.75 in Section VIII

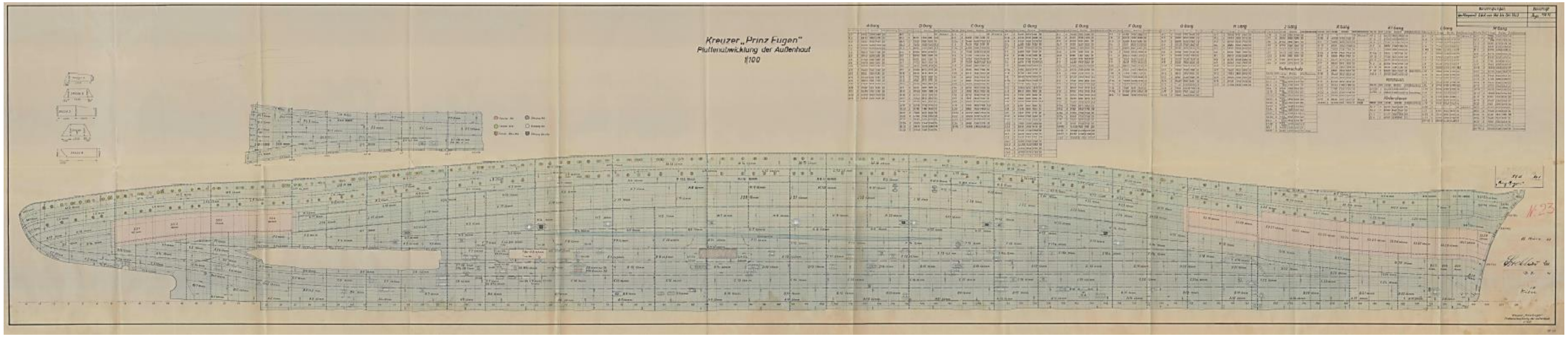


Figure K-3. *PRINZ EUGEN* Shell Expansion Plan

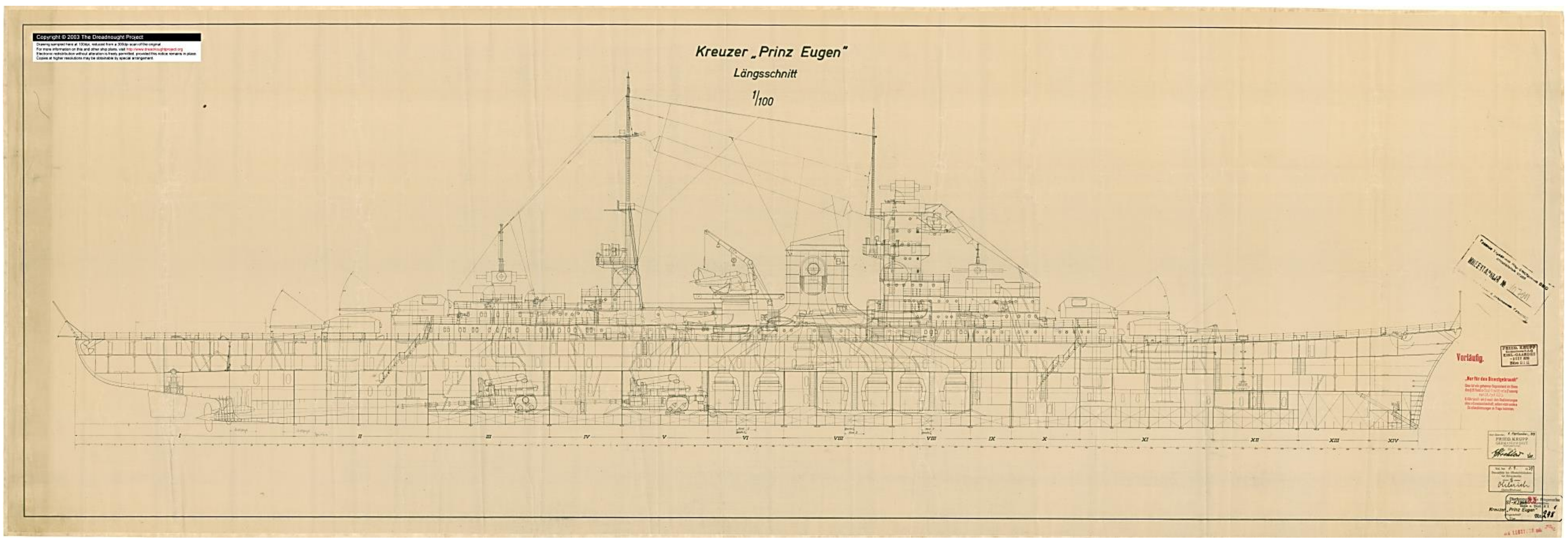


Figure K-4. *PRINZ EUGEN* Inboard Profile

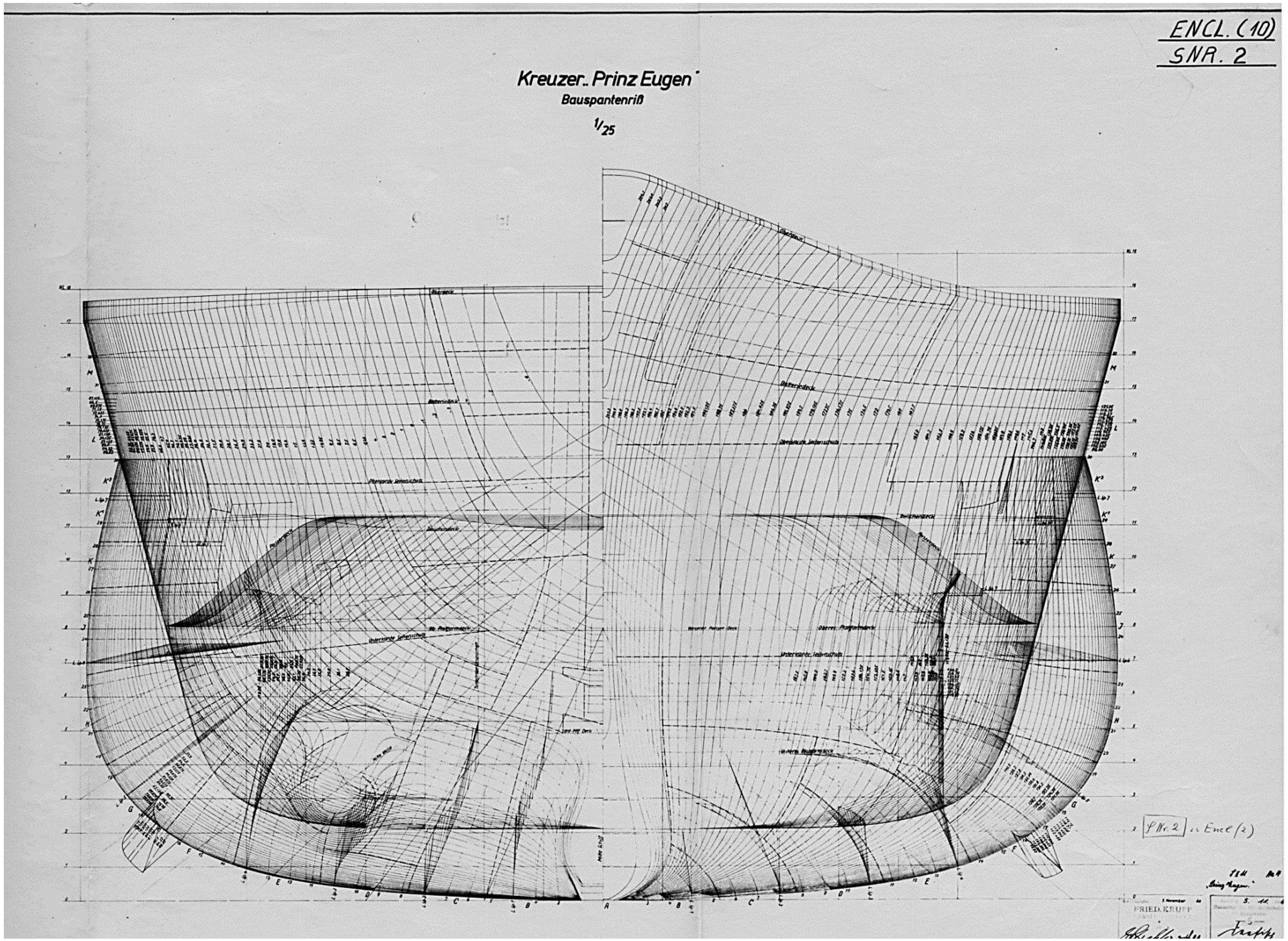


Figure K-5. *PRINZ EUGEN* Hull Form

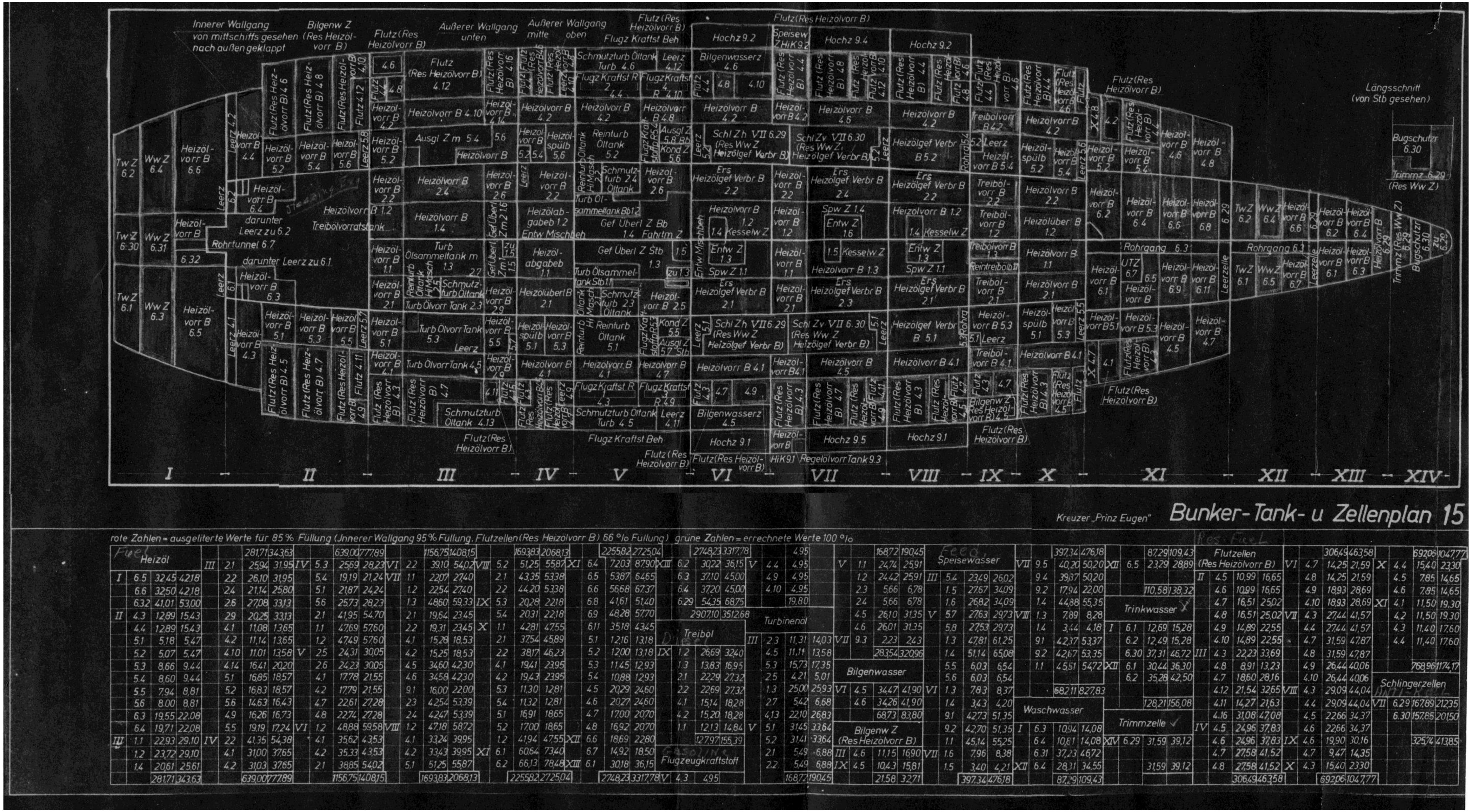


Figure K-6. Tank Plan

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Figure K-7. *PRINZ EUGEN* Gun Barrels

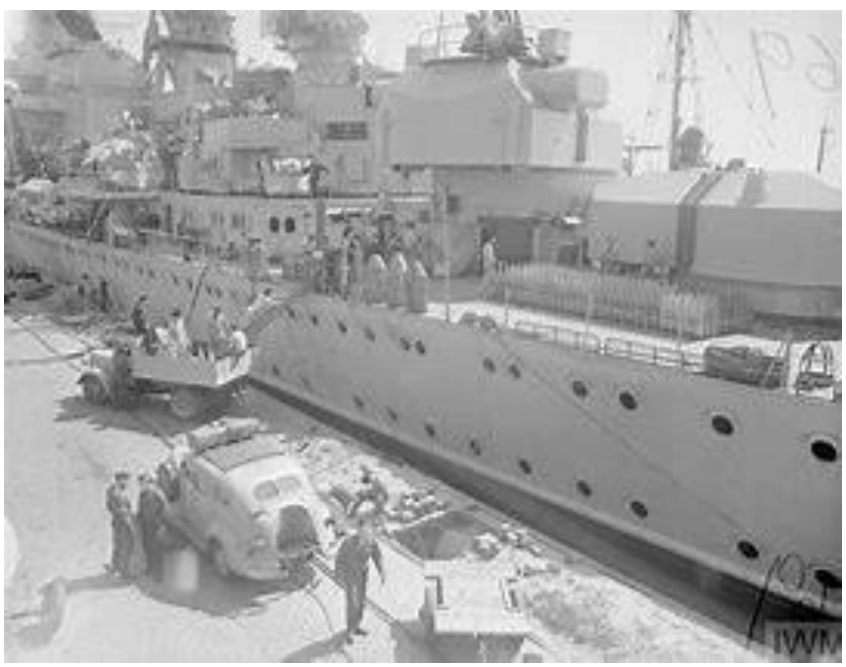

Figure K-8. *PRINZ EUGEN* Surrenders

Figure K-9.  Atomic Blast "Baker"

# APPENDIX L

## Appendix L – Oil Analysis

Table L-1. Oil Sample Analysis Results ex-USS *PRINZ EUGEN*

| OIL SAMPLE TESTS PERFORMED | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **ITEM** | **ASTM METHOD** | **DESCRIPTION** | **REQD SAMPLE VOL PER TEST (ML)** | **NUMBER OF SAMPLES** | **NSFO HEAVY** | **NSFO LIGHT** | **TURB OIL** | **DSL FUEL** |
| 1 | ASTM D4052 | DIGITAL DENSITY @ 15C | 30 | 4 | 1 | 1 | 1 | 1 |
| 2 | ASTM D92 | FLASH POINT BY COC | 100 | 3 | 1 | 1 | | 1 |
| 3 | ASTM D2983 | BROOKFIELD VISCOSITY (CP) @ 50C & 20C | 100 | 3 | 1 | | 1 | 1 |
| 4 | ASTM D5950 | POUR POINT BY AUTO TILT METHOD | 70 | 2 | 1 | | 1 | |
| 5 | ASTM D6304 | WATER BY KARL FISCHER TITRATION | 10 | 3 | 1 | | 1 | 1 |
| 6 | ASTM D5863 | SODIUM BY ICP | 10 | 1 | 1 | | | |
| 7 | ASTM D2709 | WATER AND SEDIMENT IN FUEL BY CENTRIFUGE | 100 | 3 | 1 | | 1 | 1 |
| 8 | ASTM D971 | OIL/WATER INTERFACE, INTERFACIAL TENSION | 100 | 3 | 1 | | 1 | 1 |
| 9 | ASTM D1331 | SURFACE TENSION | 100 | 3 | 1 | | 1 | 1 |

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STAR Fuels & Lubes Sample Report

410284-1 Page 1 of 2

PCCI, Inc./GPC ESSM Warehouse #12
Contact: Craig Moffatt
Address: Global PCCI
NWS Cheatham Annex Warehouse #12
Williamsburg, VA 23185
Ph: 757-637-9035 Fax:
Email: MoffattCO@ESSMNAVY.NET

**FINAL REPORT**
This report and the data within has completed QA/QC review

CLARK TESTING

Fuels & Lubrication Lab
1801 Route 51 South
Building 9
Jefferson Hills, PA 15025
Ph: 412-387-1001
Fax: 412-387-1028

| | |
|---|---|
| Primary Contact | Craig Moffatt |
| PO# | c/c 91003 exp 08/22 |
| Tracking # | 410284-1 |
| Client Sample # | III 2.3-092818PE Turbine Oil |
| Sample Date | 09/28/2018 |
| Received Date | 01/18/2019 |

**General Diagnostic Notes**

Additional detail may be available if requested, at standard Clark consulting rates.

| **Digital Density at 15C** | Test Code: D4052 / Method: D4052 |
|---|---|
| Result Date | 01/18/2019 |
| Result | 0.89628 g/cm3 |

| **Pour Point, by Automatic Tilt Method** | Test Code: D5950 / Method: D5950 |
|---|---|
| Result Date | 01/21/2019 |
| Result | -21.0 °C |

| **Water and Sediment in Fuels, by Centrifuge** | Test Code: D2709 / Method: D2709 |
|---|---|
| Result Date | 01/21/2019 |
| Temperature | 76 °F |

**Comments**

Water & Sediment = 14.0 Volume %

| **Oil/Water Interface, Interfacial Tension** | Test Code: D971 / Method: D971 |
|---|---|
| Result Date | 02/05/2019 |
| Result | 31.85 Dynes/centimeter |

**Comments**

D971 - Test performed with DI Water as per client's request.

| **Surface Tension** | Test Code: D1331 / Method: D1331 |
|---|---|
| Result Date | 02/05/2019 |
| Result | 29.85 Dynes/centimeter |

Figure L-1. Oil Analysis Results – Turbine Oil, Page 1 of 2

STAR Fuels & Lubes Sample Report 410284-1 Page 2 of 2

| **Brookfield Viscosity** | Test Code: D2983 - 3 Temps. / Method: D2983 |
|---|---|
| Result Date | 02/04/2019 |
| Temperature | 5.0 °C |
| Viscosity | 1,082 cP |
| Spindle Speed | 200 rpm |
| Temperature 2 | 20.0 °C |
| Viscosity | 193.5 cP |
| Spindle Speed | 200 rpm |
| Temperature 3 | 50.0 °C |

**Comments**

Result at 5.0°C should be considered an estimate as the torque was only 36.1% and not the minimum 40% required, even with the speed at the maximum amount of 200 rpm.

Result at 20.0°C should be considered an estimate as the torque was only 6.5% and not the minimum 40% required, even with the speed at the maximum amount of 200 rpm.

Unable to attain result at 50°C as the sample was too fluid at this temperature.

| **Water by Karl Fischer - new** | Test Code: D4377 - new / Method: D4377 - new |
|---|---|
| Result Date | 02/05/2019 |
| Result | 64764 ppm |

**Authorized Signature**

Analyst: Pat Stockton Date: 02/05/2019

Figure L-2. Oil Analysis Results – Turbine Oil, Page 2 of 2

STAR Fuels & Lubes Sample Report

410284-2 Page 1 of 2

PCCI, Inc./GPC ESSM Warehouse #12
Contact: Craig Moffatt
Address: Global PCCI
NWS Cheatham Annex Warehouse #12
Williamsburg, VA 23185
Ph: 757-637-9035 Fax:
Email: MoffattCO@ESSMNAVY.NET

**FINAL REPORT**
This report and the data within has completed QA/QC review

CLARK TESTING

Fuels & Lubrication Lab
1801 Route 51 South
Building 9
Jefferson Hills, PA 15025
Ph: 412-387-1001
Fax: 412-387-1028

| | |
|---|---|
| Primary Contact | Craig Moffatt |
| PO# | c/c 91003 exp 08/22 |
| Tracking # | 410284-2 |
| Client Sample # | IV5.1-100518PE NSFO Light |
| Sample Date | 10/05/2018 |
| Received Date | 01/18/2019 |

**General Diagnostic Notes**

Additional detail may be available if requested, at standard Clark consulting rates.

| **Digital Density at 15C** | Test Code: D4052 / Method: D4052 |
|---|---|
| Result Date | 01/18/2019 |
| Result | 0.92749 g/cm3 |

| **Flash Point by Cleveland Open Cup** | Test Code: D0092 / Method: D92, SOP 1440 |
|---|---|
| Result Date | 01/21/2019 |
| Result | 221 °F |

| **Pour Point, by Automatic Tilt Method** | Test Code: D5950 / Method: D5950 |
|---|---|
| Result Date | 01/21/2019 |
| Result | -12.0 °C |

| **Sodium by ICP, in Petroleum products** | Test Code: D5863 / Method: D5863 mod. Proc. A |
|---|---|
| Result Date | 01/24/2019 |
| Result | 0.01 % |

| **Water and Sediment in Fuels, by Centrifuge** | Test Code: D2709 / Method: D2709 |
|---|---|
| Result Date | 01/21/2019 |
| Temperature | 76 °F |
| **Comments** | |
| Water & Sediment = 0.75 Volume % | |

| **Oil/Water Interface, Interfacial Tension** | Test Code: D971 / Method: D971 |
|---|---|
| Result Date | 02/06/2019 |
| Result | 24.29 Dynes/centimeter |
| **Comments** | |
| D971 - Test performed with DI Water as per client's request. | |

| **Surface Tension** | Test Code: D1331 / Method: D1331 |
|---|---|
| Result Date | 02/06/2019 |
| Result | 28.50 Dynes/centimeter |

Figure L-3. Oil Analysis Results – NSFO Light, Page 1 of 2

STAR Fuels & Lubes Sample Report 410284-2 Page 2 of 2

| **Brookfield Viscosity** | Test Code: D2983 - 3 Temps. / Method: D2983 |
|---|---|
| Result Date | 02/04/2019 |
| Temperature | 5.0 °C |
| Viscosity | 850.5 cP |
| Spindle Speed | 200 rpm |
| Temperature 2 | 20.0 °C |
| Viscosity | 87.0 cP |
| Spindle Speed | 200 rpm |
| Temperature 3 | 50.0 °C |

**Comments**

Result at 5.0°C should be considered an estimate as the torque was only 28.1% and not the minimum 40% required, even with the speed at the maximum amount of 200 rpm.

Result at 20.0°C should be considered an estimate as the torque was only 2.9% and not the minimum 40% required, even with the speed at the maximum amount of 200 rpm.

Unable to attain result at 50°C as the sample was too fluid at this temperature.

| **Water by Karl Fischer - new** | Test Code: D4377 - new / Method: D4377 - new |
|---|---|
| Result Date | 02/06/2019 |
| Result | 5815 ppm |

**Authorized Signature**

Analyst: Pat Stockton Date: 02/06/2019

Pat Stockton

Figure L-4. Oil Analysis Results – NSFO Light, Page 2 of 2

STAR Fuels & Lubes Sample Report

410284-3 Page 1 of 2

PCCI, Inc./GPC ESSM Warehouse #12
Contact: Craig Moffatt
Address: Global PCCI
NWS Cheatham Annex Warehouse #12
Williamsburg, VA 23185
Ph: 757-637-9035 Fax:
Email: MoffattCO@ESSMNAVY.NET

**FINAL REPORT**
This report and the data within has completed QA/QC review

CLARK TESTING

Fuels & Lubrication Lab
1801 Route 51 South
Building 9
Jefferson Hills, PA 15025
Ph: 412-387-1001
Fax: 412-387-1028

| | |
|---|---|
| Primary Contact | Craig Moffatt |
| PO# | c/c 91003 exp 08/22 |
| Tracking # | 410284-3 |
| Client Sample # | IX 1.2-091718PE Diesel Fuel |
| Sample Date | 09/17/2018 |
| Received Date | 01/18/2019 |

**General Diagnostic Notes**

Additional detail may be available if requested, at standard Clark consulting rates.

| Digital Density at 15C | Test Code: D4052 / Method: D4052 |
|---|---|
| Result Date | 01/18/2019 |
| Result | 0.85602 g/cm3 |

| Flash Point by Cleveland Open Cup | Test Code: D0092 / Method: D92, SOP 1440 |
|---|---|
| Result Date | 01/21/2019 |
| Result | 224 °F |

| Brookfield Viscosity | Test Code: D2983 - 2 Temps. / Method: D2983 |
|---|---|
| Result Date | 01/23/2019 |
| Temperature | 20.0 °C |
| Viscosity | Beyond the scope of the test. cP |
| Spindle Speed | rpm |
| Temperature 2 | 50.0 °C |
| Viscosity | Beyond the scope of the test. cP |
| Spindle Speed | rpm |

**Comments**

D2983 - Instrument was unable to attain viscosity values at 20°C and 50°C as the sample was too fluid at both of these temperatures.

| Pour Point, by Automatic Tilt Method | Test Code: D5950 / Method: D5950 |
|---|---|
| Result Date | 01/21/2019 |
| Result | -27.0 °C |

| Water and Sediment in Fuels, by Centrifuge | Test Code: D2709 / Method: D2709 |
|---|---|
| Result Date | 01/21/2019 |
| Temperature | 76 °F |

**Comments**

Water & Sediment = 3.0 Volume %.

Figure L-5. Oil Analysis Results – Diesel Fuel, Page 1 of 2

STAR Fuels & Lubes Sample Report | 410284-3 Page 2 of 2

| **Oil/Water Interface, Interfacial Tension** | Test Code: D971 / Method: D971 |
|---|---|
| Result Date | 02/06/2019 |
| Result | 18.51 Dynes/centimeter |
| **Comments** | |
| D971 - Test performed with DI Water as per client's request. | |

| **Surface Tension** | Test Code: D1331 / Method: D1331 |
|---|---|
| Result Date | 02/06/2019 |
| Result | 25.14 Dynes/centimeter |

| **Water by Karl Fischer - new** | Test Code: D4377 - new / Method: D4377 - new |
|---|---|
| Result Date | 02/06/2019 |
| Result | 21599 ppm |

**Authorized Signature**

Analyst: Date: 02/06/2019

Pat Stockton

Figure L-6. Oil Analysis Results – Diesel Fuel, Page 2 of 2

STAR Fuels & Lubes Sample Report

410284-4 Page 1 of 2

PCCI, Inc./GPC ESSM Warehouse #12
Contact: Craig Moffatt
Address: Global PCCI
NWS Cheatham Annex Warehouse #12
Williamsburg, VA 23185
Ph: 757-637-9035 Fax:
Email: MoffattCO@ESSMNAVY.NET

**FINAL REPORT**
This report and the data within has completed QA/QC review

CLARK TESTING

Fuels & Lubrication Lab
1801 Route 51 South
Building 9
Jefferson Hills, PA 15025
Ph: 412-387-1001
Fax: 412-387-1028

| | |
|---|---|
| Primary Contact | Craig Moffatt |
| PO# | c/c 91003 exp 08/22 |
| Tracking # | 410284-4 |
| Client Sample # | VIII 4.2091518PE NSFO Heavy |
| Sample Date | 09/15/2018 |
| Received Date | 01/18/2019 |

| **General Diagnostic Notes** |
|---|
| Additional detail may be available if requested, at standard Clark consulting rates. |

| **Digital Density at 15C** | Test Code: D4052 / Method: D4052 |
|---|---|
| Result Date | 01/18/2019 |
| Result | 0.97544 g/cm3 |

| **Pour Point, by Automatic Tilt Method** | Test Code: D5950 / Method: D5950 |
|---|---|
| Result Date | 01/21/2019 |
| Result | -15.0 °C |

| **Sodium by ICP, in Petroleum products** | Test Code: D5863 / Method: D5863 mod. Proc. A |
|---|---|
| Result Date | 01/24/2019 |
| Result | 0.465 % |

| **Water and Sediment in Fuels, by Centrifuge** | Test Code: D2709 / Method: D2709 |
|---|---|
| Result Date | 01/21/2019 |
| Temperature | 76 °F |
| **Comments** | |
| Water & Sediment = 0.05 Volume %. | |

| **Oil/Water Interface, Interfacial Tension** | Test Code: D971 / Method: D971 |
|---|---|
| Result Date | 02/06/2019 |
| Result | 28.14 Dynes/centimeter |
| **Comments** | |
| D971 - Test performed with DI Water as per client's request. | |

| **Surface Tension** | Test Code: D1331 / Method: D1331 |
|---|---|
| Result Date | 02/06/2019 |
| Result | 28.88 Dynes/centimeter |

Figure L-7. Oil Analysis Results – NSFO Heavy, Page 1 of 2

STAR Fuels & Lubes Sample Report 410284-4 Page 2 of 2

| **Brookfield Viscosity** | Test Code: D2983 - 3 Temps. / Method: D2983 |
|---|---|
| Result Date | 01/23/2019 |
| Temperature | 3.0 °C |
| Viscosity | 16,720 cP |
| Spindle Speed | 15 rpm |
| Temperature 2 | 20.0 °C |
| Viscosity | 1,134 cP |
| Spindle Speed | 200 rpm |
| Temperature 3 | 50.0 °C |

**Comments**

Result at 20.0°C should be considered an estimate as the torque was only 37.8% and not the minimum 40% required, even with the speed at the maximum amount of 200 rpm.

Unable to attain result at 50°C as the sample was too fluid at this temperature.

| **Water by Karl Fischer - new** | Test Code: D4377 - new / Method: D4377 - new |
|---|---|
| Result Date | 02/06/2019 |
| Result | 469029 ppm |

**Authorized Signature**

Analyst: Pat Stockton Date: 02/06/2019

Pat Stockton

Figure L-8. Oil Analysis Results – NSFO Heavy, Page 2 of 2

# APPENDIX M

## Appendix M – Ship Loading Reports

STELLAR Shipmanagement
Company Registration No 199201655M

**NOTICE OF READINESS**

Date: **28 AUGUST 2018**
Vessel: **MT. HUMBER**
Voy: **01 /2018**

Messrs: **Naval Sea Systems Command Office of the Supervisor of Salvage Washington Navy Yard, DC**

**US NAVY KWAJALEIN**

Dear sir,

this to notify that above vessel has arrived at the port of **KWAJALEIN**

at **0836** hours on the **MT. HUMBER** and now she is ready

in all respects to commence ~~discharging/~~loading her cargo in accordance with the terms and condition of the Charter party.

Quantity Nominated : **NAVY SPECIAL FUEL OIL ABOUT 850MT**

The Notice Of Readiness tendered at **0836** Hours on the **MT. HUMBER**

MT HUMBER
SINGAPORE FLAG
OFF NO: 398438
GT: 2995
NT: 1204
CALL SIGN: 9V2030

**Capt. Allan Rudy Besouw**
**Master of MT. HUMBER**

This notice of Readiness accepted at 8/28/18 Hours on the 1300

**Signature of Manager**

**Chop/Stamp of Loading Master**

Craig Moffatt
**Name Of Manager**

**Company's Name**

Figure M-1. Ship Loading Report – Notice of Readiness, Page 1 of 7

STELLAR
Shipmanagement
Company Registration No. 199201656M

# TANK INSPECTION CERTIFICATE

VESSEL : MT. HUMBER DATE : 31 AUG 2018

PORT : KWAJALEIN BERTH : MV SALVOR

This is to state that I have visually inspected the cargo tanks listed, before / ~~after~~ loading / ~~discharge~~ and find them to be well clean and dry .

| TANKS NOS | REMARKS |
|---|---|
| | |
| 2 P/S | clean and dry |
| 3 P/S | clean and dry |
| 4 P/S | clean and dry |
| | |
| | |
| | |

Above inspection was carried out visually through deck opening

Remarks :

Inspection of the above tanks was completed at 1554 Hrs on 31.08.2018

Received : CHEN FU YU
For Vessel

MT HUMBER
SINGAPORE FLAG
OFF NO: 398438
GT: 2995
NT: 1204
CALL SIGN: 9V2030

By : Project Manager
10/15/18

Figure M-2. Ship Loading Report – Tank Inspection Certificate, Page 2 of 7

STELLAR Shipmanagement

STELLAR SHIPMANAGEMENT SERVICES PTE. LTD .

TIME SHEET

PORT : KWAJALEIN
VESSEL : MT HUMBER
VOY NO.: 01/2018

BERTH NO. : MV SALVOR
DATE : 15-Oct-2018
NEXT PORT : SINGAPORE

| LOADING OPERATION | TIME | | DATE | REMARK |
|---|---|---|---|---|
| ARRIVAL PORT LIMIT | 0712 | HRS | 28-Aug-2018 | |
| POB FOR ANCHOR | 0712 | HRS | 28-Aug-2018 | |
| DROP ANCHOR | 0836 | HRS | 28-Aug-2018 | |
| PILOT AWAY | 0854 | HRS | 28-Aug-2018 | |
| POB FOR BERTHING TO JETTY | 0912 | HRS | 31-Aug-2018 | |
| ANCHOR AWEIGHT | 0936 | HRS | 31-Aug-2018 | |
| ALL LINE MADE FAST | 1030 | HRS | 31-Aug-2018 | |
| PILOT AWAY | 1406 | HRS | 31-Aug-2018 | |
| POB FOR UNBERTHING FROM JETTY | 0642 | HRS | 2-Sep-2018 | |
| DROP ANCHOR | 0800 | HRS | 2-Sep-2018 | |
| PILOT AWAY | 1000 | HRS | 2-Sep-2018 | |
| POB FOR BERTHING TO SALVOR | 1242 | HRS | 4-Sep-2018 | |
| FIRST LINE | 1330 | HRS | 4-Sep-2018 | |
| ALL MADE FAST | 1554 | HRS | 4-Sep-2018 | |
| PILOT AWAY | 1618 | HRS | 4-Sep-2018 | |
| COMMENCE TANK INSPECTION | 1530 | HRS | 31-Aug-2018 | |
| COMPLETED TANK INSPECTION | 1554 | HRS | 31-Aug-2018 | |
| NOTICE READINESS TENDERED | 0836 | HRS | 28-Aug-2018 | |
| NOTICE READINESS ACCEPTED | 1300 | HRS | 28-Aug-2018 | |
| HOSE CONNECTED | 1400 | HRS | 8-Sep-2018 | |
| NO. OF HOSE CONNECTED | | 1X4 INCH | | |
| COMMENCED LOADING | 1606 | HRS | 8-Sep-2018 | |
| COMPLETED LOADING | 1715 | HRS | 14-Oct-2018 | |
| COMMENCED ULLAGING | 1200 | HRS | 15-Oct-2018 | |
| COMPLETED ULLAGING | 1330 | HRS | 15-Oct-2018 | |
| HOSE DISCONNECTED | 1900 | HRS | 14-Oct-2018 | |
| CALCULATION | 1430 | HRS | 15-Oct-2018 | |
| DOCUMENT ON BOARD | 1800 | HRS | 15-Oct-2018 | |
| POB FOR UNBERTHING | | HRS | 16-Oct-2018 | |
| START UNMOORING | | HRS | 16-Oct-2018 | |
| VESSEL CAST OFF FROM SALVOR | | HRS | 16-Oct-2018 | |
| VESSEL ALOSIDE JETTY | | HRS | 16-Oct-2018 | |
| PILOT AWAY | | HRS | 16-Oct-2018 | |
| POB FOR DEPARTURE | | HRS | 17-Oct-2018 | |
| START UNMOORING | | HRS | 17-Oct-2018 | |
| VESSEL CAST OFF FROM JETTY | | HRS | 17-Oct-2018 | |
| FAOP | | HRS | 17-Oct-2018 | |

REMARK

10/15/18

Project Manager

MT HUMBER
SINGAPORE FLAG
OFF NO: 398438
GT: 2995
NT: 1204
CALLSIGN: 9V2030

MASTER
M/T HUMBER

Figure M-3. Ship Loading Report – Timesheet, Page 3 of 7

STELLAR Shipmanagement
Company Registration No. 199201655M

STELLAR SHIPMANAGEMENT SERVICES PTE. LTD .

TIME SHEET

PORT : KWAJALEIN
VESSEL : MT HUMBER
VOY NO.: 01/2018

BERTH NO. : M/V SALVOR
DATE : 15-Oct-2018
NEXT PORT : SINGAPORE

| LOADING OPERATION | TIME | | DATE | REMARK |
|---|---|---|---|---|
| ARRIVAL PORT LIMIT | 0712 | HRS | 28-Aug-2018 | |
| POB FOR ANCHOR | 0712 | HRS | 28-Aug-2018 | |
| DROP ANCHOR | 0836 | HRS | 28-Aug-2018 | |
| PILOT AWAY | 0854 | HRS | 28-Aug-2018 | |
| POB FOR BERTHING TO JETTY | 0912 | HRS | 31-Aug-2018 | |
| ANCHOR AWEIGHT | 0936 | HRS | 31-Aug-2018 | |
| ALL LINE MADE FAST | 1030 | HRS | 31-Aug-2018 | |
| PILOT AWAY | 1406 | HRS | 31-Aug-2018 | |
| POB FOR UNBERTHING FROM JETTY | 0642 | HRS | 2-Sep-2018 | |
| DROP ANCHOR | 0800 | HRS | 2-Sep-2018 | |
| PILOT AWAY | 1000 | HRS | 2-Sep-2018 | |
| POB FOR BERTHING TO SALVOR | 1242 | HRS | 4-Sep-2018 | |
| FIRST LINE | 1330 | HRS | 4-Sep-2018 | |
| ALL MADE FAST | 1554 | HRS | 4-Sep-2018 | |
| PILOT AWAY | 1618 | HRS | 4-Sep-2018 | |
| COMMENCE TANK INSPECTION | 1530 | HRS | 31-Aug-2018 | |
| COMPLETED TANK INSPECTION | 1554 | HRS | 31-Aug-2018 | |
| NOTICE READINESS TENDERED | 0836 | HRS | 28-Aug-2018 | |
| NOTICE READINESS ACCEPTED | 1300 | HRS | 28-Aug-2018 | |
| HOSE CONNECTED | 0954 | HRS | 7-Oct-2018 | |
| NO. OF HOSE CONNECTED | 1X2 INCH | | | |
| COMMENCED LOADING | 1006 | HRS | 7-Oct-2018 | |
| COMPLETED LOADING | 1118 | HRS | 7-Oct-2018 | |
| COMMENCED SOUNDING | 1125 | HRS | 7-Oct-2018 | |
| COMPLETED SOUNDING | 1130 | HRS | 7-Oct-2018 | |
| CALCULATION | 1136 | HRS | 7-Oct-2018 | |
| HOSEDISCONNECTED | 1136 | HRS | 7-Oct-2018 | |
| DOCUMENT ON BOARD | 1200 | HRS | 7-Oct-2018 | |
| POB FOR UNBERTHING | | HRS | 16-Oct-2018 | |
| START UNMOORING | | HRS | 16-Oct-2018 | |
| VESSEL CAST OFF FROM SALVOR | | HRS | 16-Oct-2018 | |
| VESSEL ALOSIDE JETTY | | HRS | 16-Oct-2018 | |
| PILOT AWAY | | HRS | 16-Oct-2018 | |
| POB FOR DEPARTURE | | HRS | 17-Oct-2018 | |
| START UNMOORING | | HRS | 17-Oct-2018 | |
| VESSEL CAST OFF FROM JETTY | | HRS | 17-Oct-2018 | |
| FAOP | | HRS | 17-Oct-2018 | |

REMARK : **Received MV Salvor engine sludge**

10/15/18

Project manager

MT HUMBER
SINGAPORE FLAG
OFF NO: 398438
GT: 2995
NT: 1204
CALL SIGN: 9V2030

MASTER
M/T HUMBER

Figure M-4. Ship Loading Report – Timesheet Continued, Page 4 of 7

ORIGINAL

CERTIFICATE OF ORIGIN

| | | |
|---|---|---|
| Date | : 15/10/2018 | Custom Ref. no: |
| Port | : Kwajalein | Customer order no: |
| Vessel | : HUMBER | |

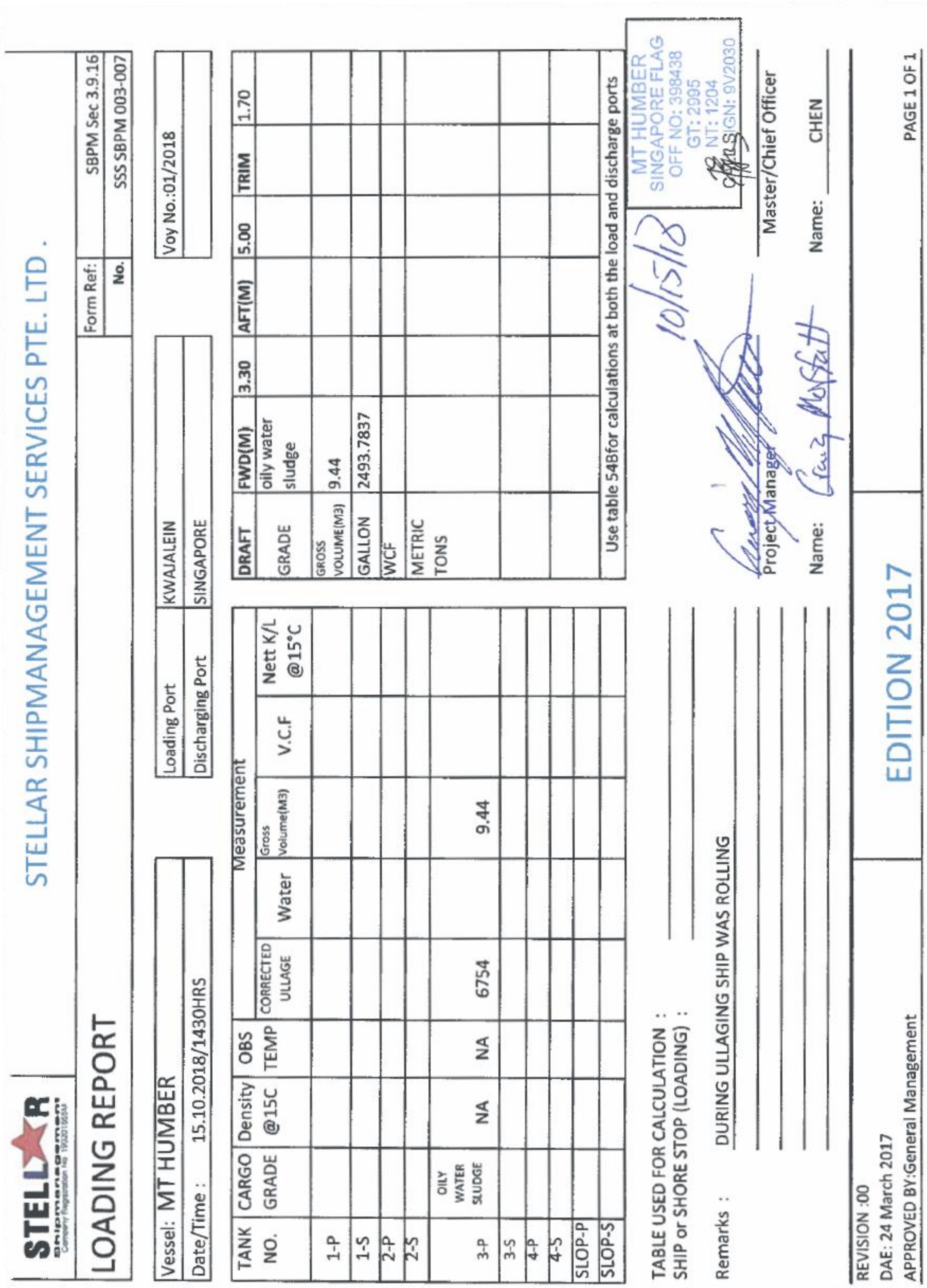
We certified that the under mentioned cargo loaded on board HUMBER on the 15th October 2018 in Kwajalein Port is of the Country of origin of Marshall Island.

| | |
|---|---|
| Product | : Navy Special Fuel Oil |
| Liters @ Obs. Temp | : 876,619 |
| Kilolitres @ 15 C | : 866.214 |
| US Gallon | : 228,829.556 |
| Metric tons | : 820.249 |
| Remarks | : |

Naval Sea Systems Command
Office of the Supervisor of Salvage
Washington Navy Yard, DC

10/15/18

Figure M-5. Ship Loading Report – Certificate of Origin, Page 5 of 7



STELLAR Shipmanagement

STELLAR SHIPMANAGEMENT SERVICES PTE. LTD .

LOADING REPORT

Form Ref: SBPM Sec 3.9.16
No. SSS SBPM 003-007

Vessel: MT HUMBER
Date/Time : 15.10.2018/1430HRS

Loading Port: KWAJALEIN
Discharging Port: SINGAPORE

Voy No.:01/2018

| TANK NO. | CARGO GRADE | Density @15C | OBS TEMP | Measurement: CORRECTED ULLAGE | Water | Gross Volume(M3) | V.C.F | Nett K/L @15°C |
|---|---|---|---|---|---|---|---|---|
| 1-P | | | | | | | | |
| 1-S | | | | | | | | |
| 2-P | | | | | | | | |
| 2-S | | | | | | | | |
| 3-P | OILY WATER SLUDGE | NA | NA | 6754 | | 9.44 | | |
| 3-S | | | | | | | | |
| 4-P | | | | | | | | |
| 4-S | | | | | | | | |
| SLOP-P | | | | | | | | |
| SLOP-S | | | | | | | | |

| DRAFT | FWD(M) | 3.30 | AFT(M) | 5.00 | TRIM | 1.70 |
|---|---|---|---|---|---|---|
| GRADE | oily water sludge | | | | | |
| GROSS VOLUME(M3) | 9.44 | | | | | |
| GALLON | 2493.7837 | | | | | |
| WCF | | | | | | |
| METRIC TONS | | | | | | |

Use table 54Bfor calculations at both the load and discharge ports

TABLE USED FOR CALCULATION :
SHIP or SHORE STOP (LOADING) :

Remarks : DURING ULLAGING SHIP WAS ROLLING

10/15/18

Project Manager
Name: Craig Moffatt

MT HUMBER
SINGAPORE FLAG
OFF NO: 398438
GT: 2995
NT: 1204
CALL SIGN: 9V2030

Master/Chief Officer
Name: CHEN

REVISION :00
DAE: 24 March 2017
APPROVED BY:General Management

EDITION 2017

PAGE 1 OF 1

Figure M-6. Ship Loading Report – Loading Report, Page 6 of 7

STELLAR Shipmanagement
Company Registration No 199201855M

STELLAR SHIPMANAGEMENT SERVICES PTE. LTD .

## LOADING REPORT

| Form Ref No. | SBPM Sec 3.9.16 / SSS SBPM 003-007 |
|---|---|

| | | | | | |
|---|---|---|---|---|---|
| Vessel: MT HUMBER | | Loading Port | KWAJALEIN | Voy No.:01/2018 |
| Date/Time : | 15.10.2018 / 1430hrs | Discharging Port | SINGAPORE | |

| TANK NO. | CARGO GRADE | Density @15C | OBS TEMP | Corrected Ullage | Water Volume | OilGross Volume | V.C.F | Nett K/L @15°C |
|---|---|---|---|---|---|---|---|---|
| 1-P | | | | | | | | |
| 1-S | | | | | | | | |
| 2-P | NSFO | 0.9361 | 31.6 | 1980 | NIL | 444.881 | 0.9879 | 439.498 |
| 2-S | NSFO | 0.9384 | 31.4 | 3922 | NIL | 263.105 | 0.9879 | 259.921 |
| 3-P | | | | | | | | |
| 3-S | | | | | | | | |
| 4-P | | | | | | | | |
| 4-S | NSFO | 0.9945 | 31 | 4940 | NIL | 168.633 | 0.9891 | 166.795 |
| SLOP-P | | | | | | | | |
| SLOP-S | | | | | | | | |

| DRAFT | FWD(M) | 3.30m | AFT(M) | 5.00 | TRIM | 1.7 |
|---|---|---|---|---|---|---|
| GRADE | NAVY SPECIAL FUEL OIL | | | | | |
| Nett K/L @15°C | 866.214 | | | | | |
| GALLON | 228829.556 | | | | | |
| WCF | | | | | | |
| METRIC TONS | 820.249 | | | | | |
| TOTAL WATER | | | | | | |
| N/BARRELS 15 °C FACTOR (0.158987 ) | | | | | | |

Use table 54B for calculations at both the load and discharge ports

TABLE USED FOR CALCULATION : 54B

SHIP or SHORE STOP (LOADING) :

Remarks : VESSEL ROLLING DURING ULLAGING
Observed density : 2P-0.9250 T-31.6C ; 2S -0.9275 T-31.4C
4S-0.9840 ,T-31.0C
Density was measuring from each tank sample , witness by project manager

10/15/18

Project Manager
Name: Craig Moffett

MT HUMBER
SINGAPORE FLAG
OFF NO: 398438
GT: 2995
NT: 1204
CALL SIGN: 9V2030

Master/Chief Officer
Name CHEN

REVISION :00
DAE: 24 March 2017
APPROVED BY:General Management

EDITION 2017

PAGE 1 OF 1

Figure M-7. Ship Loading Report – Loading Report Continued, Page 7 of 7

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# APPENDIX N

## Appendix N – Problems Encountered/Lessons Learned/Recommendations

### Problems Encountered/Lessons Learned

This appendix includes the voluntary comments and recommendations from the personnel that were working on and/or directly involved in the operation. The comments included below are as expressed by personnel (with content adjustments) and the recommendations have been modified to reflect all of the suggested resolutions to the problem and indicate if a recommendation is not in line with safe or accepted practices. Some of the problems and/or recommendations were solved on-site.

---

**Problem:**

One of the Zodiac inflatable bladders developed an air leak after it was accidently impaled with a sharp instrument that was cutting line. The leak was patched with the boat in the water. The patch failed to hold air pressure and later the bladder deflated.

**Recommendation:**

After the application of a new patch to seal the boat’s bladder, the boat’s bladder should be re-inflated and inspected for leaks to ensure that it will hold under pressure.

---

**Problem:**

The recovery of one of the 4″ Submersible Pumps (PU0305) from the dive site proved to be fairly difficult. A 3′ bell shaped lift bag was used to bring the pump to the surface for loading onto the RHIB, but the lift bag left the pump well below the surface of the water and the lines attached to the pump were saturated with oil making it difficult to hold the lines by hand.

**Recommendation:**

Objects too heavy to handle in the work boats will have to be “lift bagged” by divers and brought back to the salvage vessel for retrieval with additional personnel or using the diver davit crane. Past experience has shown that putting davits on small work boats is not usually feasible due to stability issues.

---

**Problem:**

It was observed that some of the boat operators lacked pre-operation checks expertise and boat operating skills.

**Recommendation:**

Assign an experienced boat operator for salvage/pollution response events. Use experienced personnel to lead in the setup of equipment (e.g., make-shift outrigger assemblies).

---

**Problem:**

Attachment hardware for grid lines caused small leaks when drilled into tanks containing oil. The brackets that were screwed to the hull did not have any gasket material and the fasteners initiated a leak path up past the bracket.

**Recommendation:**

Ensure all attachment points to the hull have sealant on the fastener threads and that a gasket is provided between the attachment and the hull.

---

**Problem:**

Various groups of observers came to see the operation in large groups.

**Recommendation:**

For the benefit of the operation and the personnel observing it, spread visits throughout the operation and try not to group too many people at one time.

---

**Problem:**

Large wire/brass brushes used to remove debris from the high power magnets were not effective in removing debris.

**Recommendation:**

Use smaller wire/brass brushes for removing debris from the high power magnets as they are more effective.

---

**Problem:**

Removing heavy debris from the high powered magnets was difficult.

**Recommendation:**

Paint stir sticks taped or bounded together to increase the rigidity proved very effective in removing heavy debris from the high powered magnets.

---

**Problem:**

Potable water for drinking and cooking was a concern with both ships moored over a wreck leaking oil.

**Recommendation:**

For oil offload operations, operations near other pollution/contamination sites, or operations near shores, the effects on making potable water need to be considered in the planning stages.

**Problem:**

Hardened rubber did not perform well when sealing between the flanges and rough, severely pitted, surfaces of the hull.

**Recommendation:**

Take into consideration that the hull will have pitting and utilize material that is more malleable for contact.

**Problem:**

The Devcon (two-part) underwater epoxy did not perform well in the water.

**Recommendation:**

Procure underwater epoxy PRC Standard PR944-F (utilized in Underwater Ships Husbandry) that adheres and seals well.

**Lesson Learned:**

The original planned spill response was known by all parties and executed as planned, but requires discussion for future operations.

**Recommendation:**

Allow the planning and finance to support an adequate skimming system to capture larger oil releases from all hot tap operations.

## Equipment Evaluation

The majority of the equipment utilized in the recovery operation performed as designed except for the minor problems described below:

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**Problem:**

Hot tap X-shaped flanges did not hold as well as the circular flanges. Also, circular flanges could not be placed on curved areas of the hull.

**Recommendation:**

Find a way to adapt circular flanges to a curve, possibly by machining notches similar to the X-shaped flange so the circular flange bends as it is installed.

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**Problem:**

The hydraulic powered submersible pump, 4″ Submersible Pump (PU0305) that was used for pumping the tanks, was placed on a pump stand, but the pump frequently fell over underwater.

**Recommendation:**

If a pump stand is necessary, weigh the bottom down to ensure that it stays upright underwater.

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**Problem:**

The battery operated tools were valuable to the success of the operation. The ability to have three divers independently operating during three phases of the operation (unlike the use of the hydraulic powered tools) was a substantial gain in progress.

**Recommendation:**

Advance the battery operated tool packages durability and incorporate more battery powered tool usage into the Hot Tap System.

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**Problem:**

The placement of the 4-inch hose system on the hull of the ship was difficult to maneuver due to the amount of hose utilized.

**Recommendation:**

Design the 4″ Submersible Pumps’ (PU0305) discharge side to remain in place and able to be tied into when moving the pump around on the bottom.

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**Problem:**

The original hot tap methods (as trained) evolved during this operation.

**Recommendation:**

Add the reverse Bubba Bar with the hydraulic tools and incorporate a flange mounted battery powered tool that can move around on the flange to insert the fasteners to the hull, to the hot tap training procedures.

**Problem:**

The pumped oil receiving manifold(s) (on the deck of the vessel) flowmeter(s) clogged up with debris contained in the oil during shallow water operations while using a vacuum head for oil suction.

**Recommendation:**

Procure or design a Y-strainer to install an up-line on the oil receiving manifold, to filter the oil, and/or trap debris before it reaches the flowmeter(s) resulting in a clog.

**Problem:**

The underwater electric drill overheated repeatedly during use.

**Recommendation:**

Provide feedback and/or suggestions to the drill manufacturer for performance improvements.

**Problem:**

Divers could not pull the over 400′ of hose to the 4″ pump due to its weight. Air was pumped into the hose to try and reduce the drag, but was still too heavy for the two divers. The divers had to install additional lengths of hose to reach the pump.

**Recommendation:**

Install a valve on the 4″ hose and tow the hose to the pumps general location using a RHIB. When the hose is in the desired location, open the valve to flood/sink the hose in order to reach the pump. Remove the valve and connect the discharge hose to the pump.

**Problem:**

One of the groups of fasteners that ESSM provided was 1/4″ x 3-1/2″ long self-drilling/tapping. These fasteners were used to secure the round and T-flanges to the ship's hull. Due to the low torque value (80 in-lb), there were numerous issues with fasteners breaking during the flange installation. Also, during a hot tap operation one of the flanges completely ripped out from the hull along with the fasteners and allowed the product to leak out.

**Recommendation:**

In certain areas where hull thickness was greater than 1/2″, it was found to be effective to install drill stops on the pilot bit and drill blind holes. That way the flanges could be secured down without the fasteners penetrating through the hull by using the 5/16″ self-tapping screws. Where hull thickness was less than 1/2″, the 5/16″ self-drilling/tapping screws could have been used, which would have more holding strength than the 1/4″ fasteners that were used.

**Problem:**

During pumping operations, there were many tanks that did not have adequate venting (e.g., there was no inlet for seawater) which made pulling suction difficult. Many of the tanks also had large pockets of air trapped in the top of the tank and behind internal structures.

**Recommendation:**

There were three primary methods of dealing with both poor venting and air.

Method 1 – (Venting) The suction elbow was removed and a 4″ tee was installed at the suction hose/flange connection. A 2″ PVC pipe, approximately 7′ long, was modified to fit in the stuffing box assembly tool, and installed with a 2″ valve at the top of the PVC pipe. Divers installed the vent tube (Schadow Tube) on the top of the T-connection and secured it with the camlock fitting connection on the stuffing box assembly. Once the pumping operations commenced, the divers opened the valve at the top of the vent tube which allowed seawater to be drawn into the tank while oil was removed around the 2″ stuffing box. Air however, was still a problem.

Method 2 – (Venting) On tanks where the vent tube did not work, the inlet water was augmented with a fire hose connector attached to the vent inlet on top of the 2″ valve (top of the vent tube). Lengths of fire hose were connected to the vent tube and back up to the ship and the ship's fire main. Water was force fed into the tank while the tank was pumping to provide better venting. This was used to move the product and assist in the pumping operations. It was partially effective, some of the time.

Method 3 – (Air Binding) The installation of a valve in the suction section of hose from the hot tap flange to the pump was used to bleed air out of the inlet line when the pump became air bound.

Further Recommendations: For venting issues, improve upon the vent tube design and create/make up and provide these tools in advance of the next project. For air binding issues, provide a pump that is not susceptible to becoming air bound such as one of the Archimedean screw pumps (i.e., DOP 160) or a suction line from and vacuum pump directly down from an overhead platform. There was a DOP 160 on-site, but it was not put into use. They do not work quite as well with water, but do work and will accommodate air somewhat better than the centrifugal pumps. Experimenting on the project site is however, time consuming and can lead to delays. It is suggested that experiments and/or operations with air removal be performed with wreck removal equipment during development of the new systems.

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**Problem:**

Divers are not able to "make or break" hydraulic hoses underwater due to the problems with water seeping into the hydraulic system when the connection is separated.

**Recommendation:**

Research is needed into dripless hydraulic fittings or water separators to allow for underwater connections that could make the use of hydraulic tools more efficient. Suggest that dripless fittings be researched for wreck recovery.

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**Problem:**

Hot tapping and accessing the internal tanks was time consuming and labor intensive.

**Comments:**

The internal tanks consumed a lot of energy, time, and manpower and yet yielded only a small fraction of the total oil recovered. However, the importance of being able to access and recover oil from internal tanks of a submerged wreck is very high. The increased learning curve experienced during the ex-USS *PRINZ EUGEN* recovery operation and the potential for future tool and removal methodology advancements resulting from these lessons learned are worth every minute and every penny.

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## Additional or Augmented Equipment and Materials

Recommended additional or augmented equipment and materials for the next pollution operation:

- Strainer with camlock fitting (used for vacuum, item similar to 3″ Diesel Trash Pump inventory)
- Additional 5/8″ and 1/2″ screw pin shackles (for rigging equipment)
- Boat fenders (marker buoys used as fenders were damaged during rough seas)
- Manual bilge pump (for dewatering boats)
- Manual fuel transfer pump
- Chicago fitting caps
- Boat/diver ladder
- Chain with hook (to use to pull equipment stored inside vans without rollers)

- SDS/health details (for products used and personnel exposed to)
- Variety of camlock elbows (2–4″)
- Telescoping ladder (tall enough to reach the roof of the van on a tractor trailer)
- Pelican hook
- 30W/15W-40 engine oil (for diesel engines)
- Additional beakers for receiving stations
- Spare radio antennas/clips (for batteries)
- LED lanterns
- Empty spray bottles/backpack sprayer
- Clear trash bags
- Develop a modular light-duty outrigger system for small boats (RHIB and Zodiac)
- Harbor boom could be practical equipment included with an outrigger system
- Drill press and an arbor press (for shop van)
- Use all 5/16″ flange bolts (not 1/4″ flange bolts)
- More PVC fittings, valves, and glue

# APPENDIX O

## Appendix O – Photo Log


Figure O-1. Diver on Survey Performing a Test Drill using the Miko Magnetic Drill Base and Nemo Battery Powered Submersible Drill
(Photo Taken 5 April 2017)


Figure O-2. Diver from 2017 Survey is Test Drilling (Note Leaking Oil Globule) and Measuring Hull Thickness with Cygnus Gauge
(Photo Taken 5 April 2017)

Figure O-3. Testing the Experimental Internal Hot Tap Tool at ESSM Base CAX in May of 2018
(Photo Taken 15 May 2018)

Figure O-4. The island of Kwajalein has very few automobiles, all inhabitants ride bicycles. This "Sweet Ride" belongs to NAVSEA Representative Stephanie Bocek.
(Photo Taken 30 August 2018)

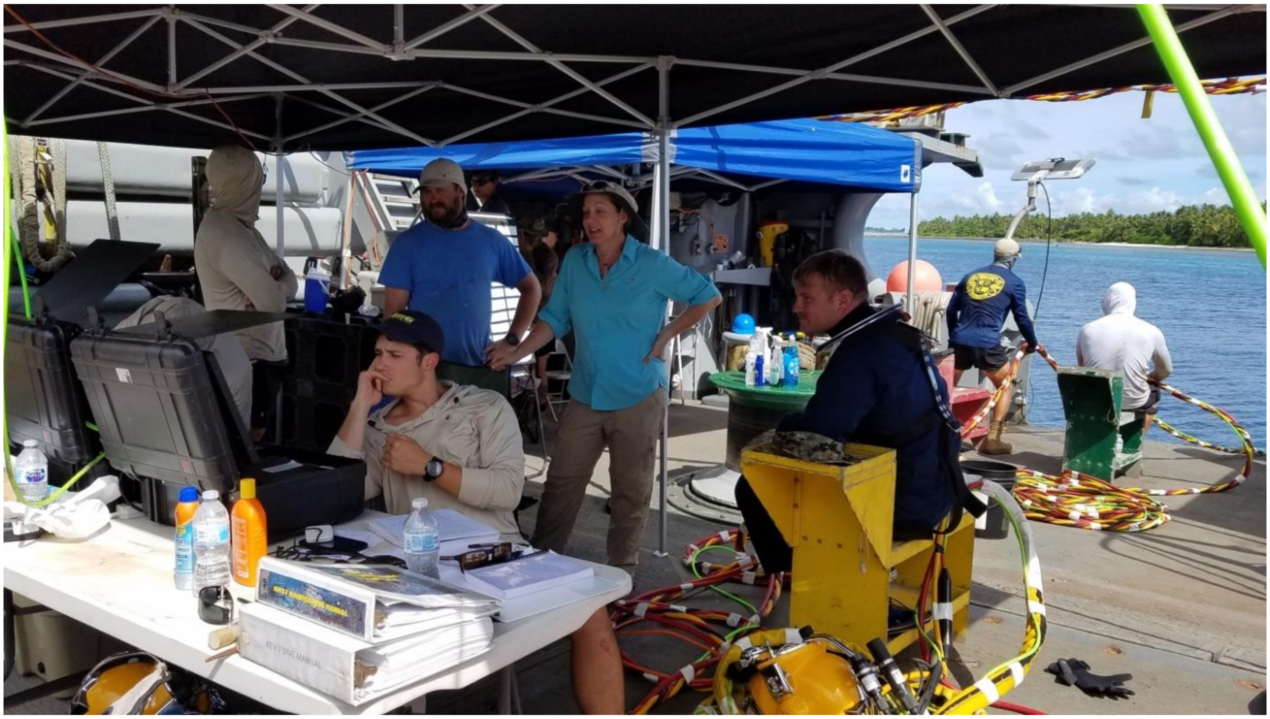

Figure O-5. Diver Support Station
(Photo Taken 3 September 2018)

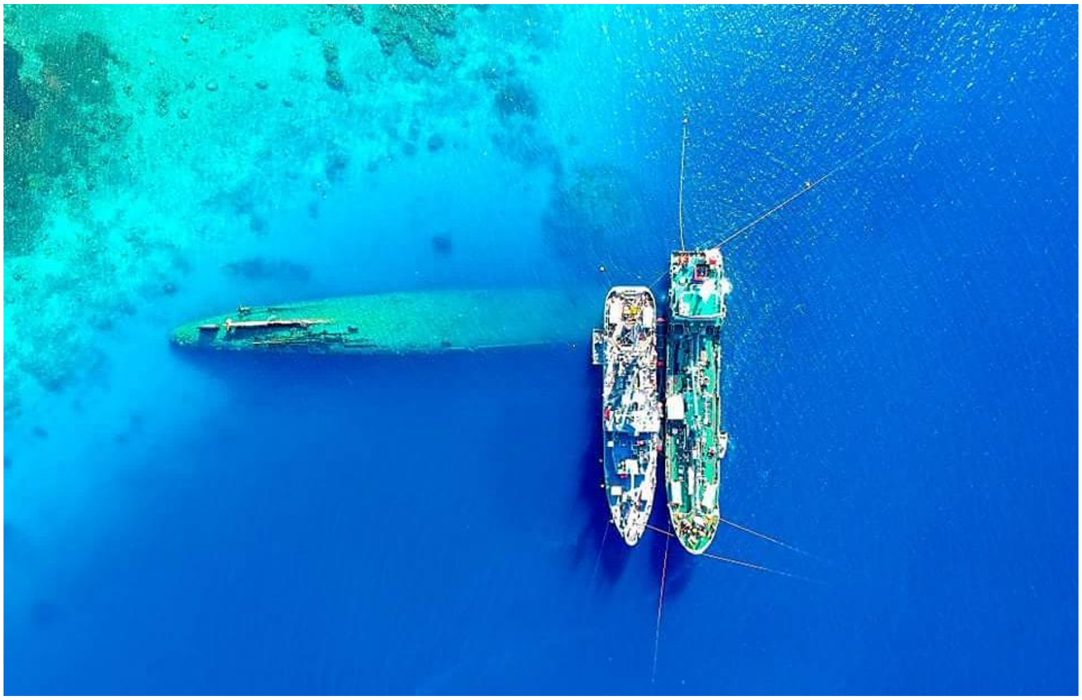

Figure O-6. Drone Shot - The USNS *SALVOR* and MT *HUMBER* Moored Together
(Photo Taken 4 September 2018)

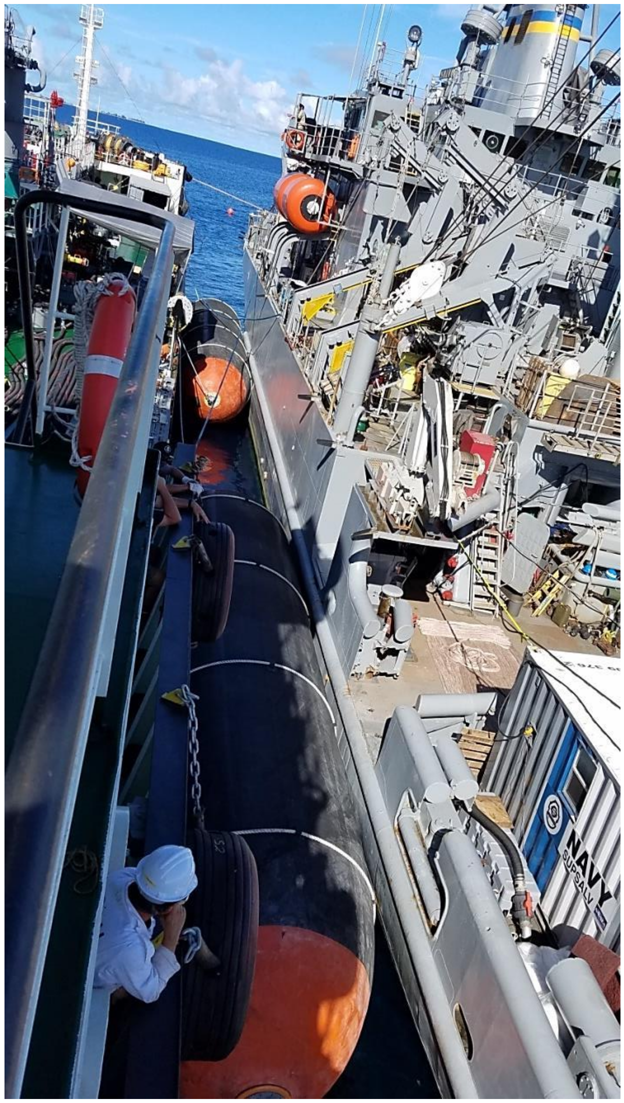


Figure O-7. Inflatable Fenders between the USNS *SALVOR* and MT *HUMBER*
(Photo Taken 5 September 2018)

Figure O-8.  MDSU-1 Divers Prep for Hull Cleaning and Hot Tap Operations
(Photo Taken 6 September 2018)

Figure O-9. Oil Receiving Station on the MT *HUMBER*
(Photo Taken 9 September 2018)

Figure O-10. Diver Installing Hot Tap on Flange in Section IV
(Photo Taken 9 September 2018)

Figure O-11. View of ex-USS *PRINZ EUGEN's* Stern from USNS *SALVOR* (Sorbent Boom and Buoys Supporting the Hydraulic Hose in the Water)
(Photo Taken 12 September 2018)

Figure O-12.  The USNS *SALVOR* and MT *HUMBER* Moored Together for Pumping Operations (Bird's Eye View)
(Photo Taken 13 September 2018)


Figure O-13.  View from Diver Camera on Monitor (at Diver Support Station)
(Photo Taken 16 September 2018)

Figure O-14. USNS *SALVOR* First Mate, using Radioactive Geiger Counter to Check for Radiation in the Oil
(Photo Taken 19 September 2018)

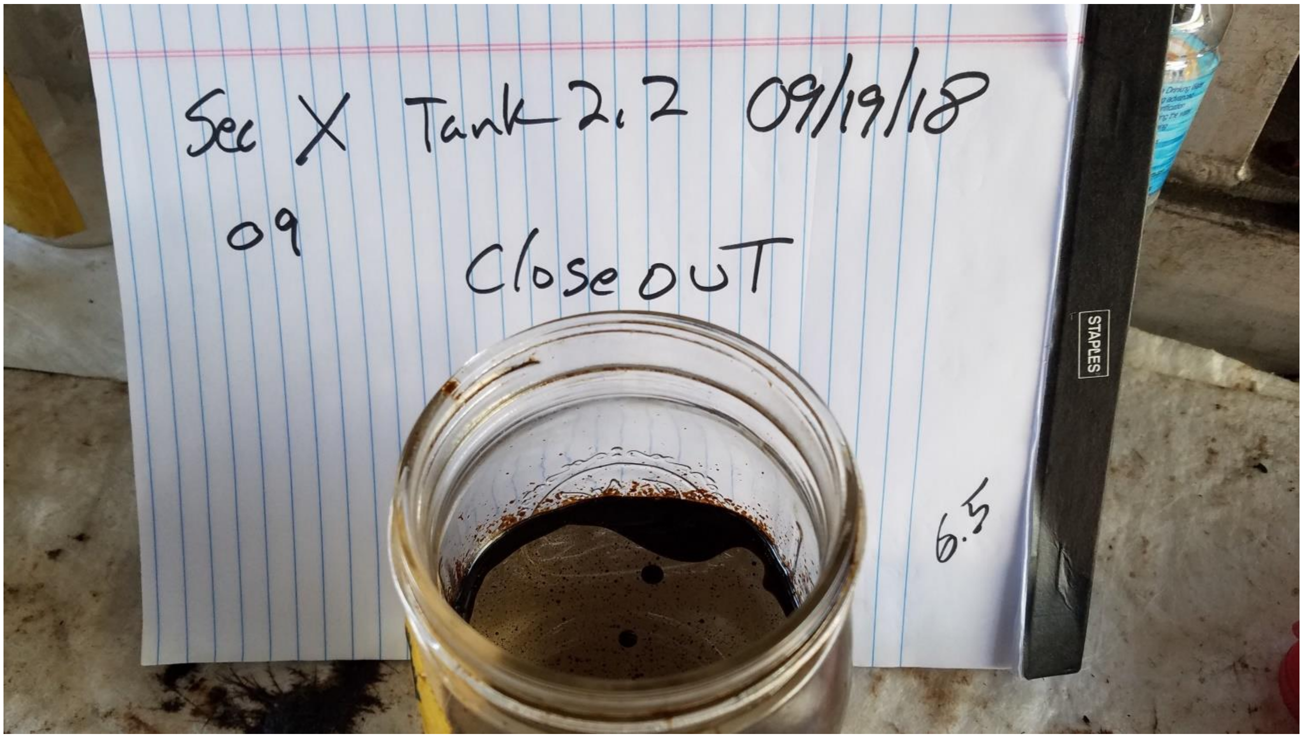


Figure O-15. Tank Stripping Indicator Samples
(Photos Taken 19 September 2018)

Figure O-16. The USNS *SALVOR* and MT *HUMBER* Moored Together for Pumping Operations (View from ex-USS *PRINZ EUGEN's* Rudder)
(Photo Taken 26 September 2018)

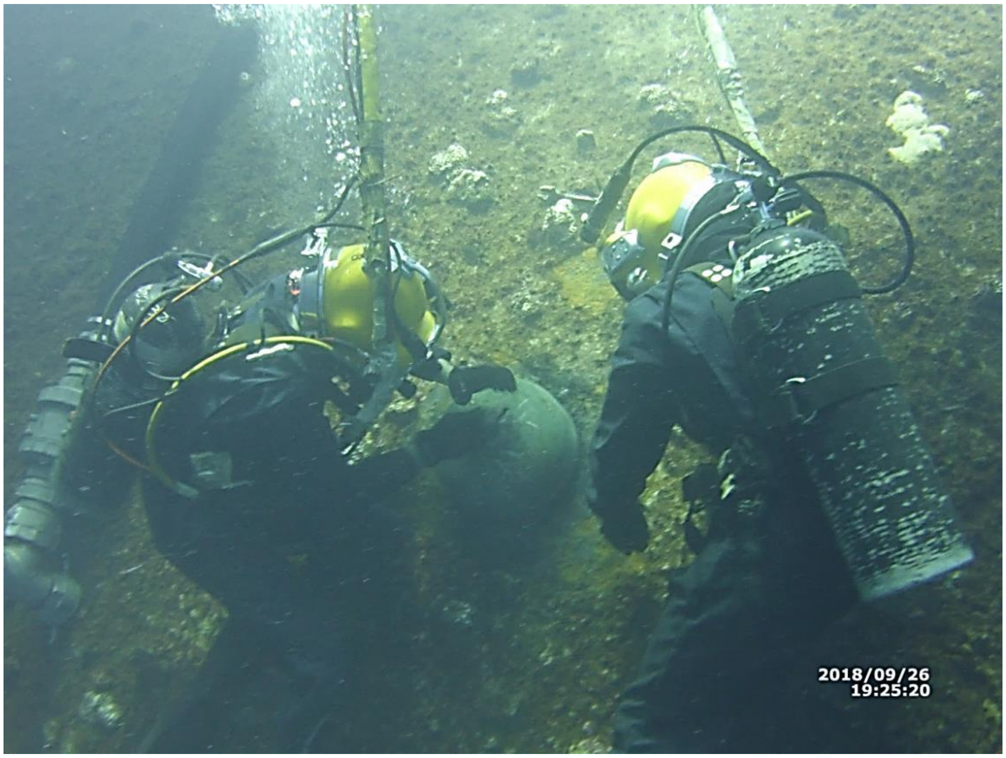


Figure O-17.  Dome Enclosure "Close-Out Cap" Installation over Hot Tap Location
(Photo Taken 26 September 2018)


Figure O-18.  Diver Staging Equipment
(Photo Taken 26 September 2018)

Figure O-19. Divers Installing Dome Enclosure Assembly on Wing Tank
(Photo Taken 26 September 2018)

Figure O-20. Port Side Looking Aft Along Bilge Keel Approximately Frame 76.75
(Photo Taken 27 September 2018)

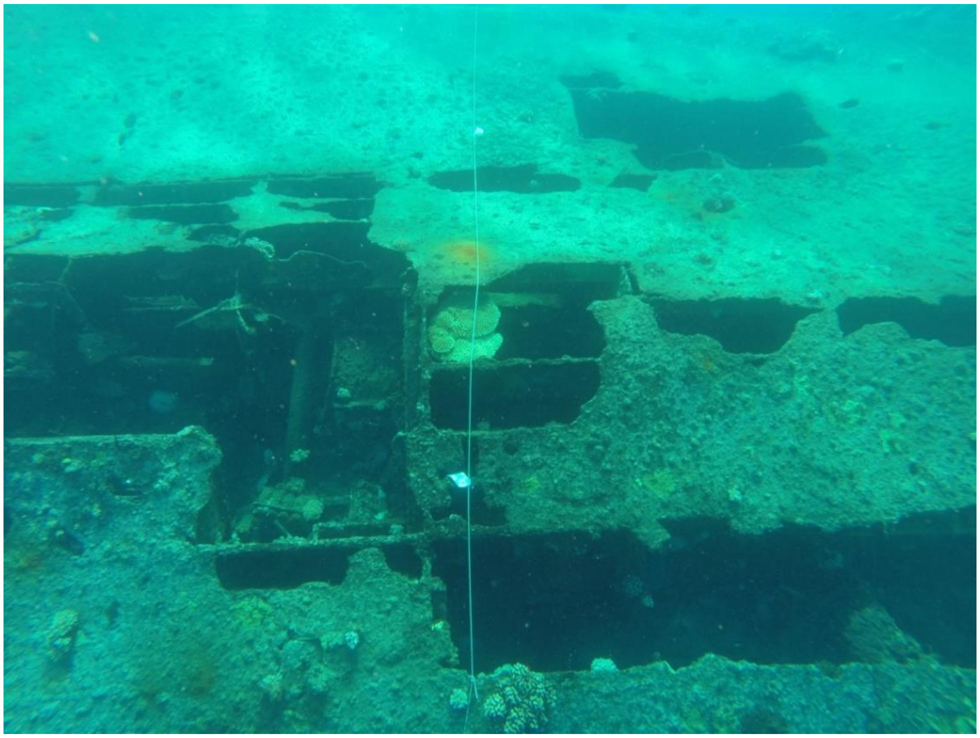

Figure O-21. View of Hull Wastage in Hull Section I and II
(Photo Taken 27 September 2018)

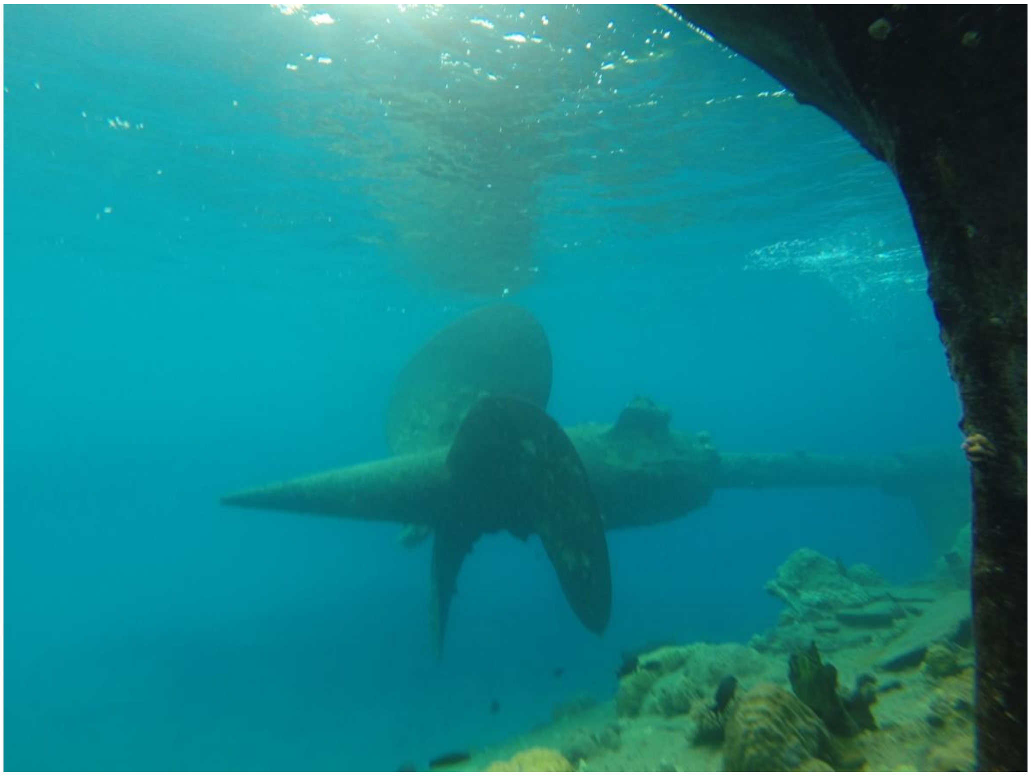

Figure O-22. Starboard Propeller
(Photo Taken 1 October 2018)

Figure O-23. Left to right: Richie Calupitan (ESSM/GPC), Richard German (ESSM/GPC), Craig Moffatt (ESSM/GPC Project Manager), and Stephanie Bocek (SUPSALV Representative), Examining Tank Samplings
(Photo Taken 6 October 2018)

Figure O-24. Typical Tank Close-Out Sample Showing Only Small Spots of Oil
(Photo Taken 6 October 2018)

Figure O-25. SUPSALV Representative Stephanie Bocek, ESSM/GPC Representatives Kevin Smith (Program Manager), Craig Moffatt (Project Manager), and MT *HUMBER* Crew
(Photo Taken 10 October 2018)

Figure O-26. The ESSM/GPC Team: Stephanie Bocek (SUPSALV Representative), Kevin Smith (ESSM Program Manager), Matt Wenner, Dan Suputski, Kenny Smith, Commander Dan Neveroski, Isidro Campus, Ron Worthington, Roy Ludi, Danny Shimmoko, Richard German, Richie Calupitan, Paul Schadow (shown in effigy) and Craig Moffatt (Project Manager), (Photo Taken 10 October 2018)


Figure O-27. SUPSALV, MDSU Dive Team, and ESSM/GPC Team
(Photo Taken 10 October 2018)


Figure O-28. 24′ Boom Handling Boat (BHB) Working as MDSU Dive Team Platform
(Photo Taken 11 October 2018)

Figure O-29. Healthy Marine Life around the Wreck of the ex-USS *PRINZ EUGEN*
(Photo Taken 15 October 2018)


Figure O-30. U.S. Army Heavy Lift Equipment Staging ESSM Equipment and Containers for Loading and Shipment during Demobilization
(Photo Taken 18 October 2018)